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The Long and Short-Term Effect of Social Media Manipulation on the NASDAQ Index

Çağrı ULU¹

Abstract

Social media's power to manipulate the financial markets has sparked significant debates, particularly regarding its impact on stock exchanges and cryptocurrency markets. This study investigates the influence of social media manipulation, specifically through Twitter, on the NASDAQ Composite index during its decline from December 1, 2021, to January 31, 2022. Utilizing daily data, the research emphasizes the direction of the relationship between Twitter sentiment and the NASDAQ index. Sentiment analysis, conducted using TextBlob, determines the positivity or negativity of the language used in tweets related to NASDAQ. The study tests the hypothesis of a long- and short-term relationship between the sentiment scores and the index. Time series analysis required ensuring stationarity, which was verified using modern and traditional unit root tests. Subsequently, an ARDL model was employed to examine these relationships. The findings reveal that social media manipulation via Twitter does not impact NASDAQ Composite prices in either the long or short term. Instead, price variations in the NASDAQ Composite index are significantly influenced by the sentiment expressed on Twitter.

Keywords: *Twitter, Sentiment Analysis, ARDL Bounds Test, NASDAQ.*



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1. INTRODUCTION

With the rapid advancement of technology, the profound impact of digitization has become increasingly evident, affecting not only social interactions but also key areas of the economy. While digitization offers numerous benefits, it also introduces significant challenges. Of particular importance is the role of social media, whose influence on the financial sector has been extensively examined (Chen et al., 2014; Zheludev et al., 2015). The manipulation of financial markets through social media platforms can often lead investors to make suboptimal decisions. Therefore, a comprehensive evaluation of multiple parameters is essential when making investment choices.

In response to these challenges, data mining techniques have been increasingly employed to enhance analytical capabilities in financial research. Traditional econometric methods alone may no longer be sufficient in this dynamic environment, highlighting the importance of monitoring patterns of human behavior. The widespread use of social media in finance offers unprecedented insights into investor sentiment and market dynamics.

Recent events, such as Elon Musk's involvement with Twitter and the cryptocurrency markets, underscore the profound impact of social media on financial markets. This study aims to investigate the long-term and short-term effects of manipulative activity on the NASDAQ Composite Index via Twitter. The analysis focuses on the period from December 1, 2021, to January 31, 2022—a time marked by significant fluctuations in the NASDAQ Composite following its peak. This timeframe provides an opportunity to examine the effectiveness of social media manipulation during market downturns.

This study seeks to determine whether the NASDAQ Composite Index is influenced by social media manipulation in both the short and long term, thereby contributing to the existing body of literature. While previous research in finance has primarily focused on time series and volatility analyses, exploring the relationship between stock price formation and sentiment analysis offers a novel perspective. What sets this study apart is its emphasis on the effects of manipulative social media activity—specifically Twitter sentiment—on the NASDAQ Composite Index. By integrating sentiment analysis with the ARDL econometric model, the research aims to provide empirical insights into the ways digital platforms shape investor behavior and market dynamics.

Methodologically, this study employs sentiment analysis of Twitter data (TSA) alongside an econometric analysis of the NASDAQ Composite Index (IXIC), with data sourced from Investing.com. To ensure the reliability of the data, stationarity tests—including the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests—were applied. Additionally, the Fourier Augmented Dickey-Fuller (FADF) test was used to validate the stationarity results and to account for potential structural breaks. The findings indicate that the TSA series is stationary at level $I(0)$, while the NASDAQ series is integrated of order one $I(1)$, thus justifying the application of the Autoregressive Distributed Lag (ARDL) Bounds Testing approach for further analysis.

The rapid advancement of digital technologies has significantly transformed not only social interactions but also the structure and behavior of financial markets. Within this digital landscape, social media platforms have emerged as powerful tools capable of shaping investor sentiment and, consequently, influencing market dynamics. While these platforms enhance access to information and promote market transparency, they also introduce challenges—particularly in the form of manipulative content that can mislead investors and undermine market efficiency.

Recent incidents—such as the influence of prominent individuals on asset prices through social media posts—have demonstrated how sentiment-driven narratives can shape financial decision-making. This development underscores the need for more robust analytical frameworks that move beyond traditional models, incorporating behavioral and sentiment-based approaches to better capture contemporary investment dynamics. In particular, platforms like Twitter have become valuable tools for gauging investor sentiment and identifying potential market manipulation. This study focuses on examining the effects of social media-driven sentiment on financial markets, with a specific emphasis on the NASDAQ Composite Index. By integrating Twitter-based sentiment analysis with econometric modeling, the research aims to determine whether manipulative activity on digital platforms has significant short- and long-term effects on market performance. In doing so, it contributes to the expanding literature on digital finance by providing empirical insights into the evolving interplay between online sentiment and financial market outcomes.

In conclusion, this study contributes to the existing body of literature by providing empirical insights into the relationship between Twitter sentiment and the NASDAQ Composite Index—an increasingly relevant connection for understanding investor behavior in the age of social media-driven financial markets.

2. LITERATURE SEARCH

Sentiment analysis, a subfield of Natural Language Processing (NLP), involves the computational assessment of human opinions and emotions expressed in written text. This technique has wide-ranging applications across various domains, including corporate marketing and sales, healthcare systems, and financial market analysis (Cristescu et al., 2022, p. 36).

The dynamic and complex nature of financial markets has challenged traditional analytical methods and opened new avenues for research. In recent years, the rapid growth of social media and digital transformation has elevated sentiment analysis in financial markets to a prominent research topic. Sentiment analysis involves examining the meaningful relationships between emotional and reactive data derived from big data sources—such as social media platforms—and financial asset prices and market movements.

Communication trends within communities are undergoing a significant transformation, as traditional communication mediums are increasingly being replaced by digital content and social media

platforms. National boundaries are becoming less distinct, facilitating a more interconnected flow of information. Research in this area plays a crucial role in understanding investor behavior in financial markets and in predicting price movements. News, comments, emotional reactions, and trends shared on social media serve as valuable sources for assessing their impact on financial asset prices. The application of sentiment analysis in financial markets offers market participants the ability to respond swiftly, update risk management strategies, and enhance decision-making processes.

The studies that attempt to explain the role of social media sentiment analysis in financial markets are as follows:

With evolving communication modes, academic studies examining the relationships between financial trends and social media reactions have gained considerable attention. Zhang et al. (2011) conducted pioneering research predicting stock market indicators such as the DJIA, NASDAQ, and S&P 500 through Twitter sentiment analysis. They found that emotionally charged tweets negatively correlated with these indices but positively correlated with the VIX. By categorizing certain words as negative or positive (e.g., “fear” or “hope”), their analysis of tweets from 2006 to 2010 revealed that expressions of fear and concern were associated with declines in these indices. Rao and Srivastava (2012) demonstrated the superior performance of Twitter sentiment analysis compared to traditional methods in forecasting market movements for major indices like the DJIA and NASDAQ-100. Analyzing sentiments from millions of tweets related to these indices and large-cap technology stocks between June 2010 and July 2011, they reported a high correlation—up to 0.88 for returns—between stock prices and Twitter sentiments. Their research underscores the significant impact of public sentiment on short-term market performance. Katsafados et al. (2023) employed Panel VAR and ARDL models to analyze the relationship between social media sentiment scores and financial variables including BEL-20, DAX-30, CAC40, FTSE-MIB, IBEX-35, FTSE, and S&P 500. Utilizing the VADER model for sentiment analysis, their findings suggest that positive sentiment is linked to short-term increases in stock prices, with positive emotions correlating with high returns and low volatility in the short term. Conversely, in English-speaking countries, an increase in negative emotions is inversely related to stock prices and exerts a long-term effect. Negative emotions are also associated with lower returns in the short term. Renault (2017) provides a comprehensive analysis of how small-cap fraudsters exploit Twitter by disseminating false or misleading stock information to artificially inflate prices, effectively orchestrating pump-and-dump schemes. Examining millions of tweets related to small-cap stocks, the study identifies patterns of suspicious sentiment spikes correlated with short-lived price surges. Renault emphasizes that, while social media can serve as a valuable informational tool, it also presents fertile ground for market manipulation, particularly affecting less transparent firms. Yang et al. (2024) critically assess the impact of aggregated Twitter sentiment on equity market efficiency. Utilizing high-frequency data, they measure efficiency through return autocorrelation and variance ratio metrics, finding that elevated social media sentiment on the previous day reduces market efficiency, evidenced

by increased predictable returns and volatility. They attribute this to intensified herding behavior, whereby traders collectively react to Twitter sentiment, thereby impeding optimal price discovery. Adams et al. (2023) constructed a real-time Twitter Financial Sentiment Index (TFSI) and demonstrated its predictive utility across various financial domains, including equity returns, credit spreads, and monetary policy surprises. Their findings indicate that declines in the TFSI often precede unexpectedly restrictive policy announcements and reliably forecast next-day stock returns. This research underscores Twitter's capacity to capture broad financial sentiment, influencing both investor behavior and macroeconomic expectations.

The studies that employ econometric modeling using a machine learning approach are as follows:

Kolasani and Assaf (2020) investigated the effectiveness of using Twitter posts to predict stock prices. By training various models on the Sentiment140 Twitter dataset, they found that Support Vector Machines (SVM) achieved the best performance in sentiment analysis, with an accuracy of 0.83. Their study focused on tweets containing keywords such as "stock market," "stocktwits," and "AAPL" to predict the stock prices of Apple Inc. and the Dow Jones Industrial Average (DJIA). They also employed a Multilayer Perceptron Neural Network model, concluding that while predicting indices posed challenges, tweets played a significant role in forecasting stock market movements. Harguem et al. (2022) focused on the NASDAQ 100, utilizing Twitter data to predict stock prices of companies worldwide. Their methodology involved classifying user tweets into optimistic, harmful, and neutral sentiments using the SVM machine learning algorithm with different kernels. The study achieved a maximum accuracy of 92% with the linear kernel and emphasized the importance of sentiment analysis in understanding the correlation between social media sentiment and stock market trends. Gaies et al. (2021) analyzed the relationship between the BMI Sensitivity Index and Bitcoin (BTC) prices using monthly data from August 2011 to July 2020. Employing Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) methods, they demonstrated that investors utilize the sensitivity index to predict BTC prices. The index also aids portfolio managers in determining short- and long-term investment strategies. In the broader literature, besides studies related to the NASDAQ, several other significant works employ similar analytical methods. For instance, Rajput et al. (2022) conducted a study using the Google Trends Sentiment Analysis Index, Bitcoin (BTC) prices, and USD exchange rate data from 2013 to 2018. They applied the ARDL method to investigate whether the Sentiment Analysis Index could predict BTC returns, trading volume, and volatility associated with BTC returns. Their findings indicated that the USD was negatively affected by BTC prices in both the short and long term. Furthermore, they highlighted the asymmetric effects of BTC sentiment on both BTC prices and fiat currency.

The other related econometric studies are as follows:

Chen (2022) examined the relationship between Bitcoin (BTC) prices, BTC mining data, and Google Trends data from February 7, 2016, to February 7, 2021, employing the Autoregressive Distributed Lag (ARDL) method. The study revealed that BTC prices responded more dramatically to changes in attitudes toward mining activities, especially after 2019, with the correlation between these variables strengthening over time. Gozbasi et al. (2021) analyzed monthly data from August 2010 to April 2021 to explore the relationship between BTC prices and the S&P 500 index. Using ARDL and Granger Causality tests, they found that BTC prices showed limited reaction to volatility in the commodity market, responding only to oil prices in the short term, while gold prices had no statistically significant effect on BTC prices. Furthermore, increases in crude oil prices negatively impacted BTC prices in the short term, with no significant long-term effect observed. Kjærland et al. (2018) investigated weekly data from September 8, 2011, to February 5, 2017, to understand the relationship between BTC prices, the S&P 500, and Google Trends. By employing ARDL and Least Squares methods, they discovered a significant and positive relationship between public interest in BTC—as measured by Google search volume—and BTC price fluctuations.

Collectively, these studies underscore the critical role of social media sentiment analysis in forecasting stock market trends. They demonstrate that emotions—both positive and negative—expressed on platforms like Twitter can exert significant short- and long-term effects on stock prices, highlighting social media as an increasingly influential external factor in financial decision-making. While prior research has employed various methodologies—such as ARDL models, machine learning algorithms, and sentiment indices—to explore the relationship between online sentiment and financial indicators, the majority focus on broad time horizons or general investor behavior.

This study differentiates itself by narrowing its focus to a highly specific and volatile timeframe, December 2021 to January 2022—a period marked by heightened uncertainty and substantial fluctuations in the NASDAQ Composite Index. By examining the short- and long-term impacts of potentially manipulative Twitter activity during this critical window, the study offers a time-sensitive and targeted contribution to the literature. Moreover, the integration of sentiment analysis with the ARDL bounds testing approach introduces a novel empirical framework for assessing whether sentiment-driven manipulation exerts statistically significant effects on market dynamics. In doing so, the study advances our understanding of investor behavior in the digital era and contributes meaningfully to the growing fields of behavioral finance and digital market efficiency. By focusing on a volatile and underexplored market phase, this research fills a notable gap in the literature and offers nuanced insights into the dynamic interplay between Twitter sentiment and the performance of the NASDAQ Composite Index.

3. DATA MINING AND SENSITIVITY ANALYSIS

Data mining is fundamentally the extraction of meaningful patterns from large datasets using methods such as classification, clustering, and association rule mining, and represents a crucial phase

within the broader knowledge-discovery paradigm (Pruengkarn et al., 2017; Solomon, 2014). A significant advancement in this domain is the incorporation of sensitivity analysis—especially global sensitivity analysis (GSA), which evaluates how uncertainty in input variables affects model outputs across their full distribution, quantifying input relevance via methods such as variance-based Sobol indices and screening tools like Morris’s method (Iooss & Lemaître, 2015; Saltelli et al., 2008). Recent literature demonstrates that GSA is beneficial in enhancing model interpretability and robustness within data mining workflows: for example, it has been utilized to identify influential pixel regions in neural network classifiers for MNIST digits and to benchmark different GSA techniques in feature-selection contexts (Sadeghi & Matwin, 2024; Yao, 2003). Integrating sensitivity analysis into data mining pipelines therefore supports a dual objective—not only revealing significant structural patterns but also quantifying the drivers of model behavior under uncertainty, which enables more transparent and dependable decision-making.

Sentiment analysis has become increasingly important for swiftly interpreting the growing volume of opinions shared on social media and other digital platforms. In recent years, the exponential rise in communication channels, digital content, air traffic, and alternative markets has generated an overwhelming amount of data—rendering traditional analytical methods insufficient. In response, researchers have developed high-efficiency techniques to process and analyze this information effectively. Sentiment analysis aims to accurately identify the polarity of textual data—positive, negative, or neutral—to support informed decision-making. The process typically involves five key steps: data collection, text preprocessing, sentiment detection, sentiment classification, and output presentation (Aqlan et al., 2019, p. 149). Sentiment modeling can be approached in three primary ways: dictionary-based models, machine learning models, and hybrid models. In this study, a dictionary-based model—TextBlob—is employed. TextBlob is a natural language processing (NLP) library in Python that simplifies textual data analysis, including sentiment detection. For the sentiment analysis conducted in this research, Python is used in conjunction with TextBlob. Underlying TextBlob is the Natural Language Toolkit (NLTK), an open-source NLP library that supports various tasks such as text classification, tokenization, part-of-speech tagging, parsing, stemming, and sentiment analysis (Natural Language Toolkit [NLTK], 2023).

Sensitivity analysis is presented as a time series and is assigned a value between -1 and +1 for the desired day, month, week, or year. When the obtained value approaches -1, it indicates a negative sentiment about the researched parameter, while approaching +1 signifies positive sentiments about the respective parameter.

In order to access sensitivity analysis, daily data was initially collected. For sensitivity analysis, the most liked 50 English tweets, using the NASDAQ hashtag, posted on Twitter between 01.12.2021 and 31.01.2022 were retrieved through the APIFY platform. Since the tweets between these dates couldn't be obtained using a Twitter developer account, they were collected from the internet using the

"Twitter URL Scraper" module within the APIFY application. The obtained tweets were daily converted into text documents and analyzed as a single daily text.

To perform sensitivity analysis, after obtaining the data, the text was prepared for analysis. The following steps were followed during the text cleaning process:

- Converting uppercase letters to lowercase: Uppercase letters in the text were converted to lowercase to ensure consistency in the analysis and facilitate data processing.
- Removing non-English words: Non-English words in the text were removed because they could introduce unwanted noise during the analysis.
- Removing unnecessary words in the stopword list: Using a list known as a stopwords list, which contains unimportant or meaningless words for text analysis, such words were removed from the text.
- Removing numbers: Numerical values in the text were removed as they were not necessary for sensitivity analysis.
- Removing special characters: Special characters in the text were removed to avoid unwanted effects on the analysis.
- Removing emoticons and emojis: Emoticons and emojis in the text were removed as they were not suitable for sensitivity analysis.
- Extracting single-word expressions: Expressions consisting of only a single word were removed from the text, as they were considered to contain insufficient information for analysis.
- Cleaning 'url' extensions indicating internet links: Internet links in the text were removed because they did not contribute to the content to be used in sensitivity analysis.
- Removing user names: User names in the text were removed as they did not contain important information for the analysis.
- Removing punctuation marks: Punctuation marks in the text were removed because they could introduce unnecessary noise during the analysis.
- Removing the NASDAQ hashtag: The NASDAQ hashtag in the text was removed as it was not suitable for the analysis purpose. After preparing the text for analysis and downloading the necessary Python libraries, sensitivity analysis results were obtained using the code created by us.

To contribute to the evaluation of the results, word frequency clouds were created from the cleaned text to visualize word frequency. The wordcloud library was used to create the word cloud, and it was visualized using the matplotlib library.

Figure 1. Word Clouds



Note: Left: Word cloud extracted from the given time period. Right: Word cloud that occurred on the last date of the index decline.

As shown in the left-hand figure, the word cloud generated from tweets containing the NASDAQ hashtag between December 1, 2021, and January 31, 2022, visually represents the most frequently used terms during this period. The size of each word indicates its frequency and relative prominence. Common terms include “market,” “stock,” “today,” “time,” “new,” and “day,” reflecting general discussions surrounding financial activities.

Understanding the sentiment surrounding the NASDAQ stock exchange is essential, and the word cloud should be interpreted in conjunction with the accompanying trend graph. The overall sentiment trajectory, as illustrated by the trend graph, appears predominantly positive throughout the broader time frame. However, the right-hand figure—depicting the word cloud from January 31, 2022, the date marking a notable decline—demonstrates a clear shift in tone. Terms such as “warning,” “worst,” and “fallen” signal a strong negative emotional response. This change is also reflected in the sentiment trend graph, which shows a distinct downturn, validating the alignment between textual sentiment and market developments.

This study adopts a mixed-methods approach by integrating Twitter Sentiment Analysis (TSA) with the Autoregressive Distributed Lag (ARDL) model to investigate the impact of social media sentiment on financial markets comprehensively. The justification for employing sentiment analysis lies in its capacity to capture the behavioral and psychological dimensions of investor activity, especially

within the context of social media. Twitter, as a widely utilized platform for financial discourse and speculation, offers a rich source of real-time sentiment data. TSA facilitates the quantification of investor mood, serving as a behavioral proxy in financial decision-making.

The ARDL model, in turn, was selected due to its ability to estimate both short- and long-run relationships between variables, even when the variables are integrated at different levels. In this study, stationarity tests—including the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Fourier ADF (FADF)—confirmed that the TSA series is stationary at level $I(0)$, while the NASDAQ Composite Index is integrated at first difference, $I(1)$. The ARDL bounds testing approach is particularly suitable for such data characteristics, enabling robust analysis without the need for pre-testing for cointegration.

By combining TSA with the ARDL framework, this study bridges the gap between behavioral finance and traditional econometric modeling. TSA provides a dynamic and timely measure of investor sentiment, whereas ARDL captures the causal impact of that sentiment on market movements over different time horizons. This integrated methodology enhances the explanatory power of the research and contributes to a deeper understanding of the complex interplay between investor psychology and financial market dynamics in the digital age.

4. ECONOMETRIC MODELING

When working with financial time series, ensuring stationarity is of paramount importance. In this study, both structural break-sensitive and structural break-insensitive unit root tests were employed to establish the stationarity of the series. The following unit root tests were used:

1. The Phillips-Perron Unit Root Test: Developed by Phillips and Perron in 1988, the Phillips-Perron Unit Root Test, also known as the PP test, ensures stationarity without allowing for structural breaks (Phillips & Perron, 1988).

2. The Augmented Dickey Fuller Unit Root Test: Another commonly used test for determining stationarity, the Augmented Dickey Fuller (ADF) Unit Root Test, was developed by Dickey and Fuller (1981).

3. The Flexible Fourier Form Dickey-Fuller Unit Root Test (FADF): Allowing for structural breaks, the FADF, also known as The Flexible Fourier Form Dickey-Fuller Unit Root Test, was developed by Enders and Lee (2012).

Following the unit root tests, an additional analysis was conducted using the Autoregressive Distributed Lag Bounds Test (ARDL), also known as the ARDL model, developed by Pesaran et al. (2021). The results were discussed in both the short and long terms.

4.1. Dataset and Methodology

Numerous studies have been conducted on time series data, and the approaches to studying the parameters of a series vary. In this study, the variables used are the NASDAQ index and sentiment

analysis values of tweets posted with the NASDAQ hashtag. The table below shows the variables and their sources used in the study:

Table 2. Variables and Sources

Variables	Explanations	Sources
NASDAQ Composite Index	IXIC	Investing
TSA	Sentiment Analysis Results of the 50 Most Popular Daily Tweets Posted with the NASDAQ Hashtag	Twitter, APIFY

The descriptive statistics of the variables under analysis are displayed in the following table:

Table 3. Descriptive Statistics

	TSA	NASDAQ
Mean	0.089378	15,031.61
Median	0.099647	15,198.89
Maximum	0.335714	15,895.20
Minimum	-0.214286	13,436.71
Std. Dev.	0.101074	714.5402
Skewness	-0.192790	-0.953296
Kurtosis	4.063246	2.807186
Jarque-Bera	3.304506	9.486703
Probability	0.191618	0.008709
Obs.	62	62

Table 3 provides descriptive statistics for the Twitter Sentiment Analysis (TSA) variable and the NASDAQ index based on 62 observations. The mean value of TSA is 0.0894, indicating a slight predominance of positive sentiment, while the NASDAQ index has a considerably higher mean of 15,031.61, reflecting its scale. TSA exhibits lower volatility with a standard deviation of 0.1011 compared to 714.54 for NASDAQ. Both variables are negatively skewed, with TSA (-0.1928) being closer to symmetry than NASDAQ (-0.9533). The kurtosis values suggest that TSA (4.0632) is more leptokurtic than NASDAQ (2.8072), implying heavier tails in its distribution. The Jarque-Bera test statistic further reveals that TSA does not significantly deviate from normality ($JB = 3.3045$, $p = 0.1916$), whereas NASDAQ shows a statistically significant departure ($JB = 9.4867$, $p = 0.0087$). Overall, TSA displays more stable and near-normal distributional characteristics compared to the NASDAQ index.

Following the descriptive statistics, the correlation matrix between variables is displayed in Table 4.

Table 4. Correlation Matrix between TSA and NASDAQ

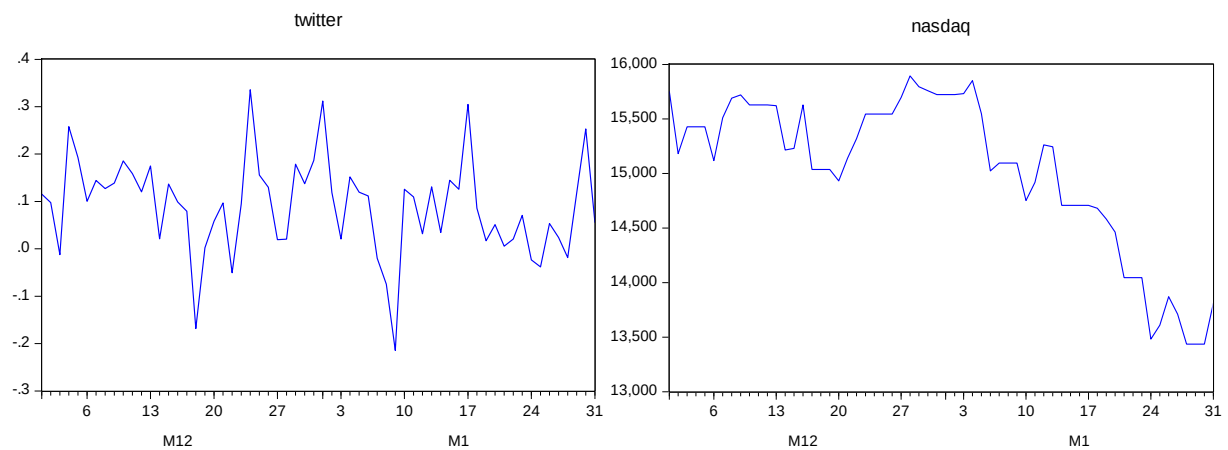
	TSA	NASDAQ
TSA	1.000000	

NASDAQ	0.274013	1.000000
Prob.	0.0312	-----

As can be seen, there is a statistically significant positive relationship between NASDAQ and TSA at a 5% significance level. Despite the coefficient being positive, its value of 0.27 (closer to 0) indicates that the relationship is weak.

Before conducting unit root tests, the trend charts of the variables within the selected period are as shown in the following figures:

Figure 2. TSA and NASDAQ Trend Charts



As can be observed from the figures, the TSA variable has shown a fluctuating trend over time. When examining the trend graph of the NASDAQ index over the selected time period, it is observed that it provided a stable return in the mid-term. However, a decline is noted after the mid-term period.

4.2. Results of Unit Root Tests Allowing and Not Allowing Structural Breaks

Stationarity plays a critical role in time series analysis, as the direction and methodology of the study are largely determined by the outcomes of stationarity tests. In the initial stage of this research, traditional unit root tests that do not account for structural breaks were employed. Specifically, the Augmented Dickey-Fuller (ADF) test, developed by Dickey and Fuller (1979), and the Phillips-Perron (PP) test, introduced by Phillips and Perron (1988), were utilized to examine the stationarity properties of the variables. The test results for the NASDAQ variable are presented in Table 5.

Table 5. Traditional Unit Root Test Results for NASDAQ and TSA

PHILLIPS PERRON UNIT ROOT TEST				
	<u>At level</u>			
Constant	t-Statistic	LOGNASDAQ	TSA	
	Probability			
Constantand Trend	t-Statistic			
	Probability			
None	t-Statistic			
	Probability			
	<u>1st difference</u>			
Constant	t-Statistic	d(LOGNASDAQ)	d(TSA)	
	Probability			
Constant and Trend	t-Statistic			
	Probability			
None	t-Statistic			
	Probability			
AUGMENTED DICKEY-FULLER UNIT ROOT TEST				
	<u>At level</u>			
Constant	t-Statistic	LOGNASDAQ	TSA	
	Probability			
Constant and Trend	t-Statistic			
	Probability			
None	t-Statistic			
	Probability			
	<u>1st difference</u>			
Constant	t-Statistic	d(LOGNASDAQ)	d(TSA)	
	Probability			
Constant and Trend	t-Statistic			
	Probability			
None	t-Statistic			
	Probability			

Note: *, **, *** respectively represent significance levels of 10%, 5%, and 1%.

The traditional unit root tests conducted on the NASDAQ series indicate that the variable is non-stationary at level. However, upon taking the first difference, the series becomes stationary at the 1% significance level according to both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)

tests. The results of the same unit root tests applied to the Twitter Sentiment Analysis (TSA) variable are presented in Table 5.

When examining the results of unit root tests applied to TSA, it is noticeable that the series achieves stationarity in level values. However, to ensure the robustness of unit root tests, it was decided to apply the FADF test developed by Enders and Lee (2012), which belongs to the modern school of thought and allows for structural breaks.

As known, for the FADF test to be valid, certain conditions must be met. Firstly, a new model is constructed by taking the first differences of the series.

Table 6. FADF Unit Root Test Results

Series	Min. KKT	k	FADF
NASDAQ	2,858,952	1	3.353617 (2)
TSA	0.505567	3	3.554876 (-)

Note: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels. The values in parentheses are the optimal lag lengths.

Here, the "k" values are used to determine the "total sum of squares" and to find the appropriate frequency range. This formulation, established in the EViews 10 program, resulted in finding different frequencies of suitability for the two series. The optimal frequency range for NASDAQ index was found to be "1", while for TSA, it was found to be "5". Another essential assumption of FADF is to calculate the appropriate lag length after determining the frequency range.

In the Augmented Dickey-Fuller (ADF) or Flexible ADF (FADF) unit root test, the appropriate lag length is crucial to ensure that the error term is white noise. The test regression includes lagged differences of the dependent variable to address serial correlation, and the optimal number of lags (p) can be determined using various information criteria. Commonly employed criteria include the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SIC/BIC), and the Hannan-Quinn Criterion (HQ), each minimizing a function that penalizes the residual variance based on the number of estimated parameters and sample size. The formulas for these criteria are:

$$AIC(p) = \ln(\sigma^2) + \frac{2k}{T}$$

$$BIC(p) = \ln(\sigma^2) + k \cdot \ln(T)/T$$

and

$$HQ(p) = \ln(\sigma^2) + 2k \cdot \ln(\ln(T))/T$$

where σ^2 denotes the estimated variance of residuals, k is the number of parameters, and T is the sample size (Lütkepohl, 2005).

In our study, lag length could not be calculated for any value. It is stated that the ADF unit root test results are valid because the series does not meet the FADF assumptions. According to these results, NASDAQ is stationary at I(1), and TSA is stationary at I(0).

The presence of stationarity at different orders of integration is essential for econometric modeling. Therefore, since the series exhibit stationarity at varying integration levels, the application of the ARDL model is considered appropriate for this study.

4.3. Application of the ARDL Model to the Time Series Data

The ARDL boundary test developed by Pesaran et al. (2001) is a commonly used analytical model in time series analysis, particularly when there are different levels of stationarity. The purpose of establishing the model is to determine the presence or absence of a cointegration relationship among the series. If cointegration exists, short and long-term coefficients of the series are estimated.

The model we have established meets all the requirements of the ARDL boundary test. The Akaike information criterion was selected, and the coefficient of the covariance matrix, as well as the problem of changing variance and autocorrelation, were addressed using the Heteroskedasticity and Autocorrelation Consistent Covariance (HAC) estimators developed by Newey and West (1987). The appropriate lag order for building the ARDL model was determined to be 1 shown at table 7, based on the Akaike information criterion.

Table 7. Lag Length Criteria for Bound Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	142.7996	NA	2.45e-05	-4.940338	-4.868652	-4.912478
1	212.2755	131.6384*	2.47e-06*	-7.237735*	-7.022677*	-7.154157*
2	213.3711	1.999152	2.73e-06	-7.135830	-6.777400	-6.996532
3	216.5349	5.550357	2.82e-06	-7.106486	-6.604684	-6.911469
4	221.5574	8.459079	2.73e-06	-7.142366	-6.497192	-6.891629
5	225.4439	6.272868	2.75e-06	-7.138382	-6.349836	-6.831926

According to the model established in the E-Views 10 program, the suitable model is estimated as ARDL(1,0). The table below shows the F-statistic value and criteria found for the ARDL(1,0) model.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta \lambda_t + \varepsilon_t$$

$$NASDAQ_t = \alpha_0 + NASDAQ_{t-1} + \beta TSA_t + \varepsilon_t$$

For the bounds testing procedure, the following hypotheses are tested to determine the existence of a long-term relationship:

$$H_0 : \alpha_1 = \beta = 0 \text{ (There is no relationship among the variables)}$$

$$H_1 : \alpha_1 \neq \beta \neq 0 \text{ (There is a relationship among the variables)}$$

Table 8. ARDL(1,0) F-Statistic and Critical Values

Model	k	M	F-Statistic	Significance Level	Lower Bound	Upper Bound
ARDL(1,0)	1	4	17.8153***	%10	4.175	4.93
				%5	5.13	5.98
				%1	7.32	8.435

Note: M represents the maximum number of lags, k denotes the number of explanatory variables, and *** signifies the 1% significance level.

The critical values used for the lower and upper bounds were taken from Table CI(ii) in the study conducted by Pesaran et al. (2001, p. 300). As can be seen from the table, the F-statistic value of the model is 17.81, which exceeds both the lower and upper bounds of the critical values at the 10%, 5%, and 1% significance levels. The model is found to be statistically significant at the 1% level. This indicates the presence of a cointegration relationship between the dependent and independent variables. Based on these results, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. However, it is essential to validate the hypothesis through appropriate diagnostic tests to ensure the robustness and reliability of the model.

Table 9. Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test	0.406357 (0.6464)
Normality Test	3.608000 (0.164639)
Heteroskedasticity Test: Breusch-Pagan-Godfrey Test	0.814114 (0.4348)
Ramsey RESET Test	0.420381 (0.5194)

Note: The values in parentheses represent the probability (p) values of the diagnostic tests.

The probability (p) values exceeding 0.05 indicate that there is no statistically significant issue with the specification of the model.

The Breusch-Godfrey Serial Correlation LM Test yielded a test statistic of 0.406357 with a corresponding p-value of 0.6464. Since the p-value exceeds conventional significance levels (e.g., 0.05), the null hypothesis of no serial correlation cannot be rejected, indicating that the residuals do not exhibit autocorrelation.

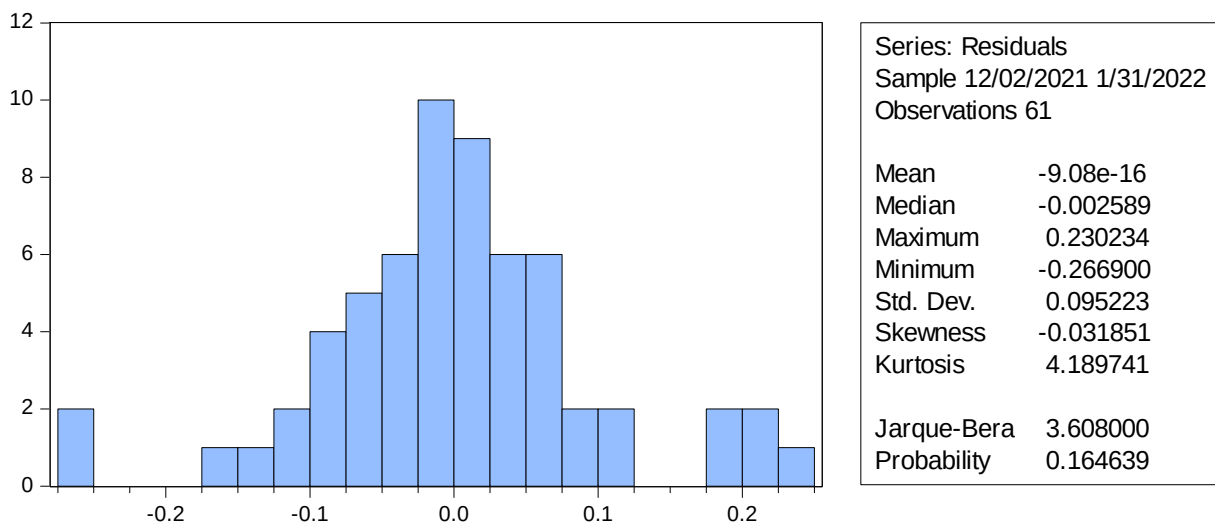
The Normality Test (Jarque-Bera) produced a test statistic of 3.608000 and a p-value of 0.164639. As the p-value is greater than 0.05, the null hypothesis of normally distributed residuals is not rejected, supporting the assumption of normality in the model's error terms.

The Breusch-Pagan-Godfrey Test for heteroskedasticity returned a test statistic of 0.814114 with a p-value of 0.4348. This result suggests that the null hypothesis of homoskedasticity cannot be rejected, indicating constant variance in the residuals and the absence of heteroskedasticity.

Finally, the Ramsey RESET Test statistic is 0.420381 with a p-value of 0.5194. Since the p-value is well above the 0.05 threshold, the null hypothesis that the model is correctly specified cannot be rejected, implying that the functional form of the model is appropriate.

The significant F-statistic allows for the interpretation of coefficients for both short and long-term relationships after confirming the assumptions of the ARDL model. The absence of autocorrelation, model specification error, and changing variance issues is essential for interpreting these coefficients in the model. In the autocorrelation test, the probability value is found to be 0.94, which is greater than 0.01, suggesting the absence of an autocorrelation problem. The result of the normality test applied to the model is as follows:

Figure 3. Normality Test of the ARDL Model

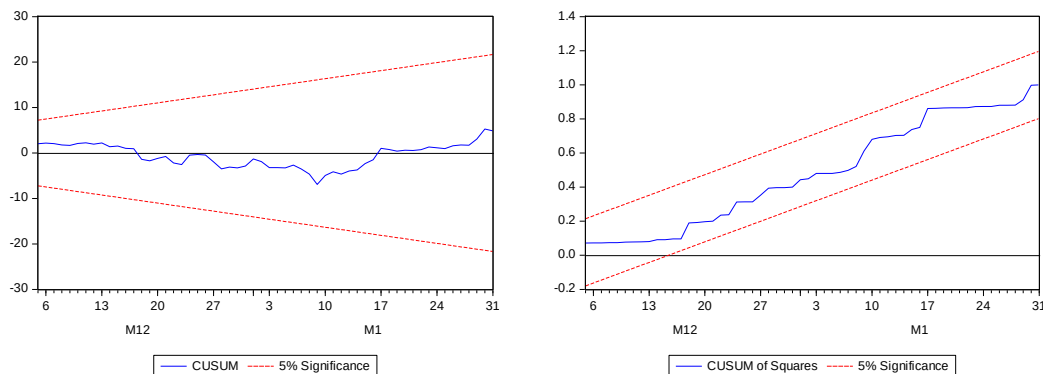


In the normality assumption, the probability value (0.16) is greater than 0.01, confirming the normality assumption. The histogram of residuals illustrates the distribution of the error terms from the model over the sample period spanning from December 2, 2021, to January 31, 2022, comprising 61 observations. The residuals exhibit a near-symmetric distribution with a mean value effectively equal to zero (mean = -9.08×10^{-16}), indicating an unbiased estimation. The median residual is slightly negative at -0.002589, reinforcing the central tendency close to zero. The spread of the residuals is moderate, with a standard deviation of 0.095223, and the residuals range between a minimum of -0.266900 and a maximum of 0.230234. Skewness is minimal at -0.031851, suggesting a near-symmetric distribution of residuals without significant asymmetry. However, the kurtosis value of 4.189741 indicates a leptokurtic distribution, implying a slightly heavier tail compared to the normal distribution. The Jarque-Bera test statistic is 3.608 with an associated p-value of 0.164639, which exceeds conventional significance thresholds (e.g., 0.05). Consequently, the null hypothesis of normality cannot be rejected, supporting

the assumption that residuals are normally distributed. Overall, the residual diagnostics suggest that the model residuals meet the assumptions of unbiasedness, homoscedasticity, and approximate normality, reinforcing the adequacy of the model specification for the analyzed sample period.

As seen, three assumptions of the ARDL test have been tested, and there are no issues found for model establishment. However, to enhance reliability and to determine whether there is a structural break in the model, the CUSUM test developed by Brown et al. (1975) has been applied, and the results are as shown in the following figure:

Figure 4. CUSUM and CUSUM of Square Chart



According to the CUSUM and CUSUM of Squares test, the coefficients move within the critical values, indicating the absence of structural breaks. Therefore, no dummy variable is required.

Once the ARDL assumptions are met, the long and short-term coefficients of the model can be interpreted. The tables below show the long and short-term coefficients of the NASDAQ and TSA series:

Table 10. ARDL Long-Term Coefficients

Variables	Co-eff.	Standard Error	t-Statistic	Prob.
LOGNASDAQ	0.566055	0.315371	1.794888	0.0779
C	-4.084255	2.564396	-1.592677	0.1167

When examining the probability values in the long term, the coefficient for NASDAQ is statistically significant at the 10% significance level. However, the coefficient has a positive sign, indicating that the impact of NASDAQ prices on TSA is positive. The probability value of the long-term coefficient falling between 5% and 10% is significant for the series' validity. However, a positive coefficient can always be interpreted. The coefficient of LOGNASDAQ is estimated at 0.566, with a standard error of 0.315. The corresponding t-statistic is 1.79, indicating marginal statistical significance at the 10% level ($p = 0.0779$). This suggests that a one-unit increase in the logarithm of the NASDAQ index is associated with an approximate 0.566 unit increase in the dependent variable, although the evidence is not strong enough to confirm this relationship at conventional 5% significance levels. The formula for the established long-term relationship is as follows:

$$TSA = (0.5661 * LOGNASDAQ)$$

Table 11. ARDL Short-Term Coefficients

Variables	Co-eff.	Standard Error	t-Statistic	Prob.
C	-4.084255	0.678353	-6.020842	0.0000***
ECT _{t-1}	-0.762766	0.126697	-6.020375	0.0000***

Not: *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels, and ECT_{t-1} represents the "Error Correction Term."

The functioning of the error correction term has significant importance for the model. For the error correction term to function correctly, its coefficient should have a negative sign and its probability value should be significant at 0.01. In the established model, the coefficient is -0.76, and the probability value is 0.00. Therefore, the model is considered to be correct.

The Error Correction Term (ECT) indicates whether the deviations in the dependent variable caused by past data are corrected by the independent variable in the long run. In other words, it shows whether the independent variable has a long-term effect on restoring equilibrium following shocks that lead to deviations from the mean in the dependent variable. The magnitude of the ECT coefficient reflects the strength of the error correction mechanism. When looking at the coefficient of the error correction term, it indicates that any long-term deviation between the variables is corrected by 76% in the following period. It can be interpreted that the gap is closed in the next period.

The R-squared value indicates the explanatory power of the model. The adjusted R-squared value reveals that 37% of the variation in TSA is explained. Considering the probability value of the F-statistic, which is less than 0.01, the model is deemed significant.

5. CONCLUSION AND DISCUSSIONS

Within the framework of the ARDL model, the roles of the dependent and independent variables were reversed in the study. Since the Twitter Sentiment Analysis results were found to have no significant effect on the NASDAQ index in both the long and short term, this finding was not reported.

This study examined the presence of both long- and short-term relationships between TSA and NASDAQ trends. The econometric analyses indicated that while the coefficients were not significant in the long term, a positive relationship was found in the short term. To determine the direction of this relationship, the roles of the dependent and independent variables were reversed. When NASDAQ was the dependent variable and TSA the independent variable, no significant relationship was detected. This implies that tweets containing the NASDAQ hashtag may not directly influence NASDAQ trends, either positively or negatively. However, when TSA was the dependent variable and NASDAQ the independent variable, it was observed that changes in the NASDAQ index affected Twitter activity in the short term. This suggests that Twitter activity referencing NASDAQ does not directly impact NASDAQ index movements. Conversely, in this second model, significant relationships were identified. The error correction term was significant in the short term, indicating a robust model fit, and a 1% increase in the NASDAQ index corresponded to a 0.56% increase in Twitter popularity in the long term.

These results imply that changes in the NASDAQ index influence Twitter discussions related to NASDAQ, particularly over longer periods. These findings are consistent with existing literature highlighting the impact of market movements on social media sentiment (Harguem et al., 2022), while challenging studies that posit the reverse causality from Twitter sentiment to market performance (Rao & Srivastava, 2012; Zhang et al., 2011). Our results emphasize the importance of considering the directionality of influence when analyzing social media and financial market interactions.

The literature contains studies on stock indices and sentiment analyses, primarily focusing on investor behavior. Similar to the findings of Harguem et al. (2022), this study underscores the influence of market movements on social media sentiment, reinforcing the interconnectedness between financial indices and social media activities. However, this study adds a different dimension by changing the dependent variable. Consequently, it was found that the NASDAQ Twitter popularity does not affect the index price in the short or long term. However, it was determined that changes in the index price influence Twitter activity. This finding challenges the assumptions of Zhang et al. (2011), who found emotional tweets correlated with stock indices, and by Rao and Srivastava (2012), who highlighted the impact of Twitter sentiments on market performance. Our findings accept the relation between TSA and NASDAQ index but the independent variable should be NASDAQ. Kolasani and Assaf (2020) specifically analyzed the movements of certain technology stocks. The relationship between Twitter activity and stock prices may vary across different sectors. However, Kolasani and Assaf's work is significant for evaluating the performance of the SVM model in NLP studies. In our study, the focus on NASDAQ stocks resulted in different findings. In these aspects, the study diverges from the existing literature and is open to further development.

Based on the findings of this study, which indicate that Twitter sentiment does not exert a significant long- or short-term influence on NASDAQ index pricing, but rather is itself shaped by fluctuations in the index, several policy implications emerge. Regulators and market participants should reconsider the presumed causality between social media sentiment and financial market performance. Efforts aimed at monitoring or controlling market volatility through sentiment analysis may yield limited effectiveness if sentiment primarily reacts to, rather than drives, market movements. Therefore, instead of allocating extensive resources to sentiment-based forecasting models for stock indices, attention should be directed towards enhancing investor education and transparency in financial communications. Furthermore, platforms like Twitter could be encouraged to improve the contextual labeling of financial content to help users better interpret emotionally charged or reactive posts that emerge during periods of heightened market activity. The relationship between investor sentiment and stock market indices, as explored in this study, can be effectively framed within the broader context of behavioral finance and the Efficient Market Hypothesis (EMH). While EMH assumes that asset prices fully reflect all available information, behavioral finance highlights systematic biases and irrational behavior that may cause deviations from fundamental values. The influence of social media sentiment, particularly manipulative

or emotionally charged content, represents a behavioral anomaly that challenges the assumptions of market efficiency. By incorporating Twitter-based sentiment analysis into an ARDL framework, this study contributes to the understanding of how psychological factors and information dissemination through digital platforms can affect price formation and market dynamics. Thus, the findings offer empirical support to behavioral finance theories, suggesting that in certain periods—especially during market corrections—investor sentiment significantly impacts index performance, potentially leading to temporary inefficiencies in the market. If a single conclusion is to be drawn from this study, it is that investors should avoid making decisions based solely on social media manipulations and instead engage in comprehensive and evidence-based analyses. Relying on rigorous research rather than sentiment-driven content can lead to more rational and informed investment strategies.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Adams, T., Ajello, A., Silva, D., & Vazquez-Grande, F. (2023). *More than words: Twitter chatter and financial market sentiment*. (FEDS Working Paper No. 2023-034). <https://doi.org/10.17016/FEDS.2023.034>
- Aqlan, A. A. Q., Manjula, B., & Naik, R. L. (2019). *A study of sentiment analysis: Concepts, techniques, and challenges*. In N. Chaki, N. Devarakonda, A. Sarkar, & N. C. Debnath (Eds.), *Proceedings of the International Conference on Computational Intelligence and Data Engineering (Lecture Notes on Data Engineering and Communications Technologies, Vol. 28, pp. 147–162)*. Springer. https://doi.org/10.1007/978-981-13-6459-4_16
- Brown, R. L., Durbin, J. & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Royal Statistical Society*, 37(2), 149-192.
- Chen, N. (2022). Bitcoin price and miner behavior an application of ARDL model. *Journal of Financial Studies & Research*, 1-16.
- Chen, H., De, P., Hu, Y. J., & Hwang, B. H. (2014). Wisdom of crowds: The value of stock opinions transmitted through social media. *The Review of Financial Studies*, 27(5), 1367–1403. <https://doi.org/10.1093/rfs/hhu001>
- Cristescu, R., Nebozhyn, M., Zhang, C., Albright, A., Kobie, J., Huang, L., Zhao, Q., Wang, A., Ma, H., Cao, Z. A., Morrissey, M., Ribas, A., Grivas, P., Cescon, D. W., McClanahan, T. K., Snyder, A., Ayers, M., Lunceford, J., & Loboda, A. (2022). Transcriptomic determinants of response to pembrolizumab monotherapy across solid tumor types. *Clinical Cancer*, 28(8), 1680-1689. <https://doi.org/10.1158/1078-0432.CCR-21-3329>

- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366), 427–431. <https://doi.org/10.1080/01621459.1979.10482531>
- Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49(4), 1057–1072.
- Enders, W. & Lee, J. (2012). The flexible Fourier form and Dickey–Fuller type unit root tests. *Economics Letters*, 117(1), 196-199.
- Gaies, B., M. S. Nakhli, J. M. Sahut & Guesmi, K. (2021). Is Bitcoin rooted in confidence? – Unraveling the determinants of globalized digital currencies. *Technological Forecasting & Social Change*, 172, 1-11.
- Gozbasi, O., Altinoz, B., Sahin, E. E. (2021). Is Bitcoin a safe haven? A study on the factors that affect Bitcoin prices. *International Journal of Economics and Financial Issues*, *Econjournals*, 11(4), pp. 35-40.
- Harguem S., Chabani, Z., Noaman, S., Amjad, M., Alvi, M. B., Asif, M., Mehmood, M. H. & Al-kassem, A. H. (2022). Machine learning based prediction of stock exchange on NASDAQ 100: A Twitter mining approach. *2022 International Conference on Cyber Resilience (ICCR)* Dubai, United Arab Emirates.
- Iooss, B., & Lemaître, P. (2015). A review on global sensitivity analysis methods. In G. Dellino & C. Meloni (Eds.), *Uncertainty Management in Simulation-Optimization of Complex Systems* (pp. 101–122). Springer. https://doi.org/10.1007/978-1-4899-7547-8_5
- Katsafados, A.G., Nikoloutsopoulos, S. & Leledakis, G. N. (2023). Twitter sentiment and stock market: A COVID-19 analysis. *Journal of Economic Studies*, 50(8) <https://doi.org/10.1108/JES-09-2022-0486>.
- Kjærland, F., Meland, M., Oust, A. & Øyen, V. (2018). How can Bitcoin price fluctuations be explained?. *International Journal of Economics and Financial Issues*, 8(1), 323-332.
- Kolasani S. V., Assaf, R. (2020) Predicting stock movement using sentiment analysis of Twitter feed with neural networks. *Journal of Data Analysis and Information Processing*, (8), 309-319
- Lütkepohl, H. (2005). New introduction to multiple time series analysis. Springer. <https://doi.org/10.1007/978-3-540-27752-1>
- Newey, W. K. & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703–708.
- Natural Language Toolkit. (2023, April 19). Documentation. <https://www.nltk.org/>.
- Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.
- Phillips C. B. P. & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335-346.
- Pruengkarn, R., Wong, K. W., & Fung, C. C. (2017). A review of data mining techniques and applications. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, 21(1), 31–58.
- Rajput, S.K.O., Soomro I. A. & Soomro, N. A. (2022). Bitcoin sentiment index, Bitcoin performance and US Dollar exchange rate. *Journal of Behavioral Finance*, 23(2), 150-165.
- Rao T. & Srivastava, S. (2012). Analyzing stock market movements using Twitter sentiment analysis. In *2012 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, (pp. 119–126). IEEE. <https://doi.org/10.1109/ASONAM.2012.30>
- Renault, T. (2017). Market manipulation and suspicious stock recommendations on social media. *SSRN Electronic Journal*. <http://dx.doi.org/10.2139/ssrn.3010850>
- Sadeghi, Z., & Matwin, S. (2024). *A review of global sensitivity analysis methods and a comparative case study on digit classification*. [Preprint]. ArXiv. <https://doi.org/10.48550/arXiv.2406.16975>
- Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D., & Tarantola, S. (2008). *Global sensitivity analysis: The primer*. John Wiley & Sons.
- Solomon, M. R. (2014). From thinking to doing: Toward a hands-on consumer behavior course. In C. H. Noble (Eds.), *Proceedings of the 1999 academy of marketing science (AMS) annual conference*, (p. 55). Springer.

- Yang, N., Fernández-Pérez, A., & Indriawan, I. (2024). Spillover between investor sentiment and volatility: The role of social media. *International Review of Financial Analysis*, 96(Part A), 103643. <https://doi.org/10.1016/j.irfa.2024.103643>
- Yao, J. T. (2003). Sensitivity analysis for data mining. In *22nd International Conference of the North American Fuzzy Information Processing Society, NAFIPS 2003*, Chicago, IL, USA, (pp. 272-277).
- Zhang X., Fuehres, H. & P. A. Gloor (2011). Predicting stock market indicators through Twitter “I hope it is not as bad as I fear”. *Procedia - Social and Behavioral Sciences*, 26, 55-62.
- Zheludev, I., Smith, R., & Aste, T. (2015). When can social media lead financial markets?. *Scientific Reports*, 4, Article 4213. <https://doi.org/10.1038/srep04213>

Evaluation of the Structure-Satisfaction Relationship in Health Organizations *

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Abstract

The aim of this paper, conducted in hospitals across Türkiye, is to investigate the relationship between organizational structure and job satisfaction, as well as to evaluate its impact on expectations and overall satisfaction. In this context, a study was carried out in hospitals operated by the Ministry of Health (MoH), universities, and private entities, examining how employees perceive the levels of formalization, centralization, complexity, and specialization that constitute the organizational structure, and how these factors influence their job satisfaction levels. We also aimed to perform a comparative analysis by illustrating the relationship between structure and satisfaction in hospitals with different ownership types, while proposing structural variables to enhance job satisfaction. The findings indicate that private hospitals significantly differ from publicly-owned and university hospitals at a notable significance level. When comparing complexity levels among hospitals, it was observed that MoH hospitals exhibited a negative difference compared to both private and university hospitals.

Keywords: *Healthcare Organizations, Job Satisfaction, Ministry of Health, Organizational Structure, Structural Variables in Healthcare System.*

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1. INTRODUCTION

Centralization, which includes the level and form of decision-making authority in the organization, also refers to the power and intensity of decision-making authority (Bradish, 2003, p. 16). Centralization is also defined as the evaluation criterion related to the determination of the area of authority, finance, evaluation, business relations and decision-making processes (Weels, 1990, p. 2). Formalization can be defined as a set of rules created by codified and defined jobs (Hage & Aiken, 1970, pp. 22-23), the most basic organizational structure dimension (Pugh et al., 1968, p. 65), the expectations of the institution for a certain role (Zeitz, 1984, p. 302), and the technique of job-related predictions that will find answers to the questions of when and how. Specialization is the level of dividing organizational responsibilities into separate jobs (Daft, 2008, p. 15), aiming to ensure that employees of the organization who do not have similar skills become successful in their work through repetition in order to achieve effective results (Robbins & Judge, 2013, p. 489). The number of occupational specialties included in the organization and the length of training required for each are important indicators of the level of complexity of the organization (Hall et al., 1967, p. 905).

Employee job satisfaction in hospital organizations, where health services must meet patient expectations across various scenarios and enhance societal confidence in the health system, is critically important and is believed to be influenced by the organizational structure. This study aimed to conduct comparative analyses by revealing the relationship between structure and satisfaction in hospitals that differ in ownership status and to provide recommendations regarding structural variables to enhance job satisfaction.

2. LITERATURE REVIEW

2.1. Organizational Structure

Today, human life, which begins in hospital organizations at birth, continues through interactions with various organizations to fulfill interests, wishes, and needs throughout life, ultimately concluding in health organizations where one engages with the world. The formal organizational structure can be visually represented through organizational charts (Koçel, 2003, p. 171). Conversely, in organizational literature, the term "design" is often used alongside "structure" (Hodge et al., 1996, p. 32).

Pugh categorized organizational structure into dimensions such as specialization, standardization, formalization, centralization, structuring, and flexibility (Pugh et al., 1968, p. 65). Reimann, who also examined structural differences in high and low-performance organizations, identified the dimensions of organizational structure as the degree of centralization, specialization, and formalization (Reimann, 1974, p. 693). Researchers who assert the existence of three fundamental dimensions within organizations typically recognize centralization, formalization, and complexity.

These dimensions are regarded as the most influential factors in the decision-making process (Frederickson, 1986, p. 282).

2.2. Job Satisfaction

Job satisfaction is the accumulation of emotions that arise from what the employee has experienced during this time, reflecting the sum of their feelings about their job. This accumulated sentiment regarding the employee's experiences in their working life may manifest as either satisfaction or dissatisfaction (Spector, 1997, p. 2).

From an organizational perspective, job satisfaction can be defined as the state in which employees experience happiness and a sense of fulfillment while performing their responsibilities with genuine pleasure. The workplace behaviors of employees who feel positive in their working life and carry out their profession with high motivation are seen as a clear reflection of their job satisfaction (Brent et al., 2017, p. 380). The impact of employee behavior, body language, and effective information sharing on customer satisfaction emphasizes the importance of aligning job satisfaction with organizational objectives (Naktiyok & Küçük, 2003, p. 240).

When reviewing the literature, it is clear that the factors identified between five and thirteen regarding work directly influence the development of satisfaction and establish internal and external classifications (Karaman & Altunoğlu, 2007, p. 110). Research indicates a significant correlation between employee autonomy, feedback effectiveness, job clarity, and job satisfaction (Friday & Friday, 2003, p. 430).

3. ORGANIZATIONAL DESIGN VARIABLES ORIENTED TO THE JOB SATISFACTION PROCESS: RESEARCH HYPOTHESIS

In addition to researchers who argue that job satisfaction is low among employees working in organizations with a high level of formalization, some scholars argue that there is a positive and linear relationship between organizational design or structure dimensions and satisfaction (Altunoğlu & Karaman, 2005, p. 84). In this context, it has been observed that success and job satisfaction levels increase in structures that convert procedures, rules, and regulations into more flexible forms (West et al., 1998, pp. 274-275), as concluded by Lambert et al. (2006, p. 39) in their study of 272 employees, where high levels of formalization were associated with high levels of job satisfaction.

Researchers Bucic and Gudergan (2004) explored the potential dynamic capabilities within organizational structures and found that the generation of new ideas is negatively impacted in highly centralized organizations, which in turn affects job satisfaction (Bucic & Gudergan, 2004, p. 261).

In contrast to Srivastava's (2010) findings, which concluded that complexity levels do not directly influence employees' job satisfaction (Srivastava et al., 2010, p. 261), some studies suggest that higher job satisfaction levels are reported by those who perceive the organizational structure as complex (Folami & Blin, 2012, p. 215). Brumels and Beach conducted a survey in 2008 involving 348 trainers

from the National High School Athletic Coaches Association to investigate the relationship between complexity levels and job satisfaction in university athletics departments. The research indicated a negative correlation between complexity levels and job satisfaction, revealing that as complexity increased, employee job satisfaction decreased (Brumels & Beach, 2008, p. 377).

Based on these studies, it has been determined that the dimensions of organizational structure—namely formalization, centralization, and complexity—impact job satisfaction, leading to the formulation of the following hypotheses.

H1: The level of formalization in hospitals affects employees' job satisfaction.

H2: The level of centralization in hospitals affects employees' job satisfaction.

H3: The level of complexity in hospitals affects employees' job satisfaction.

H4: The level of specialization in hospitals affects employees' job satisfaction.

Hospitals in Türkiye must be categorized into three groups based on their ownership structures: those affiliated with the Ministry of Health, which is the primary health service provider; university hospitals; and private hospitals. Conversely, private hospitals, which have distinct organizational reasons and structures, can be established under Private Hospitals Law No. 2419. These hospitals are managed by boards of trustees or executive boards, with a managing director responsible for administrative, medical, and technical services. Unlike public hospitals operated by the Ministry of Health, which prioritize meeting public needs and are established and operated regardless of profitability, private hospitals that are planned in regions with dense populations and high income levels are driven by profitability (Köseoğlu & Ocak, 2010, p. 72).

On the other hand, university hospitals, referred to as health practice and research centers under Article 3 of Higher Education Law Number 2547, are expected to lead innovations in the healthcare industry. They provide services to individuals to foster healthy societies and offer comprehensive solutions to emerging issues, delivering the best medical care. Additionally, they fulfill the roles of educating service providers and identifying advanced techniques for diagnosis and treatment. Established as research and application centers, university hospitals can utilize training as professional practice units to develop regulations for their internal operations and to contribute human resources to the health sector. The administrative, financial, and technical services of university hospitals are organized by chief managers, who have the opportunity to establish an additional budget and revolving fund within their financial framework. However, despite being managed by the rector through appointments, they lack a complete standard in terms of management and organization (Uğurluoğlu, 2015, p. 53).

The recognition that enhancing the quality of healthcare services is achievable by boosting the job satisfaction levels of healthcare workers, regarded as internal customers, led to the introduction of a

performance-based payment system, which was initially piloted in 10 institutions in 2003. Beginning in 2004, this system has been implemented across all hospitals offering primary, secondary, and tertiary healthcare services under the Ministry of Health. The primary objective of the system, which aims to reward employees with additional payments proportional to their contributions to health services, is to elevate service quality and patient satisfaction alongside employee job satisfaction. In this context, the Ministry of Health has aimed for a measurable increase in employee satisfaction (Kaya et al., 2013, p. 35). However, when the additional funds allocated to employees are modified without maintaining budget discipline, and organizations encounter financial difficulties, attempting to cover expenses for maintenance, upgrades, equipment, and human resources from the revenues of the revolving fund negatively affects the satisfaction levels of healthcare workers employed in university hospitals (Danacı, 2010, p. 145). The job satisfaction levels of employees in private health institutions were found to be higher than those in hospitals affiliated with the Ministry of Health and universities, with the satisfaction levels of health workers in university hospitals being assessed as the lowest (Şahin et al., 2017, p. 94).

Considering the differences arising from ownership in terms of legislation, organizational objectives, and allocated resources, the following hypothesis statements have been developed to evaluate the potential variations in hospitals and employee job satisfaction levels:

H5: Differences exist in the organizational structures of hospitals that operate under distinct institutional systems based on ownership.

H6: Variations are present in employee job satisfaction levels among hospitals that function under separate institutional systems based on ownership.

4. RESEARCH METHODOLOGY

4.1. Sample and Data Collection

The data required for this study were collected from health professionals working in private, public, and university hospitals in Trabzon in 2019. The study was conducted using a face-to-face survey method, and a survey form consisting of 61 statements was created to measure the dimensions of the organizational structure, perspectives on general job satisfaction, and the level of relationship between them. Considering the intense working conditions, the response rate might be low, and potential errors in the completed questionnaires were acknowledged. A total of 600 questionnaires were distributed to achieve the necessary sample size. Six of the 530 returned questionnaires were excluded due to deficiencies, resulting in a total of 524 questionnaires included in the analysis. The response rate of the analyzed surveys is 87.3%. This percentage and the number of questionnaires provide a strong representation of the research population.

The analysis of the research commenced with the scale tests prepared to access the data. Analyses were evaluated at a significance level of $p = 0.05$. The reliability and validity analyses of the scales used to reveal the organizational structure and job satisfaction were conducted with the assistance

of SPSS and LISREL package programs. Confirmatory factor analysis was conducted separately for the organizational structure and job satisfaction scale, and it was determined that the factor loadings of the items were between 0.35 and 0.81. Additionally, regression and variance analyses were also performed.

It is stated that the relationship between the data and the model is indicated by CMIN/DF ($2 \leq \chi^2/sd \leq 5$) and that a goodness of fit index value of $.85 \leq GFI$ is considered an acceptable measure for fit (Karagöz & Ağbektaş, 2016, p. 279). The model fit values obtained as a result of the analysis of the organizational structure scale are also within acceptable limits, as shown in Table 1. On the other hand, Table 2 shows the fit index values of the job satisfaction scale.

Table 1. Results of the DFA Fit Index Related to Organizational Structure Scale

Indexes	Measurement Model	Acceptable Fit
CMIN/DF	2.30	$2 \leq \chi^2/sd \leq 5$
AGFI	0.85	$.85 \leq AGFI \leq .90$
GFI	0.88	$.90 \leq IFI \leq .95$
CFI	0.95	$.90 \leq GFI \leq .95$
NFI	0.93	$.90 \leq CFI \leq .95$
NNFI(TLI)	0.93	$.90 \leq NFI \leq .95$
IFI	0.95	$.90 \leq TLI \leq .95$
RMSEA	0.69	$.05 \leq RMSEA \leq .08$
SRMR	0.77	$.05 \leq SRMR \leq .10$

Table 2. CFA Fit Index Results for Job Satisfaction Scale

Indexes	Measurement Model	Acceptable Fit
CMIN/DF	4.13	$2 \leq \chi^2/sd \leq 5$
AGFI	0.85	$.85 \leq AGFI \leq .90$
GFI	0.89	$.90 \leq IFI \leq .95$
CFI	0.96*	$.90 \leq GFI \leq .95$
NFI	0.95	$.90 \leq CFI \leq .95$
NNFI(TLI)	0.91	$.90 \leq NFI \leq .95$
IFI	0.96*	$.90 \leq TLI \leq .95$
RMSEA	0.71	$.05 \leq RMSEA \leq .08$
SRMR	0.59	$.05 \leq SRMR \leq .10$

*(Perfect fit)

The reliability of the scales was assessed using the method of internal consistency, evaluated according to Cronbach's Alpha criteria. Cronbach's Alpha, which yields a value between 0 and 1,

indicates reliability as it approaches 1 (Morgan et al., 2004, p. 122). The process of item correlation was examined through a three-step item deletion procedure, with the analysis repeated after each step. In the final stage of this process, it was determined that the Cronbach's Alpha values of the scales used were at an acceptable level. The results of these analyses for each scale are discussed in the findings section.

Factor analysis was also conducted on the scales regarding reliability and validity. Factor analysis, which offers advantages such as enhancing the significance level of existing variables and generating new variables, aims to uncover the relationships between the items. In Confirmatory factor analysis, the factor under which the items are grouped is known in advance (Şimşek, 2007, p. 7). In this regard, Confirmatory factor analysis can be viewed as a demonstrative analysis. In our study, both exploratory and Confirmatory factor analyses were performed on the Organizational Structure Scale. However, due to its universal nature, only Confirmatory factor analysis was carried out for the Job Satisfaction Scale. SPSS software was employed for Exploratory factor analysis, while LISREL software was utilized for Confirmatory factor analysis in our study.

4.2. Measures

When creating the survey form, reliable and validated scales previously employed in the literature were utilized. In this context, Posdakoff and MacKenzie (1994) were referenced to determine the level of formalization, Hage and Aiken (1967) for centralization, Hall et al. (1967) and Jackson (2007) for complexity (differentiation), and Schaffer (1986), Olson et al. (2005), Pugh et al. (1968), Walton (1981), and Tannenbaum (1992) for specialization. Consequently, a 34-item scale was developed to assess organizational structure.

Satisfaction levels of healthcare professionals were measured using the Minnesota Satisfaction Scale developed by Weiss et al. (1967), whose validity and reliability were established. The scale, translated into Turkish by Baycan in 1985, consists of 20 statements aimed at assessing internal satisfaction, external satisfaction, and overall job satisfaction (Gönültaş et al., 2018, p. 32). Statements 42-54 in our questionnaire are designed to measure internal satisfaction, while statements 55-61 are intended for measuring external satisfaction. The entirety of the satisfaction scale statements is focused on assessing overall job satisfaction (Weiss et al., 1967, p. 110).

Additionally, 7 questions prepared to evaluate the demographic and environmental characteristics of the employees were included in the questionnaire.

4.3. Ethical Considerations

Participation in this study was voluntary. Informed consent ensured that students were aware of the confidentiality of their collected data and their right to withdraw from the research. Each student was assigned a personal code to maintain confidentiality and facilitate data matching across surveys. Ethics approval was granted by the Social and Human Sciences Ethics Committee (Reference:

88656144-000-E.19002 24182). Ethics approval and other permissions obtained from local authorities, institutions, and hospitals are available from the corresponding author upon request.

5. RESULTS

The distributions of responses provided by participants to the directed questions aimed at identifying the employees who took part in the survey within the research criteria are summarized in Table 3.

Table 3. Findings Regarding Participants' Demographic and Descriptive Characteristics

CHARACTERISTIC		F	%	CHARACTERISTIC		F	%
Gender	Female	339	64.7	Education	Primary School	6	1.1
	Male	185	35.3		High School	106	20.2
Marital Status	Married	390	74.4		Associate's Degree	131	25.0
	Single	134	25.6		Bachelor's Degree	221	42.2
Age Range	Younger than 25	45	8.6		Graduate Degree	60	11.5
	25-42	322	61.5	Years of Service in the Profession	Less than 5 years	99	18.9
	43-54	134	25.6		5-15 yıl	207	39.5
	55-65	23	4.4		15-25 yıl	167	31.9
	Older than 65	-	-		More than 25 years	51	9.7
Employment Institution	Private	64	12.2	Occupation	Health Administrator	32	6.1
	University	207	39.5		Doctor	53	10.1
	Ministry of Health	253	48.3		Nurse	159	30.3
					Other	280	53.5

5.1. Findings Regarding Organizational Structure Scale

In this section of the analysis, we will present reliability analysis, exploratory and confirmatory factor analyses, and descriptive statistics for our organizational structure scale.

Reliability analysis serves as the foundation for measuring and interpreting the obtained values. Initially, the correlation level between each item and the total score from the questionnaire is evaluated individually, and its alignment with the overall scale is tested. In the fourth stage of the analysis, conducted according to the principles outlined in the analysis methods section and accepted within the literature, it was observed that the total correlation for any item was no less than 0.30, which was established as the cut-off point (Table 4). Furthermore, it was concluded that removing any item from the scale would not result in a significant increase in the Cronbach's alpha reliability coefficient, which was calculated to be 0.885.

Table 4. Reliability Analysis Regarding the Organizational Structure Scale: Fourth and Last Step

Item No	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item Total Score Correlation	Cronbach's Alpha Coefficient if Item Deleted	
Item 8	65.8855	130.599	.546	.878	
Item 9	66.1775	125.313	.571	.878	
Item 10	66.2615	128.794	.543	.878	
Item 11	65.9504	129.439	.604	.877	
Item 12	65.8817	129.649	.587	.877	
Item 13	65.6660	131.385	.527	.879	
Item 14	65.1718	136.678	.307	.885	
Item 23	65.1870	136.462	.320	.885	
Item 24	65.4943	131.505	.536	.879	
Item 25	65.3779	135.731	.369	.883	
Item 26	65.7824	132.526	.494	.880	
Item 30	65.7748	133.551	.413	.882	
Item 31	65.7271	131.725	.533	.879	
Item 32	66.0248	132.736	.466	.881	
Item 33	66.2061	133.265	.450	.881	
Item 34	66.0515	134.680	.429	.882	
Item 35	65.7061	133.244	.479	.881	
Item 36	65.5821	134.993	.385	.883	
Item 37	66.1660	132.433	.479	.880	
Item 38	66.1069	128.356	.606	.876	
Item 39	66.4141	129.337	.555	.878	
General Scale	Arithmetic Mean	Variance	Standard Deviation	Number of Items	Cronbach alpha
	69.1298	144.721	12.03001	21	0.885

As a result of the factor analysis, it was found that the factor loadings of 21 items in the scale were not lower than 0.30, and the items were grouped into four factors. Based on the expressions in the scale, the 1st Factor was named the formalization level, consisting of 6 statements; the 2nd Factor was named the specialization level, consisting of 7 statements; the 3rd Factor was named the complexity level, consisting of 5 statements; and the 4th Factor was named the centralization level, consisting of 3 statements. When examining the total variance results for the scale, it is observed that the formality dimension accounts for 30.921% of the variance, the specialization dimension accounts for 11.017% of the variance, the complexity dimension accounts for 9.327% of the variance, and the centralization

dimension accounts for 5.255% of the variance. The KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) sample adequacy measure (0.893), which demonstrates the suitability for applying descriptive factor analysis to the obtained data, and the degree of sphericity (Bartlett's Test of Sphericity; 4248.687 $p < .000$), which indicates the potential for significant factors to emerge from the research data, are at an adequate level. The reliability of the scale, as indicated by Cronbach's alpha coefficient in the table, is 0.885, which exceeds the acceptable level recommended in the literature for reliability.

5.2. Findings Regarding Job Satisfaction Scale

The Minnesota Job Satisfaction Questionnaire, widely utilized in the literature to assess job satisfaction levels, underwent confirmatory factor analysis. The estimation results of the Minnesota Short Form scale model, employed to gauge job satisfaction, were analyzed within the framework of confirmatory factor analysis. In the "Standardized Solution" menu, it is essential to evaluate that the factor structure of the scale and its load values should be 0.30 or higher (Seçer, 2013, p. 150). Upon examining the regression weights (parameter estimates) derived from the model, it was noted that the standardized regression weight of the items was no less than 0.35.

Initially, correlation analysis was employed to test the hypotheses underpinning the research and to ascertain the nature of the relationship between the factors constituting the organizational structure and job satisfaction, including its sub-dimensions. In the correlation analysis conducted to identify the direction and degree of the relationship between two variables, if a relationship exists, the correlation coefficient denoted by the letter "r" ranges from -1 to +1. In this context, the sign of "r" indicates the direction of the relationship, while the magnitude of the coefficient reflects its degree. A negative value signifies an inverse link between the variables, whereas positive values indicate the increase and decrease in the values of both variables (Köksal, 1994, p. 377).

When examining the relationship between organizational structure and job satisfaction in general terms, a positive and significant correlation is observed between the two variables at the 99% significance level ($r = 0.464$) (Table 5). Additionally, there is a positive and significant relationship between job satisfaction and the level of formalization ($r = 0.371$), centralization ($r = 0.332$), complexity ($r = 0.190$), and specialization ($r = 0.441$), which are sub-dimensions of organizational structure. The relationship between specialization and internal satisfaction ($r = 0.404$), external satisfaction ($r = 0.411$), and general satisfaction ($r = 0.441$) is stronger than that of other organizational structure factors (Table 5). These results suggest that the characteristics of the dimensions representing the organization's structure are related to job satisfaction. The specialization dimension shows a stronger correlation in this relationship, while the correlation is weaker in the complexity dimension.

Table 5. Correlation Table for Organizational Structure and Job Satisfaction Dimensions

FACTORS		Internal satisfaction	External satisfaction	Overall Satisfaction
Formalization	Pearson Correlation	.323**	.372**	.371**
	Sig. (2-tailed)	.000	.000	.000
	N	524	524	524
Centralization	Pearson Correlation	.292**	.330**	.332**
	Sig. (2-tailed)	.000	.000	.000
	N	524	524	524
Complexity	Pearson Correlation	.231**	.095*	.190**
	Sig. (2-tailed)	.000	.030	.000
	N	524	524	524
Specialization	Pearson Correlation	.404**	.411**	.441**
	Sig. (2-tailed)	.000	.000	.000
	N	524	524	524
Organizational Structure	Pearson Correlation	.431**	.425**	.464**
	Sig. (2-tailed)	.000	.000	.000
	N	524	524	524

To test the impact of the level of centralization, one dimension of organizational structure, on internal and external satisfaction, as well as overall job satisfaction, the regression equation considered the centralization level as the independent variable, while internal satisfaction, external satisfaction, and general job satisfaction were treated as dependent variables. Centralization accounts for 8.5% of internal satisfaction, 10.9% of external satisfaction, and 11% of total job satisfaction. Furthermore, it is evident that the independent variable's influence on internal satisfaction ($=0.292$), external satisfaction ($=0.330$), and overall job satisfaction ($=0.332$) is significant. The level of specialization, another dimension of organizational structure, was examined for its effects on internal, external, and overall job satisfaction using a regression equation where the specialization level served as the independent variable and the dependent variables were internal, external, and overall job satisfaction.

The specialization level explains 16.3% of internal satisfaction, 16.9% of external satisfaction, and 19.4% of overall job satisfaction. Additionally, the independent variable's impact on internal satisfaction ($=0.404$, $p<0.001$), external satisfaction ($=0.411$, $p<0.001$), and overall job satisfaction ($=0.441$, $p<0.001$) is significant. The effect of specialization on internal satisfaction is greater than that of other structural dimensions ($\beta=.274$) (Table 6). It was also noted that the effects of centralization and complexity on internal satisfaction were not significantly pronounced. When these results are considered collectively, they indicate that the levels of specialization and formalization have a more substantial impact on internal satisfaction than other structural dimensions.

Table 6. The Impact of Organizational Structure and its Dimensions on Job Satisfaction and its Dimensions

Factors	Dependent Variables					
	Internal Satisfaction		External Satisfaction		Overall Satisfaction	
	β	t	β	t	β	t
Formalization Level	.171**	3.818	.263**	6.087	.225**	5.201
Centralization Degree	.087	1.856	.124**	2.735	.110	2.430
Complexity Level	.024	.536	-.170**	-3.910	-.059	-1.358
Specialization Level	.274**	5.279	.310**	6.184	.313**	6.213
Durbin Watson	1.771		1.705		1.768	
R²	.197		.250		.247	
Adjusted R²	.191		.245		.241	
F	31.840**		43.328**		42.514**	

After identifying the differences in the dimensions of the organizational structure regarding ownership, LSD analysis was conducted to ascertain the source of these differences. According to the LSD analysis data, the average for private hospitals differs from that of the MoH (Ministry of Health) (.57182) and university hospitals (.72377) in terms of the level of formalization. There is no statistically significant difference between the MoH and university hospitals regarding formalization levels. This indicates that private hospitals are more formal than both the MoH and university hospitals.

In terms of centralization, the averages for private hospitals differ from those of the Ministry of Health (.41780) and university hospitals (.49348). No significant difference was found between the averages of the Ministry of Health and the university hospital. This suggests that the level of centralization in private hospitals is higher than that of the MoH and university hospitals.

In terms of the complexity, the average for MoH Hospital significantly differs from the averages of private hospitals (-0.28965) and university hospitals (-0.19016). This indicates that, unlike the other three dimensions, there is a statistical difference between the averages of university hospitals and the Ministry of Health in the findings related to complexity in the analysis of ownership structures. Conversely, no significant difference was observed between the averages of private hospitals and university hospitals. This result suggests that employees perceive both private and university hospitals as more complex than the MoH hospital.

In terms of specialization levels, the averages of private hospitals differ significantly from those of the Ministry of Health hospital (0.45253) and the university hospital (0.44362). However, no significant difference is observed between the averages of the Ministry of Health hospital and the university hospital. This suggests that private hospitals exhibit a higher level of specialization compared to both the MoH Hospital and the university hospitals.

Regarding formalization, centralization, and specialization, private hospitals, Ministry of Health hospitals, and university hospitals show considerable differences from one another. However, there are

no notable distinctions between university hospitals and Ministry of Health hospitals in these aspects. The Ministry of Health, private hospitals, and university hospitals differ significantly in terms of complexity, while no significant difference exists between private hospitals and university hospitals. Therefore, hypothesis H5 was partially supported.

A one-way analysis of variance was conducted to determine whether there are differences in internal satisfaction, external satisfaction, and general job satisfaction among employees in hospitals with distinct corporate identities based on ownership. For all three satisfaction variables, the averages for private hospital employees are higher. Conversely, there was no significant difference in the internal satisfaction levels of employees in the Ministry of Health and university hospitals. A similar outcome was observed for external satisfaction, with health workers in private hospitals reporting higher external satisfaction than those in the Ministry of Health (0.44563) and university hospitals (0.54312). There was no significant difference in external satisfaction levels between employees in the MoH and university hospitals. Similar findings were noted for overall job satisfaction. Although significant differences exist between private hospitals and the MoH and university hospitals regarding internal, external, and general satisfaction, no significant difference was found between university hospitals and MoH hospitals for the same factors. In this regard, hypothesis H6 was partially accepted.

The correlation between the degree of formalization and internal, external, and job satisfaction is stronger in hospitals affiliated with the Ministry of Health (MoH) compared to other hospitals. However, this relationship is less pronounced in private hospitals.

The connections between internal, external, and job satisfaction are more strongly correlated with centralization levels in private hospitals than in other institutions. This trend is particularly evident in terms of external satisfaction.

When examining the relationships between the level of complexity regarding ownership and satisfaction, a significant correlation emerges between the complexity perceived by MoH and private hospital employees and their internal, external, and job satisfaction. A notable relationship exists between the complexity level and internal satisfaction for university hospitals. The impact of complexity on job satisfaction is more pronounced in MoH hospitals than in other types of hospitals.

The analysis conducted to evaluate the influence of the four independent variables on the dependent variables yielded significant results across hospitals with different ownership structures. In Ministry of Health hospitals, the organizational structure had the most substantial effect on job satisfaction, while university hospitals exhibited the least impact compared to other hospital types.

6. RESULTS AND DISCUSSION

Organizations aiming to achieve their goals amid national and international competition engage in a struggle to be both efficient and perform above average to sustain their continuity in the current information age. Therefore, organizations should prioritize ensuring job satisfaction among their

employees to maximize the effectiveness of their human resources. Job satisfaction, defined as individuals' emotional response to their job roles, arises from the interplay of psychological, physiological, and environmental factors, significantly contributing to the organization's efficiency and long-term goal attainment. Job satisfaction, which merits examination through various variables, has also been evaluated from the perspective of organizational structure (Oldham & Hackman, 1981, p. 78). Previous research investigating the relationship between structural characteristics such as size, centralization, formalization, specialization, and complexity in organizations and employees' level of job engagement has revealed a paradox. Some studies found that structural parameters positively influenced job satisfaction and increased it, while others indicated the opposite, leading to a decrease in job satisfaction (Altunoğlu & Karaman, 2005, p. 84).

The first variable of this research is the level of formalization. While some studies indicate that decentralized organizations, where employees engage in decision-making processes and adopt an empowered workforce approach beyond formal communication channels, enhance job satisfaction by demonstrating flexible management behaviors instead of adhering to standard procedures (Altunoğlu & Karaman, 2005, p. 94), other studies have found high job satisfaction in environments characterized by high levels of formalization (Lambert et.al., 2006, p. 39). In our study, six statements were utilized to measure the perceived level of formalization, resulting in an average score of 3.15.

Our research revealed a positive and significant relationship between the level of formalization and job satisfaction, as well as between formalization and both internal and external satisfaction. We defined the level of formalization as the degree of role definition, rules, authority relationships, communication, power distance, norms, sanctions, and procedures. This level not only mitigates potential tensions between organizational and professional demands but also aids in establishing a trustworthy institutional image (Organ & Greene, 1981, p. 250). The research findings align with existing literature, suggesting that by predefining what, when, and how tasks should be performed in hospitals, formalization can enhance the tendency to avoid uncertainties and positively influence job satisfaction.

The second variable in our study, structured within the research questions, is the level of centralization. This variable was measured using three expressions, yielding an average score of 3.03.

When examining the literature, it can be stated that there are studies supporting a positive and linear relationship between the degree of centralization in organizational structure and satisfaction, as well as studies indicating that decentralization positively affects employee job satisfaction and both internal and external satisfaction levels. Particularly, it has been observed that employee involvement in decision-making reduces absenteeism and turnover rates and has a positive relationship with satisfaction (Bragg & Andrews, 1973, pp. 732-733). A study conducted on nurses in California hospitals with bed capacities ranging from 200 to 500 also interpreted that a decentralized structure directly affects job

satisfaction (Shoemaker & El-Ahraf, 1983, p. 75). In this study, it was noted that the degree of centralization has a significant positive effect on job satisfaction and its sub-dimensions, namely internal and external satisfaction. The positive effect of centralization on job satisfaction can be supported by the assumption that Turkish society embraces a hierarchical culture. Therefore, in organizations where power distance is high, resistance to change is observed, and the prevailing command-and-control approach is more effective than participation in decision-making in Turkish society and ultimately in organizations. In Turkish society, where being recognized as an individual is important, the structure of the society values belonging to a group, and expectations from leaders are shaped accordingly (Sargut, 2001, p. 234). In the Turkish societal structure, where leaders or managers are considered parental figures in the workplace, unlike Western studies suggesting that decentralization increases job satisfaction through participation in decision-making processes in superior-subordinate relationships, it is believed that the positive impact of the degree of centralization on internal, external, and overall job satisfaction can be among the reasons.

Within the organizational structure, we can discuss the level of complexity, also known as organizational differentiation, in terms of the diversity and depth of departments and hierarchical levels. Complexity is assessed along its dimensions: horizontal, vertical, and geographical. The variety of organizational goals and multiple major activities represents general complexity, while vertical differentiation is indicated by hierarchical depth, and horizontal differentiation is determined by the degree of differentiation among units. It is assumed that an increase in horizontal differentiation based on the organizational structure will lead to an increase in complexity. In our study, which aims to measure the level of complexity, we utilized five statements, and the average perceived complexity level was calculated to be 3.72.

In the research, it was found that the independent variable of complexity positively influenced job satisfaction. In our study, the relationship between complexity and the dependent variables of internal satisfaction, external satisfaction, and job satisfaction was evaluated separately, and it was observed that complexity positively influenced job satisfaction as well as its sub-dimensions, namely internal and external satisfaction.

Hospitals, which play a significant role and are large-scale entities within the healthcare system, are complex organizations centered around human subjects. The positive impact of perceived complexity level on satisfaction in our study arises from the differentiation of tendencies, expectations, responsibilities, and professional structures. Therefore, healthcare professionals, who have a crucial role in addressing sensitivities related to human health and managing complex processes, may experience increased satisfaction due to the respect they receive in society, among other reasons.

The fourth variable in this research is the level of specialization. To measure it, seven expressions were utilized in our study, resulting in an average perceived specialization level of 3.20.

The impact of the level of specialization, viewed as a reflection of the experience and training acquired by healthcare professionals over time, on job satisfaction within hospital organizations is significant and positively oriented. Conversely, when the four independent variables are assessed collectively, it becomes evident that the perceived level of specialization exerts a stronger influence on overall job satisfaction than the other independent variables. The level of specialization, which directly influences hospital preference from the perspective of external customers such as patients and their families, is described by Parasuraman et al. as essential for ensuring competence within the fundamental elements of service quality. In comparison to other organizations in the service sector, the significance of the level of specialization as a key factor among the distinctive features of hospitals, and its assessment as a fundamental element for the advancement of healthcare systems, justifies its notable differentiation from other variables (Zerenler & Ögüt, 2007, p. 505). Private hospitals exhibited higher averages across all categories than MoH and university hospitals, according to an analysis of structural variables for hospital organizations with diverse ownership. In this context, while the average level of formalization in private hospitals was 3.721, it was calculated as 3.149 for MoH hospitals and 2.997 for university hospitals. However, no substantial difference was found between university and MoH hospitals.

We assess that the primary reason for the distinct differentiation of private hospitals from state-owned and university-affiliated hospitals regarding formalization is attributed to legal regulations. In addition to the legal requirements binding public institutions, private hospitals are established and operated under the provisions of Law No. 2219 "Private Hospitals Law," Law No. 1219 "Law on the Manner of Practice of Medicine and Medical Arts," "Private Hospitals Rules," and "Private Hospitals Regulation" (Dönbekçi et al., 2018, p. 675). Furthermore, private hospitals, recognized as legal entities in the form of joint-stock companies according to Articles 312-346 of the Turkish Commercial Code and primarily focused on profit (Kavuncubaşı & Yıldırım, 2012, p. 148), also differ from others in terms of formalization due to their unique circumstances. In addition to their aforementioned legal obligations, we regard the fact that private hospitals are directly subject to the oversight of the Ministry of Health as a significant reason necessitating differentiation in their level of formalization. Conversely, the notion that institutional performance, which aids in addressing potential financial issues, is most influenced by the level of formalization (Öztürk, 2014, p. 164), serves as a crucial justification for the differentiation of private hospitals from state-owned and university hospitals concerning formalization.

In terms of formalization, there is no significant distinction between university hospitals and those operating under the Ministry of Health. While university hospitals have the authority to develop and implement their internal regulations, they remain managed within the framework of the "Inpatient Treatment Institutions Operation Regulation" to comply with Law No. 2547 on Higher Education. This results in similar practices regarding rules, procedures, traditions, job requirements, and employee preferences. Therefore, it can be concluded that there is no substantial difference in terms of

formalization. Additionally, although they may lack a standardized organizational structure, university hospitals do not exhibit meaningful differentiation in their level of formalization compared to Ministry of Health hospitals, owing to the establishment and operation of upper-middle and lower-level management bodies and their commitment to the principle of public interest. Furthermore, in our country, due to the incomplete implementation of the patient referral chain principle, university hospitals, which aim to focus on complex cases in healthcare delivery services, have developed a tendency to provide clinical and polyclinic services to patients who could be treated at primary and secondary healthcare facilities, thereby eliminating application differences (Tengilimoğlu et al., 2014, p. 215). In this context, patients' ability to choose any hospital without regard to the patient referral chain or the ineffective functioning of the referral system gradually shifts the organizational structure of the hospital away from the required qualifications, increasing the formal similarities between organizational mission and professional goals.

According to the findings of a comparative examination of the organizational structures of hospitals under various ownerships, the average level of centralization for private hospitals was determined to be 3,432, for MoH hospitals it was 3,014, and for university hospitals, it was 2,938. These values indicate that private hospitals differ significantly from MoH and university hospitals at a statistically significant level.

However, there was no notable distinction between university and Ministry of Health hospitals. In contrast to MoH and university hospitals, which operate under a centralized and bureaucratic structure, private hospitals, as observed in our study, exhibited a higher level of centralization (Fabnoun & Chaker, 2003, p. 290). This result can be explained by the fact that there is no dismissal under normal conditions in hospitals owned by organizations directly affiliated with the state, while employees in the private sector face risks regarding job security. Additionally, the presence of professional managers in private hospitals suggests that deficiencies in legal infrastructure and participation in the process increase the financial pressure on health workers and, consequently, the perception of centralization (Kerman et al., 2011, p. 103).

When comparing the data on complexity levels among hospitals, it was noted that MoH hospitals performed worse than both private and university hospitals. Conversely, our study did not indicate a significant relationship between private hospitals and university hospitals. In this context, the average complexity level was calculated as 3.906 for private hospitals, 3.616 for MoH hospitals, and 3.806 for university hospitals. The disparity in complexity level between MoH and university hospitals is believed to arise from the efforts of university hospitals, established as "application and research centers" by Article 3 of the Higher Education Law, to meet the demands of their educational and research roles. Despite the financial and managerial challenges, they encounter, university hospitals, which provide both education and patient care, distinguish themselves from MoH hospitals in terms of complexity level through these initiatives (Çınaroğlu, 2018, p. 193). Additionally, the position of the

chief physician, regarded as an office appointed by university rectors and lacking any managerial authority, seemingly aligns with the organizational structure of the Ministry of Health but also impacts the differentiation of the organizational framework (Karahana, 2007, p. 85). A suggested strategy for addressing the organizational and structural challenges faced by university hospitals is affiliation, which can be viewed as inter-institutional cooperation (Uğurluoğlu, 2015, p. 61). The perceived differences in complexity level between private hospitals and MoH hospitals by employees may be attributed to variations in public relations activities conducted by hospitals (Tengilimoğlu & Kılıç, 2004, p. 197). Specifically, the limited information activities carried out in MoH hospitals may lead to inadequate explanations of complex tasks and procedures to the employees compared to private hospitals.

In our study, the averages related to the levels of specialization, formality, and centralization, derived from the organizational structure variables of hospitals that differ in ownership, reveal similarities. In this context, the average level of specialization was calculated as 3.598 for private hospitals, 3.145 for MoH hospitals, and 3.154 for university hospitals. University hospitals and MoH hospitals, however, did not exhibit any significant differences. It is believed that specialized staff and the level of specialization are crucial parameters in the hospital preferences of healthcare service consumers, namely patients and their families (Akyürek & Orhaner, 2017, p. 245). The distinction between private and public hospitals, where complexity and specialization are deemed significant, introduces various differences in terms of cost and quality, with private hospitals being favored despite their costs due to shorter waiting times (Çınaroğlu & Şahin, 2013, p. 285). Furthermore, there is a prevailing belief that the job satisfaction of current employees is affected by the organizational structures and approaches established by employees possessing the requisite knowledge and skills for the job (Kuşluyan & Kuşluyan, 2005, p. 195). The rapid advancement of technology and treatment methods in the healthcare sector, along with the growing importance of competitive strategies for sustainability, heightens the demand for specialized staff. Private hospitals, characterized by a dynamic managerial structure, aim to enhance their degree of specialization and visibility to demonstrate their awareness of the healthcare market. Simultaneously, they must prioritize this process more than others to navigate financial challenges. We assess that the change in the degree of specialization in private hospitals is attributable to the aforementioned reasons, aligning with the differentiation of ownership structures.

The differences in organizational structures between private and publicly-owned institutions, such as the Ministry of Health and university hospitals, stem from their founding rationales, responsibilities toward societal expectations, adaptations in problem-solving methods due to financial challenges, and ultimately, clear distinctions in their objectives. While the primary aim of public health facilities, including the Ministry of Health and university hospitals, is to enhance the health status of their citizens, private hospitals emphasize productivity and profitability as more significant (Demirbilek & Çolak, 2008, p. 109). Given the perspective that the healthcare system should serve the entire society, we assert that collaborative efforts among stakeholders are vital concerning organizational structure,

encompassing service provision, healthcare financing, the range of services, public education about healthcare, and the formulation of healthcare legislation and policies. However, it is crucial to address the needs within hospital organizations in a way that meets them and effectively manages the balance between time, quality, and cost (Tekin, 2015, p. 500). The income and opportunities that differ due to varying education levels within the management approach and organizational structure of public institutions can foster feelings of envy and lead to the emergence of discouragement within the organization (Naktiyok et al., 2015, p. 125). Consequently, these grievances can be cited as a reason for the dissatisfaction of employees working in the Ministry of Health and university hospitals regarding their jobs and work environments.

According to average levels of job satisfaction, as well as internal and external satisfaction, employees in private hospitals report higher satisfaction levels compared to those in public and university hospitals. Conversely, there is no significant difference in the averages of job satisfaction, internal satisfaction, and external satisfaction among employees of public institutions, such as the Ministry of Health and university hospitals.

Opportunities for advancement are crucial indicators of job satisfaction for employees (Çetin et al., 2013, p. 158). Nepotism, viewed as a negative factor due to its reliance on subjective decisions rather than competence, leads to grievances and adversely affects job satisfaction (Kurt & Doğramacı, 2014, p. 83). In this context, the perception of political nepotism, which occasionally surfaces in public administration, is believed to negatively impact public employees and contribute to lower job satisfaction in both public and university hospitals compared to private hospitals. Ensuring that promotions within institutions are made without the influence of political nepotism is a vital parameter for job satisfaction among all employees (Çetinkaya & Tanış, 2017, p. 615). In contrast, private hospitals may emphasize transparent criteria for advancement in human resource management, which is essential for achieving a competitive edge, maintaining market services, and enhancing their corporate image. The equitable implementation of employee promotion requests based on these criteria can positively influence job satisfaction levels (Tanner, 2007, p. 4).

There can be several reasons for the lack of differentiation in job satisfaction levels between university hospitals and Ministry of Health hospitals. From the employees' perspective, we can attribute this to similarities in the job application and acceptance processes, job security, salary, and working conditions. In this regard, we believe that undergoing a similar preparation process for the Public Personnel Selection Exam (KPSS) and starting work under the 4b employment status according to Law No. 5510 on Social Security, along with the determination of salaries and additional income through collective bargaining between public unions and government officials held every two years, diminishes differentiation in job satisfaction. Conversely, employees in private hospitals are employed under Labor Law No. 4857, and their job acceptances are conducted through corporate interview methods. Private hospital employees, who are subject to performance-based remuneration depending on their assigned

department and responsibilities, may have different arrangements for working hours and leave, which can be considered fundamental reasons for differentiation from Ministry of Health and university hospital employees in terms of internal satisfaction, external satisfaction, and overall job satisfaction.

The results demonstrated that stressors such as centralization, excessive specialization needs, lack of advancement and development opportunities, and bureaucratic obstacles arising from the organizational structure significantly affect employees' job satisfaction levels. Addressing these negative factors will positively impact the job satisfaction levels of employees.

Depending upon the output of this study, we concluded that hypotheses H1, H2, H3, and H4 were supported.

Ethics committee approval for the study was obtained from the Atatürk University Ethics Committee on August 1, 2019, with document number 88656414-000-E.1900224636.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors declare that their contribution ratios to the study are as follows: First Author 80%; Second Author 20%.

REFERENCES

- Akyürek, A., & Orhaner, E. (2017). Özel hastanelere talebi etkileyen faktörler. *Sağlık Akademisyenleri Dergisi*, 4(4), 237-248. <https://doi.org/10.5455/sad.13-1513939681>
- Altunoğlu, A., & Karaman, F. (2005). İş tatmini ve organizasyon yapısı. Kamu üniversiteleri üzerine ampirik bir inceleme. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 23(2), 83-97.
- Baycan, A. (1985). *Analysis of several aspects of job satisfaction between different occupational groups* [Unpublished Master Thesis]. Boğaziçi University.
- Bragg, J., & Andrews, I. (1973). Participative decision making: An experimental study in a hospital. *The Journal of Applied Behavioral Science*, 6, 727-735.
- Bradish, C. (2003). *An examination of the relationship between regional sport commissions and organizational structure* (Publication No. 3137410) [Published doctoral dissertation]. Florida State University. <https://www.proquest.com/docview/193960649?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses>
- Brent, S., John, C., Evan, B., & Jeanette, T. (2017). Job satisfaction in Cascadia: A comparison of British Columbia, Oregon and Washington Civil Servants. *The Social Science Journal*, 554(4), 379-388.
- Brumels, K., & Beach, A. (2008). Professional role complexity and job satisfaction of collegiate certified athletic trainers. *Journal of Athletic Training*, 43(4), 373-378.
- Bucic, T., & Gudergan, S. (2004). The impact of organizational settings on creativity and learning in alliances. *Management*, 7(3), 257-273.

- Çetin, H., Zetter Aygen, S., Taş, S., & Çaylak, M. (2013). İş doyumu ve çalışanların demografik özellikleri arasındaki ilişkilerin belirlenmesi: Antalya Atatürk Devlet Hastanesi örneği. *Akdeniz İktisadi İdari Bilimler Fakültesi Dergisi*, 26, 145-163.
- Çetinkaya, A., & Tanış, Z. (2017). Örgütlerde kayırmacılığın iş yüküne etkisi: Kamu kurumları araştırması. *International Journal of Economic and Administrative Studies*, 16, 607-618. <https://doi.org/10.18092/ulikidince.324231>
- Çınaroğlu, S. (2018). Eğitim ve araştırma hastanesi olan ve olmayan hastanelerin teknik verimliliklerinin veri zarflama analizi. *Hacettepe Sağlık İdaresi Dergisi*, 21(2), 179-198.
- Çınaroğlu, S., & Şahin, B. (2013). Özel ve kamu hastanelerinin algılanan kurumsal itibar ve imaj açısından karşılaştırılması. *Uluslararası Yönetim İktisat ve İşletme Dergisi*, 9(18), 283-298.
- Danacı, B. (2010). *Sağlık Bakanlığı, Üniversite ve özel hastanelerin yataklı birimlerinde görev yapan hemşirelerin iş tatminlerinin karşılaştırılması* [Unpublished master's thesis]. Dumlupınar University.
- Daft, R. L. (2008). *Organization theory and design* (10th ed.). South-Western, Cengage Learning.
- Demirbilek, S., & Çolak, M. (2008). Sağlık hizmetlerinde kalite: Manisa İli örneği. *Sosyal Bilimler Enstitüsü Dergisi*, 2, 91-111.
- Dönbekçi, H., Yılmaz, F., & Özata, M. (2018). Özel hastane işletmeciliğinin mevcut durumu ve geleceği: Konya örneği. *Hacettepe Sağlık İdaresi Dergisi*, 21(4), 675-697.
- Fabnoun N., & Chaker M. (2003). Comparing the quality of public and public hospitals. *Managing Service Quality*, 13(4), 209-299.
- Folami, L., & Bline, D. (2012). Relationship Among job satisfaction, task complexity, and organizational context in public accounting. *International Review of Business Research Papers*, 8(4), 207-224.
- Frederickson, J. (1986). The strategic decision process and organizational structure. *Academy of Management Review*, 11(2), 280-297. <https://doi.org/10.5465/amr.1986.4283101>
- Friday, S., & Friday, E. (2003). Racioethnic perceptions of job characteristics and job satisfaction. *Journal of Management Development*, 22(5), 446-442.
- Gönültaş, T., Aytaç, N., & Akbaba, M. (2018). Çukurova Üniversitesi Balcalı Hastanesi'nde çalışan hemşirelerde iş doyumunun araştırılması. *Sakarya Tıp Dergisi*, 8(1), 30-40.
- Hage, J., & Aiken, M. (1970). *Social change in complex organizations* (1th ed.). Random House.
- Hall, R. (1999). *Organizations: Structures, processes and outcomes* (10th ed.). Prentice Hal.
- Hall, R., Johnson, N., & Haas, J. (1967). Organizational size, complexity and formalization. *American Sociological Review*, 32(6), 903-912.
- Hodge, B.J., Antony, W. P., & Gales, L. M., (1996). *Organization theory: A strategic approach* (5th ed.). Prentice-Hall.
- Jackson, J. (2007). *An Examination of the Relationship between elementary school principal's perceptions of shared decision making and three organizational structures* (Publication No. 3279738) [Published doctoral dissertation]. Wayne State University. <https://www.proquest.com/docview/304803378/C91C92E4A94241AAPQ/1?accountid=7412&sourcetype=Dissertations%20&%20Theses>
- Karagöz, Y., & Ağbektaş, A. (2016). Yapısal eşitlik modellemesi ile yaşam memnuniyeti modelinin geliştirilmesi. *Bartın Üniversitesi İktisadi İdari Bilimler Dergisi*, 7(13), 274-290.
- Karahan, A. (2007). *Hastane işletmelerinde örgütsel yapıdan kaynaklanan çatışmalar ve Afyon Kocatepe Üniversitesi Uygulama ve Araştırma Hastanesi örneği* [Unpublished doctoral dissertation]. Afyon Kocatepe University.
- Karaman, F., & Altunoğlu, A. (2007). Kamu üniversiteleri öğretim elemanlarının iş tatmini düzeyini etkileyen faktörler. *Celal Bayar Üniversitesi İktisadi İdari Bilimler Fakültesi Yönetim ve Ekonomi Dergisi*, 14(1), 109-120.
- Kavuncubaşı, Ş., & Yıldırım, S. (2012). *Hastane ve sağlık kurumları yönetimi* (3. Baskı). Siyasal Kitabevi.
- Kaya, S., Tengilimoğlu, D., Işık, O., Akbolat, M., & Yılmaz, A. (2013). *Sağlık kurumlarında kalite yönetimi* (3. Baskı). Eskişehir Anadolu Üniversitesi Yayını.

- Kerman, U., Demirgil, H., Altan, Y., & Aslıhan, B. (2011). Özel hastanelerin yönetsel sorunları üzerine bir araştırma: Antalya ve Isparta örneği. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 16(1), 93-108.
- Koçel, T. (2003). *İşletme yöneticiliği* (9. Baskı). Beta.
- Köksal, Bilge Aloba (1994). *İstatistik analiz metodları* (4. Baskı). Çağlayan Kitabevi.
- Köseoğlu, M., & Ocak, S. (2010). Misyon ifadelerinde kullanılan öğeler işletmelerin mülkiyet yapısına göre değişir mi? Özel ve kamu hastaneleri üzerine bir araştırma. *Hacettepe Sağlık İdaresi Dergisi*, 13(1), 63-82.
- Kurt, E., & Doğramacı, B. (2014). Terfi, işlem kayırmacılığı ve işe alma boyutlarında kayırmacılık davranışı algısının ölçülmesi: İstanbul ilinde faaliyet gösteren bir belediye iştirakinde çalışanlar üzerine bir araştırma. *Elektronik Mesleki Gelişim ve Araştırmalar Dergisi*, 2(2), 82-96.
- Kuşluyan, Z., & Kuşluyan, S. (2005). Otel işletmelerinde iş ve işletme ile ilgili faktörlerin işgören tatmini üzerinde görece etkisi: Nevşehir Örneği. *Anatolia: Turizm Araştırmaları Dergisi*, 16(2), 183-203.
- Lambert, E., Paoline III, E., & Hogan, N. (2006). The impact of centralization and formalization on correctional staff job satisfaction and organizational commitment: An exploratory study. *Criminal Justice Studies*, 19(1), 23-44.
- Morgan, G., Karen C., B., Nancy, L., & Gene, W. (2004). *SPSS for introductory statistics: Use and interpretation* (2th ed.). Lawrence Erlbaum Associates Publishers.
- Naktiyok, A., & Küçük, O. (2003). İşgören (iç müşteri) ve müşteri (dış müşteri) tatmini, işgören tatmininin müşteri tatmini üzerine etkileri: Ampirik bir değerlendirme. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 17(1), 225-243.
- Naktiyok, A., Yanık, O., & Timuroğlu, M. (2015). Yıldırmaya maruz kalan çalışanların agresif tepkileri: Bireysel ve çalışma hayatına ilişkin farklılıklar. *Amme İdaresi Dergisi*, 50(1), 117-177.
- Oldham, G., & Hackman, J. (1981). Relationships between organizational structure and employee reactions: Comparing alternative frameworks. *Administrative Science Quarterly*, 26, 66-83. <https://doi.org/10.2307/2392600>
- Olson, E.M., Slater, S.F. and Hult, G. T. M. (2005) The performance implications of fit among business strategy, marketing organization structure, and strategic behavior. *Journal of Marketing*, 69, 49-65. <https://doi.org/10.1509/jmkg.69.3.49.66362>
- Organ, D., & Greene, C. (1981). The effect of formalization on professional involvement: A compensatory process approach. *Administrative Science Quarterly*, 26(2), 237-252.
- Öztürk, P. (2014). *Sağlık kurumlarının kurumsallaşmasının kurum performansı üzerine etkisi* [Unpublished doctoral dissertation]. Haliç University.
- Parasuraman, A., Zelthaml, V. A., & Berry L. L. (1985). A conceptual model of service quality and its implications for future. *Research Journal of Marketing*, 49(4), 41-50.
- Posdakoff, F.M. & MacKenzie, Z. B. (1994). Organizational citizenship behaviors and sales unit effectiveness. *Journal of Marketing Research*, 31(3). 351-363
- Pugh, D., Hickson, D., Hinings, C., & Turner, C. (1968). Dimension of organization structure. *Administrative Science Quarterly*, 13(1), 65-105. <https://doi.org/10.2307/2391262>
- Reimann, B. (1974). Dimensions of structure in effective organizations: Some empirical evidence. *The academy of Management Journal*, 17(4), 693-708.
- Robbins, S. P., & Judge, T. A. (2013). *Organizational behavior* (15th ed.). Nobel.
- Sargut, A. (2001). *Kültürler arası farklılaşma ve yönetim* (2. Baskı). İmge Kitabevi.
- Schaffer, J. D. (1986). *Competitive strategy, organization structure and performance in the lodging industry: An empirical assessment of Miles and Snow's (1978) Perspectives of Organizations* [Unpublished doctoral dissertation]. Virginia Polytechnic Institute and State University.
- Shoemaker, H., & El-Ahraf, A. (1983). Decentralization of nursing service management and its impact on job satisfaction. *Nursing Administration Quarterly*, 7(2), 69-76.
- Spector, P. (1997). *Job satisfaction* (1th ed.). Sage Publications.

- Srivastava, A., Locke, E., Judge, T., & Adams, J. (2010). Core self-evaluations as causes of satisfaction: The mediating role of seeking task complexity. *Journal of Vocational Behavior*, 77(2), 255-265.
- Şahin, B., Ateşoğlu, D., & Çiftçi, E. (2017). *Türkiye sağlık personeli memnuniyet araştırması* (1. Baskı). Sağlık Bakanlığı
- Seçer, İ. (2013). *SPSS ve LISREL ile pratik veri analizi* (1. Baskı). Arı Yayıncılık.
- Şimşek, Ö. (2007). *Yapısal eşitlik modellemesine giriş - Temel ilkeler ve Lisrel uygulamaları* (1. Baskı). Ekinoks.
- Tanner, B. (2007). *An analysis of the relationships among job satisfaction, organizational trust and organizational commitment in an acute care hospital* (Publication No. 3266765) [Published doctoral dissertation]. Saybrook University. <https://www.proquest.com/docview/304724983?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20%20Theses>
- Tekin, B. (2015). Sağlık hizmeti sistemlerinin etkinliği: Bir kamu hastanesi ve özel hastane karşılaştırması. *Çankırı Karatekin Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 6(1), 483-506.
- Tengilimoğlu, D., Işık, O., & Akbolat, M. (2014). Sağlık işletmeleri yönetimi (6. Baskı). Nobel.
- Tengilimoğlu, D., & Kılıç, M. (2004). Hastanelerde halkla ilişkiler: Sağlık Bakanlığı, üniversite, SSK ve özel hastane yöneticilerinin halkla ilişkiler uygulamalarına yönelik ampirik bir araştırma. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 22(2), 175-200.
- Tannenbaum, A. (1992). Organizational theory and organizational practice. *Management International Review*, 32, 50-62.
- Uğurluoğlu, Ö. (2015). Üniversite hastanelerinde uygulanan organizasyon yapılarının değerlendirilmesi. *İşletme Bilimi Dergisi*, 3(1), 52-63.
- Walton, E. (1981). The comparison of measures of organization structure. *The Academy of Management Review*, 6(1), 155-160.
- Weels, G. (1990). Influence of organizational structure on nurse manager job satisfaction. *Nursing Administration Quarterly*, 14(4), 1-8.
- Weiss, D., Dawis, R., England, G., & Lofquist, L. (1967). *Manual for the minnesota satisfaction questionnaire*. University of Minnesota, Industrial Relations Center. https://vpr.psych.umn.edu/sites/vpr.umn.edu/files/files/monograph_xxii__manual_for_the_mn_satisfaction_questionnaire.pdf
- West, M., Smith, H., Feng, W., & Lawthom, R. (1998). Research excellence and departmental climate in British Universities. *Journal of Occupational Psychology*, 71, 261-281.
- Zeitz, G. (1984). Bureaucratic role characteristics and member affective response in organizations. *The Sociological Quarterly*, 25(3), 301-318.
- Zerenler, M., & Ögüt, A. (2007). Sağlık sektöründe algılanan hizmet kalitesi ve hastane tercih nedenleri araştırması: Konya örneği. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi* 18, 501-519.

Electric Vehicle Routing Problem with Battery Swapping Stations in a Multi-Echelon Distribution Network

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Abstract

Increasing environmental considerations force the logistics sector to develop more environmentally friendly approaches. Thus, the concept of "green logistics" is becoming more crucial. The use of electric vehicles, which become prominent with their low energy consumption, less cost and environmentally friendly features, is a part of green logistics. Moreover, taking into consideration of multi-echelon distribution networks can also be effective in reducing the negative outcomes of urban logistics. In this context, the Two-Echelon Electric Vehicle Routing Problem with Battery Swapping Station (2E-E-VRP-BSS) is considered in this study. A Mixed Integer Programming (MIP) model is presented for the problem in which the total cost consisting of fixed cost, transportation cost, battery swapping cost and handling cost is minimized. To test the validity of the model, three different data sets, each of different sizes, simulating a realistic distribution network were created. In addition, sensitivity analyses were carried out in order to examine the impact of changes in customer demand and battery capacities of electric vehicles on optimal solutions. The analyses indicate the applicability of the model. The findings suggest that fluctuations in customer demand directly impact the total cost, with higher demand leading to increased costs and lower demand resulting in cost reductions compared to the base case scenario. Furthermore, there is a negative correlation between the battery capacity of electric vehicles and the total cost, meaning that as battery capacity increases, the overall cost tends to decrease.

Keywords: *Green Logistics, Sustainability, Multi-Echelon Distribution Network, Electric Vehicles, Two-Echelon Electric Vehicle Routing Problem.*



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1. INTRODUCTION

Global warming, air pollution, traffic accidents, noise, and other factors worldwide are causing environmental and social concerns. To address these issues and meet the demand for energy sources, there is a necessity to develop sustainable solutions in the transportation sector. Sustainable transportation requires the development of environmentally friendly, economical, and socially compatible systems. In this context, the concept of "Green Logistics" has been introduced with the aim of increasing the transportation sustainability by taking into account social and environmental concerns. Using electric vehicles instead of fossil fuel-based vehicles constitutes a considerable area of these green logistics efforts (Jie et al., 2019).

Electric vehicles, which stand out as an environmentally friendly option, have found their place not only in individual preferences but also in the transportation sector, with many logistics companies starting to use electric vehicles in their operations (Pelletier et al., 2016; Qin et al., 2021). The environmental advantages of electric vehicles, such as zero greenhouse gas emissions, reduced noise, and increased energy efficiency, might contribute logistics companies obtain a green image and even qualify for subsidies for environmental protection (Wang & Zhou, 2021). While past charging technologies for electric vehicles required several hours for a full charge, advancements in fast charging or battery swapping stations now enable energy replenishment within a very short time (Breunig et al., 2019). All processes related to replacing an almost exhausted battery with a fully charged battery can take under 10 minutes, which can be faster than charging the battery (Kim, 2011, as cited in Jie et al., 2019). Compared to charging stations, battery swapping stations can provide a faster solution by significantly reducing waiting times for charging, allowing vehicles to travel longer distances more efficiently and enabling more flexible route planning. In some cases, the battery swapping option can be more cost-effective than investing in charging infrastructure. It is particularly beneficial in rural areas where power grids and charging stations are insufficient, ensuring uninterrupted vehicle operations. Moreover, charging multiple electric vehicles simultaneously can place considerable strain on the energy grid. Battery swapping helps alleviate this issue by allowing depleted batteries to be recharged during off-peak hours, thereby reducing grid stress. Integrating battery swapping stations into routing problems is crucial for ensuring continuous and faster operations, lowering costs, improving customer satisfaction and significant competitive advantage. Therefore, this approach is an important and promising solution for logistics companies that have or aim to acquire electric vehicles in their fleets (Li, 2014).

One of the solutions developed to reduce/eliminate the social and environmental negative impacts of urban logistics is the use of two-echelon (multi-echelon) distribution networks. In such distribution systems, instead of delivering products directly from warehouses to customers, products are first delivered to satellites located outside the city center (the first echelon), and then from the satellites to customers (the second echelon). While large trucks are used in the first echelon of distribution,

relatively more environmentally friendly and smaller vehicles are preferred in the second echelon. This prevents the entry of large trucks into city centers and aims to solve some of the problems created by urban logistics, such as noise, traffic congestion, and environmental pollution (Li et al., 2018; Zhou et al., 2018). The Two-Echelon Vehicle Routing Problem (2E-VRP) is a type of problem aimed at determining vehicle routes that minimize objective functions such as total time, total distance, total fuel consumption, etc., for delivering products to customers in two-echelon distribution networks.

2E-VRP, compared to the Vehicle Routing Problem (VRP) referring to single-echelon distribution networks, is a more recent and therefore less researched area. The problem, when electric vehicles are utilised instead of fossil fuel-based vehicles in one or both echelons of distribution, is referred to as Two-Echelon Electric Vehicle Routing Problem (2E-E-VRP). Due to the limited driving range of electric vehicles depending on the capacities of their batteries, they need to be charged on the road or have their batteries replaced. This may require planned visits to charging stations or battery swapping stations, making the problem more challenging (Breunig et al., 2019; Goli et al., 2022; Wu & Zhang, 2023).

Studies focusing on VRPs have generally centered around traditional vehicles, with only a limited number of studies aiming to investigate routing problems for electric vehicles. Therefore, routing electric vehicles still require more attention and research (Agardi et al., 2019). Furthermore, although the number of studies on 2E-VRP is increasing, only a small part of them consider electric vehicles. In this context, this study was conducted with the motivation to address the challenges brought about by using of electric vehicles in routing problems and to contribute to the gap in the relevant literature. In the problem referred to as 2E-E-VRP-BSS, traditional vehicles are used in the first echelon, whereas electric vehicles with relatively lower load-carrying capacity and limited driving range are used in the second echelon. Thus, the distribution network includes a central warehouse, satellites, customers, and battery swapping stations. The objective of the problem is to set optimal routes for primary and secondary echelon vehicles to minimize the total cost, which consists of fixed costs of vehicles, transportation costs, battery swapping costs for electric vehicles, and handling costs at satellites. Sensitivity analyses were conducted in the research to examine the effects of changes in customer demand levels and battery capacities of electric vehicles on optimal solutions.

The contributions of this study are threefold: (1) We propose a 2E-E-VRP-BSS model that integrates battery swapping stations into a two-echelon logistics system, a relatively underexplored area in the literature. (2) We conduct extensive sensitivity analyses to assess the impact of key parameters such as customer demand fluctuations and battery capacity variations on cost efficiency. (3) We validate the model with realistic datasets and provide practical insights for logistics operators on optimal vehicle routing and BSS placement. By addressing these aspects, the study offers a structured framework for improving the efficiency of green logistics operations.

The study consists of six sections. The second section gives information about relevant studies from the literature. The problem definition and mathematical model are presented in the third section. The details of the application are conveyed in the fourth section titled "Application Design". Findings from the study are mentioned in the fifth section, and conclusions are given in the final section.

2. LITERATURE

Vehicle routing optimization is a heavily researched field that has been the subject of many studies in various sectors such as manufacturing and transportation (Agardi et al., 2019). Over time, various authors have studied new variants of the basic capacitated VRP by making changes to some of its assumptions. These variants include the multi-depot VRP, heterogeneous VRP, VRP with time-windows, periodic VRP, electric VRP (E-VRP), and 2E-VRP.

This study involves the intersection of two fundamental areas of VRPs – namely, 2E-VRP and E-VRP. In this context, particular emphasis will be placed on studies focusing on 2E-E-VRP.

2E-VRP studies, which represent a specialized form of multi-echelon distribution networks where products flow from a central warehouse to satellites and then to customers instead of directly from the central depot to customers, are increasingly gaining attention. 2E-VRP is a problem type addressed to solve some of the problems created by urban logistics, such as noise, traffic congestion, and environmental pollution. Distribution is carried out using large vehicles in the first echelon, while relatively smaller/environmentally friendly vehicles are used in the second echelon (Cuda et al., 2015; Soysal et al., 2015).

Two-echelon distribution networks, resulting from the interaction between the two tiers of the logistics network, involve more complex planning models and require coordination and synchronization of vehicle fleets and operations compared to single-echelon networks (Crainic & Sgalambro, 2014). Various exact solution methods and/or heuristic/metaheuristic algorithms have been presented for solving the 2E-VRP. From exact solution methods, one can observe studies utilizing dynamic programming (Baldacci et al., 2013; Wang et al., 2020), branch and cut algorithm (Jepsen et al., 2013; Perboli et al., 2009; Perboli et al., 2018; Wei et al., 2020), branch and price algorithm (Santos et al., 2013), logical constraint programming (Sitek & Wikarek, 2014), and various mathematical models (Babaei Tirkolaee et al., 2019; Babagolzadeh et al., 2019; Soysal et al., 2015). On the other hand, because of the NP-hardness of the problem (Belgin et al., 2018; Soysal et al., 2015; Wang et al., 2017), there are studies focusing on providing solutions through heuristic and/or metaheuristic algorithms such as fast clustering heuristic (Crainic et al., 2012), multi-start heuristic (Crainic et al., 2011), adaptive large neighborhood search heuristic (Grangier et al., 2016; Hemmelmayr et al., 2012; Zhou et al., 2024), island-based memetic algorithm (Bevilaqua et al., 2019), ant colony optimization algorithm (Meihua et al., 2011), and others. Cuda et al. (2015) and Sluijk et al. (2023) have conducted detailed examinations on 2E-VRP in their studies.

With increasing environmental awareness, there has been a shift towards using vehicles that operate with alternative fuels such as natural gas and biodiesel, which cause relatively lower greenhouse gas emissions in comparison of traditional fossil fuel-consuming vehicles. Additionally, the use of electric vehicles has become more widespread since the mid-2000s. As electric vehicles gradually integrate into distribution activities, E-VRP has emerged (Koç & Özceylan, 2018). The literature on E-VRP has been extensively examined by Pelletier et al. (2016), Erdelic and Caric (2019), Kucukoğlu et al. (2021), and Qin et al. (2021).

While there are numerous studies on the VRP and its versions in the literature, research specifically focusing on the 2E-E-VRP is quite limited. Agardi et al. (2019) analyzed the 2E-E-VRP in a distribution network comprising a central depot, satellites, customers, and charging stations for electric vehicles. They employed constructive and improvement heuristics to generate solutions, considering electric vehicles only in the second echelon. Breunig et al. (2019) proposed both exact mathematical programming and metaheuristic algorithms based on large neighborhood search to minimize the total cost. They conducted tests with various types of instances to analyze the performance of the recommended algorithms and concluded that the approach was beneficial. Jie et al. (2019) addressed electric vehicles with battery driving ranges, battery swapping costs, power consumption rates and varying load capacities. The authors recommended a hybrid algorithm incorporating an integer programming model and column generation with adaptive large neighborhood search in their study. Additionally, sensitivity analysis was conducted to investigate the interaction between battery driving range and vehicle emissions. Another study conducted by Wang et al. (2019) involved the delivery of products to customers using electric vehicles in a two-echelon distribution network. Considering time windows, the study aimed to minimize total costs encompassing transportation, handling, battery swapping, fixed, and penalty costs. Numerical experiments were conducted with randomly generated 14 instances to assess the effectiveness of the developed mixed integer linear programming (MILP) model. Li et al. (2020) focused on satellites located on streets in a two-echelon urban logistics system. They employed time windows and satellite transfer constraints to regulate interaction between the two echelons. Additionally, an economic analysis was performed on the difference between diesel and electric vehicles. In the study by Wang and Zhou (2021), the time-windows and battery replacement station-based 2E-E-VRP problem was addressed. Conventional vehicles were used in the first echelon of the distribution network, while electric vehicles were employed in the second echelon. They proposed a MILP model to minimize the total cost comprised of transportation costs for both echelon, fixed costs, handling costs at satellites, and battery swapping costs for electric vehicles. Additionally, they developed a metaheuristic procedure based upon the large neighborhood search algorithm to generate solutions for large instances. In another study by Akbay et al. (2022), focusing on a two-echelon distribution network where electric vehicles were used in the second echelon and considering time windows for customer deliveries, a MILP model was introduced to solve the problem. They proposed a

constructive heuristic algorithm based on the Clarke and Wright savings algorithm for solution generation. In the study by Goli et al. (2022), they developed the MILP model and improved moth-flame optimization algorithm for solving the problem where electric vehicles were routed in both echelons. They found that the algorithm had an approximate error of about 1.2% for small and medium-sized problems. Sensitivity analyses were made to observe the impact of changes in demand and time window parameters. In the study by Wu and Zhang (2023), where conventional vehicles were routed in the first-tier and electric vehicles in the second-tier, a column-generation algorithm was presented for solving the problem. The effectiveness of the algorithm was demonstrated using small and medium-sized examples. The study investigated the effect of the density of charging stations, battery capacity, and fixed costs of electric vehicles on the optimal solution. An overview on 2E-E-VRP is provided in Table 1, summarizing the type of problem addressed, solution method, objective function, and assumptions included in the studies.

Table 1. Studies on 2E-E-VRP

Author(s)	Acronym of Problem Studied	Acronym of Solution Method	Objective Function (Minimization)	Assumption Numbers
Agardi et al. (2019)	2E-VRP-RS	NNA, AIA HCA, GA	Route length	3, 4, 6
Breunig et al. (2019)	E-2E-VRP	MPA LNS	Total cost (fixed and travel costs)	3, 4, 6, 7, 8
Jie et al. (2019)	2E-CEVRP-BSS	IP, CGA ALNSA	Total cost (travel, handling and battery swapping costs)	2, 3, 5, 6, 7, 9
Wang et al. (2019)	2E-EVRP-TW-BSS	MILP	Total cost (travel, handling, battery swapping, fixed and penalty costs)	1, 3, 5, 6, 7
Li et al. (2020)	2E-CLS-OS	MILP VNSA SA	Total time (running times of vehicles and waiting times at customers) Total fuel consumption	1, 3, 6
Wang and Zhou (2021)	2E-EVRP-TW-BSS	MIP VNSA	Total cost (travel, fixed, handling and battery swapping costs)	1, 3, 5, 6, 7
Akbay et al. (2022)	2E-EVRP-TW	MILP, SA VNSA	Total distance	1, 3, 4, 6, 7
Goli et al. (2022)	E-2E-VRP	MILP IMFOA	Total cost (travel, handling and battery swapping costs)	1, 2, 3, 4, 6, 7
Wu and Zhang (2023)	E-2E-VRP	BPA, CGA LA	Total cost (fixed and travel costs)	3, 4, 6, 8
This study	2E-E-VRP-BSS	MIP	Total cost (fixed, travel, handling and battery swapping cost)	3, 5, 6, 7

***2E-VRP-RS:** Two-Echelon Vehicle Routing Problem with Recharge Stations, **E-2E-VRP:** Electric Two-Echelon Vehicle Routing Problem, **2E-CEVRP-BSS:** Two-Echelon Capacitated Electric Vehicle Routing Problem with Battery Swapping Stations, **2E-EVRP-TW-BSS:** Two-Echelon Electric Vehicle Routing Problem with Time Windows and Battery Swapping Stations, **2E-CLS-OS:** Two-Echelon City Logistics System with On-Street Satellites, **2E-EVRP-TW:** Two-Echelon Electric Vehicle Routing Problem with Time-Windows, **NNA:** The Nearest Neighbor Algorithm, **AIA:** Arbitrary Insertion Algorithm, **HCA:** Hill Climbing Algorithm, **GA:** Genetic Algorithm, **MPA:** Mathematical Programming Algorithm, **LNS:** Large Neighborhood Search, **IP:** Integer Programming, **CGA:** Column Generation Algorithm, **ALNSA:** Adaptive Large Neighborhood Search Algorithm, **MILP:** Mixed Integer Linear Programming, **VNSA:** Variable Neighborhood Search Algorithm, **SA:** Savings Algorithm, **MIP:** Mixed Integer Programming, **IMFOA:** Improved Moth-Flame Optimization Algorithm, **BPA:** Branch-and-Price Algorithm, **LA:** Labeling Algorithm, **1:** Time windows are present, **2:** Electric vehicles are used in the first echelon, **3:** Electric vehicles are used in the second echelon, **4:** Electric vehicles are charged, **5:** Batteries of electric vehicles are swapped, **6:** Electric vehicles have limited driving range, **7:** Charging or battery swapping facilities are available at depots and/or satellites, **8:** Sequential visits to charging stations are prevented, **9:** Primary and secondary echelon vehicles can use the same stations.

As mentioned before, the number of studies on 2E-E-VRP is quite limited. When Table 1 is examined, it is seen that the studies generally adopt heuristic or metaheuristic solution approaches. It is observed that almost all of the studies that address the exact solution method use the mixed integer linear programming model. Various objective functions are taken into account in the studies, but they generally focus on total cost minimization. These studies were built upon various assumptions, including the presence of time windows, the driving range limitations of electric vehicles, and the necessity for charging or battery replacement at specific intervals to ensure operational feasibility. Some studies assume that electric vehicles are used exclusively in the second echelon, while others consider their use in both echelons. Additionally, while some studies focus on charging electric vehicles, others incorporate battery swapping as an energy replenishment method. Despite the growing interest in electric vehicle routing problems in two-echelon distribution network, only three studies have incorporated the battery replacement approach. This indicates a significant research gap that requires further exploration to fully understand the implications of battery swapping on cost efficiency, route optimization and overall logistics performance. From this point of view, in addition to proposing a methodological framework, this research was undertaken to focus on a deeper understanding of the challenges associated with integrating the battery swapping approach of electric vehicles into multi-echelon logistics networks. By exploring how key factors such as customer demand fluctuations and battery capacity variations influence routing decisions and cost structures, we offer a more comprehensive perspective on the efficiency drivers in electric vehicle-based distribution networks. Moreover, this study bridges the gap between theory and practice by validating the model with realistic datasets in Turkey, ensuring that the findings reflect real-world operational conditions. Through this in-depth analysis, we not only highlight the critical constraints and trade-offs in electric vehicle routing but also provide valuable insights for optimizing sustainable logistics strategies.

3. 2E-E-VRP-BSS DEFINITION AND MODEL FORMULATION

The problem definition and MIP model for 2E-E-VRP-BSS are presented in this section of the study.

3.1. Problem Definition

In the problem considered in the study, product deliveries are made from a central depot to a set of customers through a certain number of satellites. In the distribution network consisting of two echelons, in the first echelon, deliveries are made from the central depot to the satellites; in the other echelon, deliveries are made from the satellites to the customers. While travels between satellites are allowed in the first echelon, they are prevented in the second echelon. In the problem given on a complete network $G(V, A)$, there is one central depot ($V_0 = 0$), a certain number of satellites ($V_U = \{1, 2, \dots, u\}$), customers ($V_M = \{1, 2, \dots, m\}$) and battery swapping stations ($V_B = \{1, 2, \dots, b\}$). A_1 and A_2 respectively denote the sets of arcs for the first and second echelons ($A_1 = \{(i, j) \mid i, j \in V_0 \cup V_U, i \neq j\}$).

$j\}$, $A_2=\{(i, j) \mid i, j \in V_U \cup V_M \cup V_B, i \neq j\} \setminus A_2'$, $A_2' = \{(i, j) \mid i, j \in V_U\} \cup \{(i, j) \mid i, j \in V_B\}$. In the first echelon of distribution, conventional vehicles start their route from the depot, visit one or more satellites, and then return back to the depot. In the second echelon, electric vehicle travelling starts from a satellite, may stop at a battery swapping station if necessary, visit one or more customers, and then return back to the same satellite. In the first echelon of distribution, multiple vehicles can visit a single satellite, but a vehicle cannot visit the same satellite more than once. In the second echelon, each customer is prevented from being visited by multiple vehicles. $K^1=\{1,2,\dots,k^1\}$ and $K^2=\{1,2,\dots,k^2\}$ define the sets, E^1 and E^2 denote the capacities, while f^1 and f^2 represent the fixed costs of first and second echelon vehicles, respectively. Satellite capacities are expressed by the number of vehicles that can be directed from there, and k_u^2 symbolizes the maximum number of second echelon vehicles that can be used at each satellite. Handling costs arise from unloading products from first echelon vehicles at the satellites and loading them onto second echelon vehicles. In this context, h_u represents the unit handling cost at satellite u . The customer demand quantities, denoted by t_i , are deterministic and known in advance.

d_{ij} represents the distance between nodes i and j . c_{ij}^1 and c_{ij}^2 are the travel costs for primary and second echelon vehicles, respectively. r^2 denotes the charge consumption rate of the electric vehicle in the second echelon. It is assumed that travel costs and charge consumption rate are linear functions of distance ($\alpha, \beta, \theta > 0$, $c_{ij}^1 = \alpha \cdot d_{ij}$ ($i, j \in A_1$), $c_{ij}^2 = \beta \cdot d_{ij}$ ($i, j \in A_2$), $r_{ij}^2 = \theta \cdot d_{ij}$ ($i, j \in A_2$)). s^2 represents the battery swapping cost for the electric vehicles, while W^2 denotes the battery capacity.

It is assumed that the electric vehicles' battery is fully charged whenever they visit any satellite or battery swapping station. Sequential visits to battery swapping stations are prohibited. Each satellite and battery swapping station in the distribution network do not have to be utilized.

To assist the reader, all the notations used in the problem are demonstrated in Table 2. The distribution network example of 2E-E-VRP-BSS is illustrated in Figure 1.

Figure 1 represents the central depot as a square, satellites as hexagons, customers as circles, and battery swapping stations as triangles. Additionally, the numbers on the arcs indicate the distance between two nodes, while the numbers on the vehicle indicate the driving range (battery capacity) when departing from the respective node. In the first echelon, load distribution is carried out from the central depot to the satellites. In the second echelon, distribution is directed from the satellites to the customers for delivery. During the second echelon of distribution, the vehicle serving customers 6, 7, and 8 departs from the satellite with a fully charged battery (driving range = 65,000 m). The vehicle first delivers products to customer 6. Upon departing from this customer, the battery capacity is reduced to 45,000 m ($65,000 - 20,000$, $\theta=1$). Since the battery would not be sufficient, the vehicle visits customer 7 and then stops at a battery swapping station, where a battery replacement is performed. After leaving the station

with a fully charged battery, the vehicle continues its route, delivers products to customer 8, and then returns to the satellite point where it started, completing its route.

Figure 1. An Example of 2E-E-VRP-BSS Distribution Network

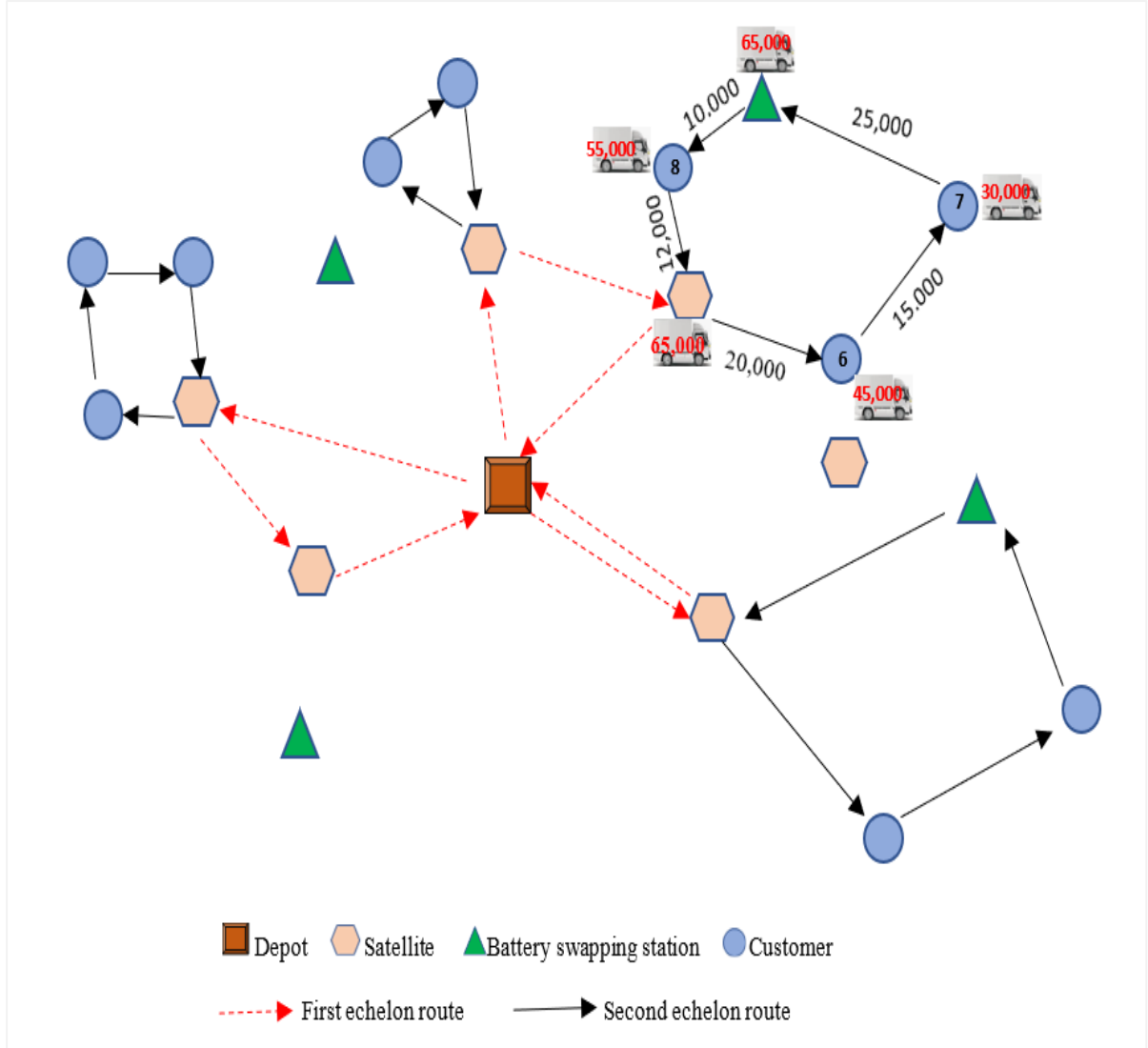


Table 2. Sets, Parameters and Decision Variables in the 2E-E-VRP-BSS Model

Group	Symbol	Definition
Sets	V_0	Depot, $V_0=\{0\}$
	V_U	Sets of satellites, $V_U=\{1,2,\dots,u\}$
	V_M	Sets of customers, $V_M=\{1,2,\dots,m\}$
	V_B	Sets of battery swapping stations, $V_B=\{1,2,\dots,b\}$
	V_1	$V_0 \cup V_U$
	V_2	$V_U \cup V_B \cup V_M$
	A_1	Sets of the first echelon arcs, $A_1=\{(i,j) \mid i,j \in V_0 \cup V_U, i \neq j\}$
	A_2	Sets of the second echelon arcs, $A_2=\{(i,j) \mid i,j \in V_U \cup V_M \cup V_B, i \neq j\} \setminus A_1', A_1' = \{(i,j) \mid i,j \in V_U\} \cup \{(i,j) \mid i,j \in V_B\}$
	K^1	Sets of the first echelon vehicles, $K^1=\{1,2,\dots,k^1\}$
	K^2	Sets of the second echelon vehicles, $K^2=\{1,2,\dots,k^2\}$

(Table 2 cont.)

Group	Symbol	Definition
Parameters	k^1	Number of first echelon vehicles
	k^2	Number of second echelon vehicles
	k_u^2	Maximum number of second echelon vehicles that can be routed at the satellite u , $u \in V_U$
	h_u	Unit handling cost at satellite u , $u \in V_U$
	E^1	Vehicle capacity of first echelon vehicles
	E^2	Vehicle capacity of second echelon vehicles
	f^1	Fixed cost of first echelon vehicles
	f^2	Fixed cost of second echelon vehicles
	t_i	Demand of customer i , $i \in V_M$
	c_{ij}^1	Transportation cost of first echelon vehicle travels on arc (i, j) , $(i, j) \in A_1$
	c_{ij}^2	Transportation cost of second echelon vehicle travels on arc (i, j) , $(i, j) \in A_2$
	d_{ij}	Distance of arc (i, j)
	r_{ij}^2	Charge consumption rate of electric vehicles on arc (i, j)
	s^2	Battery swapping cost of electric vehicles
	W^2	Battery capacity of electric vehicles
Decision Variables	x_{ijk}	Binary decision variable that takes a value of 1 if vehicle k travels from i to j , and 0 otherwise, $(i, j) \in A_1$, $k \in K^1$
	v_{uk}	Amount of cargo transported to satellite u by vehicle k , $u \in V_U$, $k \in K^1$
	z_{ijk}^1	The load on vehicle k when departing from node i , $(i, j) \in A_1$, $k \in K^1$
	$y_{iju k}$	Binary decision variable that takes a value of 1 if vehicle k dispatched from satellite u travels from node i to j , and 0 otherwise, $(i, j) \in A_2$, $u \in V_U$, $k \in K^2$
	q_u	The total demand transported from satellite u , $u \in V_U$
	$z_{iju k}^2$	The load on vehicle k when departing from node i directed from satellite u , $(i, j) \in A_2$, $u \in V_U$, $k \in K^2$
	p_{iuk}^{2+}	The residual battery power when the vehicle k directed from satellite u arrives at node i in the second echelon
	p_{iuk}^{2-}	The residual battery power when the vehicle k directed from satellite u departs from node i in the second echelon

3.2. Mathematical Model

The 2E-E-VRP-BSS model inspired by the studies of Jepsen et al. (2013), Jie et al. (2019), and Wang et al. (2019) is presented below.

$$\begin{aligned} \text{Min} \sum_{k \in K^1} \sum_{(i, j) \in A_1} c_{ij}^1 x_{ijk} + \sum_{k \in K^2} \sum_{u \in V_U} \sum_{(i, j) \in A_2} c_{ij}^2 y_{iju k} + \sum_{k \in K^1} \sum_{j \in V_U} f^1 x_{0jk} + \\ \sum_{k \in K^2} \sum_{u \in V_U} \sum_{(u, j) \in A_2} f^2 y_{uju k} + \sum_{k \in K^2} \sum_{u \in V_U} \sum_{i \in V_B} \sum_{j \in V_U} s^2 y_{iju k} + \sum_{u \in V_U} h_u q_u \end{aligned} \quad (1)$$

subject to

$$\sum_{(i, j) \in A_1} x_{ijk} = \sum_{(i, j) \in A_1} x_{jik} \quad \forall i \in V_1, k \in K^1 \quad (2)$$

$$\sum_{(i, j) \in A_1} x_{ijk} \leq 1 \quad \forall j \in V_0 \cup V_U, k \in K^1 \quad (3)$$

$$v_{ik} = \sum_{(i,j) \in A_1} z_{jik}^1 - \sum_{(i,j) \in A_1} z_{ij k}^1 \quad \forall i \in V_U, k \in K^1 \quad (4)$$

$$z_{ij k}^1 \leq E^1 x_{ijk} \quad \forall (i,j) \in A_1, k \in K^1 \quad (5)$$

$$\sum_{(i,j) \in A_1} z_{ij k}^1 \leq 0 \quad \forall j \in V_0, k \in K^1 \quad (6)$$

$$\sum_{k \in K^1} v_{ik} = q_i \quad \forall i \in V_U \quad (7)$$

$$\sum_{k \in K^2} \sum_{u \in V_U} \sum_{(i,j) \in A_2} y_{ijuk} = 1 \quad \forall j \in V_M \quad (8)$$

$$\sum_{(i,j) \in A_2} y_{ijuk} = \sum_{(i,j) \in A_2} y_{jiuk} \quad \forall i \in V_2, u \in V_U, k \in K^2 \quad (9)$$

$$\sum_{u \in V_U} \sum_{(u,j) \in A_2} y_{ujuk} \leq 1 \quad \forall k \in K^2 \quad (10)$$

$$\sum_{\bar{u} \in V_U \setminus \{u\}} \left(\sum_{(u,j) \in A_2} y_{uj\bar{u}k} + \sum_{(i,u) \in A_2} y_{i\bar{u}k} \right) = 0 \quad \forall u \in V_U, k \in K^2 \quad (11)$$

$$\sum_{k \in K^2} \sum_{(u,j) \in A_2} y_{ujuk} \leq k_u^2 \quad \forall u \in V_U \quad (12)$$

$$\sum_{k \in K^2} \sum_{u \in V_U} \sum_{(u,j) \in A_2} y_{ujuk} \leq k^2 \quad (13)$$

$$\sum_{k \in K^2} \sum_{u \in V_U} \sum_{(i,j) \in A_2} z_{ijuk}^2 = \sum_{k \in K^2} \sum_{u \in V_U} \sum_{(i,j) \in A_2} z_{jiuk}^2 - t_i \quad \forall i \in V_M \quad (14)$$

$$\sum_{(i,j) \in A_2} z_{ijuk}^2 = \sum_{(i,j) \in A_2} z_{jiuk}^2 \quad \forall i \in V_B, u \in V_U, k \in K^2 \quad (15)$$

$$z_{ijuk}^2 \leq E^2 y_{ijuk} \quad \forall (i,j) \in A_2, u \in V_U, k \in K^2 \quad (16)$$

$$q_u = \sum_{k \in K^2} \sum_{(u,j) \in A_2} z_{ujuk}^2 \quad \forall u \in V_U \quad (17)$$

$$\sum_{u \in V_U} q_u = \sum_{i \in V_M} t_i \quad (18)$$

$$p_{iuk}^2 = W^2 \quad \forall i \in V_U \cup V_B, u \in V_U, k \in K^2 \quad (19)$$

$$p_{iuk}^2 = p_{iuk}^+ \quad \forall i \in V_M, u \in V_U, k \in K^2 \quad (20)$$

$$p_{juk}^{2+} \leq p_{juk}^{2-} - r_{ij}^2 y_{juk} + W^2 (1 - y_{juk}) \quad \forall (i, j) \in A_2, u \in V_U, k \in K^2 \quad (21)$$

$$p_{juk}^{2+} \geq p_{juk}^{2-} - r_{ij}^2 y_{juk} - W^2 (1 - y_{juk}) \quad \forall (i, j) \in A_2, u \in V_U, k \in K^2 \quad (22)$$

$$x_{ijk} \in \{0, 1\} \quad \forall (i, j) \in A_1, k \in K^1 \quad (23)$$

$$y_{juk} \in \{0, 1\} \quad \forall (i, j) \in A_2, u \in V_U, k \in K^2 \quad (24)$$

$$v_{uk} \geq 0 \quad \forall u \in V_U, k \in K^1 \quad (25)$$

$$q_u \geq 0 \quad \forall u \in V_U \quad (26)$$

$$z_{ijk}^1 \geq 0 \quad \forall (i, j) \in A_1, k \in K^1 \quad (27)$$

$$z_{juk}^2 \geq 0 \quad \forall (i, j) \in A_2, u \in V_U, k \in K^2 \quad (28)$$

$$p_{uk}^{2+} \geq 0 \quad \forall i \in V_U \cup V_M \cup V_B, u \in V_U, k \in K^2 \quad (29)$$

$$p_{uk}^{2-} \geq 0 \quad \forall i \in V_U \cup V_M \cup V_B, u \in V_U, k \in K^2 \quad (30)$$

The objective function, denoted by (1), minimizes the total cost, comprising of first and second-echelon transportation costs, fixed costs of first and second-echelon vehicles, battery swapping costs for second echelon vehicles, and handling costs at satellites. Constraints (2) -(6) concern the first echelon. Constraints (7) relate to the synchronization of the first and second echelons. Constraints (8) -(22) pertain to the second echelon. Additionally, constraints (19) -(22) regulate the battery powers of second echelon electric vehicles. Constraints related to defining decision variables are provided in (23) -(30). Constraints (2) regulate flow conservation for vehicles. Constraints (3) indicate that each first echelon vehicle can visit depots and satellites at most once. The load flow of each vehicle at satellites is regulated through constraints (4). Constraints (5) guarantee that capacity of vehicles are not exceeded. Constraints (6) mandate that each vehicle must distribute all its load upon returning to the depot. Constraints (7) balance the flow of goods in satellites by equalizing the amount of goods coming from the first echelon and distributed to the second echelon. Each customer is ensured to be visited exactly once through constraints (8). Constraints (9) ensure flow conservation for second echelon vehicles. The constraints (10) allow second echelon vehicles to go out for distribution at most once. Constraints (11) prevent vehicles in the second echelon from traveling from satellite to satellite. The number of satellites and vehicles available in the second echelon is regulated by constraints (12) -(13). Constraints (14) -(15) guarantee flow conservation at customers and battery swapping stations. Second echelon vehicle capacities are controlled through constraints (16). Constraints (17) -(18) regulate the quantity of products sent from satellites. Constraints (19) ensure that the battery of a second echelon vehicle is fully charged when it leaves a satellite or a battery swapping station. Constraints (20) ensure that the battery power remains the same for each second echelon electric vehicle when visiting a customer. Constraints (21) -(22) control the battery powers of electric vehicles traveling from node i to node j . These

constraints guarantee that electric vehicles have enough battery power to travel remaining customers and return back to the satellite.

4. APPLICATION DESIGN

Applications using real/realistic data can contribute to the generalization of results by reflecting practical difficulties beyond theoretical models. More concrete and applicable strategies can be created. Studies with real/realistic data are important to test the validity of theoretical findings in practice. Therefore, the datasets used in this research were designed to simulate realistic multi-echelon distribution networks with electric vehicles and battery swapping stations to ensure the generalizability of the findings and test the accuracy of the model. For this purpose, three different datasets, each representing the real distribution network of a health and personal care products company operating in Türkiye with varying sizes, have been considered. This diversity allows for analyzing the model's performance under various operational conditions, including different numbers of customers, satellites and battery swapping stations.

In the first dataset, there is 1 depot, 2 satellites, 2 battery swapping stations, and 5 customers. The second dataset consists of 1 depot, 3 satellites, 3 battery swapping stations, and 8 customers. Finally, the third dataset includes 1 depot, 4 satellites, 4 battery swapping stations, and 11 customers. The number of batteries swapping stations has been determined based on the recommendation in the literature, which suggests that the number of batteries swapping stations should be $1/5$ of the total number of nodes in the distribution network (Schneider et al., 2014). The locations of nodes (depot, satellites, battery swapping stations, and customers) have been determined using the central depot of the company, along with intermediate depots and store locations in three metropolitan cities, as reference points. These locations have been randomly marked on a map to ensure distributed representation. Distances between nodes have been obtained from Google Maps, ensuring geographical accuracy.

The numbers of primary and second echelon vehicles are, respectively, 2 and 4 for dataset 1, 3 and 6 for dataset 2, and 4 and 8 for dataset 3. The maximum number of second echelon vehicles that can be used at satellites is the same for each dataset. Traditional vehicles are utilized in the first echelon of distribution, while in the second echelon, relatively smaller and thus environmentally friendly electric vehicles with lower carrying capacities are used. The data on vehicle capacities and purchase prices (fixed costs) were sourced from sahibinden.com, an online marketplace in Türkiye, ensuring that the values reflect real-world market conditions (Sahibinden, n.d.). The capacity of the first echelon vehicle is 3,500 kg for all datasets, while the capacity of the second echelon vehicle is 1,700 kg. The fixed costs of the first and second echelon vehicles are 3,400,000 TL and 2,100,000 TL, respectively, for all datasets.

Since obtaining precise real-world data for certain parameters is challenging, some values were selected randomly, while others were derived from relevant literature. Customer demands have been

randomly generated to not exceed vehicle capacities, within the range of (0, 1700]. Customer demand quantities for each dataset are presented in Table 3 below. The handling cost per unit at all satellites is 5 TL. To the best of our knowledge, there are no battery swapping stations in Türkiye. Therefore, the battery swapping cost was chosen randomly. The battery swapping cost for electric vehicles is 1,000 TL. The battery capacities of electric vehicles have been considered to be 1.3 times the maximum second echelon distance in the distribution network (Jie et al., 2019; Schneider et al., 2014). For all datasets, α , β , and θ values are taken as 1 (Jie et al., 2019).

Table 3. Customer Demand Quantities (kg)

Data Set	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	Total
1	800	600	300	1,000	1,300	-	-	-	-	-	-	4,000
2	1,200	300	1,000	500	300	900	500	400	-	-	-	5,100
3	500	700	200	300	1,000	350	250	400	900	100	150	4,850

* **M:** Customer

5. RESULTS OF ANALYSIS

The optimal results of three different-sized samples, whose details were shared in the previous section, are presented in this section. These analyses are referred to as "base case analysis" throughout the rest of the study. In addition to the base case analysis, sensitivity analyses were conducted to examine whether changes in customer demand quantities and battery capacities of electric vehicles affect the optimal results, and to what extent and in which direction. The relevant results are discussed in subsections 5.2 and 5.3.

The solutions were obtained using SolverStudio (SolverStudio, n.d.) and Gurobi 11.0.0 (Gurobi, n.d.) programs on a computer equipped with an Intel(R) i7 processor running at 2.4 GHz and 6 GB of memory.

5.1. Base Case Analysis

Optimal results for all datasets were obtained within reasonable timeframes. Table 4 presents these optimal results, showing vehicle routes, product transportation amounts, and battery power levels at different nodes.

Upon examining Table 4, it can be observed that in the optimal solutions of dataset 1, all vehicles in the first echelon and three out of four vehicles in the second echelon are utilized for distribution. Both satellites in the distribution network are utilized. More goods are delivered to satellite point 2 in the first echelon compared to the other satellite point, and more vehicles serve from this satellite point in the second echelon. Since the battery capacities of the vehicles are sufficient, all customer demands have been met without the need to visit any battery swapping stations. The total cost, consisting of transportation costs, fixed costs of vehicles, battery swapping costs for electric vehicles, and handling costs of products at satellites, is found to be 14,943,300 TL.

Table 4. Base Case Optimum Results

Data Set	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)
1	14,943,300	K1	D-U1-D	1,400-0	-
		K2	D-U2-D	2,600-0	-
		E1	U1-M1-M2-U1	1,400-600-0	37,180-32,480-21,280-4,180
		E2	U2-M4-U2	1,000-0	37,180-27,780-18,680
		E4	U2-M5-M3-U2	1,600-300-0	37,180-22,680-15,280-2,380
2	14,788,300	K2	D-U2-D	3,400-0	-
		K3	D-U1-D	1,700-0	-
		E2	U2-M6-M5-M7-U2	1,700-800-500-0	53,430-46,530-39,430-29,730-22,930
		E4	U2-M3-M2-B3-M8-U2	1,700-700-400-400-0	53,430-38,530-27,730-53,430-44,630-31,730
		E6	U1-M4-M1-U1	1,700-1,200-0	53,430-37,030-30,730-19,230
3	13,428,950	K2	D-U3-D	1,700-0	-
		K3	D-U2-D	3,150-0	-
		E1	U2-M8-M5-M4-U2	1,700-1,300-300-0	93,990-77,090-70,690-57,690-53,490
		E2	U3-M1-M2-M7-M10-M11-U3	1,700-1,200-500-250-150-0	93,990-84,090-59,690-36,290-26,390-21,490-12,790
		E8	U2-M9-M6-M3-U2	1,450-550-200-0	93,990-83,890-81,790-65,490-59,590

* **K**: First-echelon vehicle, **E**: Second-echelon vehicle, **D**: Depot, **U**: Satellite, **B**: Battery swapping station, **M**: Customer

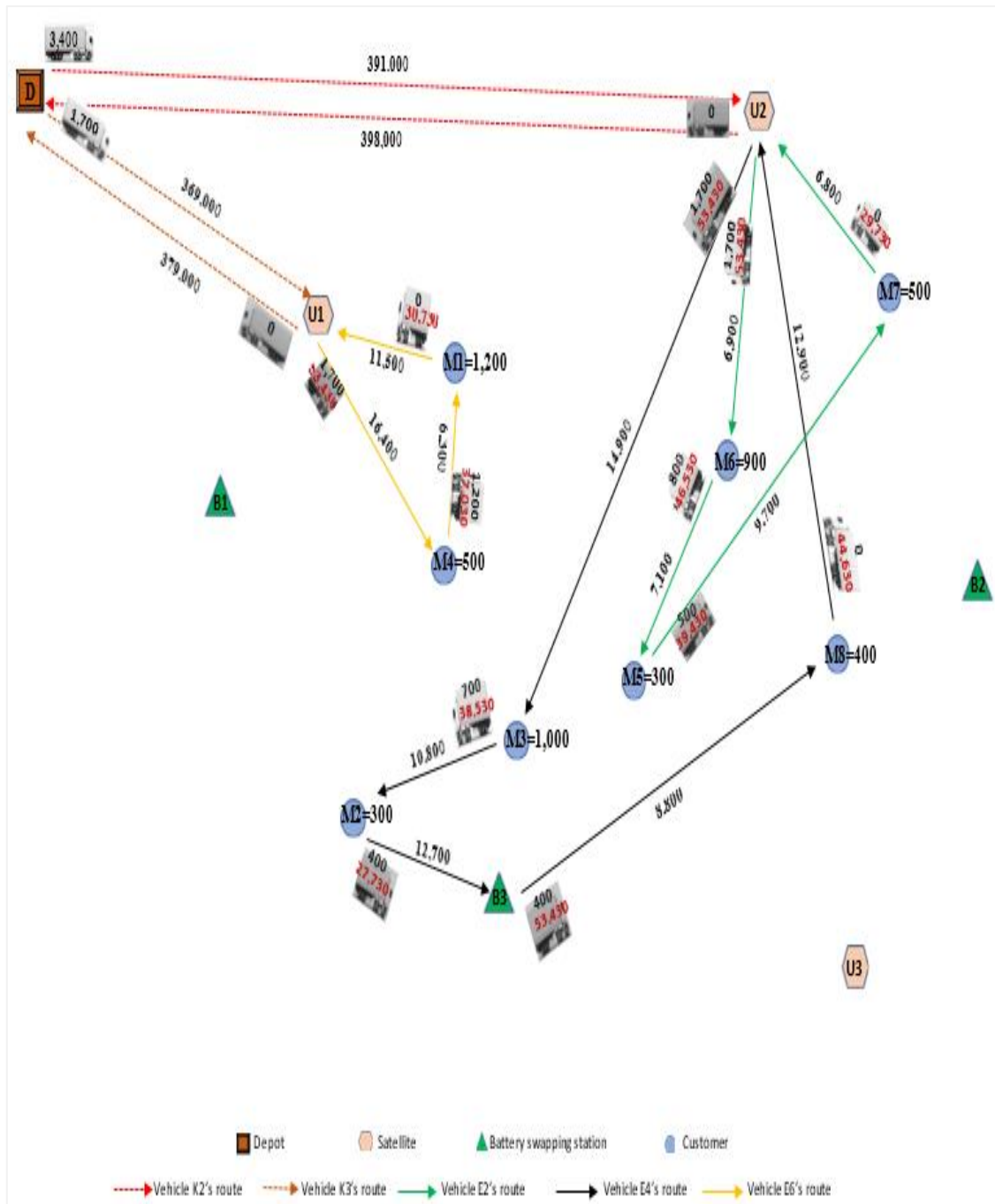
In the optimal results for dataset 2, it is observed that 2 out of 3 first echelon vehicles and 3 out of 6 second echelon vehicles are deployed for distribution. Satellite 3 in the distribution network is not utilized. In other words, no goods have been transported to this point in the first echelon, and therefore, there is no flow of goods from here to the second echelon. In the second echelon, it is observed that 2 out of 3 vehicles originate from satellite 2. All second echelon vehicles start their routes fully loaded. After servicing customer 2, second echelon vehicle 4 visits battery swapping station 3 due to insufficient battery capacity, replenishes its battery to full capacity (53,430 m), and continues its route. The optimal total cost is 14,788,300 TL.

The optimal results for dataset 3 show that 2 first echelon vehicles and 3 second echelon vehicles are utilized, resulting in an optimal total cost of 13,428,950 TL. Out of the 4 satellite points in the distribution network, only two (U2 and U3) are utilized. More goods are delivered to satellite point 2, and consequently, more vehicles serve from there. Similar to the results of dataset 1, the vehicles complete their routes without the need to visit any battery swapping stations.

In order for the reader to interpret the results more easily, the optimal routes of vehicles for dataset 2 are shown in Figure 2 as an example. In the Figure, the black numbers on the vehicles represent the amount of load in the vehicle and the red numbers represent the battery capacity, in other words, the driving range, when leaving the relevant node. The numbers on the blue circles representing customer

locations show the customer demand amounts. The numbers on the arcs indicate the distance between two nodes.

Figure 2. Representation of Optimal Routes for Data Set 2

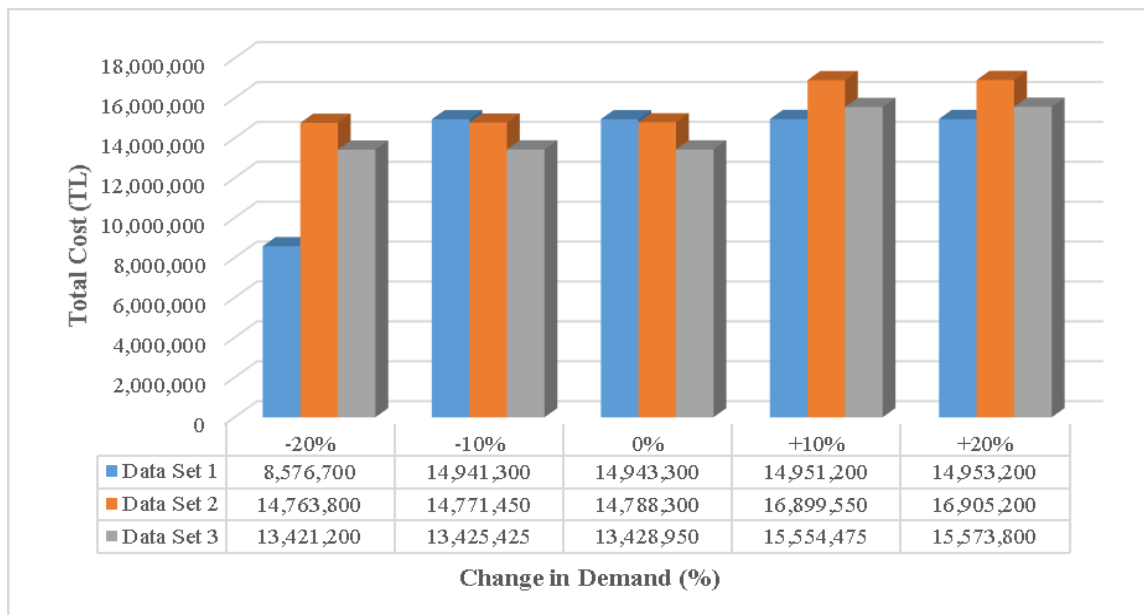


5.2. Effect of Change in Demand Quantities

The variation of parameters within the VRP can significantly impact the optimal solutions. Among these parameters, customer demand plays a crucial role in shaping distribution costs. An increase in demand leads to a higher load per vehicle, potentially exceeding the existing fleet capacity and necessitating the deployment of additional vehicles. Furthermore, as vehicles operate under heavier

loads, fuel consumption rises, which may be particularly critical for electric vehicles, as it accelerates battery depletion, requiring more frequent stops for recharging or battery replacement. Consequently, an increase in demand not only escalates fixed costs but also raises fuel, driver, handling and maintenance costs, among others. In extreme cases, it may even render certain solutions infeasible. Conversely, a decrease in demand can have the opposite effect, leading to improved cost efficiency and greater feasibility in routing solutions. In this context, sensitivity analyses have been conducted for each dataset to examine the effect of changes in demand on the total cost. Sensitivity analyses were performed by varying the demand quantity for all customers within the range of -20% to +20%. The determination of this range was based on the research of Goli et al. (2022). Moreover, if the demand quantity increase for Dataset 1 exceeds 30.77%, it will result in insufficient vehicle capacity and lead to an infeasible solution. Detailed results for the optimal solutions are provided in Tables A1, A2, and A3 for datasets 1 to 3, respectively, in the appendix. The change in total cost due to demand variation is summarized in Figure 3.

Figure 3. Change in Total Cost Depending on Demand



According to the results, as expected, it is observed that an increase/decrease in demand quantity causes to a corresponding increase/decrease in total cost compared to the base case for all datasets. The most significant change in the objective function value is caused by a 20% decrease in demand for dataset 1, while for datasets 2 and 3, it is caused by a 20% increase in demand. In this context, it can be said that dataset 1 is more sensitive to negative changes in demand, while datasets 2 and 3 are more sensitive to positive changes in demand.

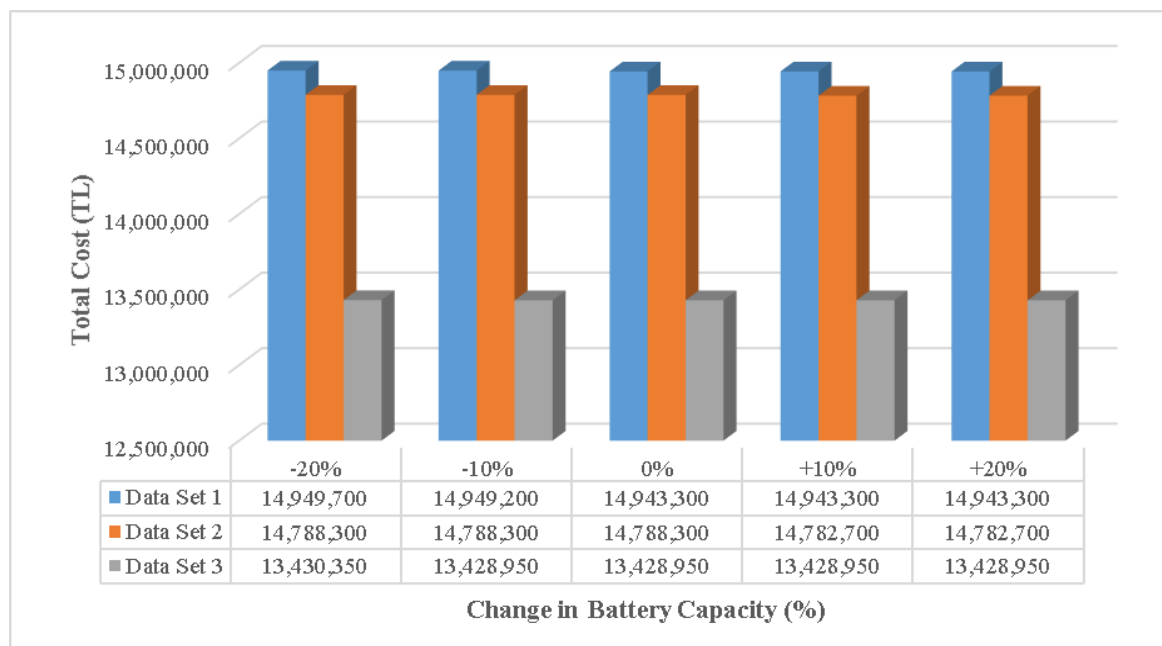
In cases where demand changes are highly sensitive, both the number of vehicles used and the vehicle routes have changed. Except for a 10% increase in demand for datasets 2 and 3, other percentage

changes in demand have resulted in minor changes in the objective function values without causing any changes in the number of vehicles or routes.

5.3. Effect of Change in Battery Capacities

Changes in the battery capacities (driving ranges) of electric vehicles can affect vehicle routes and thus the objective function value. A higher battery capacity enables vehicles to travel longer distances, thereby reducing the frequency of energy replenishment. In regions with limited charging infrastructure, high-capacity batteries offer a significant advantage by mitigating the challenges associated with insufficient charging or swapping stations. Moreover, a reduced need for charging can enhance operational efficiency by minimizing delays caused by energy replenishment times. Given these factors, an increase in battery capacity can contribute to both cost reduction and improvements in overall operational efficiency. On the other hand, as the battery capacities of vehicles decrease, they will need to visit charging stations or battery swapping stations more frequently. Consequently, vehicles will be able to make fewer customer visits on their routes, more frequent energy replenishment, longer travel distances, experience more time loss and more costly operations. In this context, sensitivity analysis was conducted by varying the battery capacities of second echelon electric vehicles within the range of -20% to +20% for all datasets to analyze the impact of changes in battery capacities on the total cost. In choosing this range, the knowledge that decreases in battery capacity exceeding 30% compared to the base case in all data sets will lead to infeasible results was utilized. Detailed optimal results are provided in Tables A4 to A6 for datasets 1 to 3, respectively, in the appendix. The change in total cost due to battery capacity variation is summarized in Figure 4.

Figure 4. Total Cost Change Depending on Battery Capacity



Upon examining the relevant tables and figure, in dataset 1, increases in battery capacities have not changed the total cost. However, decreases in battery capacities have led to an increase in the total cost, creating a reverse situation. Although the decreases in battery capacities have not changed the number of vehicles used, changes in routes are observed. Additionally, while there was no need to visit any battery swapping stations in the base case, a 20% decrease in capacity necessitated a visit to the station. In dataset 2, unlike dataset 1, an increase in battery capacities has resulted in a decrease in the total cost, while decreases in battery capacities have not changed the total cost. In the base case, an electric vehicle visits the battery swapping station, but with an increase in capacity, it completes its route without the need to visit the station. In dataset 3, a change in the total cost occurred only with a 20% decrease in battery capacity. Here, with the decrease in capacity, the vehicle had to visit the battery swapping station, leading to an increase in the total cost. It can be said that there is an inverse relationship between the battery capacity of electric vehicles and the total cost.

In conclusion, the sensitivity analysis indicates that customer demand levels and the battery capacities of electric vehicles may significantly impact both fixed and variable costs. These parameters may influence critical factors such as the number of vehicles required, vehicle routes, energy consumption, and energy replenishment frequency, all of which can directly or indirectly affect overall costs. Analyzing the sensitivity of total costs to customer demand and battery capacity enables logistics companies to improve operational efficiency, reduce expenses, and establish a more sustainable distribution network. By leveraging these insights, companies can implement dynamic route optimization, ensuring that delivery schedules and fleet deployment adapt to fluctuations in demand. Additionally, flexible fleet management allows for optimal utilization of available vehicles, preventing underutilization during low-demand periods and avoiding capacity shortages during peak times. Furthermore, strategic investment decisions regarding battery capacity and charging infrastructure can be optimized, ensuring cost-effective and energy-efficient operations. Ultimately, integrating sensitivity analysis into decision-making processes helps logistics companies maintain resilience, minimize financial risks, and improve overall service quality in an increasingly competitive and environmentally conscious market.

6. CONCLUSION

Sustainability-focused VRPs aim to optimize transportation operations to minimize their environmental and social impacts. Towards these objectives, studies in the literature consider fuel consumption and/or carbon emissions, use environmentally friendly vehicles such as electric vehicles instead of traditional vehicles, or consider multi-echelon distribution networks. As far as is known, there are limited studies focusing on optimizing the routes of electric vehicles in two-echelon distribution network. To contribute to this gap in the literature, the 2E-E-VRP-BSS was addressed in this study. In the study, which considers the battery capacities of electric vehicles with limited driving range, a MIP model was proposed to minimize the total cost. To test the accuracy of the model, three different datasets

were created, each representing a realistic distribution network of different sizes. Additionally, sensitivity analyses were conducted to examine whether customer demands and the battery capacities of electric vehicles affect the optimal solutions, and if so, in what direction. Sensitivity analyses were performed by varying customer demands and electric vehicle battery capacities within the range of -20% to +20% for all datasets. The results indicate that increases/decreases in customer demand lead to corresponding increases/decreases in the total cost in comparison with the base case scenario. Furthermore, there is an inverse relationship between the battery capacity of electric vehicles and the total cost.

From a managerial perspective, this research can contribute to companies in managing their vehicle fleets, increasing operational efficiency, improving service quality, reducing costs and establishing a more sustainable distribution network.

The limitations of this study are that the findings are valid within the framework of the assumptions used in the modeling and the data sets in the application. Although the application was made on real data as much as possible, precise data could not be used for some parameters and some were derived hypothetically. Since the method adopted in the study was MIP, the application was made on small/medium-sized samples and the findings were obtained.

In the future, researchers in this field may consider incorporating customer service times, battery replacement times, and station capacities into their studies. Researchers may propose heuristic/metaheuristic methods to generate solutions for large-scale problems. Different sensitivity analyses can be performed to analyze the impact of various factors such as the number and location of battery swapping stations.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

Agardi, A., Kovacs, L., & Banyai, T. (2019). Two-echelon vehicle routing problem with recharge stations. *Transport and Telecommunication Journal*, 20(4), 305-317. <https://doi.org/10.2478/ttj-2019-0025>

- Akbay, M. A., Kalayci, C. B., Blum, C., & Polat, O. (2022). Variable neighborhood search for the two-echelon electric vehicle routing problem with time windows. *Applied Sciences*, 12(3), 1014. <https://doi.org/10.3390/app12031014>
- Babae Tirkolaee, E., Hadian, S., & Golpira, H. (2019). A novel multi-objective model for two-echelon green routing problem of perishable products with intermediate depots. *Journal of Industrial Engineering and Management Studies*, 6(2), 196-213. <https://doi.org/10.22116/JIEMS.2019.94158>
- Babagolzadeh, M., Shrestha, A., Abbasi, B., Zhang, S., Atefi, R., & Woodhead, A. (2019). Sustainable open vehicle routing with release-time and time-window: A two-echelon distribution system. *IFAC-PapersOnLine*, 52(13), 571-576. <https://doi.org/10.1016/j.ifacol.2019.11.219>
- Baldacci, R., Mingozzi, A., Roberti, R., & Calvo, R. W. (2013). An exact algorithm for the two-echelon capacitated vehicle routing problem. *Operations Research*, 61(2), 298-314. <https://doi.org/10.1287/opre.1120.1153>
- Belgin, O., Karaoglan, I., & Altıparmak, F. (2018). Two-echelon vehicle routing problem with simultaneous pickup and delivery: Mathematical model and heuristic approach. *Computers and Industrial Engineering*, (115), 1-16. <https://doi.org/10.1016/j.cie.2017.10.032>
- Bevilaqua, A., Bevilaqua, D., & Yamanaka, K. (2019). Parallel island based memetic algorithm with Lin-Kernighan local search for a real-life two-echelon heterogeneous vehicle routing problem based on Brazilian wholesale companies. *Applied Soft Computing*, (76), 697-711. <https://doi.org/10.1016/j.asoc.2018.12.036>
- Breunig, U., Baldacci, R., Hartl, R. F., & Vidal, T. (2019). The electric two-echelon vehicle routing problem. *Computers and Operations Research*, (103), 198-210. <https://doi.org/10.1016/j.cor.2018.11.005>
- Crainic, T. G., Mancini, S., Perboli, G., & Tadei, R. (2011, April 27-29). *Multi-start heuristics for the two-echelon vehicle routing problem* [Conference presentation]. 11th European Conference EvoCOP 2011, Torino (IT). https://doi.org/10.1007/978-3-642-20364-0_16
- Crainic, T. G., Mancini, S., Perboli, G., & Tadei, R. (2012). Impact of generalized travel costs on satellite location in the two-echelon vehicle routing problem. *Procedia-Social and Behavioral Sciences*, (39), 195-204. <https://doi.org/10.1016/j.sbspro.2012.03.101>
- Crainic, T. G., & Sgalambro, A. (2014). Service network design models for two-tier city logistics. *Optimization Letters*, 8, 1375-1387. <https://doi.org/10.1007/s11590-013-0662-1>
- Cuda, R., Guastaroba, G., & Speranza, M. G. (2015). A survey on two-echelon routing problems. *Computers and Operations Research*, (55), 185-199. <https://doi.org/10.1016/j.cor.2014.06.008>
- Erdelic, T., & Caric, T. (2019). A survey on the electric vehicle routing problem: Variants and solution approaches. *Journal of Advanced Transportation*, (2019), 5075671. <https://doi.org/10.1155/2019/5075671>
- Goli, A., Golmohammadi, A. M., & Verdegay, J. L. (2022). Two-echelon electric vehicle routing problem with a developed moth-flame meta-heuristic algorithm. *Operations Management Research*, 15(3), 891-912. <https://doi.org/10.1007/s12063-022-00298-0>
- Grangier, P., Gendreau, M., Lehoue, F., & Rousseau, L. M. (2016). An adaptive large neighborhood search for the two-echelon multiple-trip vehicle routing problem with satellite synchronization. *European Journal of Operational Research*, 254(1), 80-91. <https://doi.org/10.1016/j.ejor.2016.03.040>
- Gurobi (n.d.). *Gurobi downloads and licenses*. <https://www.gurobi.com>
- Hemmelmayer, V. C., Cordeau, J. F., & Crainic, T. G. (2012). An adaptive large neighborhood search heuristic for two-echelon vehicle routing problems arising in city logistics. *Computers and Operations Research*, 39(12), 3215-3228. <https://doi.org/10.1016/j.cor.2012.04.007>
- Jepsen, M., Spoorendonk, S., & Ropke, S. (2013). A branch-and-cut algorithm for the symmetric two-echelon capacitated vehicle routing problem. *Transportation Science*, 47(1), 23-37. <https://doi.org/10.1287/trsc.1110.0399>
- Jie, W., Yang, J., Zhang, M., & Huang, Y. (2019). The two-echelon capacitated electric vehicle routing problem with battery swapping stations: Formulation and efficient methodology. *European Journal of Operational Research*, 272(3), 879-904. <https://doi.org/10.1016/j.ejor.2018.07.002>

- Koç, Ç., & Özceylan, E. (2018). Yeşil ve elektrikli araç rotalama problemleri üzerine bir literatür taraması ve araştırma öngörülleri. *Gaziantep University Journal of Social Sciences*, 17(3), 1041-1053. <https://doi.org/10.21547/jss.404377>
- Kucukoğlu, I., Dewil, R., & Cattrysse, D. (2021). The electric vehicle routing problem and its variations: A literature review. *Computers and Industrial Engineering*, (161), 107650. <https://doi.org/10.1016/j.cie.2021.107650>
- Li, H., Liu, Y., Chen, K., & Lin, Q. (2020). The two-echelon city logistics system with on-street satellites. *Computers and Industrial Engineering*, (139), 105577. <https://doi.org/10.1016/j.cie.2018.12.024>
- Li, H., Liu, Y., Jian, X., & Lu, Y. (2018). The two-echelon distribution system considering the real-time transshipment capacity varying. *Transportation Research Part B: Methodological*, (110), 239-260. <https://doi.org/10.1016/j.trb.2018.02.015>
- Li, J. Q. (2014). Transit bus scheduling with limited energy. *Transportation Science*, 48(4), 521-539. <https://doi.org/10.1287/trsc.2013.0468>
- Meihua, W., Xuhong, T., & Shumin, W. (2011). Hybrid ant colony optimization algorithm for two echelon vehicle routing problem. *Procedia Engineering*, (15), 3361-3365. <https://doi.org/10.1016/j.proeng.2011.08.630>
- Pelletier, S., Jabali, O., & Laporte, G. (2016). Goods distribution with electric vehicles: Review and research perspectives. *Transportation Science*, 50(1), 3-22. <https://doi.org/10.1287/trsc.2015.0646>
- Perboli, G., Tadei, R., & Fadda, E. (2018). New valid inequalities for the two-echelon capacitated vehicle routing problem. *Electronic Notes in Discrete Mathematics*, (64), 75-84. <https://doi.org/10.1016/j.endm.2018.01.009>
- Perboli, G., Tadei, R. & Masoero, F. (2009). *Valid inequalities for the two-echelon capacitated vehicle routing problem*. Technical report. CIRRELT-2009-39, CIRRELT, Montreal, Canada. <https://doi.org/10.1016/j.endm.2018.01.009>
- Qin, H., Su, X., Ren, T., & Luo, Z. (2021). A review on the electric vehicle routing problems: Variants and algorithms. *Frontiers of Engineering Management*, 8, 370-389. <https://doi.org/10.1007/s42524-021-0157-1>
- Sahibinden (n.d.). *Truck capacity and purchase price*. <https://sahibinden.com>
- Santos, F. A., da Cunha, A. S., & Mateus, G. R. (2013). Branch-and-price algorithms for the two-echelon capacitated vehicle routing problem. *Optimization Letters*, 7, 1537-1547. <https://doi.org/10.1007/s11590-012-0568-3>
- Schneider, M., Stenger, A., & Goeke, D. (2014). The electric vehicle-routing problem with time windows and recharging stations. *Transportation Science*, 48(4), 500-520. <https://doi.org/10.1287/trsc.2013.0490>
- Sitek, P., & Wikarek, J. (2014). A novel integrated approach to the modelling and solving of the two-echelon capacitated vehicle routing problem. *Production and Manufacturing Research*, 2(1), 326-340. <https://doi.org/10.1080/21693277.2014.910716>
- Sluijk, N., Florio, A. M., Kinable, J., Dellaert, N., & Van Woensel, T. (2023). Two-echelon vehicle routing problems: A literature review. *European Journal of Operational Research*, (304), 865-886. <https://doi.org/10.1016/j.ejor.2022.02.022>
- SolverStudio (n.d.). *Program download and install*. <https://solverstudio.org>
- Soysal, M., Bloemhof-Ruwaard, J. M., & Bektaş, T. (2015). The time-dependent two-echelon capacitated vehicle routing problem with environmental considerations. *International Journal of Production Economics*, (164), 366-378. <https://doi.org/10.1016/j.ijpe.2014.11.016>
- Wang, D., & Zhou, H. (2021). A two-echelon electric vehicle routing problem with time windows and battery swapping stations. *Applied Sciences*, 11(22), 10779. <https://doi.org/10.3390/app112210779>
- Wang, D., Zhou, H., & Feng, R. (2019). A two-echelon vehicle routing problem involving electric vehicles with time windows. In *Journal of Physics: Conference Series*, 1324(1), 012071. <https://doi.org/10.1088/1742-6596/1324/1/012071>

- Wang, K., Lan, S., & Zhao, Y. (2017). A genetic-algorithm-based approach to the two-echelon capacitated vehicle routing problem with stochastic demands in logistics service. *Journal of the Operational Research Society*, (68), 1409-1421. <https://doi.org/10.1057/s41274-016-0170-7>
- Wang, Y., Yuan, Y., Guan, X., Xu, M., Wang, L., Wang, H., & Liu, Y. (2020). Collaborative two-echelon multicenter vehicle routing optimization based on state–space–time network representation. *Journal of Cleaner Production*, (258), 120590. <https://doi.org/10.1016/j.jclepro.2020.120590>
- Wei, M., Guan, H., Liu, Y., Gao, B., & Zhang, C. (2020). Production, replenishment and inventory policies for perishable products in a two-echelon distribution network. *Sustainability*, 12(11), 4735. <https://doi.org/10.3390/su12114735>
- Wu, Z., & Zhang, J. (2023). A branch-and-price algorithm for two-echelon electric vehicle routing problem. *Complex and Intelligent Systems*, 9(3), 2475-2490. <https://doi.org/10.1007/s40747-021-00403-z>
- Zhou, L., Baldacci, R., Vigo, D., & Wang, X. (2018). A multi-depot two-echelon vehicle routing problem with delivery options arising in the last mile distribution. *European Journal of Operational Research*, 265(2), 765-778. <https://doi.org/10.1016/j.ejor.2017.08.011>
- Zhou, S., Zhang, D., Ji, B., & Li, S. (2024). Two-echelon vehicle routing problem with direct deliveries and access time windows. *Expert Systems with Applications*, (244), 121150. <https://doi.org/10.1016/j.eswa.2023.121150>

APPENDIX

Table A1. Optimum Solution Results According to The Change in Demand for Data Set 1

Change in Demand	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	8,576,700	K2	D-U1-D	3,200-0	-	-42.605
		E2	U1-M2-B1-M5-U1	1,520-1,040-1,040-0	37,180-21,980-37,180-25,580-280	
		E4	U1-M3-M4-B1-M1-U1	1,680-1,440-640-640-0	37,180-21,280-14,380-37,180-28,080-22,780	
-10%	14,941,300	K1	D-U2-D	2,340-0	-	-0.013
		K2	D-U1-D	1,260-0	-	
		E1	U2-M4-U2	900-0	37,180-27,780-18,680	
		E2	U2-M5-M3-U2	1,440-270-0	37,180-22,680-15,280-2,380	
		E4	U1-M1-M2-U1	1,260-540-0	37,180-32,480-21,280-4,180	
+10%	14,951,200	K1	D-U1-D	1,540-0	-	0.052
		K2	D-U2-D	2,860-0	-	
		E2	U1-M1-M2-U1	1,540-660-0	37,180-32,480-21,280-4,180	
		E3	U2-M4-M3-U2	1,430-330-0	37,180-27,780-20,380-7,480	
		E4	U2-M5-U2	1,430-0	37,180-22,680-7,680	
+20%	14,953,200	K1	D-U1-D	1,680-0	-	0.066
		K2	D-U2-D	3,120-0	-	
		E1	U2-M5-U2	1,560-0	37,180-22,680-7,680	
		E2	U1-M1-M2-U1	1,680-720-0	37,180-32,480-21,280-4,180	
		E3	U2-M4-M3-U2	1,560-360-0	37,180-27,780-20,380-7,480	

*Change (%) represents the percentage change in total cost compared to the base case.

Table A2. Optimum Solution Results According to The Change in Demand for Data Set 2

Change in Demand	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	14,763,800	K1	D-U2-D	2,480-0	-	-0.165
		K2	D-U1-D	1,600-0	-	
		E1	U1-M1-M4-M2-U1	1,600-640-240-0	53,430-41,630-33,930-22,730,4,830	
		E3	U2-M7-M6-U2	1,120-720-0	53,430-45,930-39,730-33,130	
		E4	U2-M3-M5-M8-U2	1,360-560-320-0	58,430-38,530-33,830-28,830-15,930	
-10%	14,771,450	K1	D-U2-D	3,240-0	-	-0.113
		K3	D-U1-D	1,350-0	-	
		E1	U2-M6-M8-M7-U2	1,620-810-450-0	53,430-46,530-37,430-28,030-21,230	
		E2	U2-M5-M3-M4-U2	1,620-1,350-450-0	53,430-40,230-35,730-27,830-13,830	

		E4	U1-M2-M1-U1	1,350-1,080-0	53,430-35,430-25,230-13,730	
+10%	16,899,550	K1	D-U1-D	3,300-0	-	14.276
		K3	D-U2-D	2,310-0	-	
		E1	U2-M5-M8-M7-U2	1,320-990-550-0	53,430-40,230-35,230-25,830-19,030	
		E2	U2-M6-U2	990-0	53,430-46,530-39,930	
		E3	U1-M3-M4-U1	1,650-550-0	53,430-30,330-22,430-6,530	
		E4	U1-M2-M1-U1	1,650-1,320-0	53,430-35,430-25,230-13,730	
+20%	16,905,200	K1	D-U1-D	3,000-0	-	14.314
		K2	D-U2-D	3,120-0	-	
		E1	U2-M7-M6-U2	1,680-1,080-0	53,430-45,930-39,730-33,130	
		E3	U1-M3-M2-U1	1,560-360-0	53,430-30,330-19,530-1,630	
		E4	U2-M4-M5-M8-U2	1,440-840-480-0	53,430-39,730-29,130-24,130-11,230	
		E5	U1-M1-U1	1,440-0	53,430-41,630-30,130	

Table A3. Optimum Solution Results According to The Change in Demand for Data Set 3

Change in Demand	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	13,421,200	K1	D-U3-D	1,160-0	-	-0.057
		K3	D-U2-D	2,720-0	-	
		E2	U2-M7-M8-M5-M4-U2	1,560-1,360-1,040-240-0	93,990-80,290-75,990-69,590-56,590-52,390	
		E7	U2-M9-M6-M3-U2	1,160-440-160-0	93,990-83,890-81,790-65,490-59,590	
		E8	U3-M1-M2-M10-M11-U3	1,160-760-200-120-0	93,990-84,090-59,690-30,390-25,490-16,790	
-10%	13,425,425	K1	D-U2-D	3,060-0	-	-0.026
		K3	D-U3-D	1,305-0	-	
		E2	U3-M1-M2-M10-M11-U3	1,305-855-225-135-0	93,990-84,090-59,690-30,390-25,490-16,790	
		E5	U2-M5-M8-M7-U2	1,485-585-225-0	93,990-78,290-71,490-67,190-52,490	
		E8	U2-M9-M6-M4-M3-U2	1,575-765-450-180-0	93,990-83,890-81,790-69,190-63,590-57,690	
+10%	15,554,475	K2	D-U3-D	3,135-0	-	15.827
		K4	D-U2-D	2,200-0	-	
		E3	U3-M1-M2-M11-U3	1,485-935-165-0	93,990-84,090-59,690-27,590-18,890	
		E4	U3-M8-M5-M10-U3	1,650-1,210-110-0	93,990-71,990-65,590-51,490-38,690	
		E5	U2-M9-M6-M7-U2	1,650-660-275-0	93,990-83,890-81,790-73,690-58,990	
		E8	U2-M4-M3-U2	550-220-0	93,990-91,690-86,090-80,190	
+20%	15,573,800	K2	D-U3-D	2,760-0	-	15.971
		K3	D-U2-D	3,060-0	-	
		E1	U2-M9-M6-U2	1,500-420-0	93,990-83,890-81,790-66,490	
		E2	U3-M1-M2-M3-U3	1,680-1,080-240-0	93,990-84,090-59,690-45,190-6,990	
		E3	U3-M7-M8-M10-M11-U3	1,080-780-300-180-0	93,990-73,590-69,290-58,890-53,990-45,290	
		E5	U2-M5-M4-U2	1,560-360-0	93,990-78,290-65,290-61,090	

Table A4. Optimum Solution Results According to The Change in Battery Capacities for Data Set 1

Change in Battery Capacity	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	14,949,700	K1	D-U2-D	2,300-0	-	0.042
		K2	D-U1-D	1,700-0	-	
		E1	U2-M4-U2	1,000-0	29,744-20,344-11,244	
		E2	U2-M5-U2	1,300-0	29,744-15,244-244	
		E4	U1-M2-B1-M3-M1-U1	1,700-1,100-1,100-800-0	29,744-14,544-29,744-24,744-10,844-5,544	
-10%	14,949,200	K1	D-U1-D	1,400-0	-	0.039
		K2	D-U2-D	2,600-0	-	
		E1	U2-M4-M3-U2	1,300-300-0	33,462-24,062-16,662-3,762	
		E2	U1-M1-M2-U1	1,400-600-0	33,462-28,762-17,562-462	
		E4	U2-M5-U2	1,300-0	33,462-18,962-3,962	

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+10%	14,943,300	K1	D-U2-D	2,600-0	-	0
		K2	D-U1-D	1,400-0	-	
		E2	U1-M1-M2-U1	1,400-600-0	40,898-36,198-24,998-7,898	
		E3	U2-M5-M3-U2	1,600-300-0	40,898-26,398-18,998-6,098	
		E4	U2-M4-U2	1,000-0	40,898-31,498-22,398	
+20%	14,943,300	K1	D-U2-D	2,600-0	-	0
		K2	D-U1-D	1,400-0	-	
		E2	U1-M1-M2-U1	1,400-600-0	44,616-39,916-28,716-11,616	
		E3	U2-M5-M3-U2	1,600-300-0	44,616-30,116-22,716-9,816	
		E4	U2-M4-U2	1,000-0	44,616-35,216-26,116	

Table A5. Optimum Solution Results According to The Change in Battery Capacities for Data Set 2

Change in Battery Capacity	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	14,788,300	K2	D-U2-D	3,400-0	-	0
		K3	D-U1-D	1,700-0	-	
		E2	U2-M6-M5-M7-U2	1,700-800-500-0	42,744-35,844-28,744-19,044-12,244	
		E3	U1-M4-M1-U1	1,700-1,200-0	42,744-26,344-20,044-8,544	
		E5	U2-M3-M2-B3-M8-U2	1,700-700-400-400-0	42,744-27,844-17,044-42,744-33,944-21,044	
-10%	14,788,300	K2	D-U1-D	1,700-0	-	0
		K3	D-U2-D	3,400-0	-	
		E1	U1-M4-M1-U1	1,700-1,200-0	48,087-31,687-25,387-13,887	
		E2	U2-M6-M5-M7-U2	1,700-800-500-0	48,087-41,187-34,087-24,387-17,587	
		E4	U2-M3-M2-B3-M8-U2	1,700-700-400-400-0	48,087-33,187-22,387-48,087-39,287-26,387	
+10%	14,782,700	K1	D-U1-D	3,400-0	-	-0.037
		K2	D-U2-D	1,700-0	-	
		E1	U1-M2-M3-M8-U1	1,700-1,400-400-0	58,773-40,773-29,573-21,573-3,273	
		E2	U1-M4-M1-U1	1,700-1,200-0	58,773-42,373-36,073-24,573	
		E5	U2-M6-M5-M7-U2	1,700-800-500-0	58,773-51873-44,773-35,073-28,273	
+20%	14,782,700	K1	D-U2-D	1,700-0	-	-0.037
		K3	D-U1-D	3,400-0	-	
		E1	U1-M2-M3-M8-U1	1,700-1,400-400-0	64,116-46,116-34,916-26,916-8,616	
		E4	U2-M6-M5-M7-U2	1,700-800-500-0	64,116-57,216-50,116-40,416-33,616	
		E6	U1-M4-M1-U1	1,700-1,200-0	64,116-47,716-41,416-29,916	

Table A6. Optimum Solution Results According to The Change in Battery Capacities for Data Set 3

Change in Battery Capacity	Total Cost (TL)	Vehicle No	Optimal Route	Amount of Product Transported in Arcs (kg)	Battery Power of Vehicles at Nodes (m)	Change (%)
-20%	13,430,350	K1	D-U3-D	1,700-0	-	0.010
		K4	D-U2-D	3,150-0	-	
		E2	U2-M8-M5-M4-U2	1,700-1,300-300-0	75,192-58,292-51,892-38,892-34,692	
		E4	U3-M1-M2-M7-M10-B4-M11-U3	1,700-1,200-500-250-150-150-0	75,192-65,292-40,892-17,492-7,592-75,192-72,692-63,992	
		E7	U2-M9-M6-M3-U2	1,450-550-200-0	75,192-65,092-62,992-46,692-40,792	
-10%	13,428,950	K1	D-U3-D	1,700-0	-	0
		K3	D-U2-D	3,150-0	-	
		E2	U3-M1-M2-M7-M10-M11-U3	1,700-1,200-500-250-150-0	84,591-74,691-50,291-26,891-16,981-12,091-3,391	
		E3	U2-M8-M5-M4-U2	1,700-1,300-300-0	84,591-67,691-61,291-48,291-44,091	
		E7	U2-M9-M6-M3-U2	1,450-550-200-0	84,591-74,491-72,391-56,091-50,191	
+10%	13,428,950	K2	D-U2-D	3,150-0	-	0
		K4	D-U3-D	1,700-0	-	

		E1	U2-M8-M5-M4-U2	1,700-1,300-300-0	103,389-86,489-80,089-67,089-62,889	
		E3	U2-M9-M6-M3-U2	1,450-550-200-0	103,389-93,289-91,189-74,889-68,989	
		E5	U3-M1-M2-M7-M10-M11-U3	1,700-1,200-500-250-150-0	103,389-93,489-69,089-45,689-35,789-30,889-22,189	
		K1	D-U2-D	3,150-0	-	
		K3	D-U3-D	1,700-0	-	
+20%	13,428,950	E2	U3-M1-M2-M7-M10-M11-U3	1,700-1,200-500-250-150-0	112,788-102,888-78,488-55,088-45,188-40,288-31,588	0
		E4	U2-M9-M6-M3-U2	1,450-550-200-0	112,788-102,688-100,588-84,288-78,388	
		E8	U2-M8-M5-M4-U2	1,700-1,300-300-0	112,788-95,888-89,488-76,488-72,288	

A Qualitative Research Examining the Impact of the Earthquakes on Financial Reports within the Scope of IAS 10 *

Ahmet ONAY¹, Recep GÜNEŞ²

Abstract

Deeply affecting the Turkish economy, the earthquakes that struck Kahramanmaraş on February 6, 2023, had an adverse effect on the operations of numerous companies. As of the occurrence date, these earthquakes have been reported in the financial statements of many publicly traded companies as events after the reporting period. The purpose of this study is to determine how events after the balance sheet date are reported in the financial statements of companies in Türkiye in the post-earthquake period. In line with this objective, two sample groups were created from companies whose stock trading was suspended after the earthquake and those in the BIST-100 Index that continued trading. The financial statements of these sample groups, specifically regarding events after the reporting period, were separately examined. Qualitative methods were employed in the analysis, and word frequencies and word clouds were obtained using Maxqda Analytics Pro 24. The analyses confirmed that publicly traded companies report events after the reporting period in accordance with International Financial Reporting Standards. Additionally, the study qualitatively revealed the economic impacts of the earthquake disaster in Türkiye, resulting in both material and non-material losses. This study has the potential to contribute to the limited domestic literature by addressing events after the reporting period through conceptual or theoretical examinations. Additionally, it stands to contribute to the broader international literature on the subject.

Keywords: *Events After the Reporting Period, Accounting Standards, Financial Reporting, Qualitative Research.*



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1. INTRODUCTION

One of the most crucial attributes of financial information affecting the success of decision-makers' predictions and preferences is its completeness. Financial statements reflect the company's performance and financial position regarding its activities in the relevant period at the end of the accounting process. Financial statements are prepared at the end of the period, that is, as of the balance sheet date. However, the audit of financial statements, correcting entries, publication, and approval of financial statements can be completed within a considerable period of time after this date. In the period from the balance sheet date until the financial statements are published, new information may be obtained, or new events may occur that affect the relevant period or can be associated with the relevant period and, therefore, need to be presented to users of financial statements. In summary, financial statements may be affected by information obtained or an event occurring after the balance sheet date. When evaluated in terms of completeness of financial information, it becomes a necessity to convey such information and events to decision-makers.

International accounting and auditing standards determine reporting and auditing responsibilities for events after the balance sheet date. International Accounting Standard (IAS) 10: Events After the Reporting Period, translated into Turkish and published by the Public Oversight Authority (POA), is applied to account for events within this scope and disclose them in footnotes. International Standard on Auditing (ISA) 560: Subsequent Events, published by the International Federation of Accountants (IFAC) and translated into Turkish by the POA, regulates the responsibilities of independent auditors regarding such events. The purpose of international standards is to ensure the appropriate accounting or disclosure of subsequent events and that affect the financial statements in favor of or against the company and to guide the independent audit in the processes of obtaining evidence of such events and explaining them in the audit report.

Publicly traded companies in Türkiye are subject to Turkish Financial Reporting Standards (TFRS), which are fully compliant with International Financial Reporting Standards (IFRS). The TFRS are published and supervised by the POA, an independent body responsible for setting, implementing, and auditing financial reporting standards in Türkiye. The Capital Markets Board (CMB) regulates the financial reporting processes of publicly traded companies and ensures investor protection. Therefore, financial reporting practices in Türkiye aim to comply with international standards and be transparent.

The primary aim of this study is to qualitatively analyze the subsequent events reported in the financial statements of companies directly impacted by the Kahramanmaraş earthquakes of February 6, 2023, deemed the "disaster of the century" and characterized as the most severe natural catastrophe in the history of the Republic of Türkiye. These earthquakes disrupted the economic activities of many companies in Türkiye and deeply affected the Turkish economy. Occurring before the approval of many companies' financial statements, the earthquakes affected the 2022 financial statements of publicly traded companies and were thus evaluated as events after the reporting period. In this study, the financial

statements of the companies directly affected by the earthquake and the BIST-100 Index companies other than these companies were included in the scope of the research, and the subsequent events were examined.

In the next part of the study, the conceptual framework and relevant literature directed by international standards that determine the reporting of events after the reporting period in financial statements and the responsibilities of the audit are discussed. In the following sections, the research method and the findings obtained from the financial statements of the companies included in the research are included, respectively. The final section encompasses conclusions and recommendations.

2. CONCEPTUAL FRAMEWORK

In this section, the conceptual framework guided by ISA 560: Subsequent Events and IAS 10: Events after the Reporting Period has been elucidated.

2.1. Events after the Reporting Period

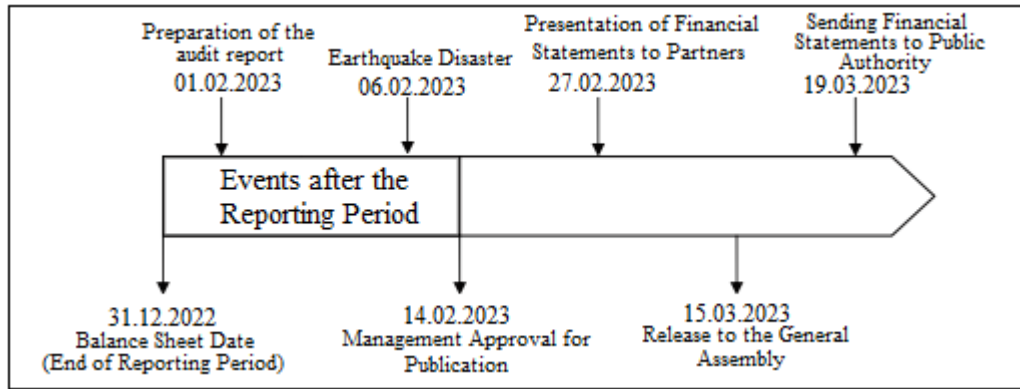
IAS 10 defines events that occur within the period between the end of the reporting period, or in other words, between the balance sheet date and the date when the financial statements are approved for publication, and that affect the business favorably or unfavorably, as either event after the balance sheet date or events after the reporting period. In the standard, such events are divided into two: events that require adjustment and events that do not require adjustment. Adjustment is required where there is evidence that the relevant events existed as of the balance sheet date (end of the reporting period). In cases where there are conditions indicating that the relevant events occurred after the balance sheet date (end of the reporting period), no adjustment is required (International Accounting Standards Board, 2003, p. 2). ISA 560 adopts a similar approach to accounting standards when defining subsequent events. Accordingly, it is underlined that financial statements may be affected by subsequent events, and such events are classified into two categories: events confirming the situations existing at the balance sheet date and events indicating situations occurring after the balance sheet date (Financial Reporting Council, 2018, p. 5).

Legal regulations and practices considered when preparing financial statements and the structure of management may differentiate the processes for approving financial statements for publication. In addition, in some cases, the financial statements of companies may need to be presented to their partners after their publication for approval, in other words, for acquittal. In such cases, the date of approval of the financial statements is accepted as the date on which the board of directors decided to publish the financial statements, not the date on which the partners approved the financial statements.

E Inc. prepared its financial statements on 31.12.2022. Audit firm F prepared the audit report on the financial statements on 01.02.2023. On 06.02.2023, one of the largest earthquake disasters in history occurred in Türkiye. The company's board of directors approved the publication of the financial statements on 14.02.2023. Financial statements were presented to partners and other relevant parties on

27.02.2023. The company's financial statements were released to the general assembly on 15.03.2023 and sent to the relevant public authority on 19.03.2023. The date of approval of the financial statements is considered to be 14.02.2023, which is the date that the company's senior management approved their publication. The events are shown chronologically in the Figure 1.

Figure 1. Scope of Events After the Balance Sheet Date



Some situations may have arisen during the period from the balance sheet date until the date when the financial statements are approved for publication by the management. (1) Events may have occurred or emerged that may affect future financial statements. (2) Information regarding past events may have just been obtained. (3) Changes may have been made regarding the terms used in the preparation of financial statements. While the first two of these are evaluated within the scope of events after the reporting period, the last one is evaluated within the scope of accounting policies, changes in accounting estimates, and error standards (Sümer & Erer, 2009, p. 3).

The date on which the board approves the financial statements of directors for publication must be disclosed to the public. This date is important for financial statement users to know, as the financial statements do not cover information and events after this date. In addition, if the company's owners and partners, managers or other relevant parties have the authority to change the financial statements, this must be disclosed to the public. In this study, events after the balance sheet date were examined by dividing them into two: events that require adjustment and events that do not require adjustment, as discussed in accounting standards.

2.1.1. Events Requiring Adjustment After the Reporting Period

Events that require adjustment in the financial statements after the reporting period define situations where there are conditions that provide evidence that the relevant events existed as of the balance sheet date. Events that require adjustment in the financial statements are events that have evidence of their existence as of the balance sheet date and have a materiality level that will affect the estimates regarding the financial statements. Reflecting such events in the financial statements will ensure that useful financial information is complete and relevant, which are its most basic characteristics. The simplest distinction as to whether an event occurring after the balance sheet date will require

adjustment in the financial statements is to determine whether the event in question affects any accounting item. Accordingly, if an event affects the amount of any account, it requires adjustment in the financial statements. If conditions arise regarding events that require adjustment in the financial statements, the relevant accounting accounts are corrected or those that were not previously shown in the financial statements are included in the financial statements. Examples of such events can be listed as follows (Tüm & Memiş, 2015, p. 325):

- The bankruptcy of a customer who owes the company money,
- Selling inventory below its net realizable value,
- Determination or change of net realizable amounts of stocks,
- Occurrence of erroneous or fraudulent situations before the reporting date,
- Determining the reasons for excesses or deficiencies,
- Determining the revenues related to the sale of assets or the costs related to their purchase,
- Finalization of bonus or dividend amounts to be provided to employees,
- The resolution of a legal case related to a subsequent event for which a provision was previously recognized,
- A change in significant accounting estimates.

2.1.2. Events Not Requiring Adjustment After the Reporting Period

Events that do not require adjustment in the financial statements, as stated in the standard, reflect situations where conditions exist that indicate the relevant subsequent events. In short, these are events that do not exist as of the balance sheet date but occur after this date. Although such events do not affect the amounts reported in current financial statements, they will affect the amounts of future periods. Although no adjustments will be made in the financial statements for these events, the characteristics and financial effects of the events or the reasons why it is not possible to detect them should be presented in the footnotes of the financial statements. Examples of such events can be listed as follows (Pamukçu & Pamukçu, 2009, pp. 75-76; Sümer & Erer, 2009, pp. 10-11; Doğan & Cengiz, 2018, pp. 128-129):

- Significant impairment losses on assets,
- Disposal of a subsidiary or significant merger,
- Disclosure of management plans for the liquidation of an activity,
- categorization of assets for divestment or disposal,
- Purchase, exchange, expropriation or nationalization of important assets,
- Devastation of significant operating facilities due to fire or other disaster,
- Announcement of a plan for restructuring a debt or implementation of the announced plan,
- Conducting share purchase and sale transactions reaching significant amounts,
- Significant changes in foreign exchange rates and asset prices,

- Making or announcing that important tax regulations affecting the company's current tax receivables or debts will be made,
- The company is a party to significant commitments, contingent liabilities or guarantees,
- Opening of an important lawsuit to which the company is a party, due to a subsequent event.

The declaration of dividend distribution and the loss of validity of the going concern assumption, which can be considered as important events that do not require adjustment in the financial statements, are regulated explicitly under separate headings in the relevant standards.

In cases where it is announced that dividends will be distributed to stockholders after the reporting period, dividends are not reported as a liability in the financial statements since no obligation binding the company arises on the balance sheet date, and information is provided only in the footnotes of the financial statements. When dividend payments are announced to be made in the period between the balance sheet date and the date the financial statements are approved for publication, that is, when the approval of the payments is no longer at the initiative of the company, the dividends are not reported as liabilities in the financial statements because they do not meet the criteria for short-term liabilities. Information about these is presented only in the balance sheet footnotes in accordance with IAS 1 (International Accounting Standards Board, 2007; Yılmaz & Sarı, 2013).

3. LITERATURE

There are few studies in the Turkish literature examining events after the reporting period. Most of these studies examined the subject only theoretically. In the studies of Sümer and Erer, (2009), Delikanlı (2009), Pamukçu and Pamukçu (2009), Şalış (2011), Gönen and Kutay (2013), Doğan and Cengiz (2018), events after the reporting period are defined within the framework of IAS 10 and they are classified into two: events that require adjustment and events that do not require adjustment. In these studies, it is explained by giving examples of how such events will be accounted for and reported within the scope of accounting standards. In two studies (Dönmez, 2010; Tüm & Memiş, 2015) obtained as a result of the literature review, subsequent events were evaluated in terms of auditing standards. However, in these studies, the subject is primarily explained within the framework of IAS 10 and reporting examples are included. In these two studies, unlike the others, the responsibilities of the independent audit regarding subsequent events are briefly explained in the context of auditing standards.

The study of Yılmaz and Sarı (2013) differs from the studies in the literature, albeit limited. In this study, subsequent events are briefly explained within the scope of standards, accounting and reporting examples are given, and in the research section, subsequent events footnotes in the financial statements of Borsa Istanbul 100 Index companies are examined. As a result of these examinations, research reveals that 63 out of 100 companies made statements regarding subsequent events in their financial statements. Their research showed that the statements of those 63 companies comprised 171

subsequent events, classified into 28 topics. This study is the only research article in the Turkish literature, albeit in a limited scope.

Relatively more studies in the English literature have examined events after the reporting period. A considerable portion of these investigations employ quantitative methodologies. In numerous studies, data were gathered via surveys. Janvrin and Jeffrey (2007) investigated the impact of events after the reporting period on the independent audit process and auditors' perceptions on the matter. A combined total of 106 independent auditors participated in the data collection process, with 46 respondents completing printed questionnaires and 60 respondents filling out internet-based surveys. The findings indicated that evidence pertaining to subsequent events holds considerable significance within the independent audit process. Moreover, auditors demonstrate a stringent adherence to the prescribed audit procedures outlined by auditing standards when gathering such evidence. Nawaiseh and Jaber (2015) aimed to determine to what extent independent auditors in Jordan comply with ISA 560. Data was obtained via a survey administered to 62 out of 189 auditors in Jordan. The answers showed that they strictly adhered to the directive of the standard in the audit of subsequent events in the period between the balance sheet date and the audit report date, and that they avoided assuming their responsibilities after the audit report was published. Results indicate that auditors' characteristics, including professional expertise, experience, and education, do not significantly influence compliance with the standards. Another similar study that used a survey as a data collection tool is Özdemir and Gökçen (2016). The main motivation of this study is that the Capital Markets Board of Türkiye shortened the period between the balance sheet date and the report announcement date, thus the legally allowed period for the preparation of financial statements. Their findings are presented regarding which events after the reporting period are considered important by auditors in Türkiye. Subsequent events have been identified as a difficult audit area (Chung et al., 2013). In another study, Herda and Lavelle (2014) collected data from 76 auditors through a survey and reported suggestions that may be useful for improving the audit of subsequent events. Oyedokun (2015) examines the adoption of IFRS in Nigeria and the challenges posed by IAS 10 in audit reporting, particularly in distinguishing between adjusting and non-adjusting events. Abu-Nassar and Orabi (2012) assess the compliance of Jordanian companies with IAS 10, finding that adherence to its provisions remains low.

In a few studies in the English literature, models examining relationships in which subsequent events are included as a variable have been tested using statistical analysis methods. Michels (2017) examined investors' reactions to the distinction between recognizing disclosures related to natural disasters either within the reporting period as of the occurrence date or within the subsequent events. Evidence suggests that investors' responsiveness to statements made within the realm of events after the reporting period is delayed. Hategan and Crucean (2018) sought to elucidate the significance of events after the reporting period for financial statements, factors influencing reporting, and their implications for auditing. The study tested four regression models to assess an equation explaining the binary

dependent variable, which measured whether events after the reporting period were reported. The findings present whether there exists a relationship between the independent variables, including the audit opinion, auditor type (Big4), the company's financial performance (profit or loss disclosure), and the company size, and the reporting of subsequent events. In another empirical study, Donatella et al. (2022) investigated to what extent situational factors related to the COVID-19 outbreak affected the possibility of disclosing COVID-19 information as an event after the reporting period in 2019 financial statements. In the study, logistic regression models were applied to estimate the probability of COVID-19 being disclosed within the scope of events after the reporting period, utilizing annual financial statement and audit report data. In the first of two other studies examining the impact of the COVID-19 pandemic, Al-Bishtawi and Al-Harasees (2022) analyzed how COVID-19 affected reporting on IAS 10 in Jordanian firms. In the second study, Esen and Sakin (2022) conducted a content analysis of Turkish firms, revealing deficiencies in post-reporting event disclosures during the pandemic. Collectively, these studies provide a comprehensive evaluation of IAS 10's role in financial reporting and regulatory compliance.

Studies examining the impact of earthquakes on financial reports and accounting practices explore various effects of natural disasters on financial reporting and markets. The current study, which qualitatively examines the earthquake-related disclosures in financial reports within the scope of IAS 10, is also related to these studies in this aspect of the literature. Collectively, these studies provide a comprehensive analysis of the financial reporting, investment, and market fluctuations associated with earthquakes. Ferreira and Karali (2015) analyze the influence of earthquakes on stock market returns and volatility, highlighting market resilience. Shaw (2011) provides a financial risk management perspective on the economic consequences of the 2011 Tōhoku earthquake and tsunami. Miyazaki (2013) investigates the financial burden on local governments following earthquakes, while Scholtens and Voorhorst (2013) examine changes in stock values post-earthquake. Tunji et al. (2022) assess the impact of IAS 10 on investment decisions, whereas Yamada et al. (2012) analyze the financial consequences of earthquakes on a railway company. Skufina et al. (2017) evaluate the global economic implications of large-scale earthquakes, and Dhakal et al. (2024) examine the financial risks and post-earthquake performance of commercial banks in Nepal.

Studies examining the effects of natural disasters on financial reporting, financial management, and investment decisions provide valuable insights into the economic consequences of such events. The current study can be defined as a part of the literature consisting of these studies as it provides important inferences regarding the economic consequences of the Kahramanmaraş earthquake through qualitative examinations. Collectively, these studies provide a comprehensive understanding of how natural disasters affect financial stability, investment behavior, and policy responses. Chen (2020) analyzes the financial impact of natural disasters on local governments, highlighting their influence on liquidity, debt, and fiscal reserves. Keerthiratne and Tol (2017) examine the effects of natural disasters on financial

development, particularly their influence on private credit markets. Miao et al. (2018) investigate how natural disasters affect public finances, including government expenditures, debt issuance, and tax revenues. Miao et al. (2020) analyze how disasters shape fiscal policy and intergovernmental financial transfers in China. Seo et al. (2018) assess the role of local financial capability in mitigating disaster-related economic losses. An and Park (2019) examine the impact of natural disasters on sovereign credit ratings and international financial accessibility in developing countries. Pauch et al. (2024) investigate the role of insurance in mitigating the financial burden of disasters and supporting asset reconstruction.

4. METHODOLOGY

After the balance sheet date of 2022, Türkiye occurred an earthquake disaster that impacted 11 provinces, resulting in significant destruction, particularly in 5 provinces. From a financial reporting perspective, this major disaster is reported as events after the reporting period. In this context, our study examined the financial statements of companies operating in the earthquake-affected areas. The purpose of this review is to elucidate how companies documented the earthquake in their financial statements and assess the repercussions the disaster had on the companies' operations. Conversely, the earthquakes on February 6, dubbed the "disaster of the century," impacted all companies nationwide, albeit indirectly, beyond the area of direct devastation. For this reason, in our study, the financial statements of other companies, as well as companies operating in the earthquake zone, were examined within the scope of events after the reporting period. In this context, the study sample was divided into two groups and compared based on the data reported within the scope of events after the balance sheet date.

To identify the companies directly affected by the earthquake, the statements published by Borsa Istanbul's (Stock Exchange of Türkiye) management on the Public Disclosure Platform (PDP) were considered. Accordingly, it has been decided to suspend the transactions of partnership shares located in the earthquake zone until the companies make a special situation statement regarding how they were affected by the earthquake. In addition, four companies with activities or investments in the region, apart from the companies for which Borsa Istanbul took measures, were evaluated within this scope. As a result of this sample selection methodology, a total of 12 firms were encompassed in the scope of companies directly affected by the earthquake. Information about these companies is presented in Table 1.

Table 1. Companies Directly Affected by the Earthquakes

	Market Value (TL)	Index	Province
Sasa Polyester Industry	212,529,149,300	BIST-30	Gaziantep
Bossa Trade and Industry Enterprises	3,987,200,000	BIST-100	Adana
Bilici Investment Industry and Trade	1,263,000,000	BIST-100	Adana
Sanko Marketing Import Export	2,249,100,000	BIST-All	Gaziantep
Hateks Hatay Textile Enterprises	589,050,000	BIST-All	Hatay
Iskenderun Iron and Steel	96,744,000,000	BIST-50	Hatay
Arsan Textile Trade and Industry	1,635,595,720	BIST-100	Kahramanmaraş

(Table 1 cont.)

	Market Value (TL)	Index	Province
Rubenis Textile Industry Trade	1,536,190,000	BIST-100	Şanlıurfa
Çemaş Foundry Industry	1,190,000,000	BIST-100	Kahramanmaraş
Aydem Renewable Energy	8,490,000,000	BIST-100	Adana
Barem Packaging Industry	3,230,000,000	BIST-100	Gaziantep
RTA Laboratory Biological	720,000,000	BIST-All	Malatya

In our research, a second sample group was formed from the BIST-100 companies for comparative analysis with the first group's data. To prevent redundancy and maintain consistency with the study objectives, the companies from the first group of BIST-100 firms were excluded from the second group. Consequently, the second group comprised 91 companies.

A qualitative research methodology was adopted in our study. In line with this methodology, first of all, the financial reports of the companies we divided into two sample groups were examined, and their statements regarding the scope of events were analyzed after the balance sheet date. Thus, it will be determined what kind of disclosures companies make in their financial statements regarding events after the balance sheet date. In addition, such statements will reveal the extent of the earthquake's impact. Then, the words in the data set obtained from the companies' financial reports will be classified according to a certain frequency limit. Thus, it will be possible to make an inference about which events were reported after the balance sheet date. Finally, the methodology of this study ends with word cloud analysis to reinforce the previous analysis. Word cloud analysis allows the researcher to visualize the relationships obtained from the data set and to understand the relationships within the data set more easily. In this analysis, the purpose of visualization is to provide information on the subject rather than aesthetic concerns (Williams et al., 2013). The summary provided by the word cloud will enable judgment regarding subsequent events to be made. In this analysis, the most repeated words in the data set are presented with a font size consistent with their frequencies (Heimerl et al., 2014, p. 1833).

Within the scope of the research, the 2022 financial reports of a total of 103 companies, 12 of which were companies whose activities were directly affected by the earthquake, were analyzed. The data of the study were analyzed with the Maxqda Analytics Pro 24 program (MAXQDA, 2024) which is a computer software that allows detailed qualitative analysis. The outcomes derived from content analysis are expounded upon in the subsequent section. Throughout the analysis process, conjunctions, prepositions, suffixes, punctuation marks, and irrelevant words were excluded from the dataset, ensuring relevance to the research objectives. The findings were then interpreted in alignment with the aims of the study, with particular attention given to highlighting disparities between the two sample groups.

5. FINDINGS

In presenting the findings of our study, we adhered to an approach suitable for qualitative research methodology. Initially, significant findings pertaining to the disclosure of “Events After the

Balance Sheet Date” were elucidated based on the examined reports. Subsequently, the analyses outlined in the methodology section of the study were detailed.

In the financial reports of most companies within the research scope, “Events After the Balance Sheet Date” are typically addressed in a distinct footnote located on the final pages. Upon scrutinizing the financial statements, occurrences falling under “Events After the Balance Sheet Date” are delineated under various headings, supplementing the standard nomenclature. These titles include:

- “Events After the Balance Sheet Date (Nomenclature in Accounting Standards)”
- “Events After the Reporting Period”
- “Events That Occurred After the Balance Sheet Date”
- “Events After Reporting Date”
- “Disclosures and Footnotes Regarding After the Balance Sheet Matters” (In Banks' Reports)
- “Subsequent Events”
- “Events After the Financial Position Statement (Balance Sheet) Date”
- “Subsequent Events from The Financial Position Statement”

Upon reviewing the financial reports of the companies, it was noted that within sections detailing the reporting standards adhered to, concise elucidations regarding “Events After the Reporting Period” were provided. Within these statements, “Events After the Reporting Period” are defined, and a distinction is made between events that require adjustment and events that do not require adjustment. For example, the report of Akfen Renewable Energy Inc. includes the following statements: *“Events after the reporting period encompasses all occurrences between the balance sheet date and the date when authorization for the publication of the balance sheet is granted, irrespective of any prior disclosure of profit or other pertinent financial data. Should events necessitating adjustments arise subsequent to the balance sheet date, the Group rectifies the figures presented in the consolidated financial statements to reflect this new development.”* A comparable instance is Alfa Solar Energy Industry and Trade Inc., which can be cited as follows: *“If an event necessitating adjustment arises in the financial statements between the balance sheet date and the authorization date, the requisite adjustments are implemented. In instances where no adjustment is required, the pertinent event is elucidated in the footnotes of the balance sheet.”* The concept of materiality has been mentioned in certain reports. For instance, the following statement is contained in the report of Aksa Acrylic Chemical Industry Inc.: *“Events that occur after the reporting period of the Group and may affect its situation during the reporting period (events that require adjustment) are reflected in the consolidated financial statements. Events that do not require adjustment are explained in footnotes if they are of particular importance.”* In some reports, emphasis is placed on the presentation of financial statements in accordance with the new circumstances after defining “Events After the Balance Sheet Date”. An example of this is the report of Bilici Investment Industry and Trade Inc.: *“...It refers to the events that*

occur in favor or against the Group between the balance sheet date and the authorization date for the publication of the balance sheet. If there is new evidence indicating that the mentioned events occurred as of the balance sheet date or subsequent to it, the Group elaborates on these matters in the corresponding footnotes. The Group adjusts the amounts included in the financial statements if events requiring adjustment occur after the balance sheet date, aligning them with the new circumstances.”

Upon examination of the financial reports, it was identified that two events transpired in the first quarter of 2023, both of which were disclosed in the footnotes pertaining to “Events After the Reporting Period”. The first of these is the earthquake disaster, which is the reason for the sample classification of our study. The second is the Social Insurance and General Health Insurance Law and the Law on Amendments to the Decree Law No. 375, which came into force after being published in the Official Gazette on March 3, 2023. It has been observed that pension regulations impact the financial statement footnotes of companies that disclose their annual financial reports after the publication date. This adjustment is specifically reported in the footnotes under “Events After the Balance Sheet Date”. For instance, the financial statement footnotes of Ahlatcı Natural Gas Distribution Energy and Investment Inc. include the following explanations: *“The Law on Amendments to the Decree Law No. 375 entered into force by being published in the Official Gazette No. 32121 dated March 3, 2023. Although this issue is considered as an event that does not require adjustment after the reporting period within the scope of TAS 10: Events After the Reporting Period standard, studies on measuring its impact on the Group's operations and financial position are continuing.”* A similar explanation is also available in the footnotes of Alarko Holding Inc.: *“The Law on Amending the Social Insurance and General Health Insurance Law No. 7438 and the Decree Law No. 375 entered into force by being published in the Official Gazette No. 32121 dated March 3, 2023. This issue was evaluated within the scope of TAS 10: Events After the Reporting Period standard.”*

The Kahramanmaraş earthquakes that occurred in February 2023 caused tangible and intangible damage in the region covering the borders of 11 provinces. It is predicted that material damages will be over 100 billion dollars (Bloomberg HT, 2023). In the report by the Turkish Economic Policy Research Foundation (TEPAV), it was estimated that the funding needed to address the financial repercussions of the earthquake and to facilitate the region's development amounted to approximately 150 billion dollars (NTV, 2023). The negative economic effects of the Kahramanmaraş earthquakes impacted much of Türkiye beyond the earthquake zone. In the Kahramanmaraş and Hatay Earthquakes Report by the Presidency of Strategy and Budget, it was projected that the earthquake would exert a negative influence of 1-1.4% on the economic growth figures of Türkiye in 2023 (Presidency of Strategy and Budget, 2023, p. 122). The earthquake caused direct damage to the facilities of companies operating in the region or loss of workforce. For example, the following statements are included in the annual financial reports of Arsan Textile Trade and Industry Inc., which we determined has production activities in the earthquake zone: *“Following the earthquake centered in Kahramanmaraş on February 6, 2023, the Group notified*

the insurance company regarding the damages incurred in its production facilities. Experts assigned by the relevant insurance company have started to work to determine the damage in the Woven Fabric, Woven Dyeing Finishing, Knitted Dyeing Finishing, Yarn Dyeing Finishing, Purification Facility and Energy Production facilities of Arsan Weaving Dyeing Industry and Trade Inc., which realizes almost all of the production and textile turnover of the parent company. The review and negotiation processes are continuing regarding the type and amount of damage occurring in the specified production facilities, who will carry out the maintenance, repair and commissioning works of the construction and machinery and how long it will take. Again, depending on these processes, the relevant insurance company and its experts continue to work on the amount of Profit Loss that should be taken for the period when the facilities are not in operation. Due to these reasons, there is currently no definite opinion on when the production facilities of Arsan Weaving Dyeing Industry and Trade Inc. will become operational. Nevertheless, it is expected that the production facilities will resume operations before the expiration of the Loss of Profit policy period. Consequently, the Group's shares are suspended from trading on the stock exchange due to the abovementioned circumstances. A significant portion of the Yarn Production facilities owned by Arsan Textile Trade and Industry Inc. sustained damage, resulting in a total compensation payment of 222,609,670 TL by Anadolu Turkish Incorporated Insurance Company. Investigations by the insurance company regarding the stocks in the Group's production facilities are continuing, and some of the stocks have still not been reached due to the damage to the buildings. The value of inventory in the damaged buildings is approximately 44,000,000 TL, and it remains unclear how much of this inventory has been damaged. This inventory is covered by insurance.”

On the other hand, many companies outside the region were damaged because they carried out direct or indirect commercial activities with companies in the earthquake zone. Since the majority of companies carrying out production activities outside the region carry out commercial activities in the earthquake region, their relationships have been damaged and they have lost their customer base. The adverse economic impacts were also evident in the financial statements of companies unaffected directly by the earthquake, primarily due to the absence of production activities in the earthquake region. For instance, the financial statement footnotes of Ülker Biscuit Industry Inc. include the following disclosures: *“Following the earthquakes centered in Kahramanmaraş, which impacted multiple provinces, a state of emergency was declared encompassing 10 provinces in the area. Efforts to assess the situation and closely monitor the developments related to this natural disaster are ongoing.”* Similar statements were echoed by numerous service businesses. Examples of such statements can be found in the footnotes of financial statements, such as those made by Albaraka Turkish Bank Inc.: *“An earthquake struck the southeastern region of Türkiye, impacting several provinces. Efforts to gauge the effect on the Parent Bank's operations and financial standing are ongoing, as the full extent of this earthquake, resulting in the loss of thousands of lives and injuries, remains uncertain.”*

Finally, another observation we made after reviewing the financial reports is that many companies felt compelled to issue statements even if they were not directly affected by the earthquake. This finding indicates that companies perceive the earthquake as an event of significant magnitude that will profoundly impact the entire country. The statements of Eczacıbaşı Investment Holding Corporation serve as examples in this regard: *“The developments concerning the earthquake disaster that affected 11 provinces in the same region, with Kahramanmaraş at the center, on February 6, 2023, are being closely monitored. There are no conditions or uncertainties affecting the company's operations and financial statements.”*

After detailed qualitative analysis without using any computer program, frequency and word cloud analysis was carried out with the help of Maxqda Analytics Pro 24. The data set used in these analyzes consists of documents containing events after the reporting period footnotes in the financial statements of a total of 103 companies. Analyzes were applied separately to the two sample groups we defined before. Table 2 presents the most frequently repeated words in the footnotes concerning subsequent events for two distinct groups: one comprising 12 companies, whose stock transactions were suspended by Borsa Istanbul until a special disclosure was made by the company management on the public disclosure platform, and the other consisting of 91 companies listed on the BIST-100 Index. Word frequency tables are visualized with the graphs in Figure 2.

Table 2. Word Frequencies

Companies with Suspended Stock Transactions				Bist-100			
Row	Word	Fre.	Percentage	Row	Word	Fre.	Percentage
1	February	27	3.26	1	Company	133	0.83
2	Financial	25	3.02	2	February	127	0.79
3	Kahramanmaraş	21	2.53	3	Group	101	0.63
4	Company	18	2.17	4	Board	99	0.61
5	Share	17	2.05	5	Financial	91	0.56
6	Balance sheet	14	1.69	6	Management	75	0.47
6	Adjustment	14	1.69	7	Decision	74	0.46
8	Group	13	1.57	8	Share	73	0.45
9	Earthquake	12	1.45	9	Issue	70	0.43
9	Production	12	1.45	10	Kahramanmaraş	68	0.42

Following the word frequency analysis, it was observed that there were 168 words with a frequency of at least 3 in the events after the balance sheet date footnote in the financial statements of the companies whose stock transactions were suspended by Borsa Istanbul. It was determined that there

earthquakes are predominant. Considering the criteria of the word cloud, it can be said that a significant portion of the most frequently repeated words are related to earthquakes. Similar analysis was conducted for companies in the BIST-100 index. Figure 4 presents a word cloud of BIST-100 Index companies. The size of each word corresponds to its frequency within the companies' public disclosures related to subsequent events.

Figure 4. Word Cloud of Bist-100 Index



The analysis of the word cloud generated from the data of BIST-100 companies reveals that while there are fewer earthquake-related words compared to the companies whose stock transactions were suspended post-earthquake, they are still present. Particularly, words associated with the Kahramanmaraş earthquakes are noticeable among those with repetition above certain frequency thresholds. This observation aligns with the extensive scale of the earthquake disaster and its significant economic repercussions nationwide. The word clouds and frequency tables effectively reflect the findings obtained from the detailed qualitative examinations conducted through the footnotes of subsequent events.

6. CONCLUSION

In this research, events after the balance sheet date are conceptually examined, primarily within the framework of ISA 560: Subsequent Events and IAS 10: Events After the Reporting Period. Following these conceptual reviews and definitions, qualitative reviews and analyses were conducted to assess how events after the balance sheet date were disclosed in the financial statements of Turkish companies. The primary motivation for investigating this issue within the research scope is to observe how the Kahramanmaraş earthquakes, significantly impacting Türkiye, were reported within the context of events after the balance sheet date. This determination confirms that companies listed on Borsa İstanbul report events after the balance sheet date in accordance with IAS 10, and the qualitative analysis reveals how the effects of the earthquake disaster, causing substantial tangible and intangible losses in Türkiye, are reflected in the financial statements.

In addition to companies whose production facilities were directly damaged, service businesses that had commercial relations with companies in the earthquake zone or whose customer base resided in the region were greatly damaged by the earthquake. The destructive power of the earthquake that affected the whole country was reflected in the financial reports of almost all of the publicly held companies within the scope of our research. However, it has been determined that the longest statements were made by companies that had production activities in the earthquake zone and whose stock transactions in Borsa Istanbul were temporarily suspended immediately after the earthquake.

In addition to the earthquake disaster in 2023, another significant event considered within the realm of events after the reporting period is the enactment of amendments to pension laws. This legal reform impacts approximately 5 million employees nationwide. Given that a substantial portion of those affected by the regulation are employed in public entities, its repercussions on financial reporting are magnified. Many companies, issuing their financial reports after March 3, the date of publication of the law in the Official Gazette, assessed the implications of the retirement regulation under the events after the balance sheet date category and elucidated its influence on financial reporting.

Turkish literature concerning events after the balance sheet date predominantly comprises conceptual or theoretical analyses. Empirical investigations on the topic are scarce in the international literature as well. Our study holds promise for bridging this identified gap in the literature. Future research endeavors, particularly those employing quantitative or mixed analysis methodologies, have the potential to yield further insights and advancements in the field.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all processes of the research.

REFERENCES

- Abu-nassar, M., & Orabi, H. (2012). The extent of compliance of the Jordanian companies in applying the International Accounting Standard 10: Events after the reporting period. *Journal of Administrative And Economics Science*, 5(2), 113-131.
- Al-Bishtawi, S., & Al-Harasees, M. (2022). Subsequent events under Covid-19 pandemic. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 12(2), 25-43. <https://doi.org/10.6007/ijarafms/v12-i2/13112>
- An, J., & Park, B. (2019). Natural disasters and international financial accessibility in developing countries. *Asian Economic Papers*, 4(18), 245-261. https://doi.org/10.1162/asep_a_00682

- Bloomberg HT. (2023, March 17). *Depremlerin maliyeti açıklandı*. <https://www.bloomberght.com/depremlerin-maliyeti-aciklandi-2327187>
- Chen, G. (2020). Assessing the financial impact of natural disasters on local governments. *Political Economy: National*, 40(1), 22-44. <https://doi.org/10.1111/pbaf.12245>
- Chung, J. O., Cullinan, C. P., Frank, M., Long, J. H., Mueller-Phillips, J., & O'Reilly, D. M. (2013). The auditor's approach to subsequent events: Insights from the academic literature. *Auditing: A Journal of Practice & Theory*, 32(1), 167-207. <https://doi.org/10.2308/ajpt-50328>
- Delikanlı, İ. U. (2009). Finansal tabloların yayımının onaylanma süreci ve bu süreçteki gelişmelerin tablolara yansıtılması. *Muhasebe ve Denetime Bakış*, (29), 101-118.
- Dhakal, D., Shrestha, S., & Shrestha, A. (2024). Impact of financial risk and macro-economic variable on stock return: Evidence from commercial banks of Nepal. *Janabhawana Research Journal*, 3(1), 1-20. <https://doi.org/10.3126/jrj.v3i1.68380>
- Doğan, U., & Cengiz, S. (2018). International Financial Reporting Standards (IFRS) –10 Determination events after reporting period accounted for and reported. *Kırıkkale University Journal of Social Sciences*, 8(1), 123-144. <https://doi.org/10.1108/04-2018-1021>
- Donatella, P., Haraldsson, M., & Tagesson, T. (2022). Reporting on covid-19–or not? Annual report disclosure of the pandemic as a subsequent event. *Journal of Public Budgeting, Accounting & Financial Management*, 34(6), 117-136. <https://doi.org/10.1108/JPBAFM-04-2021-0074>
- Dönmez, A. (2010). Evaluation of events occurring after the balance sheet date in terms of auditing standards. *Financial Analyze Journal*, 20(99), 13-34.
- Esen, Ö., & Sakin, T. (2022). The effects of covid 19 pandemic to "events after the reporting date": A content analysis on Turkish firms. *Econder International Academic Journal*, 6(1), 35-49. <https://doi.org/10.35342/econder.987113>
- Ferreira, S., & Karali, B. (2015). Do earthquakes shake stock markets?. *PLoS One*, 10(7): e0133319. <https://doi.org/10.1371/journal.pone.0133319>
- Gönen, S., & Kutay, N. (2013). Importance of IAS 10 events after the reporting period in decision taking of financial statement users. *International Journal of Alanya Faculty of Business*, 5(3), 39-46. <https://doi.org/10.2308/acch.2007.21.3.281>
- Hategan, C. D., & Crucean, A. C. (2018). Reporting of subsequent events in financial statements-between obligation and necessity. *Audit financiar*, 16(152), 571-583. <https://doi.org/10.20869/AUDITF/2018/152/025>
- Heimerl, F., Lohmann, S., Lange, S., & Ertl, T. (2014). Word cloud explorer: Text analytics based on word clouds. In *47th Hawaii International Conference on System Sciences* (pp. 1833-1842). IEEE Xplore Press. <https://doi.org/10.1109/HICSS.2014.231>
- Herda, D. N., & Lavelle, J. J. (2014). Auditing subsequent events: Perspectives from the field. *Current Issues in Auditing*, 8(2), 10-24. <https://doi.org/10.2308/ciia-50886>
- International Accounting Standards Board. (2003). *IAS 10: Events after the reporting period*. <https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2021/issued/part-a/ias-10-events-after-the-reporting-period.pdf>
- International Accounting Standards Board. (2007). *IAS 1: Presentation of financial statements*. <https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2022/issued/part-a/ias-1-presentation-of-financial-statements.pdf?bypass=on>
- Financial Reporting Council. (2018). *ISA 560: Subsequent events*. <https://www.frc.org.uk/library/standards-codes-policy/audit-assurance-and-ethics/auditing-standards/isa-uk-560/>
- Janvrin, D. J., & Jeffrey, C. G. (2007). An investigation of auditor perceptions about subsequent events and factors that influence this audit task. *Accounting Horizons*, 21(3), 295-312. <https://doi.org/10.2308/acch.2007.21.3.295>
- Keerthirathne, S., & Tol, R. (2017). Impact of natural disasters on financial development. *Economics of Disasters and Climate Change*, 1(1), 33-54. <https://doi.org/10.1007/S41885-017-0002-5>

- MAXQDA (2024). Software for qualitative data analysis, VERBI Software. Consult. Sozialforschung GmbH, Berlin, Germany.
- Miao, Q., Hou, Y., & Abrigo, M. (2018). Measuring the financial shocks of natural disasters. *National Tax Journal*, 71(1), 11 - 44. <https://doi.org/10.17310/ntj.2018.1.01>
- Miao, Q., Chen, C., Lu, Y., & Abrigo, M. (2020). Natural disasters and financial implications for subnational governments: Evidence from China. *Public Finance Review*, 48(1), 101-72. <https://doi.org/10.1177/1091142119884710>
- Michels, J. (2017). Disclosure versus recognition: Inferences from subsequent events. *Journal of Accounting Research*, 55(1), 3-34. <https://doi.org/10.1111/1475-679X.12128>
- Miyazaki, T. (2013). Effect on the finances of local governments in the case of an earthquake occurring directly beneath the Tokyo metropolitan area: Projections by year and prefecture(in Japanese). *Economic Analysis*, 186(1), 52-68.
- Nawaiseh, M. A. L., & Jaber, J. (2015). Auditing subsequent events from the perspective of auditors: study from Jordan. *International Journal of Financial Research*, 6(3), 78-85. <https://doi.org/10.5430/ijfr.v6n3p78>
- NTV. (2023, March 14). *Rapor: Deprem Türkiye ekonomisine maliyeti 150 milyar dolar*. <https://www.ntv.com.tr/ntvpara/rapor-depremin-turkiye-ekonomisine-maliyeti-150-milyar-dolar,UUKGaIWDRUikZseMHFa0kw>
- Oyedokun, G. (2015). Adoption of IFRS: Implication of event after reporting period on auditors' reports. *International Accounting e-Journal*, 5, 1-27. <https://doi.org/10.2139/SSRN.2912245>
- Özdemir, Z., & Gökçen, B. A. (2016). Auditing of subsequent events: A survey of auditors in the city of Istanbul in Turkey. *Accounting and Finance Research*, 5(2), 42-56. <https://doi.org/10.5430/afr.v5n2p42>
- Pamukçu, F., & Pamukçu, N. (2009). Events after the balance sheet date and the effects to financial statements. *Financial Analyze Journal*, (91), 67-80.
- Pauch, D., Bera, A., & Walczak, D. (2024). Insurance in mitigating the financial consequences of natural disasters. *Economics and Environment*, 89(2), 1-11. <https://doi.org/10.34659/eis.2024.89.2.769>
- The Official Gazette (2023, March 3). *Sosyal sigortalar ve genel sağlık sigortası kanunu ile 375 sayılı kanun hükmünde kararnamede değişiklik yapılmasına dair kanun*. The Official Gazette No: 32121. <https://www.resmigazete.gov.tr/eskiler/2023/03/20230303-8.htm>
- Scholten, B., & Voorhorst, Y. (2013). The impact of earthquakes on the domestic stock market. *Earthquake Spectra*, 29(1), 325-337. <https://doi.org/10.1193/1.4000103>
- Seo, H., Jung, J., & Lee, D. (2018). The impact of local financial capability on damage from natural disasters. *Journal of the Korean Society of Hazard Mitigation*, 18(3), 381-389. <https://doi.org/10.9798/KOSHAM.2018.18.3.381>
- Shaw, W. (2011). The 2011 Tohoku, Japan quake and tsunami: Provisional financial impact assessment. *Risk Management e-Journal*, 11, 9-18. <https://doi.org/10.2139/ssrn.1797845>
- Skufina, T., Baranov, S., & Samarina, V. (2017). The influence of strong earthquakes on the global economy: Facts and assessment. *International Journal of Ecological Economics and Statistics*, 38(4), 108-114.
- Sümer, H., & Erer, M. (2009). Events after the balance sheet date. *World of Accounting Science Journal*, 11(1), 1-17.
- Şalış, İ. (2011). *Accounting and application of events after the balance sheet date* [Unpublished master's thesis]. Marmara University.
- Presidency of Strategy and Budget (2023). *Kahramanmaraş and Hatay earthquakes report*. <https://www.sbb.gov.tr/wp-content/uploads/2023/03/2023-Kahramanmaras-and-Hatay-Earthquakes-Report.pdf>
- Tunji, S., Adeleye, O., Olakunle, O., & Okon, E. (2022). Events after the reporting period and investment decisions in manufacturing companies in Nigeria. *Sumerianz Journal of Economics and Finance*, 5(2)31-38. <https://doi.org/10.47752/sjef.52.31.38>
- Tüm, K. & Memiş, M. Ü. (2015). IAS 10 – Events after the reporting period (Balance sheet date) and responsibilities of independent auditors. *Journal of Çukurova University Social Sciences Institute*, 24(1), 321-324.

- Williams, W., Parkes, E. L., & Davies, P. (2013). Wordle: A method for analysing MBA student induction experience. *The International Journal of Management Education*, 11(1), 44-53. <https://doi.org/10.1016/j.ijme.2012.10.002>
- Yamada, H., Yashiro, H., Omine, H., & Yoshikawa, H. (2012). Financial impact on the measurement of earthquake risk transfer in railway company. *Journal of Japan Association for Earthquake Engineering*, 12(4), 201-208. https://doi.org/10.5610/jaee.12.4_201
- Yılmaz, F., & Sarı, E. S. (2013). Evaluation of events after the reporting period (Balance sheet date) in terms of TAS and a research on companies in the ISE-100 Index. *Journal of the Accounting Institute*, 73(1), 65-82.

Understanding Consumer Values: An Explanatory Sequential Mixed Methods

Adem UYSAL¹

Abstract

This study aims to accomplish two goals: First, the analysis uses the means-end theory (MEC) to test a conceptual model that includes relevant variables, such as engagement, emotional value, functional value, attitude, and environmental consciousness established to comprehend how Turkish consumers evaluate non-auction-based C2C secondary marketplaces; second, in line with the variables, to reveal the views of Turkish users on these marketplaces through in-depth. A sequential exploratory mixed method design combining quantitative and qualitative parts is used in this study. The data in Study 1 acquired from 363 consumers via face-to-face surveys were analyzed using explanatory factor analysis, and the process model produced by Hayes tested the hypotheses—study 2 featured 20 in-depth interviews with C2C online secondary marketplace users. The findings reveal that the variable of consumer engagement partially mediated the relationship between functional value/emotional value and attitude toward platforms. Additionally, Environmental consciousness moderates the strength of the relationships between functional value/emotional value and attitude toward platforms mediated by consumer engagement. The results of Study 2 show that in addition to functional and emotional values, social and environmental values result from the consumer's evaluation of C2C online secondhand platforms. Moreover, consumer engagement, mainly associated with platform features, user comments, and seller profiles, leads to positive attitudes toward platforms. The study is original in that it uses a sequential explanatory mixed method approach to determine the thoughts of Turkish users about the online secondary marketplace in the relationship between consumer values dimension, consumer engagement, environmental consciousness, and attitudes.

Keywords: Consumer to Consumer, Consumer Engagement, Consumer Attitude, Consumer Value, Environmental Consciousness, Mixed Methods.



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1. INTRODUCTION

Advancements in technology and resource scarcity are driving both consumers and organizations toward collaborative production and consumption in the sharing economy (Chen & Wang, 2019). Economic conditions, unemployment, and a desire for increased earnings may influence this shift, but the primary driving forces include the progress of digital technology, increased digital security, and the adaptation of these technologies to consumer needs (Bilgin, 2021). In globalized world, rapidly advancing technology is elevating the importance of the sharing economy, with people joining this economic model for reasons such as cost-effectiveness, environmental friendliness, and a willingness to engage with new applications (Belk, 2014).

C2C platforms are called sharing economies or collaborative consumption platforms, as described in the literature by Ek Styvén and Mariani (2020) and Joyner Armstrong and Lang (2018). A C2C platform is digital technology enabling the acquisition and distribution of goods through collaborative consumption. Online second-hand sales are re-commerce, which combines e-commerce and resale. Platform-related entities categorize them into three categories: peer-to-peer, business-to-consumer, and customer-to-customer (C2C) transactions (Wertz & Kingyens, 2015).

During the COVID-19 era, consumer-to-consumer (C2C) trade has significantly expanded, particularly on emerging social commerce marketplace platforms facilitated by digital technologies (Sim, 2023). This growth is especially notable in the used-product exchange and transaction markets within C2C platforms (Ofori et al., 2023). For instance, consumer spending on Amazon between May and July 2020 increased by 60% compared to the same period in the previous year, highlighting the surge in online shopping during the pandemic. Additionally, eBay's projected gross merchandise volume for the first quarter of 2025 ranges between \$18.3 billion and \$18.6 billion, indicating sustained activity in C2C transactions (Reuters, 2025). Moreover, recent market research shows that the global C2C e-commerce market is projected to grow from \$300 billion in 2024 to \$800 billion by 2032, with a compound annual growth rate of 13% (HTF Market Intelligence, 2024).

C2C second-hand trading platforms are proliferating. However, academic interest in the characteristics of consumers using C2C second-hand trading platforms is scant (Park, 2023; Wen et al., 2023). Second, prior research has concentrated chiefly on C2C electronic marketplaces that use auctions to determine prices (Meksopavankul, 2017). The C2C secondary marketplace, referred to as non-auction-based transactions (Moriuchi & Takahashi, 2023), has recently become more prominent. This research will focus on C2C electronic classified markets that do not use auctions. Furthermore, the number of second-hand shopping websites on digital platforms is expected to rise along with the shopping volume (Telli & Gezmişoğlu Şen, 2022). Despite the high growth projections, insufficient studies on Turkish users are a significant shortcoming. Also, no in-depth study exists in Turkey, except for Özkaya and Kazançoğlu (2021), to explain why consumers prefer online second-hand shopping.

In the context of these research problems, the central purpose of this investigation is to gain insight into Turkey's online C2C e-commerce. A sequential exploratory mixed method design, including a survey and in-depth interviews, was used to obtain broader and more detailed information based on the means-end theory (MEC). This theory addresses the consumer decision-making process through a cognitive approach, aiming to reveal what products consumers purchase for what purpose during this process and what they perceive in products from a consumer perspective. According to the theory, consumers perceive the products they choose not only as consumption tools but also as psychological and functional outcomes where they can express their goals, values, and aspirations (Costa et al., 2004). Therefore, this research study has a twofold purpose. First, it aims to test a conceptual model with relevant variables, including functional value, emotional value, consumer engagement, attitude, and environmental consciousness. This model is designed to understand how Turkish consumers evaluate non-auction-based C2C secondary marketplaces. Second, the study seeks to reveal the views of Turkish users on online second-hand shopping platforms through in-depth qualitative analysis and to examine whether the quantitative and qualitative data support each other.

This study contributes to the literature on consumer-to-consumer (C2C) e-commerce by applying the Means-End Chain (MEC) theory to understand consumer behavior in non-auction-based secondary marketplaces. Specifically, it extends prior research by conceptualizing functional and emotional value as independent variables, consumer engagement as a mediator, environmental consciousness as a moderator, and consumer attitude as an outcome. This integrated model provides a comprehensive framework for examining how consumers evaluate second-hand platforms, which have been underexplored in existing studies. In line with Gutman (1982), consumer value emerges from evaluations of product attributes that fulfill personal goals. These evaluations are shaped by platform-specific elements, such as consumer interest in second-hand platforms, advertisements, and product-related comments. Moreover, the study highlights the importance of psychological benefits obtained through buyer–seller interaction (Parihar et al., 2019), which in turn foster positive consumer attitudes (Ofori et al., 2023).

Secondly, this research adds to consumer engagement and environmental consciousness literature. In the present marketing literature, consumer engagement has become increasingly important (Kumar et al., 2019). Previous research has validated the affirmative correlation between engagement and several forms of conduct (such as pro-environmental, green citizenship, in-role, extra-role, etc.) (Mohammad et al., 2021). Hence, the roles of consumer engagement and environmental consciousness as attitudinal factors influencing attitude toward C2C e-commerce platforms have not been closely examined. This study contends that environmental consciousness will moderate the relationship between consumer engagement and attitude.

Thirdly, a mixed methods study is used to analyze consumer attitude toward C2C secondary marketplaces in Turkey using a holistic approach. Based on the MEC theory, it seeks to understand the

role of consumer value, consumer engagement, and environmental consciousness. Unlike previous studies that solely used quantitative or qualitative methods, this research employs this method approach to provide a comprehensive understanding (Creswell, 2013). A quantitative study examines constructs and relationships, with findings informing subsequent qualitative research to better comprehend and address anomalies in the quantitative results (Maxwell & Mittapalli, 2010).

The rest of this paper is structured as follows. First, it provides a short theoretical overview of functional value, emotional value, consumer engagement, attitude, and environmental consciousness, followed by a description of our mixed methods of research design. Subsequently, we report on the findings from our quantitative and qualitative research. We conclude with our theoretical contributions, managerial implications, and future research directions.

2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1. Functional Value

It is assumed that functional value is generally the most influential factor in consumer preferences (Sheth et al., 1991). A product or service's observable performance and beneficial features constitute the functional value (Furukawa et al., 2019). Functional value expresses individuals' rational and economic values, with the product and service quality shaping this dimension (Khan, 2010). In other words, functional value comprises the physical features that a product should have (Berry et al., 2002). The functional value of a product can also be derived from its unique characteristics, such as reliability, durability, and price (Sheth et al., 1991).

2.3. Emotional Value

Emotional value is associated with a product or service's emotional gains to the consumer (Sweeney & Soutar, 2001). While emotional value includes various positive emotions such as trust, excitement, etc., it also represents a value related to human emotions, sometimes encompassing emotions like fear, excitement, and tension (Sánchez-Fernández & Iniesta-Bonillo, 2007; Sheth et al., 1991). Evaluated from the product perspective, it can be said that emotional value is a value that leads to preference due to the emotions or emotional states the product evokes in the consumer (Xiao & Kim, 2009).

2.4. Consumer Engagement

Engagement is a complex concept in marketing literature, encompassing both a process and a state. Bowden (2009) defines it as a psychological process that drives customer loyalty, while Brodie et al. (2013) present it as a psychological state with specific intensity at specific points in time. Both views acknowledge that consumer engagement is a continuum, with different levels of intensity and complexity expected in different situations and times (Sim & Plewa, 2017). According to Hollebee et al. (2012), consumer engagement can also be defined as the extent to which an individual participates

in and feels emotionally connected to a company's offerings and activities, irrespective of whether these activities are initiated by the company or by the consumer. In the context of the research scope, according to Cheung et al. (2014), consumer engagement is the degree of a customer's mental, emotional, and physical presence about a particular online purchasing platform, which is known as consumer engagement.

Ofori et al. (2023), analyzing the structural equation model with survey responses from experienced users of C2C used-product platforms, reveals that multi-dimensional consumer values (hedonic, utilitarian, environmental, and social) significantly influence consumer engagement. Moriuchi and Takahashi (2023) found that Functional and emotional value indirectly affect consumer engagement through trust in the immediacy platform and trust in the online seller on the C2C e-marketplace. Another study discovered that, for utilitarian and hedonistic brands, there is a curvilinear relationship between customer engagement and customer value. It was observed that hedonic brands contribute to a more significant increase in customer value with increasing consumer engagement compared to brands that are beneficial for a brand, category, consumer, or situation (Hollebeek, 2013). Therefore, this study proposes that functional value and emotional values will directly influence consumer engagement.

H1a. Functional value positively impacts consumer engagement.

H1b. Emotional value positively impacts consumer engagement.

2.5. Consumer Engagement and Attitude

Individual engagement and values can affect how customers feel about goods and services and what they buy. According to attitude research, a person's intention to carry out a behavior determines that person's behavior. One definition of action is the determination to carry out a course of action or activity, like engaging in a relationship (Fishbein & Ajzen, 1975). According to Vivek et al. (2012), a person actively involved in a brand, company, or product may form more positive attitudes toward it, strengthening the psychological process and raising the possibility of a positive behavioral response. With or without direct interaction, consumer engagement affects consumers' attitudes, behavioral intentions, and actual behavior (Kim & Lee, 2012). We assume then that engaged individuals are more likely to develop positive attitudes.

H2: Consumer engagements positively affect attitude toward platforms.

Based on the existing literature, it has been widely recognized that consumer engagement plays a central role in shaping consumer attitudes and behaviors, especially within the context of value-based frameworks. According to prior research, customer engagement serves as a critical mediator in various relationships, such as between value and satisfaction (Parihar et al., 2019). Moreover, engagement has been shown to mediate the link between trust toward a retailer and consumer behavioral intentions (Thakur, 2018), emphasizing its role in influencing decision-making processes.

Further studies have demonstrated that customer engagement is essential in promoting value co-creation behaviors, which enhance the overall consumer experience (Merrilees, 2016; Zhang et al., 2017). Hollebeek (2011) also emphasized that engagement is a multifaceted concept, incorporating emotional, cognitive, and behavioral dimensions, which aligns with the idea that engagement influences a consumer's attitude toward a brand or platform.

In the hospitality industry, research has confirmed that consumer engagement significantly impacts both attitudes and behaviors (Aluri et al., 2019; Ou et al., 2020). Functional value, in particular, has been found to affect engagement, which, in turn, shapes consumer attitudes toward platforms and brands (Vivek et al., 2012). Building upon this body of work, the following hypotheses are proposed:

H3a: Consumer engagement mediates the relationship between functional value and attitude toward platforms.

H3b: Consumer engagement mediates the relationship between emotional value and attitude toward platforms.

2.6. As a Moderator, Environmental Consciousness

Previous research has explored the impact of environmental consciousness on consumers' decision-making processes. Consumers who care about the environment believe they should reduce their consumption and refrain from doing things that harm the environment (Segev et al., 2015). Fu and Kim (2019) found that buyers' awareness of environmental issues positively impacted their cognitive reactions, which in turn affected their intention to buy and willingness to pay a premium for eco-fashion. Furthermore, environmental and green factors can significantly impact a customer's behavior by encouraging them to look up more information about the product online from reputable sources (Luzio & Lemke, 2013).

The C2C used product platform promotes sustainable consumption, reduces resource waste, and addresses environmental pollution by offering economically efficient alternative used products to consumers (Liu et al., 2021; Moriuchi & Takahashi, 2023). Moreover, the ability of a C2C platform to share idle resources yields both demand and supply economic advantages that increase resource efficiency and provide societal and environmental benefits (Park, 2023; Teubner et al., 2014). In this context, we assume that environmentally conscious consumers are aware of the savings and environmental advantages of reusing products through the C2C online platform, leading to a change in attitudes. Therefore, Hypothesis 4 was established.

H4a: Environmental consciousness moderates the mediation effects of consumer engagement in the relationship between functional value and attitude toward platforms.

H4b: Environmental consciousness moderates the mediation effects of consumer engagement in the relationship between emotional value and attitude toward platforms.

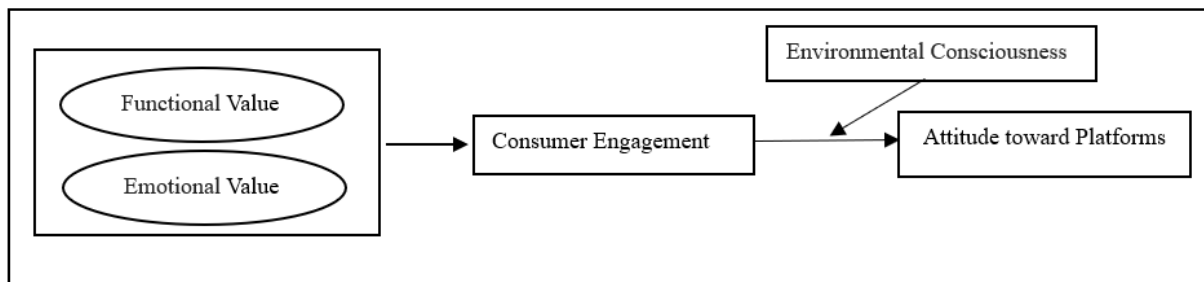
3. RESEARCH METHODOLOGY

The study employed a mixed-method explanatory sequential design. This design aims to begin with a quantitative phase and subsequently explain the results obtained through qualitative studies (Creswell, 2017). This design commences with the collection of quantitative data, followed by the analysis of the gathered quantitative data and the identification of participants for the qualitative phase. In the subsequent stage, qualitative data are collected and analyzed, and finally, the quantitative and qualitative data are integrated (Creswell, 2017). Maxwell and Mittapalli (2010) have associated the significance of mixed-method research with its explanatory power. The use of both qualitative and quantitative approaches enables the attainment of results that would be unattainable through either method alone.

3.1. Study 1: Quantitative research

Study 1 determined the variables of functional value, emotional value, environmental consciousness, consumer engagement, and attitude toward platforms. In terms of the purpose of the research and hypotheses, the research model depicting the interactions among the variables in question is presented in Figure 1.

Figure 1. Research Model



3.1.1. Sample and Data Collection.

The study sample comprises individuals 18 or older who have used online second-hand shopping platforms operating in Turkey. In the quantitative phase of the research, a survey form was employed as the primary data collection method. Four hundred twenty surveys were distributed by pollsters in the study, with 380 surveys completed. Seventeen surveys with incomplete or inconsistent responses were excluded from the analysis, resulting in 363 surveys being included in the analytical process. A 5-point Likert scale was utilized to rate the scales included in the survey form. The data were analyzed using statistical programs, specifically SPSS and AMOS.

3.1.2. Stimulus Design and Measure

In this study, it is decided to include nine C2C online secondhand platforms: Letgo, Sahibinden, Dolap, Gardrops, Gittigidiyor, ModaCruz, Zebramo, BebeCruz, and Others (social media tools). Based on MEC theory, the study uses these secondhand platforms to reveal the relationships between consumer

values, engagement, attitude, and environmental consciousness. It is observed from previous studies that the most preferred platforms in Turkey are Letgo, Sahibinden, and Dolap (Akin, 2020; Telli et al., 2021).

The measurement of functional and emotional variables utilized a scale developed by Sweeney and Soutar (2001) and adapted by Moriuchi and Takahashi (2023). The scale Moriuchi and Takahashi (2022) were employed to measure the consumer engagement variable. The scale from Telli et al. (2021) was utilized to gauge consumer attitudes toward online second-hand shopping platforms. Finally, expressions related to environmental consciousness were adapted from the scales used in the study conducted by Banerjee and McKeage (1994), which has been widely employed and validated in more recent studies as well (Chang, 2012; Karakaş, 2022; Sadachar et al., 2016;), demonstrating its continued reliability and relevance.

3.1.3. Analysis and Results

Mediation and moderated mediation models were evaluated using the PROCESS macro developed by Hayes (2013), incorporating bootstrapping to generate 95 percent bootstrap confidence intervals. The PROCESS analysis involved:

- Independent variables (functional value/emotional value).
- A mediator (consumer engagement).
- A moderator (environmental consciousness).
- A single dependent variable (attitude toward platforms).

To test the hypothesis, the 4-stage model suggested by Baron and Kenny was substituted with the mediation analysis method proposed by Hayes (2017) and other researchers (Mackinnon, 2000; Shrout & Bolger, 2002). As a result, a two-stage model was used. The process macro's number four model, the mediator analysis, was presented first, followed by the number fourteen model, the moderated mediation (Korkmaz & Gedik, 2020).

A reliability analysis was performed to assess the reliability of the measurement and the consistency of scale statements within the research. Following the approach suggested by Malhotra (2010), Cronbach's alpha method was employed in evaluating internal consistency. Each measurement demonstrated reliability, with alpha values higher than 0.70.

3.1.4. Explanatory Factor Analysis

To investigate the structural validity of the research scales, explanatory factor analysis was carried out independently for the variables of functional value, emotional value, consumer engagement, attitude, and environmental consciousness. The suitability of the data for factor analysis was assessed through the Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Tests. Principal component analysis and the varimax rotation method were employed to determine the factors of the scale (Hair et al., 2010).

The final factor structures obtained from the conducted exploratory factor analyses, along with factor loadings, explained the variance of the factors, Cronbach's alpha values, Composite Reliability (CR), and Average Variance Extracted (AVE) values, which are presented in Table I.

Table 1. Exploratory Factor Analysis and Reliability Analysis Results

Latent and Observed Variables	AVE	CR	Factor Loadings
Consumer Value (Variance Explained: 59.126%; Cronbach's Alpha: 0.784)			
Functional Value	.56	.83	
Products that I buy from a C2C online secondary marketplace are reasonably priced			.767
Products that I buy from a C2C online secondary marketplace offer value for money			.785
Products that I buy from a C2C online secondary marketplace is a good product for the price			.742
Products that I buy from a C2C online secondary marketplace would be economical			.700
Emotional Value	.58	.81	
Products that I buy from a C2C online secondary marketplace would make me want to use it			.751
Products that I buy from on a C2C online secondary marketplace would make me feel good			.759
Products that I buy from on a C2C online secondary marketplace would give me pleasure			.790
Environmental Consciousness (Variance Explained: 62.126%; Cronbach's Alpha: 0.796)	.62	.86	
I am a person who cares about the environment.			.724
The whole environmental issue is very important to me.			.807
Whenever possible, I choose products with the lowest environmental impact.			.760
When I have to choose between two equivalent products, I question the pollution level of the products and try not to select the most polluting product.			.856
Consumer Engagement (Variance Explained: 50.778%; Cronbach's Alpha: 0.805)	.50	.86	
I spend a lot of my discretionary time on online secondary marketplace platforms.			.767
I am heavily into online secondary marketplace platforms.			.771
I am passionate about online secondary marketplace platforms.			.687
My days would not be the same without browsing online secondary marketplace platforms.			.712
I love shopping on online secondary marketplace platforms with my friends.			.690
I enjoy shopping on online secondary marketplace platforms more when I am with others			.639
Attitude toward Platform (Variance Explained: 58.111%; Cronbach's Alpha: 0.819)	.58	.87	
Shopping 2nd hand online is a good idea.			.701
I find it rational to shop from 2nd hand online sites.			.756
I tell people around me positive things about 2nd hand online shopping sites.			.741
I have a positive attitude toward shopping on 2nd hand online shopping sites.			.856
I like using 2nd hand online shopping sites for shopping.			.752

As seen in Table 1, the consumer value variable maintained its two-factor structure. As stated in the literature, the first dimension was named "functional value", and the second dimension, consisting of three statements, was defined as "emotional value". The other variables, engagement, attitude toward platforms, and environmental consciousness, were explained by a single factor. When the explanation ratios and Cronbach's alpha values of these factor structures were evaluated, it was seen that they were within acceptable limits.

Each construct's underlying constructs are judged appropriately, and the indicators' factor loadings were both high and statistically significant (see Table 1). All loading estimates were found to be significant ($p < 0.00$), with 0.856 representing the highest loading estimate and 0.639 representing the lowest. Table 1 shows that the CR and AVE were above the 0.50 and 0.70 thresholds, respectively. (see Table 1). Within the scope of convergent validity, composite reliability (CR) and average variance extracted (AVE) values were calculated for each latent variable construct. CR values of at least 0.70 and AVE values of 0.50 and above are considered the limit for the convergent validity of the construct in the measurement model (Malhotra, 2010). Hence, the average variance extracted (AVE) was above the threshold of 0.50, and CR was above the threshold of 0.70.

Before conducting hypothesis tests, a correlation matrix depicting the relationships between variables was generated, and multicollinearity was assessed. There are no relationships (>0.85) between variables that would lead to multicollinearity (Hair et al., 2010). Therefore, it was concluded that the variables are suitable for hypothesis testing.

3.1.5. Hypothesis Tests

3.1.5.1. Mediation Effects

As seen in Table 2, functional value is predicted by H1 to positively affect consumer engagement ($\beta = 0.66$, $p < 0.001$). H1a is therefore supported. According to H1a, there is a positive impact emotional value on consumer engagement ($\beta = 0.24$, $p < 0.001$). H2 is therefore supported. Support is found for H3a's prediction that consumer engagement ($\beta = 0.23$, $p < 0.05$) positively affects attitude toward platforms.

The bootstrap tests ($N = 5000$) by SPSS Process (version 4.3) Model 4 were used to examine the mediation effects. The 95% BootCIs of Paths 1 and 2 do not include zero points, showing that the mediating role of consumer engagement between functional value/emotional value and attitude toward platforms is significant at 0.05.

Table 2 shows a significant and positive effect between FV and AtP, where the path coefficient decreases from $\beta = .65$ to $\beta = .07$ by incorporating the mediating variable into the model. Additionally, a significant and positive effect is found between EV and AtP, and the path coefficient decreases from $\beta = .78$ to $\beta = .13$ with the inclusion of the mediating variable in the model. These results indicated that CE partially mediated the relationship between FV and AtP and between EV and AtP. Namely,

Consumer engagement mediates between (a) functional value and attitude toward platforms and (b) emotional value and attitude toward platforms. Thus, H4a and H4b were supported.

Table 2. Mediation Analysis (n = 363)

	Variables	B	SE	t-value	p
Path 1	Functional Value → Consumer Engagement	.32	.07	4.561	.0000
	Functional Value → Attitude	.65	.05	12.42	.0000
	Consumer Engagement → Attitude	.24	.03	6.535	.0000
	Indirect effect(s) of Emotional Value on Attitudes toward Platforms	Effect	BootSE	BootLL 95% CI	BootUL 95% CI
		.07	.02	0.351	0.1309
	Variables	B	SE	t-value	p
Path 2	Emotional Value → Consumer Engagement	.56	.09	5.874	.0000
	Emotional Value → Attitude	.78	.07	10.08	.0000
	Consumer Engagement → Attitude	.23	.04	5.765	.0000
	Indirect effect(s) of Emotional Value on Attitude toward Platforms	Effect	BootSE	BootLL 95% CI	BootUL 95% CI
		.13	.03	.672	.2136

3.1.5.2. Moderated Mediation Effects

SPSS Process (version 4.3) Model 14 (bootstrap = 5000) is applied to examine the moderated mediation effects (Hayes, 2017). As shown in Table III, the mediation effects of consumer engagement in the relationship between functional value and attitude toward platforms are significant in a lower level of environmental consciousness. In comparison, the effects are also significant in a higher level of environmental consciousness. Moreover, the mediation effects of consumer engagement in the relationship between emotional value and attitude toward platforms are significant in a lower level of environmental consciousness. In comparison, the effects are also significant in a higher level of environmental consciousness. Hence, Hypotheses 4a and 4b were supported.

Table 3. Results of Moderated Mediation Effects

Outcome variable: Attitude toward Platforms					
	Variables	B	SE	t	p
Path 1	Functional Value → Attitude	.49	.05	9.828	.0000
	Consumer Engagement → Attitude	.17	.03	4.979	.0000
	Interaction (Consumer Engagement * Environmental Consciousness)	.02	.00	5.367	.0000
	R ² = .52/p: 0.000				
	Moderator (Environmental Consciousness)	Indirect effect		95% BootCI	
				SE	
		Functional Value → Consumer Engagement → Attitude		LLCI	ULCI
	Higher	.1138		.0313	.0534
	Mean	.0565		.0194	.0222
	Lower	-.0009		.0183	-.0371

(Table 3 cont.)

Path 2	Outcome variable: Attitude toward Platforms				
	Variables	B	SE	t	p
	Emotional Value→ Attitude	.49	.08	6.039	.0000
	Consumer Engagament→Attitude	.17	.03	4.680	.0000
	Interaction (Consumer Engagament *Environmental Consciousness)	.03	.00	5.23	.0000
	R ² =.44/ p: 0.000				
	Moderator (Environmental Consciousness)	Indirect effect		95% BootCI	
		Emotional Value→Consumer Engagament→Attitude		LLCI	ULCI
				SE	
	Higher	.2097		.0500	.1183 .3159
	Mean	.1017		.0317	.0463 .1712
	Lower	-.0064		.0399	-.0866 .0729

According to the degree of environmental consciousness, the slope plot analysis of the moderated mediation (Process model 14) reveals that the impact of consumer engagement on attitude toward platforms varies.

3.1.6. Discussion

Based on MEC theory, study 1 provides insights into the relationships between functional value, emotional value, consumer engagement, and attitudes in C2C online secondhand platforms. Moreover, the moderating role of environmental consciousness in the relationship between consumer engagement and consumer attitudes is investigated. The findings suggest that the extended MEC theory can explain consumer behavior in the C2C online marketplace. Consumer engagement, environmental consciousness, and attitude toward C2C e-secondary platforms are all additional factors that we added to the MEC theory.

The analysis findings show that consumer engagement is positively impacted by both functional and emotional values (H1a and H2a), with emotional value demonstrating a stronger influence. This result aligns with previous studies indicating that perceived value significantly affects consumer engagement (Moriuchi & Takahashi, 2023; Ofori et al., 2023; Pang, 2021). However, while Ofori et al. (2023) emphasized both types of value equally, this study highlights the relatively greater importance of emotional value in the context of second-hand C2C marketplaces in Turkey. Emotional value—such as enjoyment, satisfaction, and the sense of positivity—appears to be a more dominant motivator for consumer engagement in this context (Moriuchi & Takahashi, 2023). This may be due to the social and experiential nature of second-hand shopping, where users seek not only functional benefits like cost savings but also emotional satisfaction from making sustainable or unique purchases. In contrast, functional value, while still significant, plays a more supportive role by providing utility and convenience through access to in-demand products and efficient platform services (Ma et al., 2023).

These results contribute to existing literature by offering context-specific insights and suggest that enhancing emotional appeal may be more effective for increasing engagement in emerging C2C markets.

Moreover, consumer engagement positively influences attitudes toward the platform (Supported by H2). About this outcome, Venetis and Ghauri (2004) stated that engaging in a relationship is not solely indicated by behavior; instead, it is more strongly signaled by the attitudes and reasons behind the behavior. Also, affective and cognitive elements comprise the attitude structure, which serves as the basis for consumer engagement (Ofori et al., 2023). Hence, users selecting, sharing, selling, and tracking the products they are interested in on second-hand C2C online platforms through product notification services contribute to engagement and lead consumers to develop a positive attitude toward these platforms. Additionally, consumer attitudes have a positive effect on continuous use intention. Additionally, it is found that consumer engagement is a mediator in the relationship between functional value/emotional value and attitude toward platforms (Supported by H3a and H3b). As a result, functional and emotional values generate a cognitive and affective process triggered during platform engagement, resulting in attitudes toward online C2C secondhand platforms.

Finally, the moderating effect of environmental consciousness is observed, signifying that environmental consciousness moderates the indirect impact of consumer value on attitudes toward platforms through consumer engagement (Supported by H4a, H4b). This suggests that highly environmentally conscious consumers emphasize the savings and environmental advantages of second-hand purchases made through the C2C online platform, eventually changing attitudes.

3.2. Study 2: Qualitative research

The qualitative section of this study was conducted using the mixed-methods explanatory sequential design following the quantitative research. In the second part of the study, qualitative research was undertaken to interpret the quantitative results better and understand the reasons behind the findings that emerged from the quantitative analysis.

For Study 2, a purposive sampling method was employed (Creswell & Creswell, 2017). The characteristics of participants from Study 1 were considered to identify suitable participants. The purposive sample consisted of 20 participants who exclusively used second-hand online shopping sites and made purchases from these sites. Initial contact was established through a phone call. An intentional effort was made to select a sample that balanced age, usage experience, income, and occupational diversity. Individuals meeting the specified criteria and agreeing to the interview were scheduled for interviews at a mutually convenient time and location.

The interview form technique was employed in the research to gather similar information from individuals to comprehend related topics. The interviews were conducted face-to-face. These data for the research were collected in addition to Study 1, and a semi-structured interview form was employed

to elaborate on the results obtained in detail. The interview questions were prepared using the items in the scales used in Study 1. The content analysis technique, a qualitative data analysis method, was used to analyze the data obtained from 20 interviews.

3.2.1. Findings

This study explores how dimensions of consumer values serve as consumer engagement, leading to attitude toward C2C secondary marketplace platforms through the means-end result theory. As previously stated, a mixed-methods design incorporating an explanatory sequential pattern were employed to achieve this objective. This approach aimed to compensate for the limitations of qualitative and quantitative research, providing a more comprehensive outcome by examining online second-hand users from a broader perspective.

The first theme is related to the perceived value of the online secondhand platform and attitude toward platforms via consumer engagement. Subsequently, these values were categorized into four categories: "functional value", "emotional value", "environmental value", and "social value". Under the category "functional value", there are subcodes "property/profit advantage", "cheaper/compatible", "product features and variety", "space saver", "time-saving", and "ease of moving". The second theme, 'platform features', 'comments', and 'sellers', is associated with consumer engagement in the C2C e-commerce secondary marketplace. The third theme is linked to consumers' attitudes toward online secondhand platforms. This theme is further divided into two sub-categories internally. These are positive attitudes and negative attitudes.

Table 4. Themes, Categories, and Codes

Theme	Category	Code	Quotes
Perceived Values	Functional Value	Property/ Profit Advantage	"The product I bought is almost unchanged and at a reasonable price, according to which I do my shopping." (P-5). "I can reduce the cost by buying clean second-hand stuff instead of paying high prices to zero." (P-14)
		Cheaper/ Compatible	"Because it's much cheaper economically"(P-2). "There is a fair price difference between a zero product and a second-hand clean product, which encourages the purchase of second-hand products." (P-3)
		Product Features and Variety	"Some products have a continued warranty period, especially if I prefer second-hand products. I pay attention to this as much as possible, and the products must come in full package. For example, your phone comes with a charger." (P-9).
		Space Saver	"I'm an artist, and I sell works of art over the Internet. Besides, I also sell my personal belongings, such as clothes, books, and household items, over the Internet. It's both an extra source of income for me and a good way to throw away the excess stuff in the house." (P-15)
		Time-Saving	"The main reason I buy and sell second-hand products is to save time. And because it's online, I'm able to reach more people."(P-1).
		Ease of Moving	"The most important element that makes it easier for me to shop in applications is the ability to filter. Determining my desired product's category, color, body, brand, and price range makes it much more manageable. (P-14)

(Table 4 cont.)

Theme	Category	Code	Quotes
Perceived Values	Emotional value		"Sometimes, when it comes to shopping with products used in very old years, I feel like I'm traveling in time, and I am sure I can't even find those nostalgic products in most of the city's shops right now. I like it; I enjoy it." (P-6)
	Environmental value		"Second-hand trading makes sense for a more sustainable and livable world. In the 21st century, consumer madness has gone so far, and so far, I'd rather be part of this bullshit and, as an ecologist, not be in this bully." (P-12)
	Social Value	Ensuring that the Product Stays in Consumption	"I sell products that I rarely use or never use. It's mostly clothes, and I'm selling what I've been wearing once in a brother's style with the rental method. So it works for people who want to wear it once in a while on special days." (P-6)
		Social Interaction	"I'm using second-hand platforms more for phone exchanges. Communicating with a lot of people online has been a great achievement for me." (P-20).
		Meeting the Needs of Others	"I sell products that I have not used for a long time or that I will not be able to use continuously. They don't work for me. I sell them to the trash. Both I make money and people buy well." (P-20)
Consumer Engagement	Platform Features		"I use the sites I mentioned above because they are official and very prestigious." (P-1) "The 2nd hand sites do not leave in this sense with any circumstances that would sacrifice the buyer and seller."(P-3)
	Comments		"I look at customer reviews about the seller and the product." (P-2). "I'm looking at the products he's already sold, the reviews on the products." (P-11)
	Seller		"I'm conducting one-on-one talks with the sellers."(P-19). "Sellers always look at their score, so I take it."(P-18).
Attitude toward Platforms	Positive		"When I buy the product at a reasonable price, I make money by selling it at a decent price, as I have already contributed to my pocket. What could be better? The government should create public spot ads to promote these practices :)" (P-12).
	Negative		"I'm not very comfortable buying things that another person has, because I still think he has the smell, the air of that person, in this case, I am not positive." (P-10)

In conclusion, the findings of this stage have shown that consumer values of online second-hand shopping platforms are essential variables for Turkish consumers' positive attitudes to platforms that demonstrate their engagement with them if we interpret Table IV. Namely:

Theme 1: In Study 1, it was observed that consumers' perceived values of online second-hand platforms differed. These values include functional, emotional, social, and environmental values. Therefore, the interviewees confirmed the functional and emotional values identified in the first study, and two different values (social and environmental) were revealed together with these values. These benefits include the diversity of products offered, the savings of space and time, the ease of movement, and the economic cost advantage and affordability. In this case, it provided justification and clarity to the financial aspects of the functional values found in Study 1 and led to the emergence of new categories (time-saver, easy of moving, space saver). Hence, participants state that they continue to use C2C platforms by giving importance to factors such as ensuring that products remain in consumption,

meeting the needs of others in an alternative way, and social interaction. In addition, it is observed that participants also attach importance to ecological values while using these platforms.

The second theme, consumer engagement, is associated with the categories of platform features, comments, and seller in the C2C e-commerce secondary marketplace. The characteristics of a good or service are how it achieves values (Gutman, 1982). Nonetheless, the product's utility extends beyond its capabilities (Moriuchi & Takahashi, 2023). According to Calder et al. (2009), consumer engagement is defined as the overall experience of users on the C2C product platform. In a C2C context, as Abdul-Ghani et al. (2019) described, consumer engagement constitutes a cyclic process initiated by consumer experiences, generating value for the consumer and encouraging ongoing consumption activities iteratively. Similar to the findings in Study 1, this stage demonstrates that consumer engagement is a psychological state marked by providing information, assimilation, and interaction with the C2C platform and its users, thereby influencing the consumer decision-making process. Hence, most participants agree that platform awareness, security, seller reviews, seller profile, and the number of followers are of utmost concern to them.

Theme 3: The third theme, attitude toward online platforms, was divided into two subcategories: positive and negative, i.e., supportive and opposing views. Participants who expressed a positive attitude highlighted the advantages of one-to-one communication with the seller, cost savings, and a sense of contributing to a circular economy. As one participant stated, "When I buy the product at a reasonable price, I make money by selling it at a decent price, as I have already contributed to my pocket. What could be better? The government should create public spot ads to promote these practices :)" (P-12). This illustrates a value-oriented and economically mindful engagement with second-hand platforms. However, some participants expressed a more cautious or negative stance. Concerns were raised about hygiene, emotional discomfort, and trust-related issues. For instance, one participant remarked, "I'm not very comfortable buying things that another person has, because I still think he has the smell, the air of that person, in this case, I am not positive" (P-10). These views reflect emotional and psychological barriers to participation in the second-hand market and suggest a need for strategies to increase consumer trust and comfort on these platforms

4. CONCLUSION

Today's businesses acknowledge customers' vital role in communications and product development, viewing them as co-creators (Sawhney et al., 2005). In today's marketing literature, consumer engagement has become increasingly prominent (Rather, 2020). However, our understanding of consumer engagement in C2C e-secondary marketplaces still needs to be improved. This study is essential to examine the effects of CE in the context of C2C e-secondary marketplaces and to address the consumer values that influence CE. Furthermore, the relationship between consumer engagement, attitude, and environmental consciousness has yet to be thoroughly studied, with most surveys

concentrating on Western nations. Consequently, this research makes a substantial contribution by presenting data on these relationships in the context of developing countries, especially in online secondhand marketplaces.

Secondly, in the Turkish literature, it has been observed that studies on C2C online second-hand shopping platforms are generally quantitative. Since most of such studies focus on individual users, studies indicating the need for more in-depth studies were identified as limitations. This study was conducted using mixed-method research to minimize these limitations. Various value concepts emerged for the users of this platform, different from those mentioned in the in-depth interviews and questionnaires.

Furthermore, the incorporation of a sequential exploratory approach is what adds value to the study. A survey was used in Study 1 to evaluate the moderating effect and look at the relationships between the constructs. The inclusion of in-depth interviews in Study 2, which sought to clarify the viewpoints of Turkish users of online second-hand platforms, strengthened the findings' robustness.

In addition to its theoretical and methodological contributions to literature, the study is vital for its recommendations targeting decision-makers, practitioners, users, and researchers.

Findings from Study 1 and Study 2 suggest that the values offered to their customers by online second-hand platforms positively influence attitude toward the platform and encourage its use through consumer engagement. Platform managers ought to assemble a team of experts to enhance user interaction and engagement by monitoring customer attitudes, satisfaction levels, recommendations, and complaints. This initiative has the potential to influence consumer engagement positively through an increase in platform interaction.

Especially, qualitative research findings indicate that participants raised concerns about online second-hand shopping platforms targeting sellers and platform operators. These concerns commonly encompass fraud, non-delivery of the desired product, hygiene issues, counterfeit products, and product loss. Considering the criteria that determine channel preferences, standardizing information such as how the product was purchased, used, and sold by its previous owners, and for what reasons, can reduce concerns. Practices such as buyer-seller identification, creating approved users, and accessing product history via blockchain are expected to impact second-hand consumption positively.

In addition, the 'My Money is Safe' feature available on some platforms, i.e., the existence of money pools, the registration of trading contracts on the application, the storage of contracts formed by the declaration of the parties in the application, and recourse to application management in some cases are important issues for users. These features minimize concerns and create a secure trading environment. Furthermore, enhancing platform security can be achieved by implementing an AI-based filter. This filter automatically reviews user ads, identifying potentially risky listings by detecting previously reported ads, similar content, specific keywords in descriptions, and images not meeting

safety standards. Such measures ensure a safer and more reliable shopping experience, ultimately enhancing the overall user experience.

C2C platforms can increase consumer trust by improving transaction security, dispute policies, and the safety of monetary transactions, primarily by elaborating product descriptions. To make the platform more usable features such as live chat, push notifications, and a customizable interface can strengthen trust by increasing user communication.

Based on the study results, merchants can improve their marketing communications by segmenting users based on utilitarian, hedonic, or social values and emphasizing specific value propositions to encourage user engagement. For example, based on users' value judgments, they could improve their search algorithms, allowing them to find the products they want faster. They can also customize the user experience using interest-based recommendation systems.

In digital business, consumer engagement is becoming increasingly important, where customers participate in company communication and buy products. Therefore, features such as events, competitions, or forums could be added so that users can build a sense of community within the platform. These suggestions increase the platform's credibility and ensure users have a more positive experience.

Similar to any empirical study, there are certain limitations to the current work. This study has four main limitations that can be resolved by additional research. Firstly, the qualitative study observed that various concerns and value differences related to online second-hand shopping vary across product groups. Future studies on second-hand shopping can be designed by focusing on a specific platform or specific product groups (such as clothing, electronics, and household products). In this way, the differences and similarities between product groups can be examined in more detail. Secondly, the fact that we did not measure age differences limits our understanding of variations within the overall age group of the study. The results from the in-depth interviews in Study 2 suggest that other factors influence consumers' behavioral intentions, such as trust in the seller, trust in the intermediary, and consumer values, such as social and environmental values. Future research should better encompass a broader range of age groups to understand the influence on platform usage intentions. Comparing the survey results with those of Generations X and Z may help obtain a more thorough understanding of second-hand consumption. The results from the in-depth interviews in Study 2 suggest that other factors influence consumers' behavioral intentions, such as trust in the seller, trust in the intermediary, and consumer values, such as social and environmental values. Survey models that take these factors into account can be future rules. Finally, people's character is quite complex and multifaceted. Therefore, people's inclination toward online second-hand shopping is not only limited to the desire to save money but may also depend on multifaceted character traits such as fast adaptation to new technologies, thriftiness, idealism, and ecological thinking. Therefore, it is essential to consider a broad context for further research models to assess people's character for future studies.

Ethics committee approval for the study was obtained from the Muş Alparslan University Ethics Committee on February 6, 2024, with decision number 4/54.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Abdul-Ghani, E., Hyde, K. F., & Marshall, R. (2019). Conceptualising engagement in a consumer-to-consumer context. *Australasian Marketing Journal*, 27(1), 2–13. <https://doi.org/10.1016/j.ausmj.2018.06.004>
- Akın, M. S. (2020). Çevrimiçi ikinci el alışveriş motivasyonları: Ölçek uyarlama çalışması. *Uygulamalı Sosyal Bilimler Dergisi*, 4(2), 74–88.
- Aluri, A., Price, B. S., & McIntyre, N. H. (2019). Using machine learning to cocreate value through dynamic customer engagement in a brand loyalty program. *Journal of Hospitality & Tourism Research*, 43(1), 78–100. <https://doi.org/10.1177/1096348017753521>
- Banerjee, B., & McKeage, K. (1994). How green is my value: Exploring the relationship between environmentalism and materialism. *Advances in Consumer Research*, 21(1).
- Belk, R. (2014). You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research*, 67(8), 1595–1600. <https://doi.org/10.1016/j.jbusres.2013.10.001>
- Berry, L. L., Carbone, L. P., & Haeckel, S. H. (2002). Managing the total customer experience. *MIT Sloan Management Review*, 43(3), 85–89.
- Bilgin, Y. K. (2021). *Türk turistlerin paylaşım ekonomisine katılma nedenleri ve memnuniyetlerinin belirlenmesi: Airbnb örneği üzerine bir karma yöntem araştırması* [Unpublished doctoral dissertation]. Sakarya University of Applied Sciences.
- Bowden, J. L. H. (2009). The process of customer engagement: A conceptual framework. *Journal of Marketing Theory and Practice*, 17(1), 63–74. <https://doi.org/10.2753/MTP1069-6679170105>
- Brodie, R. J., Ilic, A., Juric, B., & Hollebeek, L. (2013). Consumer engagement in a virtual brand community: An exploratory analysis. *Journal of Business Research*, 66(1), 105–114. <https://doi.org/10.1016/j.jbusres.2011.07.029>
- Calder, B. J., Malthouse, E. C., & Schaedel, U. (2009). An experimental study of the relationship between online engagement and advertising effectiveness. *Journal of Interactive Marketing*, 23(4), 321–331. <https://doi.org/10.1016/j.intmar.2009.07.002>
- Chang, C. T. (2012). Are guilt appeals a panacea in green advertising? The right formula of issue proximity and environmental consciousness. *International Journal of Advertising*, 31(4), 741–771. <https://doi.org/10.2501/IJA-31-4-741-771>
- Chen, Y., & Wang, L. (2019). Commentary: Marketing and the sharing economy: Digital economy and emerging market challenges. *Journal of Marketing*, 83(5), 28–31. <https://doi.org/10.1177/0022242919868470>
- Cheung, C. M., Zheng, X., & Lee, M. K. (2014, January). *Customer loyalty to C2C online shopping platforms: An exploration of the role of customer engagement*. In *Proceedings of the 47th Hawaii International Conference on System Sciences* (pp. 3065–3072). IEEE. <https://doi.org/10.1109/hicss.2014.380>

- Costa, A. D. A., Dekker, M., & Jongen, W. M. F. (2004). An overview of means-end theory: Potential application in consumer-oriented food product design. *Trends in Food Science & Technology*, 15(7–8), 403–415. <https://doi.org/10.1016/j.tifs.2004.02.005>
- Creswell, J. D. (2017). Mindfulness interventions. *Annual Review of Psychology*, 68(1), 491–516. <https://doi.org/10.1146/annurev-psych-042716-051139>
- Creswell, J. W. (2013). Steps in conducting a scholarly mixed methods study. *DBER Speaker Series*, 48. <https://digitalcommons.unl.edu/dberspeakers/48>
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
- Ek Styvén, M., & Mariani, M. M. (2020). Understanding the intention to buy secondhand clothing on sharing economy platforms: The influence of sustainability, distance from the consumption system, and economic motivations. *Psychology & Marketing*, 37(5), 724–739. <https://doi.org/10.1002/mar.21334>
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley.
- Fu, W., & Kim, Y.-K. (2019). Eco-fashion consumption: Cognitive-experiential self-theory. *Family and Consumer Sciences Research Journal*, 47(3), 220–236. <https://doi.org/10.1111/fcsr.12296>
- Gutman, J. (1982). A means-end chain model based on consumer categorization processes. *Journal of Marketing*, 46(2), 60–72. <https://doi.org/10.1177/002224298204600>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Prentice Hall.
- Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. The Guilford Press.
- Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.
- Hollebeek, L. D. (2011). Exploring customer brand engagement: Definition and themes. *Journal of Strategic Marketing*, 19(7), 555–573. <https://doi.org/10.1080/0965254X.2011.599493>
- Hollebeek, L. D. (2013). The customer engagement/value interface: An exploratory investigation. *Australasian Marketing Journal*, 21(1), 17–24. <https://doi.org/10.1016/j.ausmj.2012.08.006>
- HTF Market Intelligence. (2024). *C2C e-commerce market: Global trends, growth and forecast 2024–2032*. HTF Market Intelligence Reports. <https://www.htfmarketreport.com/>
- Joyner Armstrong, C. M., & Lang, C. (2018). The clothing style confidence mindset in the circular economy. In K. Niinimäki (Ed.), *Sustainable fashion through circular economy approach*. Aalto Arts Books.
- Karakaş, G. (2022). Factors affecting food waste awareness in Turkey. The case of Çorum province. *Eastern Journal of European Studies*, 13(1), 271–289
- Khan, N. (2010). Functional and relational value influence on commitment and future intention: The case of banking industry. *The Journal of International Social Research*, 3(10), 376–391. <https://www.researchgate.net/publication/42637328>
- Kim, S., & Lee, Y. J. (2012). The complex attribution process of CSR motives. *Public Relations Review*, 38(1), 168–170. <https://doi.org/10.1016/j.pubrev.2011.09.024>
- Korkmaz, S., & Gedik, Ö. (2020). Endüstri 4.0’ın sağlık sektörüne etkisinde demografik özelliklerin düzenleyici rolü. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 38(4), 743–776. <https://doi.org/10.17065/huniibf.684717>
- Kumar, V., Rajan, B., Gupta, S., & Pozza, I. D. (2019). Customer engagement in service. *Journal of the Academy of Marketing Science*, 47, 138–160. <https://doi.org/10.1007/s11747-017-0565-2>
- Liu, W., Shao, W., and Wang, Q. (2021). Psychological distance from environmental pollution and willingness to participate in second-hand online transactions: An Experimental Survey in China. *Journal of Cleaner Production*, 281, 124656.
- Luzio, J. P. P., & Lemke, F. (2013). Exploring green consumers’ product demands and consumption processes. *European Business Review*, 25(3), 281–300. <https://doi.org/10.1108/09555341311314825>

- Ma, L., Zhang, X., Hao, F., & Liu, S. (2023). Service quality, perceived price fairness, and users' continuous usage intentions regarding shared bike service. *Total Quality Management & Business Excellence*, 34(13–14), 1682–1702. <https://doi.org/10.1080/14783363.2023.2198121>
- MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention Science*, 1, 173–181. <https://doi.org/10.1023/A:1026595011371>
- Malhotra, N. K. (2010). *Marketing research: An applied orientation* (6th ed.). Pearson Education.
- Maxwell, J. A., & Mittapalli, K. (2010). A realist approach to qualitative research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (2nd ed., pp. 145–168). SAGE Publications.
- Meksopavankul, P. (2017). *The affecting factors on consumer purchase intention in C2C electronic classified marketplaces: A Thai perspective* [Unpublished doctoral dissertation]. National Institute of Development Administration.
- Merrilees, B. (2016). Interactive brand experience pathways to customer-brand engagement and value co-creation. *Journal of Product & Brand Management*, 25(5), 402–408. <https://doi.org/10.1108/JPBM-04-2016-1151>
- Mohammad, J., Quoquab, F., & Mohamed Sadom, N. Z. (2021). Mindful consumption of second-hand clothing: The role of e-WOM, attitude and consumer engagement. *Journal of Fashion Marketing and Management: An International Journal*, 25(3), 482–510. <https://doi.org/10.1108/JFMM-05-2020-0080>
- Moriuchi, E., & Takahashi, I. (2023). An empirical study on repeat consumer's shopping satisfaction on C2C e-commerce in Japan: The role of value, trust, and engagement. *Asia Pacific Journal of Marketing and Logistics*, 35(3), 560–581. <https://doi.org/10.1108/APJML-08-2021-0631>
- Ofori, H., Kang, J., & Yang, S. B. (2023). What makes people purchase used products online? Focusing on the roles of consumer value, platform attachment, and consumer engagement. *Korean Management Review*, 52(5), 1003–1043. <http://dx.doi.org/10.17287/kmr.2023.52.5.1003>
- Ou, J., Wong, I. A., Prentice, C., & Liu, M. T. (2020). Customer engagement and its outcomes: The cross-level effect of service environment and brand equity. *Journal of Hospitality & Tourism Research*, 44(2), 377–402. <https://doi.org/10.1177/1096348019893065>
- Özkaya, B., & Kazançoğlu, İ. (2021). Y kuşağının ikinci el tüketim motivasyonlarının ve engellerinin belirlenmesine ilişkin nitel bir araştırma. *Journal of Business in The Digital Age*, 4(1), 1–20. <https://doi.org/10.46238/jobda.935244>
- Pang, H. (2021). Identifying associations between mobile social media users' perceived values, attitude, satisfaction, and eWOM engagement: The moderating role of affective factors. *Telematics and Informatics*, 59, 101561. <https://doi.org/10.1016/j.tele.2020.101561>
- Parihar, P., Dawra, J., & Sahay, V. (2019). The role of customer engagement in the involvement–loyalty link. *Marketing Intelligence & Planning*, 37(1), 66–79. <https://doi.org/10.1108/MIP-04-2018-0135>
- Park, H. H. (2023). Scarce fashion products consumption in the C2C second-hand trading platform. *Family and Consumer Sciences Research Journal*, 51(3), 216–230. <https://doi.org/10.1111/fcsr.12471>
- Rather, R. A. (2020). Customer experience and engagement in tourism destinations: The experiential marketing perspective. *Journal of Travel & Tourism Marketing*, 37(1), 15–32. <https://doi.org/10.1080/10548408.2019.1686101>
- Reuters. (2025, February 26). *eBay forecasts quarterly revenue below expectations*. <https://www.reuters.com/technology/ebay-forecasts-quarterly-revenue-below-expectations-2025-02-26/>
- Sadachar, A., Feng, F., Karpova, E. E., & Manchiraju, S. (2016). Predicting environmentally responsible apparel consumption behavior of future apparel industry professionals: The role of environmental apparel knowledge, environmentalism and materialism. *Journal of Global Fashion Marketing*, 7(2), 76–88. <https://doi.org/10.1080/20932685.2015.1131433>
- Sánchez-Fernández, R., & Iñiesta-Bonillo, M. Á. (2007). The concept of perceived value: A systematic review of the research. *Marketing Theory*, 7(4), 427–451. <https://doi.org/10.1177/1470593107083165>
- Sawhney, M., Verona, G., & Prandelli, E. (2005). Collaborating to create: The Internet as a platform for customer engagement in product innovation. *Journal of Interactive Marketing*, 19(4), 4–17. <https://doi.org/10.1002/dir.20046>

- Segev, S., Shoham, A., & Gavish, Y. (2015). A closer look into materialism construct: The antecedents and consequences of materialism and its three facets. *Journal of Consumer Marketing*, 32(2), 85–98. <https://doi.org/10.1108/JCM-07-2014-1082>
- Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. *Journal of Business Research*, 22(2), 159–170. [https://doi.org/10.1016/0148-2963\(91\)90050-8](https://doi.org/10.1016/0148-2963(91)90050-8)
- Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, 7(4), 422–445. <https://psycnet.apa.org/buy/2002-11349-006>
- Sim, J. (2023). *Forward to the past: Redesigning the form and flow of C2C marketplace* [Doctoral dissertation]. Massachusetts Institute of Technology.
- Sim, M., & Plewa, C. (2017). Customer engagement with a service provider and context: An empirical examination. *Journal of Service Theory and Practice*, 27(4), 854–876. <https://doi.org/10.1108/JSTP-03-2016-0057>
- Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing*, 77(2), 203–220. [https://doi.org/10.1016/S0022-4359\(01\)00041-0](https://doi.org/10.1016/S0022-4359(01)00041-0)
- Thakur, R. (2018). “Customer engagement and online reviews”, *Journal of Retailing and Consumer Services*, 41, 48–59. <https://doi.org/10.1016/j.jretconser.2017.11.002>
- Telli, S. G., Aydın, S., & Şen, D. G. (2021). Covid-19 sürecinde çevrimiçi ikinci el ürün alışverişine yönelik tutum ve satın alma niyeti üzerine bir araştırma. *Aksaray Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 13(2), 11–22. <https://doi.org/10.52791/aksarayiibd.870124>
- Telli, S. G., & Gezmişoğlu Şen, D. (2022). Tüketicilerin ikinci el çevrimiçi pazardaki plansız satın almalarında demografik farklılığı belirlemeye yönelik bir çalışma. *Kırşehir Ahi Evran Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 6(2), 160–174.
- Teubner, T., Adam, M. T., Camacho, S., & Hassanein, K. (2014, December 8–10). *Understanding resource sharing in C2C platforms: The role of picture humanization*. In *Proceedings of the 25th Australasian Conference on Information Systems*. Auckland, New Zealand.
- Venetis, K. A., & Ghauri, P. N. (2004). Service quality and customer retention: Building long-term relationships. *European Journal of Marketing*, 38(11/12), 1577–1598. <https://doi.org/10.1108/03090560410560254>
- Verhoef, P. C., Reinartz, W. J., & Krafft, M. (2010). Customer engagement as a new perspective in customer management. *Journal of Service Research*, 13(3), 247–252. <https://doi.org/10.1177/1094670510375461>
- Vivek, S. D., Beatty, S. E., & Morgan, R. M. (2012). Customer engagement: Exploring customer relationships beyond purchase. *Journal of Marketing Theory and Practice*, 20(2), 122–146. <https://doi.org/10.2753/MTP1069-6679200201>
- Wen, P., Tao, L., & Zhang, Q. (2023, July). Identification of consumer factors that influence purchase intention in online C2C second-hand transactions. In *International Conference on Human-Computer Interaction* (pp. 380–387). Cham: Springer Nature Switzerland.
- Wertz, B., & Kingyens, A. T. (2015). *A guide to marketplaces*. Version One. <https://versionone.vc/marketplace-handbook/>
- Xiao, G., & Kim, J. O. (2009). The investigation of Chinese consumer values, consumption values, life satisfaction, and consumption behaviors. *Psychology & Marketing*, 26(7), 610–624. <https://doi.org/10.1002/mar.20291>
- Zhang, M., Guo, L., Hu, M., & Liu, W. (2017). Influence of customer engagement with company social networks on stickiness: Mediating effect of customer value creation. *International Journal of Information Management*, 37(3), 229–240. <https://doi.org/10.1016/j.ijinfomgt.2016.04.010>

Time-Varying Market Efficiency in the Turkish Stock Market: Evidence from an Entropy-Based Analysis

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Abstract

This study analyzes the time-varying informational efficiency of the Borsa Istanbul composite index (XU100) and its main sector indices from January 2017 to June 2023. The sample entropy method is used to measure market efficiency across multiple timescales ranging from 1 to 30 business days, and a rolling window approach is used to capture daily informational efficiency dynamics. Our findings indicate that market efficiency decreases as the timescale increases, which suggests that indices are more efficient in the short-term periods than in the long-term periods. Among the indices, BIST Financials (XUMAL) has the highest average efficiency, while BIST Technology (XUTEK) displays the lowest. The results also reveal that efficiency levels across all indices fluctuate widely on a daily basis, and a particularly sharp decline was noticed during the onset of the COVID-19 pandemic. This suggests that a major disruption in informational efficiency occurred during this time. The Russia-Ukraine war and the 2023 February earthquake further weakened the efficiency of all indices, though their impacts were comparatively less severe than COVID-19. An entropic correlation analysis reveals strong positive correlations between XU100 and BIST Industrials, which highlights that these indices are related in terms of efficiency dynamics. This study offers new insights into the dynamic nature of market efficiency in the Turkish stock market, emphasizing that informational efficiency is strongly influenced by sector-specific characteristics and external shocks. Our empirical findings strongly support the Adaptive Market Hypothesis (AMH), confirming that market efficiency evolves dynamically in response to changing market conditions and external events.

Keywords: *Informational Efficiency, Adaptive Market Hypothesis, Sample Entropy, Borsa Istanbul, Extreme events.*



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1. INTRODUCTION

The efficient market hypothesis (EMH) is one of the fundamental theories of finance and has long been the subject of debate in various studies. The weak form of the EMH contends that it is unfeasible to create an investing strategy that continuously outperforms the market because all previous market prices have already been included in asset values. The underlying assumption of weak form efficiency is that price movements are random, rendering them unpredictable and unexploitable (Fama, 1970).

The traditional EMH framework assumes that markets maintain efficiency under all conditions, but this assumption has been widely contested. The evidence in the literature suggests that panic and investors' irrational behaviour following wars, crises, shocks and bubbles lead to asset prices diverging from their fundamental values, violating the efficient markets hypothesis (Ali et al., 2020; Gaio et al., 2022; Kim et al., 2011; Lalwani & Meshram, 2020; Lim et al., 2008; Lim et al., 2013; Özkan, 2021; Vasileiou, 2021).

The Adaptive Market Hypothesis (AMH), introduced by Lo (2004), suggests that market efficiency evolves as economic and geopolitical conditions change over time. According to this approach, financial markets alternate between periods of efficiency and inefficiency depending on investor behavior, economic policies, and crisis events. In previous studies, it has been demonstrated that market efficiency is highly sensitive to financial and economic crises, highlighting the need for a more dynamic approach to measuring it (Alvarez-Ramirez et al., 2012; Ortiz-Cruz et al., 2012; Patra & Hiremath, 2022).

Financial markets have experienced several shocks in recent years, including the COVID-19 pandemic and the Russian-Ukraine conflict, which are critical to test the robustness and adaptability of market efficiency. A growing body of international literature examines market efficiency during the COVID-19 (Ammy-Driss & Garcin, 2023; Choi, 2021; Gaio et al., 2022; Özkan, 2021). These studies generally concluded that financial markets were not efficient during these time periods. A number of studies have also examined how these crises impacted Turkish financial markets. Özkan (2022) investigated the effects of the Russia-Ukraine war on market efficiency in Türkiye and found significant declines following the war. Erer et al. (2023) presented the distinct dynamics of sectoral market efficiency in Türkiye during COVID-19 and the global financial crisis. Yıldırım (2021) also evaluated financial market efficiency in Türkiye during COVID-19 and found there was a significant decline in efficiency. Suyadal (2021) examined the EMH for the countries with the greatest impact from COVID-19 (U.S.A., France, Brazil, India, Türkiye, and Russia). The author used the Run Test and the findings revealed that while USA and Brazil's markets are inefficient during COVID-19, other markets were found to be efficient. Unal (2020) investigated the financial impacts of the pandemic on several industries in Borsa Istanbul. In the study, the overreaction hypothesis was tested and it was determined

that leather clothing, transportation logistics, marketing, tourism and airlines are the sectors that are most severely impacted by COVID-19.

In addition to global crises, the Turkish economy has faced a number of challenges that have likely affected the efficiency of the market. During the Turkish currency crisis of 2018, the Turkish lira plunged sharply, which caused the liquidity issues and a spike in financial market volatility. More recently, ongoing inflation has caused extreme fluctuations in asset prices due to monetary policies and rising inflation rates. Moreover, after the 2023 February earthquake, Borsa Istanbul was closed for five days, followed by a sharp market reaction after reopening.

Given the complexity of the problem, it is important to determine whether Borsa Istanbul is efficient or not, as well as to provide quantitative indicators of informational efficiency and to assess temporal changes associated with socioeconomic factors. To achieve this, we utilize the sample entropy method to estimate the daily evolving informational efficiency.

Entropy, which has been used in many studies to analyze the market efficiency (Alvarez-Ramirez et al., 2012; Oh et al., 2007; Ortiz-Cruz et al., 2012; Wang & Wang, 2021; Wang et al., 2012), calculates the level of informational efficiency over time and provides more information. Traditional market efficiency tests, such as the Variance Ratio Test, Runs Test, and Augmented Dickey-Fuller (ADF) Test, classify financial markets in a strict efficient or inefficient framework, which assumes a binary structure. However, these methods fail to account for the nonlinear dependencies. Financial markets are neither perfectly efficient nor entirely inefficient but operate on a continuum of efficiency levels that evolve over time. Unlike traditional tests, which offer only categorical classifications, entropy-based methods provide a more nuanced and dynamic measure of efficiency, which provide a continuous measure of efficiency and allow us to assess partial efficiency states rather than imposing strict classifications.

To overcome these limitations of traditional methods, we employ Sample Entropy (SampEn) and Multiscale Sample Entropy (MSE) in this study, which quantify the degree of randomness and complexity in stock returns. SampEn, in particular, is a more sensitive tool for detecting informational efficiency variations, as it captures irregularities in price movements that traditional statistical tests might overlook. By evaluating market efficiency across different time horizons, MSE further enhances this analysis, making it possible to track short-term and long-term efficiency trends dynamically. The methodological details of these entropy-based techniques and their advantages over conventional approaches are discussed in Section 3.

This research focuses primarily on the application of entropy-based methods to analyze dynamic changes in Turkish market efficiency over extended periods, which includes recent global crises (COVID-19, Russian-Ukraine conflict) and domestic crises (currency crisis, inflation crisis, and a major earthquake in 2023). In this context, this study aims to answer the following critical research questions:

1. How has the Turkish stock market's informational efficiency evolved from 2017 to 2023, particularly in light of recent global and domestic crises?
2. Do specific sectors within Borsa Istanbul demonstrate different informational efficiency profiles during this period? How do these external shocks shape market dynamics at the sectoral level?
3. Is there a relationship between different sectoral indices in terms of informational complexity?
4. How do market efficiency dynamics vary over short-term and long-term horizons when examined across multiple timescales (1 to 30 business days)?
5. Are the observed patterns of informational efficiency consistent with the Adaptive Market Hypothesis (AMH)?

By addressing these questions, this article offers insights into Borsa Istanbul's resilience and adaptability under crises by conducting an entropy-based analysis of time-varying efficiency.

This study makes several distinct contributions to the existing literature by considering both global and domestic crises in a long-run efficiency analysis by integrating an entropy-based framework. By capturing the dynamic evolution of market efficiency, it allows us to better understand how different sectors in Borsa Istanbul react to economic shocks. The proposed approach fills an important gap in the literature on the Turkish stock market's efficiency. This comprehensive analysis enables how patterns of efficiency vary across industries and over time.

The paper is organized as follows: Section 2 covers the literature review. Section 3 outlines the methodology. Section 4 provides data and parameter selection. Empirical results are reported in Section 5. Finally, Section 6 concludes with key findings and implications.

2. LITERATURE REVIEW

Market efficiency is widely discussed as the focus of financial studies (Aggarwal, 2019; Darrat & Zhong, 2000; Durusu-Ciftci et al., 2019; Huang, 2019; Palamalai et al., 2021; Poshakwale, 2002; Rehman et al., 2018; Rizvi & Arshad, 2014; Sadat & Hasan, 2019; Shternshis et al., 2022; Stakić et al., 2016; Tiwari & Kyophilavong, 2014).

In studies involving crisis and shock periods, Lim et al. (2008) studied the effects of the 1997 financial crisis on the efficiency of eight Asian stock markets, using the rolling bivariate correlation test statistics. According to their findings, during the crisis, most Asian stock markets experienced adverse effects on their efficiency, but after the crisis, many of these markets returned to their pre-crisis efficiency levels. During the financial crisis period, Mishra et al. (2009) examined the efficiency of the Indian stock market and found that the stock market was weak-form inefficient. According to Chen & Jarrett (2011), the Chinese stock markets were not efficient prior to the financial crisis and turned out to be weakly efficient during the crisis. Anagnostidis et al. (2016) investigated the impact of the global

finance crisis on Eurozone stock market efficiency, applying Dynamic Hurst exponents and rolling window technique. The findings indicated that stock price efficiency was negatively impacted by the 2008 crisis in the majority of Eurozone markets.

Choi (2021) conducted a study covering both the global crisis and the COVID-19 pandemic and identified sectors with low market efficiency for the two crisis periods by using the S&P 500 index data. The findings revealed that the efficiency of the real estate sector and the IT sector were low in the global crisis, while the efficiency of the material sector was low due to the stagnation in the manufacturing industry during the COVID-19 pandemic. Ahmed (2021) focused on market efficiency of Dhaka Stock Exchange in COVID-19. The results rejected the random walk and concluded that the market was inefficient. Wang and Wang (2021) applied the multiscale entropy method by using daily data of S&P 500 index, Bitcoin and US dollar index and gold futures prices during the COVID-19 period. From the outcomes of this research, it was determined that the market efficiency decreased significantly in all markets in the period of February 2020 – March 2020.

In other entropy-based studies, Alvarez-Ramirez et al. (2012) determined that the level of market efficiency of the Dow Jones Index varies over time and is time scale dependent. Shternshis et al. (2022) used the data of the 100 most liquid stocks in the Russell 3000 index for the period 02.01.1998 - 23.06.2017, and the data of the Exchange Traded Funds (ETF) from 02.01.2003 to 01.12.2009. In the study, it was concluded that the market was not efficient on a one-minute time scale and weekly.

A number of studies have shown that the conflict between Russia and Ukraine impacts the efficiency of the market as well. According to Özkan (2022), the conflict caused the Turkish stock market to become less efficient, more volatile, and generated abnormal returns. Gaio et al. (2022) also found that conflict affected developed stock markets by increasing multifractality and reducing market efficiency. Memon et al. (2024) studied the efficiency and herding behavior of G20 stock markets during the Russia-Ukraine War and COVID-19 pandemic. Developed stock markets were more efficient than emerging markets. Italy was the least efficient and Germany the most efficient. The study also found that the impact of crises on market efficiency varies from one market to another, with developed markets showing a greater degree of resilience. Maurya et al. (2024) examined the dynamic link between market volatilities during the COVID-19 pandemic and the Russia-Ukraine conflict. The study found that volatility connectedness increased significantly during these periods. Developed countries were net volatility transmitters, while developing countries were net volatility receivers. This suggests that global crises significantly affect market volatility and efficiency.

There are many studies in the literature investigating the efficiency of Borsa Istanbul. Some of these studies report that there is insufficient evidence to support the EMH (Bal et al., 2021; Bektur & Aydın, 2019; Duman Atan et al., 2009; Gözbaşı, 2014; Karademir & Evci, 2020; Yücel, 2016; Zeren et al., 2013). Others conclude that stock prices behave according to the theory (Altunöz, 2020; Ayaydın et

al., 2018; Aytekin et al., 2021; Çevik, 2012; Çevik & Erdoğan, 2009; Malcıoğlu & Aydın, 2016; Şahin, 2020; Tanrıöver & Çöllü, 2015).

In recent years, research has expanded to test the weak-form efficiency of Islamic indices in Borsa Istanbul. Özkan and Çakar (2020) examined weak-form efficiency of Turkish Islamic indices by using autocorrelation analyses. They found that while these indices generally exhibit weak-form efficiency, there are occasional deviations on certain dates that allow abnormal returns. Similarly, Sakınç and Sakınç (2023) found that Borsa Istanbul (BIST) Participation Indices do not meet the weak-form efficiency criteria.

Sectoral differences in weak-form efficiency have also been a focus of research. Özkan (2020a) used the automatic portmanteau test on 19 primary sector indices of Borsa Istanbul to compare market efficiency. According to the study, sectors such as transportation, insurance, electricity, and metal products machinery exhibit higher return predictability and lower market efficiency than other sectors, while sectors like food and beverage, banking, wholesale and retail trade, and wood-paper-printing sectors are found to be more efficient. Dallı and Uğur (2022) tested the weak form efficiency of the BIST Food and Beverage Index using unit root and variance ratio tests on monthly closing prices from November 2019 to September 2021, and found that the index exhibits weak form efficiency. Ahmetogulları (2024) analyzed the weak form efficiency in the BIST electricity sector and concluded that individual energy companies exhibit weak form efficiency, but the overall BIST Electricity Index shows mixed results. Ekmen and Evci (2024) examined weak-form efficiency in airline stocks on Borsa Istanbul and found that the stock prices of CLEBI, PGSUS, TAVHL, and THYAO exhibit unit roots, demonstrating that the weak-form efficient market hypothesis is applicable to them.

Ertaş and Özkan (2018) tested the AMH in Turkish and U.S. stock markets using monthly return data from the BIST 100 and S&P 500 indices. They found that the AMH can better explain stock market behavior than the EMH. Based on wild bootstrap automatic variance ratio tests, Özkan (2020b) found Brazil, South Africa, and Germany to be consistently weak-form efficient, while other markets' efficiency varied over time. Özkan (2020c) further supported this by examining the MIST countries (Mexico, Indonesia, South Korea, and Türkiye) and found that market efficiency evolves over time in response to changing market conditions. This confirms that return predictability is time-varying and consistent with the AMH. Aytekin and Dogan (2023) examined the validity of the AMH in Borsa Istanbul during major financial crises using sectoral and main indices. According to their findings, there are fluctuations in market efficiency depending on the type and duration of crises, supporting the hypothesis that efficiency varies over time.

Several studies have incorporated structural breaks and nonlinearities into tests of market efficiency. Altuntaş et al. (2022) used Fourier and nonlinear unit root tests to examine the efficiency of the weak form of six BIST indices and found mixed results. Demiralp and Belliler (2023) extended this

analysis to specific sub-indices and concluded that traditional unit root tests may produce biased results when nonlinearity exists.

Alkan (2024) investigated the relationship between liquidity and market efficiency in 397 stocks of the Borsa Istanbul by using the sample entropy. The study found that the stocks have different degrees of information complexity and illiquidity, which suggests that there is a strong relationship between liquidity and inefficiency.

Market efficiency can be adversely affected by external shocks, such as natural disasters and pandemics. Yıldırım (2021) analyzes the impact of COVID-19 on financial returns and market efficiency in Türkiye using BIST 100, sectoral indices, and currency returns and finds an initial decline followed by a recovery within 30 days. While ADF tests suggest weak form efficiency, the variance ratio test suggests inefficiency in the short run. Erer et al. (2023) investigated the time-varying efficiency of Turkish stock market and sectoral indices during the COVID-19 outbreak and the global financial crisis using multifractal detrended fluctuation analysis. In line with the adaptive market hypothesis, their results indicate that sectoral returns were more persistent during COVID-19, with the real estate and information technology sectors showing the lowest efficiency. According to Aksoy and Akyüzlü (2024), the Earthquake of 2023 had a significant impact on the Borsa Istanbul by causing significant abnormal returns in the Insurance and Non-Metal Mineral Product sectors. Similarly, Süşay Alkan (2024) examined how foreign and domestic investors affected Borsa Istanbul market efficiency during the COVID-19 pandemic and found that foreign investors positively enhanced market efficiency while domestic investors negatively affected market efficiency. Scalamonti (2025) used statistical techniques such as variance ratio tests and Hurst exponent analysis to analyze the weak-form efficiency of MEDA's capital markets, including Türkiye. According to the findings, institutional inefficiencies and exogenous shocks cause these markets to deviate from EMH.

The details of the studies on the efficiency of the Turkish stock market are given in Table 1.

Table 1. Overview of the EMH Literature on the Turkish Stock Market

Study	Data	Methodology	Series	Results
Duman Atan et al. (2009)	03.01.2003-30.12.2005	Unit root tests and Exact Local Whittle (ELW) estimator	XU100	efficient
Çevik and Erdoğan (2009)	2003 -2007 (Daily data)	Structural break test and long memory models	BIST Banking	not efficient
Çevik (2012)	03.01.1997-27.05.2011	Parametric and semi parametric long memory models	BIST Sector indices	not efficient
Zeren et al. (2013)	01.11.1987-30.11.2021	Structural breaks unit root tests	XU100	efficient
Gözbaşı (2014)	02.01.2004–07.03.2014 (Daily), 21.12.2009–07.03.2014 (Hourly)	Nonlinear unit root tests	XU100	efficient
Tanrıöver and Çöllü (2015)	01.1990-06.2014 (monthly)	Ljung-Box and LM analysis	XU100	not efficient
Malcıoğlu and Aydın (2016)	03.07.2000-22.09.2015	Harvey linearity test	XU100 and BIST Sector indices	not efficient

(Table 1 cont.)

Study	Data	Methodology	Series	Results
Yücel (2016)	2000-2015 (Daily)	Unit root tests	BIST indices	efficient
Ayaydın et al. (2018)	31.01.1997-27.01.2017 (weekly)	Harvey linearity test	XU100	not efficient
Bektur and Aydın (2019)	30.06.2000-29.12.2017	Unit root tests and Fourier unit root test	XU100 and BIST Sector indices	efficient
Özkan and Çakar (2020)	2014-2020	Autocorrelation analysis	BIST Islamic indices	Weak-form efficiency with deviations
Karademir and Evci (2020)	11.2008–11.2018	Unit root tests and structural break unit test	BIST Sector indices	efficient
Özkan (2020a)	2000-2020	Automatic portmanteau test	BIST sectoral indices	Varies by sector
Şahin (2020)	2008–2019 (Daily)	Run test	XU100, Dollar Exchange Rate and Gold Prices	not efficient
Altunöz (2020)	2004-2019 (monthly)	Structural break unit tests	BIST Sector indices	not efficient
Yıldırım (2021)	2020 (COVID-19 period)	ADF and Variance Ratio Test	BIST 100 & currency returns	Short-term inefficiency
Bal et al. (2021)	03.01.2005-28.12.2018	Unit root test and Fourier unit root test	BIST Baking	efficient
Aytekin et al. (2021)	15.02.2019-20.03.2020	Event study	XU100 and XU30 companies	not efficient
Altuntaş et al. (2022)	2010-2022	Fourier & nonlinear unit root tests	Six BIST indices	Mixed results
Dallı and Uğur (2022)	2019-2021 (Monthly)	Unit root and variance ratio tests	BIST Food & Beverage Index	Efficient
Özkan (2022)	2022 (Russia-Ukraine Conflict)	Volatility analysis	BIST	Increased inefficiency and volatility
Demiralp and Belliler (2023)	2015-2023	Nonlinear unit root tests	BIST sub-indices	Nonlinearity affects efficiency
Erer et al. (2023)	2008-2022	Multifractal detrended fluctuation analysis	BIST sectors	Efficiency varies across crises
Sakıncı and Sakıncı (2023)	2021-2023	Unit root and runs test	BIST Participation Indices	Not efficient
Alkan (2024)	2022-2024	Sample entropy	397 BIST stocks	Liquidity impacts efficiency
Aksoy and Akyüzlü (2024)	2023	Event study	BIST Insurance & Non-Metal Mineral Product indices	Abnormal returns after the earthquake
Ahmetoğulları (2024)	2015-2024	Unit root tests	BIST Electricity	Mixed results
Ekmen and Evci (2024)	2014-2024	Unit root tests	BIST Airlines	Weak-form efficiency
Süsay Alkan (2024)	2020-2021	Fourier cointegration	BIST 100	Foreign investors improve efficiency; domestic reduce it

3. METHODS

3.1. Sample Entropy

Traditional market efficiency tests, such as the Variance Ratio Test, Runs Test, and Augmented Dickey-Fuller (ADF) Test, rely on a binary classification framework, determining whether a market is either efficient or inefficient. However, these methods are limited in their ability to provide a continuous measure of efficiency, as they only confirm or reject the presence of a random walk. Financial markets, particularly emerging ones, often exhibit complex, nonlinear behavior that evolves over time due to external shocks, investor sentiment, and policy changes. Traditional statistical tests, which are based on

linear assumptions, often struggle to detect hidden dependencies and structural breaks, making them less effective in capturing the true dynamics of market efficiency. Additionally, these methods typically require stationary data and large sample sizes, making them unreliable when applied to volatile or short time-series datasets.

To overcome these limitations, Sample Entropy (SampEn) is employed in this study as a more flexible and adaptive approach. Unlike traditional methods, SampEn quantifies the degree of randomness and complexity in stock price movements, providing a continuous measure of efficiency rather than a binary classification. This allows for a more nuanced analysis, where efficiency levels can be tracked over time, revealing gradual shifts rather than abrupt categorizations. Moreover, SampEn is robust to noise and nonlinearity, enabling it to detect subtle patterns in financial time series that would otherwise be missed by conventional tests. Given these advantages, SampEn serves as an effective tool for assessing time-varying efficiency in financial markets, making it particularly suitable for studying the Borsa Istanbul and its response to market fluctuations, crises, and structural shifts.

Sample entropy measures the level of complexity and regularity of a time series. This method was primarily applied to examine the short and noisy signals in the field of biomedicine (Richman & Moorman, 2000). SampEn provides a non-negative numerical value for a given time series, where higher scores indicate a greater level of apparent randomness in the data. Conversely, lower scores suggest a greater presence of recognizable patterns within the data. A time series with many repeating samples will result in a comparatively small SampEn value, while more complex and unpredictable processes will produce higher values.

Let $x = \{x_1, x_2, \dots, x_N\}$ be a time series of N points. Fix input parameters m and r , where m is the length of sequences to be compared, and r is the tolerance for accepting matches. The SampEn of the time series is calculated as below (Richman & Moorman 2000).

Construct the m -dimensional template vectors $x_m(i)$:

$$x_m(i) = \{x_i, x_{i+1}, \dots, x_{i+m-1}\}, \quad 1 \leq i \leq N - m + 1 \quad (1)$$

Compute the distance between $x_m(i)$ and $x_m(j)$ using the Chebyshev metric (the maximum difference in their respective scalar components):

$$d(x_m(i), x_m(j)) = ||x_m(i), x_m(j)|| = \max\{|x_{i+k} - x_{j+k}| : 0 \leq k \leq m - 1\},$$

$$1 \leq i, j \leq N - m + 1, j \neq i \quad (2)$$

Two vectors $x_m(i)$ and $x_m(j)$ are called m -dimensional template match if the distance $d(x_m(i), x_m(j))$ is less than r . Let $n_i^m(r)$ be the number of vectors $x_m(j)$ within r of $x_m(i)$, without allowing self-counting. In the same way, let $n_i^{m+1}(r)$ present the number of vectors $x_{m+1}(j)$ within r of $x_{m+1}(i)$ for the vectors of length $m+1$, without allowing self-counting.

Then SampEn is given by the equation:

$$\text{SampEn}(m, r, N) = \ln \left(\frac{\sum_{i=1}^{N-m} n_i^m(r)}{\sum_{i=1}^{N-m} n_i^{m+1}(r)} \right) \quad (3)$$

3.2. Multiscale Sample Entropy (MSE)

MSE is an extension of SampEn developed by Costa et al. (2002) to quantify the complexity of time series data at multiple timescales simultaneously. MSE provides a more comprehensive view by analyzing how regularity varies when the time series is evaluated at multiple scales, as opposed to sample entropy, which measures the irregularity of a single time series at one scale.

In the MSE analysis, the original time series is first partitioned into separate windows of length X , and then the average of the data points within each window is calculated. Each element of the coarse-grained time series y^s is determined as:

$$y_j^s = \frac{1}{s} \sum_{i=(j-1)s+1}^{js} x_i, 1 \leq j \leq \frac{N}{s}, \quad (4)$$

The SampEn is then calculated for each time scale using Eq. 3.

3.3. Relative Informational Efficiency Index

To further refine our analysis and ensure a standardized and comparable efficiency measure, we employ the Relative Informational Efficiency Index (RIEI), which normalizes SampEn values using Monte Carlo simulations of a pure random walk. This approach provides a relative efficiency score, allowing for direct comparisons across indices, sectors, and time periods, rather than relying on absolute entropy values that may vary due to sample-specific characteristics. By benchmarking against the maximum entropy observed in Monte Carlo simulations, RIEI allows for a more refined classification of market efficiency, distinguishing between varying degrees of efficiency rather than imposing a rigid efficient/inefficient classification.

Following the approach outlined in (Alvarez-Ramirez et al., 2012; Wang & Wang, 2021), the relative market efficiency index is calculated for each time scale s using the following formula:

$$I_{IME(s)} = \frac{MSE(s)}{\beta(s)} \times 100\% \quad (5)$$

where $\beta(s)$ denotes the upper bound for the entropy of Gaussian white noise. It is derived from 10,000 Monte Carlo simulations. If the entropy of index returns is below the entropy of Gaussian white noise (as determined by $\beta(s)$), or $I_{IME(s)} < 100\%$, it indicates that the market efficiency is only partial or fractional.

By integrating MSE and RIEI, this study moves beyond traditional efficiency assessments by providing a continuous, multi-scale, and standardized measure of market efficiency. This methodology

allows us to track how efficiency evolves dynamically and compare efficiency trends across different time periods and sectors, making it a more suitable approach for analyzing the time-varying nature of informational efficiency in Borsa Istanbul. The ability to detect partial efficiency states provides deeper insights into market behavior, making RIEI a novel contribution to the study of financial market efficiency, particularly in emerging markets where efficiency levels often fluctuate due to economic and structural shifts.

4. DATA AND PARAMETER SELECTION

In this study, we use the daily closing prices of the Borsa Istanbul composite index (XU100) and five major sector indices: Financials, Industrials, Services, Transportation, and Technology. In Table 2, these indices and the tickers associated with them are listed. The data span from January 2, 2017, to June 1, 2023, covering a total of 1,610 trading days. The chosen period provides sufficient data for rolling window analysis, which allows for a detailed examination of time-varying efficiency trends. It also includes major financial shocks such as the 2018 Turkish currency crisis, the COVID-19 pandemic (March 2020), the Russia-Ukraine conflict (2022), and the February 2023 earthquake, all of which had a significant impact on market dynamics.

Table 2. List of the indices with their associated tickers

Indices Name	Tickers
Borsa Istanbul composite index	XU100
BIST Financials	XUMAL
BIST Industrials	XUSIN
BIST Services	XUHIZ
BIST Transportation	XULAS
BIST Technology	XUTEK

These indices were chosen because they represent the main sectors of the Turkish stock market and show how the market works overall. Each sector index helps us understand how different parts of the economy react to market events and changes in the economy. By looking at both the whole market and its main sectors, the study aims to give a detailed and complete view of informational efficiency in Borsa Istanbul over time.

The daily logarithmic returns for each index are computed using the formula:

$$r_i(t) = \log P_i(t) - \log P_i(t - 1) \quad (6)$$

where $r_i(t)$ is the return for index i at time t , $P_i(t)$ and $P_i(t - 1)$ are the closing prices on days t and $t-1$. Similar to Wang et al. (2012), returns are normalized by dividing $r_i(t)$ by $\sigma_i(t)$.

In accordance with previous studies (Richman & Moorman, 2000; Wang, et al., 2012), the length of sequences to be compared (m) is set to 2, and the tolerance range (r) is set to 0.25 times the standard deviation (σ) of the return series. To assess the efficiency at different time scales, we consider a range of 30 business days, which corresponds to six weeks.

5. EMPIRICAL RESULTS

The findings are presented in two distinct stages. Firstly, an evaluation of the Multiscale Entropy (MSE) and informational efficiency is conducted for each index throughout the entire sample period. Secondly, a rolling window technique is employed to investigate the time-varying nature of informational efficiency, enabling a comprehensive examination of how the efficiency levels of the indices evolve over time.

5.1. Informational Efficiency for Full Sample

Figure 1 displays the sample entropy estimates for scales up to 30 business days. It appears that the complexity of index returns is essentially dependent upon the time-scale s . There is generally a tendency for entropy to be higher at small time scales, while it declines at long time scales, indicating that reduction in pattern diversity and information content. The observed behavior indicates that the long-term return predictability of indices is relatively high as the entropy exhibits moderately small values at longer timeframes with coarse-graining procedure. The decline in entropy with higher time scales has been observed in previous studies using entropy methods for financial markets (Alvarez-Ramirez et al., 2012; Ortiz-Cruz et al., 2012; Wang & Wang, 2021). It should be noted, however, that XULAS and XUSIN show a local peak at the time scale of 20 days. This finding indicates that these indices were significantly influenced by information flows on a monthly basis.

Figure 1. MSE pattern across time scales

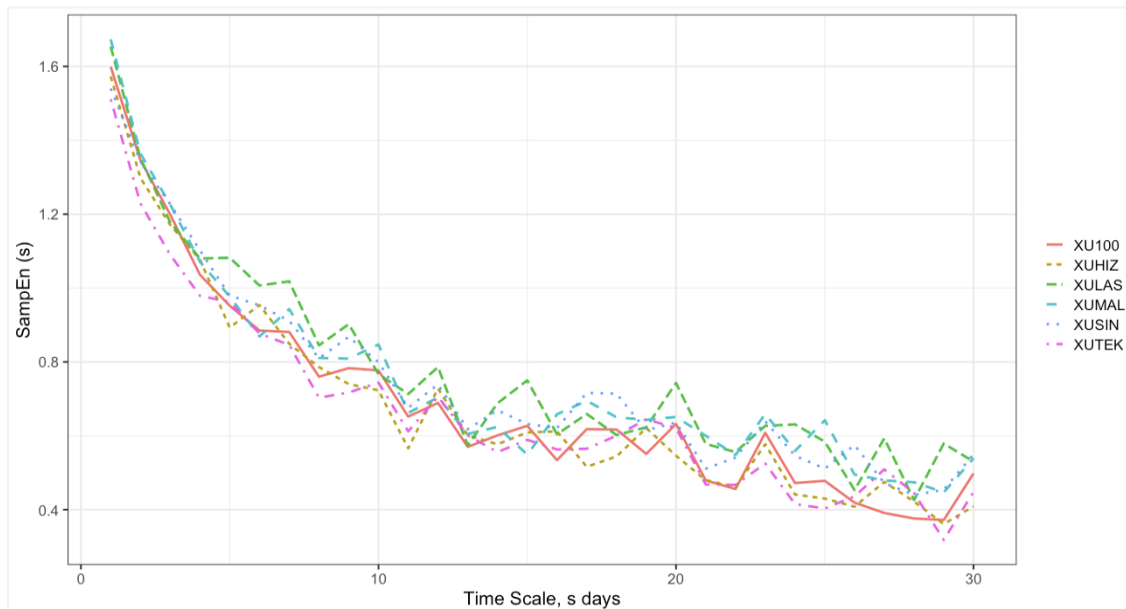


Figure 2. Relative informational efficiency index over time scales

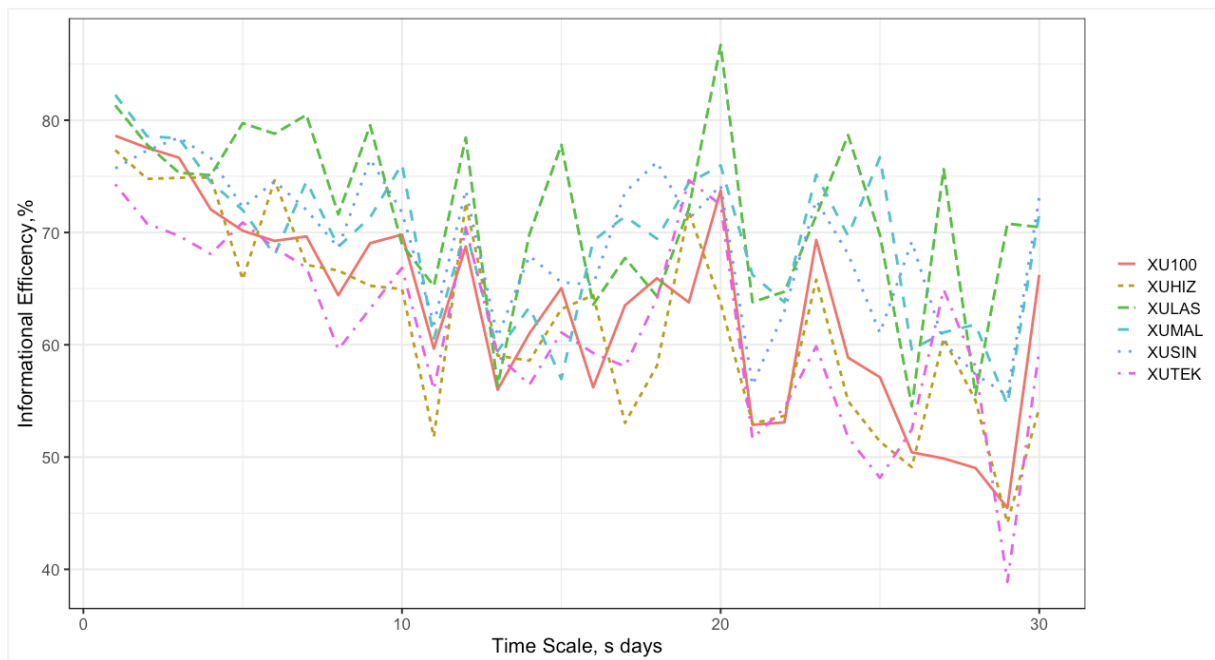


Figure 2 illustrates the relative informational efficiency of the indices over different time scales. The XUMAL Index has the most efficiency on a daily basis (82.25%), followed by the XULAS (81.32%), XU100 (78.61%), XUHIZ (77.34%), XUSIN (75.71%), and the XUTEK Index, which has the lowest efficiency (74.3%). There is a general trend of declining efficiency levels as the time scale increases. This implies that index returns cannot be fully characterized by purely random fluctuations, as evidenced by the decreasing number of entropy patterns observed with increasing time intervals. Instead, the indices exhibit partial efficiency, indicating deviations from perfect efficiency (100%) within certain time scales.

These findings illustrate that the market efficiency of the indices changes across different time scales, with some time scales showing higher efficiency levels than others. The findings suggest that there are factors influencing the behavior of the indices that lead to departures from full efficiency.

5.2. Time-varying informational efficiency

A rolling window procedure is used to study the fluctuations in market information efficiency over time. We split the dataset into M windows $t=1, 2, \dots, M$ of width 252 daily returns (about one year) retained in the window, where successive windows were replaced by one trading day. Then, we calculate the informational efficiency for each index over a one-year period for each window.

Figure 3 illustrates the time-varying daily relative informational efficiency of the six indices. Several conclusions can be drawn from the figures. Firstly, they demonstrate the highly volatile nature of information efficiency levels across all indices, displaying a strong sensitivity to both the macroeconomic conditions within Türkiye and global events. This is in line with findings from Erer et al. (2023), who also observed time-varying efficiency in Turkish stock market sectors during financial

crises. During the period between 2018 and June 1, 2023, Türkiye's financial outlook underwent significant fluctuations and challenges. Numerous economic and political factors impacted the country's financial stability and performance.

In 2018, Türkiye experienced significant events such as the presidential election and strained diplomatic relations with the United States. The tightening monetary policy and interest rate hikes carried out by the Federal Reserve also influenced the flow of capital into stock markets, including Borsa Istanbul (BIST). Consequently, these factors contributed to a significant depreciation of the Turkish Lira and negatively affected BIST, resulting in it being categorized as a losing stock market. According to Table A2, both national and foreign investors experienced a decrease in their portfolio values, with a decline of 9.38% and 12.07% respectively.

In March 2019, local elections took place, followed by the repeat of Istanbul elections in June. Following periods after these elections, Borsa Istanbul's market capitalization showed improvement compared to the previous year. Moreover, the figures clearly indicate that the information efficiency of all indices exhibited an upward trend before the start of the COVID-19 outbreak.

Second, it is evident that all six indices encountered a sharp drop in efficiency in March 2020, when the World Health Organization (WHO) announced the COVID-19 outbreak as a pandemic. During the period from March 2nd to March 31st, the XUSIN Index experienced the largest decrease in informational efficiency, dropping by 17.29%. It was followed by XUHIZ with a decrease of 14.24%, XU100 with 11.3%, XUTEK with 10.72%, and XULAS with 8.91%. The XUMAL Index had the smallest decrease in daily market efficiency, with a drop of only 7.21%.

The average daily efficiency of the indices showed a significant decrease after March 2020. Prior to the pandemic, the XU100 index had the highest average market efficiency at 79.19%. It was followed by XUMAL with 77.95%, XUHIZ with 77.58%, XUSIN with 76.19%, XULAS with 75.15%, and finally XUTEK with the lowest average market efficiency of 65.89%. After March 2, 2020, the average market efficiency of the indices was as follows: XUMAL (67.89%), XUHIZ (66.38%), XU100 (65.7%), XULAS (64.27%), XUTEK (63.94%), and XUSIN (61.9). Comparing the two-period averages, the largest efficiency drops were observed for XUSIN (14.29%), XU100 (13.5%), XUHIZ (11.2%), XULAS (10.79%), XUMAL (10.06%), and XUTEK (1.94%). This study agrees with previous findings that extreme events can negatively affect market efficiency (Gaio et al., 2022; Lim et al., 2008; Ortiz-Cruz et al., 2012; Sensoy, 2013; Wang & Wang, 2021); however, the findings show that the extent of the impact appears to vary by sector.

The investigation has shown that the XULAS index attained its peak efficiency level of 82.29% on February 18, 2020. A steady decrease in efficiency was observed until December 10, 2020, when it reached its lowest efficiency level of 46.3%. As a precautionary measure, many countries and regions implemented quarantines, entry bans, or other travel restrictions due to the COVID-19 epidemic. As a

result of the restrictions, the travel industry has been adversely affected worldwide. In Türkiye, the financial performance of companies in this sector was negatively impacted by the pandemic.

During this period, the profitability of travel sector declined substantially and survived by financing from banks and other financial institutions (Alnıpak & Kale, 2021). Following the release of the news that the vaccines of Pfizer–BioNTech (November 9, 2020), Moderna (November 16, 2020), and AstraZeneca (November 23, 2020) were effective, the stock prices of passenger transportation companies indicated a bright outlook on the operating status of the companies and prospective earnings anticipations. As a result of the vaccine announcement, investors' panic and fear decreased, which contributed to a rise in the efficiency of the transportation sector as a result of optimism. Our finding is parallel to (Maneenop & Kotcharin, 2023; Martins & Cró, 2022) that a pandemic declaration harmed transportation stocks, while the announcement of vaccines had a favorable impact. However, unlike these studies, which focused on developed markets, our results highlight sectoral differences within an emerging market context. The transportation sector, in particular, experienced the largest efficiency decline, confirming previous research on the impact of pandemic-related travel restrictions (Alnıpak & Kale, 2021).

Overall, the results indicate the significant influence of external events, such as the COVID-19 epidemic and vaccine announcements, on the efficiency of the transportation industry within the Turkish stock market.

During the pandemic, the government implemented measures and programs designed to mitigate its effects and stimulate economic growth. The adoption of expansionary monetary policies led to a surge in the number of national investors participating in the stock market, resulting in a rapid rise in stock values. In response to the unusual price movements in the stock market during 2020, the Capital Markets Board of Türkiye and Borsa Istanbul implemented several measures. As a result, the trading volume of the Borsa Istanbul stock market increased significantly compared to the previous year (Turkish Capital Markets Association [TCMA], 2021). The high turnover rate in the stock market indicates liquidity but also suggests that investors have a short-term perspective when evaluating their portfolios. Since 2020, the portfolio values of national investors in Borsa Istanbul have surpassed those of foreign investors (Table A2). Furthermore, there has been a significant decrease in the holding period of foreign investors (Table A1). This shift in investment behavior can be attributed to increasing uncertainty, leading investors to adopt a short-term approach in evaluating their investments.

In 2021, due to the emergence of mutations and a rise in COVID-19 cases, lockdown measures were implemented in April and May. Within a span of 20 months, The Central Bank of the Republic of Türkiye (CBRT) witnessed four changes in its governor, with a new appointment made on March 20, 2021. From the third quarter of 2021 onwards, the CBRT began a gradual reduction of interest rates. Additionally, Türkiye experienced a currency crisis toward the end of 2021 that resulted in a sharp

depreciation of the Turkish lira against major currencies. In December, CBRT intervened directly in the market by engaging in selling transactions in response to distorted price formations in exchange rates. The crisis was triggered by a combination of factors, including persistent inflationary pressures, widening current account deficits, and mounting apprehensions surrounding the effectiveness of monetary policy.

Figure 3. Daily Market Efficiency



The outbreak of the Russia-Ukraine conflict in early 2022 led to a further drop in information efficiency across all indices, which reached even lower levels. Following the COVID-19 pandemic, the already low information efficiency levels experienced a slight decline with the occurrence of the February 2023 earthquake disaster in Türkiye. According to an evaluation of the entire period, it is evident that all indices, except XULAS, have not reached pre-COVID-19 levels of information efficiency. This suggests that the effects of the pandemic and subsequent events continue to impact the market's ability to effectively incorporate and reflect available information.

Table 3 provides descriptive statistics of the time-varying informational efficiency, aiming to enhance our understanding of the distribution of informational efficiency across the indices.

Table 3. Descriptive statistics of the time-varying informational efficiency

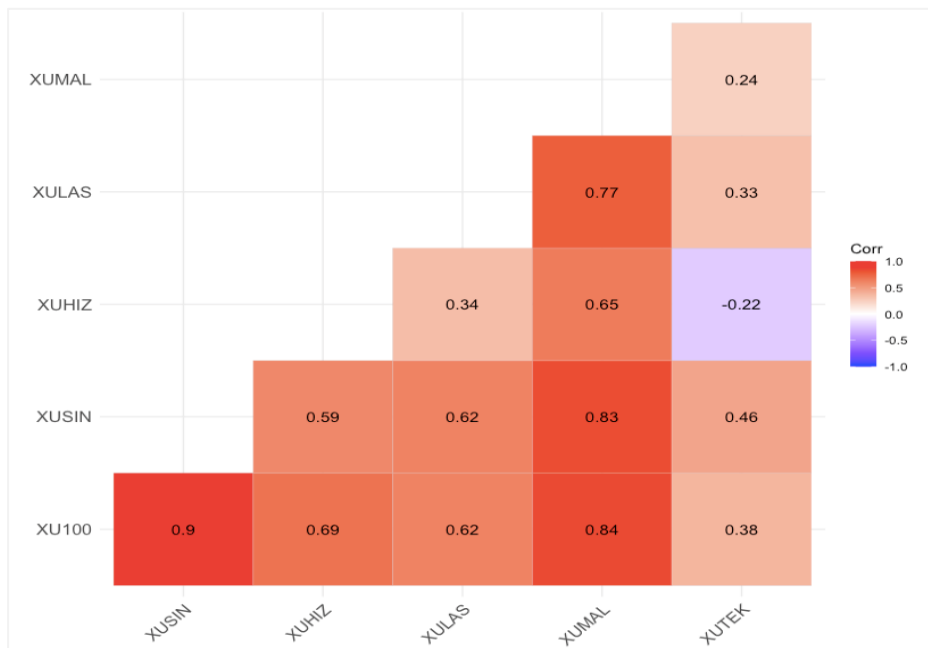
	XU100	XUSIN	XUHIZ	XULAS	XUMAL	XUTEK
Mean	71.10	67.62	70.87	68.59	71.92	64.72
Median	68.98	66.95	68.84	71.96	71.90	63.76
Maximum	89.93	90.59	90.26	82.66	82.33	87.55
Minimum	56.78	54.27	55.51	46.30	60.07	50.41
SD	7.82	8.50	7.53	8.52	5.82	7.82
Skewness	0.34	0.57	0.59	-0.84	-0.08	0.53
Kurtosis	2.10	2.39	2.35	2.81	1.72	3.11
JB p-value	0.00	0.00	0.00	0.00	0.00	0.00

Table 3 shows that XUMAL has the lowest standard deviation of the indices, followed by XUHIZ. In order to assess whether the observed time-varying informational efficiencies are influenced by random noise or adhere to a normal distribution, a normality test was conducted, the results of which strongly indicate a departure from normal distribution.

By considering the average of the calculated daily time-varying informational efficiencies, we can rank the indices accordingly. The findings reveal that XUTEK is characterized as the least efficient index in the Turkish stock exchange market, exhibiting relatively lower levels of informational efficiency. Conversely, XUMAL emerges as the most efficient index, showcasing higher levels of informational efficiency, followed by XU100.

A pairwise entropic correlation between two indices is used to evaluate the level of similarity between the informational complexity of the indices. In this context, entropic correlation is defined as the Pearson correlation between time-varying daily relative informational efficiency values (Stosic et al., 2016). Figure 4 displays the entropic correlation coefficients between any two indices. The range of correlation matrix values lies between -0.22 and 0.9. As can be seen, XU100 and XUSIN show the highest positive correlation, followed by XU100 and XUMAL, and then XUMAL and XUSIN indices, while XUTEK and XULAS indices have negative correlation. A weak correlation between the XUTEK and other indices suggests that there is little interaction between the XUTEK and other indices regarding information efficiency fluctuations. A high level of information efficiency in the XUMAL index may lead to higher correlations with other indices due to information spillovers.

Figure 4. Entropic correlation coefficient matrix of indices



6. CONCLUSION

The present research investigates the time-dependent nature of informational complexity and efficiency in the Turkish stock market for the BIST-100 and five major sector indices. The MSE-based method is implemented to measure market efficiency for 1 to 30 business days, and the rolling window technique is applied to investigate daily time-varying informational efficiency from January 2017 to June 2023.

Firstly, it is discovered that informational efficiency increased in all indices before the COVID-19 outbreak. Nonetheless, it is clear that all six indices experienced a sharp drop in efficiency in March 2020 after WHO classified the COVID -19 outbreak as a pandemic. During the period the XUSIN Index experienced the largest decrease in informational efficiency while the XUMAL Index had the smallest decrease in daily market efficiency. These findings support the studies that extreme events decrease the market efficiency (Gaio et al., 2022; Lim et al., 2008; Ortiz-Cruz et al., 2012; Sensoy, 2013; Wang & Wang, 2021).

Second, the application of severe measures to combat the spread of the virus resulted in a reduction in global economic activities and increased market uncertainty. The disruptions in production and trade, the slowdown in the service sector, and the prevailing atmosphere of panic and uncertainty all influenced investor behavior during this period. On the other hand, the vaccine announcements contributed to a decrease in investor panic and fear, leading to increased optimism and a rise in the efficiency of the transportation sector. This finding supports the studies by Maneenop and Kotcharin (2023) and Martins and Cró (2022), which state that the pandemic declaration had an adverse impact on transportation stocks, but vaccine announcements had a positive effect.

Third, during the pandemic, the implementation of expansionary monetary policies resulted in a spike in the number of national investors participating in the stock market, leading to a rapid surge in stock prices. Since 2020, the portfolio values of national investors in Borsa Istanbul have surpassed those of foreign investors. Furthermore, there has been a significant decrease in the holding period of foreign investors. This shift in investment behavior can be attributed to increasing uncertainty, leading investors to adopt a short-term approach in evaluating their investments. Although national investors have shown a high level of interest in the market, market efficiency has not returned to its pre-pandemic levels.

Finally, the occurrence of various events, including Türkiye's macroeconomic situation, the currency crisis, the Russia-Ukraine conflict, and the earthquake disaster, led to a further decrease in information efficiency, causing all indices, except XULAS, to fail in reaching their pre-COVID-19. The findings suggest that both the macroeconomic situation in Türkiye and global events impact the behavior of the indices, causing deviations from full efficiency. The notable reduction in efficiency observed during the COVID-19 pandemic and the Russia-Ukraine conflict is consistent with the results of previous studies. For instance, Gaio et al. (2022) and Özkan (2022) found that heightened volatility and uncertainty during crisis periods negatively impact market efficiency. Additionally, Aksoy and Akyüzü (2024) reported that extreme events, such as earthquakes, trigger abnormal market responses and contribute to increased inefficiencies. These findings further reinforce and validate our results.

Our results support the Adaptive Market Hypothesis (AMH), which emphasizes that market efficiency changes depending on external events. Similar observations have been noted by Özkan (2020b, 2020c) and Aytekin and Doğan (2023), who found that market efficiency tends to fluctuate significantly during financial crises and geopolitical tensions. In contrast to earlier studies that typically examined individual crises separately, our research provides a broader perspective by analyzing multiple events, which includes the financial crises, geopolitical conflicts, a natural disaster, and prolonged economic instability. This approach helps reveal deeper patterns of efficiency reduction and underlines the importance of considering how different crises collectively affect investor behavior and market conditions. Such insights may be useful for policymakers aiming to enhance financial stability.

In this study, we provided valuable insights into Borsa Istanbul's time-varying efficiency; however, we must acknowledge certain limitations. We focused our research on five major industries, excluding subsector indices that may exhibit unique efficiency characteristics. Despite analyzing major crises such as COVID-19, the Russia-Ukraine war, inflation shocks, and earthquakes, the study does not take into account investor behavior at the micro level or effects related to high-frequency trading. In future research, intraday data could be explored, and cross-country comparisons carried out to determine whether these findings are unique to Türkiye or representative of a broader trend in emerging markets.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

REFERENCES

- Aggarwal, D. (2019). Do Bitcoins follow a random walk model?. *Research in Economics*, 73(1), 15-22. <https://doi.org/10.1016/j.rie.2019.01.002>
- Ahmed, F. (2021). Assessment of capital market efficiency in COVID-19. *European Journal of Business and Management Research*, 6(3), 42-46. <https://doi.org/10.24018/ejbmr.2021.6.3.839>
- Ahmetoğulları, K. (2024). BİST elektrik sektöründe etkin piyasa hipotezinin sınanması. *Journal of Economics and Research*, 5(2), 33-46. <https://doi.org/10.53280/jer.1512720>
- Aksoy, M., & Akyüzlü, M. K. (2024). Depremin hisse senedi piyasası üzerindeki etkileri: 6 Şubat 2023 Kahramanmaraş örneği. *Anadolu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 25(4), 213-228. <https://doi.org/10.53443/anadoluibfd.1481104>
- Ali, M., Alam, N., & Rizvi, S. A. R. (2020). Coronavirus (COVID-19)—An epidemic or pandemic for financial markets. *Journal of Behavioral and Experimental Finance*, 27, <https://doi.org/10.1016/j.jbef.2020.100341>
- Alkan, S. (2024). Liquidity and market efficiency in Borsa İstanbul. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 42(3), 371-384. <https://doi.org/10.17065/huniibf.1388807>
- Alnıpak, S., & Kale, S. (2021). COVID-19 sürecinin ulaştırma sektörü finansal performansına etkileri. *Journal of Research in Economics, Politics & Finance*, 6(IERFM Special Issue), 139–156. <https://doi.org/10.30784/epfad.1020882>
- Altunöz, U. (2020). Türk finans piyasaları etkin mi? Yapısal kırılma ve uzun hafıza yöntemleriyle Borsa İstanbul üzerine bir uygulama. *Econder 2020 3rd. International Economics Business and Social Sciences Congress Full Text Proceeding E-Book*, 9-18.
- Altuntaş, M., Kılıç, E., Pazarcı, Ş., & Umut, A. (2022). Borsa İstanbul alt endekslerinde etkin piyasa hipotezinin test edilmesi: Fourier kırılmalı ve doğrusal olmayan birim kök testlerinden kanıtlar. *Ekonomi Politika ve Finans Araştırmaları Dergisi*, 7(1), 169-185. <https://doi.org/10.30784/epfad.1041187>
- Alvarez-Ramirez, J., & Rodriguez, E., & Alvarez, J. (2012). A multiscale entropy approach for market efficiency. *International Review of Financial Analysis*, 21, 64–69. <https://doi.org/10.1016/j.irfa.2011.12.001>
- Ammy-Driss, A., & Garcin, M. (2023). Efficiency of the financial markets during the COVID-19 crisis: Time-varying parameters of fractional stable dynamics. *Physica A: Statistical Mechanics and Its Applications*, 609, 128335. <https://doi.org/10.1016/j.physa.2022.128335>
- Anagnostidis, P., Varsakelis, C., & Emmanouilides, C. J. (2016). Has the 2008 financial crisis affected stock market efficiency? The case of Eurozone. *Physica A: Statistical Mechanics and Its Applications*, 447, 116–128. <https://doi.org/10.1016/j.physa.2015.12.017>
- Ayaydın, H., Çam, A. V., Barut, A., & Pala, F. (2018). Harvey doğrusallık testi ile BIST piyasa etkinliğinin analizi. *TURAN Stratejik Araştırmalar Merkezi TURAN-CSR International Scientific Peer-Reviewed Refereed Journal*, 40(10), 112-123. <http://dx.doi.org/10.15189/1308-8041>
- Aytekin, S., & Doğan, S. (2023). Testing the Adaptive Market Hypothesis in equity markets in global financial crisis periods: An application on Borsa İstanbul indices. *İktisadi İdari ve Siyasal Araştırmalar Dergisi*, 8(21), 377-402. <https://doi.org/10.25204/iktisad.1208721>

- Aytekin, S., Abdioglu, N., & Sezgin, A. (2021). BİST pay piyasasında açığa satış yasağı ve COVID-19 düzenlemelerinin piyasa etkinliği üzerindeki etkisi. *MANAS Journal of Social Studies*, 10(4), 2433-2448. <https://doi.org/10.33206/mjss.759448>
- Bal, H., Algan, N., Erdoğan, E., & Tekin, İ. (2021). Etkin piyasa hipotezinin zayıf formunun Türkiye’de bankacılık sektörü için test edilmesi, *Journal of Cukurova University Faculty of Economics and Administrative Sciences*, 25(2), 327-345. <https://doi.org/10.51945/cuiibfd.995297>
- Bektur, Ç., & Aydın, M. (2019). Borsa İstanbul ve alt endekslerinde zayıf formda piyasa etkinliğinin analizi: Fourier yaklaşımı. *Journal of Academic Inquiries*, 14(2), 59-76. <https://doi.org/10.17550/akademikincelemeler.556185>
- Çevik, E. (2012). İstanbul Menkul Kıymetler Borsası’nda etkin piyasa hipotezinin uzun hafıza modelleri ile analizi: Sektörel bazda bir inceleme. *Journal of Yaşar University*, 7(26), 4437-4454.
- Çevik, E. İ., & Erdoğan, S. (2009). Bankacılık sektörü hisse senedi piyasasının etkinliği: Yapısal kırılma ve güçlü hafıza. *Doğuş Üniversitesi Dergisi*, 10(1), 26-40.
- Chen, F., & Jarrett, J. E. (2011). Financial crisis and the market efficiency in the Chinese equity markets. *Journal of the Asia Pacific Economy*, 16(3), 456-463. <https://doi.org/10.1080/13547860.2011.589632>
- Choi, S. Y. (2021). Analysis of stock market efficiency during crisis periods in the US stock market: Differences between the global financial crisis and COVID-19 pandemic. *Physica A: Statistical Mechanics and Its Applications*, 574, 125988. <https://doi.org/10.1016/j.physa.2021.125988>
- Costa, M., Goldberger, A. L., & Peng, C. K. (2002). Multiscale entropy analysis of complex physiologic time series. *Physical review letters*, 89(6), 068102. <https://doi.org/10.1103/PhysRevLett.89.068102>
- Dallı, T., & Uğur, B. (2022). BİST Gıda ve İçecek Sektörü Endeksinin zayıf formda etkinliğinin sınanması. *Alanya Akademik Bakış*, 6(3), 3189-3197. <https://doi.org/10.29023/alanyaakademik.1016279>
- Darrat, A. F., & Zhong, M. (2000). On testing the random-walk hypothesis: A model-comparison approach. *Financial Review*, 35(3), 105-124. <https://doi.org/10.1111/j.1540-6288.2000.tb01423.x>
- Demiralp, A., & Belliler, İ. S. (2023). Seçilmiş Bist alt endekslerinde etkin piyasa hipotezinin sınanması. *İşletme Araştırmaları Dergisi*, 15(4), 2807-2815. <https://doi.org/10.20491/isarder.2023.1749>
- Duman Atan ,S., Özdemir, Z. A., & Atan, M. (2009). Hisse senedi piyasasında zayıf formda etkinlik: İMKB üzerine ampirik bir çalışma. *Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 24(2), 33-48.
- Durusu-Ciftci, D., Ispir, M. S., & Kok, D. (2019). Do stock markets follow a random walk? New evidence for an old question. *International Review of Economics & Finance*, 64, 165-175. <https://doi.org/10.1016/j.iref.2019.06.002>
- Ekmen, C., & Evci, S. (2024). Havayolu sektöründe zayıf formda piyasa etkinliğinin analizi: Borsa İstanbul üzerine bir uygulama. *Turizm Ekonomi ve İşletme Araştırmaları Dergisi*, 6(2), 155-167.
- Erer, D., Erer, E., & Güngör, S. (2023). The aggregate and sectoral time-varying market efficiency during crisis periods in Turkey: A comparative analysis with COVID-19 outbreak and the global financial crisis. *Financial Innovation*, 9(1), 80. <https://doi.org/10.1186/s40854-023-00484-4>
- Ertas, F. C., & Özkan, O. (2018). Piyasa etkinliği açısından adaptif piyasa hipotezi’nin test edilmesi: Türkiye ve ABD hisse senedi piyasaları örneği. *Finans Politik ve Ekonomik Yorumlar*, (642), 223-240.
- Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), 383-417. <https://doi.org/10.2307/2325486>
- Gaio, L. E., Stefanelli, N. O., Júnior, T. P., Bonacim, C. A. G., & Gatsios, R. C. (2022). The impact of the Russia-Ukraine conflict on market efficiency: Evidence for the developed stock market. *Finance Research Letters*, 50, 103302. <https://doi.org/10.1016/j.frl.2022.103302>
- Gözbaşı, O. (2014). Borsa İstanbul hisse senedi piyasasında doğrusal olmayan yöntemler ile piyasa etkinliğinin test edilmesi. *Journal of Productivity*, (4), 7-18.
- Huang, C. (2019). US Stock market efficiency: EMH or AMH?. In *2019 4th International Conference on Financial Innovation and Economic Development (ICFIED 2019)*, Atlantis Press, 171-175. <https://doi.org/10.2991/icfied-19.2019.32>

- Karademir, F., & Evci, S. (2020). Testing of the weak form market efficiency on Borsa Istanbul: An analysis in the sectoral framework. *Business & Management Studies: An International Journal*, 8(1), 82–100. <https://doi.org/10.15295/bmij.v8i1.1416>
- Kim, J. H., Shamsuddin, A., & Lim, K. P. (2011). Stock return predictability and the adaptive markets hypothesis: Evidence from century-long US data. *Journal of Empirical Finance*, 18(5), 868–879. <https://doi.org/10.1016/j.jempfin.2011.08.002>
- Lalwani, V., & Meshram, V. V. (2020). Stock market efficiency in the time of COVID-19: Evidence from industry stock returns. *International Journal of Accounting & Finance Review*, 5(2), 40–44. <https://doi.org/10.46281/ijafr.v5i2.744>
- Lim, K. P., Brooks, R. D., & Kim, J.H. (2008). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. *International Review of Financial Analysis*, 17(3), 571–591. <https://doi.org/10.1016/j.irfa.2007.03.001>
- Lim, K.-P., Luo, W., & Kim, J. H. (2013). Are US stock index returns predictable? Evidence from automatic autocorrelation-based tests. *Applied Economics*, 45(8), 953–962. <https://doi.org/10.1080/00036846.2011.613782>
- Lo, A. W. (2004). The Adaptive Markets Hypothesis. *Journal of Portfolio Management*, 30(5), 15–29. <https://doi.org/10.3905/jpm.2004.442611>
- Malcıoğlu, G., & Aydın, M. (2016). Borsa İstanbul'da piyasa etkinliğinin analizi: Harvey dogrusallık testi. *Journal of Accounting, Finance and Auditing Studies*, 2(1), 112–122.
- Maneenop, S., & Kotcharin, S. (2023). Comparative evidence on the impact of the COVID-19 outbreak and vaccine discovery on the global transportation industry. *Transportation Research Interdisciplinary Perspectives*, 17, 100741. <https://doi.org/10.1016/j.trip.2022.100741>
- Martins, A. M., & Cró, S. (2022). Airline stock markets reaction to the COVID-19 outbreak and vaccines: An event study. *Journal of Air Transport Management*, 105. <https://doi.org/10.1016/j.jairtraman.2022.102281>
- Maurya, P. K., Bansal, R., & Mishra, A. K. (2024). Dynamic connectedness among market volatilities: A perspective of COVID-19 and Russia-Ukraine conflict. *Studies in Economics and Finance*, 41(5), 1119–1140. <https://doi.org/10.1108/SEF-01-2024-0029>
- Memon, B. A., Aslam, F., Naveed, H. M., Ferreira, P., & Ganiev, O. (2024). Influence of the Russia–Ukraine War and COVID-19 pandemic on the efficiency and herding behavior of stock markets: Evidence from G20 Nations. *Economies*, 12(5), 106. <https://doi.org/10.3390/economies12050106>
- Mishra, P. K., Das, K. B., & Pradhan, B. B. (2009). Empirical evidence on Indian stock market efficiency in context of the global financial crisis. *Global Journal of Finance and Management*, 1(2), 149–157.
- Oh, G., Kim, S., & Eom, C. (2007). Market efficiency in foreign exchange markets. *Physica A: Statistical Mechanics and its Applications*, 382(1), 209–212. <https://doi.org/10.1016/j.physa.2007.02.032>
- Ortiz-Cruz, A., Rodriguez, E., Ibarra-Valdez, C., & Alvarez-Ramirez, J. (2012). Efficiency of crude oil markets: Evidences from informational entropy analysis. *Energy Policy*, 41, 365–373. <https://doi.org/10.1016/j.enpol.2011.10.057>
- Özkan, O. (2020a). In which sectors can historical prices be used for return predictability? An empirical study on Istanbul stock exchange with automatic portmanteau test. *Business and Economics Research Journal*, 11(3), 703–712.
- Özkan, O. (2020b). Weak-form market efficiency comparison of stock markets on global scale: An empirical study on G-20 members. *Celal Bayar Üniversitesi Sosyal Bilimler Dergisi*, 18(02), 327–338. <https://doi.org/10.18026/cbayarsos.695125>
- Özkan, O. (2020c). Time-varying return predictability and adaptive markets hypothesis: Evidence on MIST countries from a novel wild bootstrap likelihood ratio approach. *Bogazici J: Rev Soc Econ Adm Stud*, 34(2), 101–113.
- Özkan, O. (2021). Impact of COVID-19 on stock market efficiency: Evidence from developed countries. *Res. Int. Bus. Finance*, 58, 101445. <https://doi.org/10.1016/J.RIBAF.2021.101445>
- Özkan, O. (2022). Rusya-Ukrayna Savaşının Türkiye hisse senedi piyasasına etkileri. In Cuma Cataloluk and Dogan Bozdagan (Eds.), *Sosyal Bilimlerde Degisim ve Gelisim Yazilari V* (pp. 3–20). Iksad Yayinlari.

- Özkan, O., & Çakar, R. (2020). Türkiye'deki islami endekslerin zayıf form bilgisel etkinlikleri. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 38(4), 805-822. <https://doi.org/10.17065/huniibf.700420>
- Palamalai, S., Kumar, K. K., & Maity, B. (2021). Testing the random walk hypothesis for leading cryptocurrencies. *Borsa Istanbul Review*, 21(3), 256-268. <https://doi.org/10.1016/j.bir.2020.10.006>
- Patra, S., & Hiremath, G. S. (2022). An entropy approach to measure the dynamic stock market efficiency. *Journal of Quantitative Economics*, 20(2), 337-377. <https://doi.org/10.1007/s40953-022-00295-x>
- Poshakwale, S. (2002). The random walk hypothesis in the emerging Indian stock market. *Journal of Business Finance & Accounting*, 29(9-10), 1275-1299. <https://doi.org/10.1111/1468-5957.00469>
- Rehman, S., Chhapra, I. U., Kashif, M., & Rehan, R. (2018). Are stock prices a random walk? An empirical evidence of Asian stock markets. *Etikonomi*, 17(2), 237-252. <http://dx.doi.org/10.15408/etk.v17i2.7102>
- Richman, J. S., & Moorman, J. R. (2000). Physiological time-series analysis using approximate entropy and sample entropy. *American Journal of Physiology-Heart and Circulatory Physiology*, 278(6), H2039-H2049. <https://doi.org/10.1152/ajpheart.2000.278.6.H2039>
- Rizvi, S. A. R., & Arshad, S. (2014). Investigating the efficiency of East Asian stock markets through booms and busts. *Pacific Science Review*, 16(4), 275-279. <https://doi.org/10.1016/j.pscr.2015.03.003>
- Sadat, A. R., & Hasan, M. E. (2019). Testing weak form of market efficiency of DSE based on random walk hypothesis model: A parametric test approach. *International Journal of Accounting and Financial Reporting*, 9(1), 400-413. <https://doi.org/10.5296/ijaf.v9i1.14454>
- Şahin, Ö. (2020). Finansal piyasa etkinliğinin run testi ve volatilité modelleri ile analizi: BIST 100, dolar kuru ve altın fiyatı piyasaları üzerine bir uygulama. *The International Journal of Economic and Social Research*, 16(2), 333-348.
- Sakınç, S. Ö., & Sakınç, İ. (2023). Borsa İstanbul Katılım Endekslerinin etkin piyasa hipotezi analizi: Zayıf formda etkinlik incelemesi. *Hitit Sosyal Bilimler Dergisi*, (ICAFR'23 Özel Sayısı), 42-53. <https://doi.org/10.17218/hititsbd.1391325>
- Scalamonti, F. (2025). The weak form efficient markets hypothesis: Macroeconomic Evidence from MEDA capital markets. Available at SSRN 5078907. <https://doi.org/10.2139/ssrn.5078907>
- Sensoy, A. (2013). Generalized Hurst exponent approach to efficiency in MENA markets. *Physica A: Statistical Mechanics and its Applications*, 392(20), 5019-5026. <https://doi.org/10.1016/j.physa.2013.06.041>
- Shternshis, A., Mazzarisi, P., & Marmi, S. (2022). Measuring market efficiency: The Shannon entropy of high-frequency financial time series. *Chaos, Solitons & Fractals*, (162), 112403. <https://doi.org/10.1016/j.chaos.2022.112403>
- Stakić, N., Jovancai, A., & Kapor, P. (2016). The efficiency of the stock market in Serbia. *Journal of Policy Modeling*, 38(1), 156-165. <https://doi.org/10.1016/j.jpolmod.2015.12.001>
- Stosic, D., Stosic, D., Ludermit, T., & Stosic, T. (2016) Correlations of multiscale entropy in the FX market. *Physica A: Statistical Mechanics and its Applications*, (457), 52-61. <https://doi.org/10.1016/j.physa.2016.03.099>
- Süsay Alkan, A. (2024). Yerli ve yabancı yatırımcıların Borsa İstanbul'un piyasa etkinliğine etkisi: Fourier eşbütünleşme yaklaşımı. *Trakya Üniversitesi İktisadi ve İdari Bilimler Fakültesi E-Dergi*, 13(1), 66-81. <https://doi.org/10.47934/tife.13.01.05>
- Suyadal, M. (2021). COVID-19 pandemisinde piyasa etkinliği ve davranışsal finans teorilerinin geçerliliği: Uluslararası piyasalarda bir uygulama. *Erciyes University Journal of Faculty of Economics and Administrative Sciences*, (60), 519-546. <https://doi.org/10.18070/erciyesiibd.994139>
- Tanrıöver, B., & Çöllü, D. A. (2015). Türkiye'de yatırımcıların öngörü performanslarının rassal yürüyüş modeli çerçevesinde analizi. *Business and Economics Research Journal*, 6(2), 127-139.
- Tiwari, A. K., & Kyophilavong, P. (2014). New Evidence from the random walk hypothesis for BRICS stock indices: A wavelet unit root test approach. *Economic Modelling*, (43), 38-41. <https://doi.org/10.1016/j.econmod.2014.07.005>

- Turkish Capital Markets Association (2021). *Turkish Capital Markets 2020 Annual Review*.
<https://tspb.org.tr/en/periodic-publications/>
- Turkish Investor Relations Society. (2022). *BIST Trends Report (January - December 2022)*, No: 43.
https://www.tuyid.org/files/yayinlar/BorsaTrendleriRaporu_4C22.pdf
- Unal, S. (2020). COVID-19 Salgınında Borsa İstanbul şirketlerinin fiyatlamalarının etkinliği. *Journal of Research in Economics Politics and Finance*, 5(Special Issue), 13-31.
<https://doi.org/10.30784/epfad.795868>
- Vasileiou, E. (2021). Behavioral finance and market efficiency in the time of the COVID-19 pandemic: Does fear drive the market?. *International Review of Applied Economics*, 35(2), 224–241. <https://doi.org/10.1080/02692171.2020.1864301>
- Wang, G. J., Xie, C., & Han, F. (2012). Multi-scale approximate entropy analysis of foreign exchange markets efficiency. *Systems Engineering Procedia*, 3, 201–208. <https://doi.org/10.1016/j.sepro.2011.10.030>
- Wang, J., & Wang, X. (2021). COVID-19 and financial market efficiency: Evidence from an entropy-based analysis. *Finance Research Letters*, (42), 1-7. <https://doi.org/10.1016/j.frl.2020.101888>
- Yıldıran, M. (2021). *COVID-19 korkusu altında finansal piyasalarda getiriler ve etkinlik analizi: Türkiye örneği*. <https://doi.org/10.2139/ssrn.3940392>
- Yücel, Ö. (2016). Finansal piyasa etkinliği: Borsa İstanbul üzerine bir uygulama. *International Review of Economics and Management*, 4(3), 107-123. <https://doi.org/10.18825/irem.16916>
- Zeren, F., Kara, H., & Arı, A. (2013). Piyasa etkinliği hipotezi: İMKB için ampirik bir analiz. *Dumlupınar University Journal of Social Sciences*, (36), 141-148.

APPENDIXES

Table A1. Holding Period

Index	Nationality	2018	2019	2020	2021	2022
XU100	National	27	28	18	26	25
	Foreign	119	115	55	46	29
XUSIN	National	34	38	21	29	31
	Foreign	133	147	51	39	28
XUMAL	National	36	32	19	28	27
	Foreign	158	166	107	41	27
XUTEK	National	19	24	13	26	19
	Foreign	41	42	22	36	18
XUHIZ	National	25	22	14	22	24
	Foreign	111	109	63	64	35

Table A1 is obtained from the BIST Trends Report (January - December 2022) published by Turkish Investor Relations Society (2022).

Table A2. National and Foreign Portfolio Value

Year	National		Foreign		Portfolio weight of foreign investor (%)	Market Capitalization (Change %)
	Number of investors (Change %)	Portfolio Value (Change %)	Number of investors (Change %)	Portfolio Value (Change %)		
2011	5.26	-5.32	2.78	-20.74	62.16	-34.33
2012	-0.90	37.49	7.40	61.80	65.91	54.10
2013	1.91	0.49	15.07	-13.03	62.60	-23.65
2014	-3.21	22.82	2.83	30.29	63.97	13.53
2015	-1.49	-5.11	-0.92	-11.33	62.39	-29.52
2016	-1.74	6.12	-2.57	10.84	63.41	-8.24
2017	4.85	35.75	0.89	48.40	65.45	33.74
2018	8.12	-9.38	1.69	-12.07	64.76	-35.51
2019	2.10	67.19	-0.25	42.20	60.99	24.02
2020	65.61	104.97	23.25	24.54	48.71	28.72
2021	18.46	37.79	9.89	-3.87	39.85	-31.85
2022	60.83	249.83	29.63	118.72	29.29	102.77

The authors generated the Table A2 by utilizing data from the Central Securities Depository of the Turkish capital markets and Borsa İstanbul websites.

Ideational Factors and Regime Security in Post-Arab Spring Realignments: Analyzing Türkiye-Gulf Arab States Relations (2011-2022)

Ahmet ÜÇAĞAÇ¹, Duygu KALKAN²

Abstract

This study examines the complex dynamics shaping relations between Türkiye and the Gulf Arab States in the aftermath of the Arab Spring. It addresses the central question: “How has the Arab Spring reconfigured alignments between Türkiye and the Gulf Arab States?” The research posits that Middle Eastern geopolitics can be more comprehensively understood through a framework that synthesizes material and ideational factors. It argues that the fluctuating convergence and divergence between these actors are primarily driven by ideational factors, with material considerations playing a significant secondary role. The study employs the regime security approach as its theoretical foundation, complemented by process tracing methodology to analyze the political, economic, and social dimensions of Türkiye-Gulf Arab States relations. This multifaceted approach aims to provide a nuanced understanding of regional realignments and contribute to the broader discourse on Middle Eastern security dynamics. By focusing on the interplay between ideational factors and regime security concerns, this research offers novel insights into the evolving nature of inter-state relations in the post-Arab Spring Middle East.

Keywords: *Arab Spring, Türkiye, Gulf Arab States, Regime Security, Regional Realalignments.*



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1. INTRODUCTION

The Middle Eastern regional order is characterized by a dynamic interplay of competition, conflict, and cooperation among various state actors (Amour, 2020). This study examines the complex relations between Türkiye and the Gulf Arab States in the wake of the Arab Spring, focusing on the period from 2011 to 2022. The central research question guiding this investigation is: How has the Arab Spring reshaped the alignments between Türkiye and the Gulf Arab States?

This research posits that the emergence and transformation of intra-regional rivalries (Amour, 2020) during this period can be explained through a synthesis of ideational and material factors. While ideational elements, particularly those related to political Islam and regime security, play a predominant role, material considerations significantly influence these dynamics as well. The study argues that the rise of ideas potent enough to challenge existing political structures increases the likelihood of regional competition and conflict, while the waning of such ideas facilitates normalization among competing actors.

The Arab Spring, which began in 2010, initiated a profound transformation across the region (Hamzaoglu & Merdan, 2024; Hinnebusch, 2014), leading to the proliferation and realignment of various conflict lines. This series of uprisings had two significant impacts on regional politics. First, it destabilized many traditional Arab powers, causing them to shift from active to more passive roles in regional affairs. Consequently, countries like Egypt and Syria, which had historically shaped Arab politics, were relegated to secondary roles. This power vacuum created an opportunity for the Gulf Arab states (Hinnebusch, 2019), with their relatively stable domestic politics and substantial material resources, to assume more prominent roles in regional dynamics. Second, the initial phase of the uprisings saw a shift in the balance of power from the Iranian-led resistance axis to the Saudi-led pro-Western bloc. The credibility of Hezbollah and Iran diminished in the Arab public sphere, while Türkiye and Qatar moved closer to the anti-Iran camp. Simultaneously, Sunni Islamist and pro-democracy movements gained traction against authoritarian nationalist regimes in countries like Libya and Syria, further weakening the dominant resistance discourse.

In this context, the idea of Political Islam, which gained significant influence during the Arab Spring, became a critical point of contention. It pitted actors who embraced and instrumentalized it to shape the regional order against those who perceived it as a vital threat to their political models. Political Islam emerged as the most significant ideational threat to the security of many authoritarian status quo regimes in the region. The concept of regime security, a crucial component of the political security sector, has always been a top priority for the authoritarian regimes of the Middle East. To explore these dynamics, the study employs the regime security approach as its theoretical framework, complemented by process tracing methodology. This combination allows for a comprehensive analysis of the political, economic, and social aspects of convergence and divergence between Türkiye and the Gulf Arab States. By focusing on the interplay between ideational factors and regime security concerns, this research aims

to contribute to the growing discourse on regional security and fill a gap in the literature, which has predominantly emphasized material determinants in analyzing Türkiye-Gulf relations.

The literature on Türkiye-Gulf Arab States relations is ever-growing. However, although there has been an unprecedented increase in the academic literature on Türkiye's relations with the Gulf Arab States since the AK Party came to power, a review of relevant literature reveals that material determinant factors have been heavily focused on, while ideational determinant factors have been neglected. This study aims to contribute to this literature by addressing the issue of regime security, which still tops the list of priorities in the foreign policies of the countries in the region (Üçağaç et al., 2022). In this context, the current study has two main objectives. The first is to contribute to the growing debate on regional security and the second is to fill the aforementioned gap in the literature. It intends to do so by exploring the role of the ideational factors in Türkiye's relations with the Gulf Arab States since the outbreak of the Arab uprisings. To this end, the study provides a detailed assessment of Türkiye-Gulf Arab States relations during this period, centering on the issue of regime security.

The study examines how Türkiye and the Gulf Arab States, which had been fostering closer relations and following parallel policies in the region since the early 2000s, entered a period of intense rivalry after the first phase of the Arab Spring, particularly following the 2013 Egyptian coup. However, this competition did not pit Türkiye against a unified bloc of Gulf Arab countries. While pro-change Qatar aligned with Türkiye, status quo powers Saudi Arabia and the UAE, viewing the dominance of authoritarian governments in regional politics as aligning with their interests, positioned themselves in opposition to Türkiye and Qatar. The research argues that the main point of contention between the Turkish-Qatari bloc and the Saudi-UAE bloc stemmed from Türkiye and Qatar's support for Political Islam during the Arab Spring, which had the potential to transform the established political order of the region. Political Islam, represented primarily by the Muslim Brotherhood movement, was perceived as an anti-status quo and revisionist ideology. Riyadh, Abu Dhabi, and Cairo (after the 2013 military coup) viewed this revisionist ideology, supported by Türkiye and Qatar, as a critical threat to the security of their regimes.

The research also explores how these dynamics evolved over time, particularly after 2021, when the influence of the Arab Spring began to wane, and global developments led to a dramatic decline in the influence of Political Islam. This shift caused ideational factors to become less of a priority in the foreign policies of regional actors, leading them to focus more on material interests, especially in light of the economic challenges posed by the Covid-19 pandemic. By examining these complex dynamics, this study aims to contribute to a more comprehensive understanding of Middle Eastern geopolitics and the evolving nature of inter-state relations in the post-Arab Spring era. It offers insights into how the interplay of ideational and material factors shapes regional alignments and influences the foreign policy decisions of key actors in this volatile region.

This study adopts a qualitative case study design using the process tracing method. Process tracing is a qualitative research approach that allows for the detailed analysis of causal mechanisms within a single case or a limited set of cases. It involves systematically examining empirical evidence to trace how particular events or sequences of events contribute to specific outcomes. As Andrew Bennett notes, process tracing facilitates the identification and analysis of diagnostic evidence that helps explain change over time within a case (Bennett, 2010, p. 8). At the core of this method is the concept of a causal mechanism, a structured framework that outlines how various theoretical elements interact to produce an outcome. According to Checkel, causal mechanisms consist of a set of hypotheses that serve as potential explanations for observed phenomena (Checkel, 2008, p. 115). These mechanisms offer a bridge between diverse theoretical perspectives, enabling researchers to integrate insights from multiple approaches. By uncovering the specific causal processes underlying a phenomenon, process tracing adds analytical depth and enhances our understanding of how and why certain outcomes occur. This makes it particularly well-suited for this research, as it reveals the logic behind causal relationships and provides a clearer understanding of the dynamics at play.

The study employs process tracing to analyze the causal mechanisms underlying the evolution of Türkiye-Gulf Arab states relations during the Arab Spring and its aftermath, using regime security theory as the theoretical lens. Regime security theory posits that states, particularly authoritarian regimes, prioritize actions that safeguard the ruling elite's hold on power. In this context, process tracing facilitates the identification of how threat perceptions, rooted in domestic regime stability concerns, shaped foreign policy responses. By closely examining key events, decisions, and diplomatic shifts from 2010 onward, this method enables a nuanced understanding of how Türkiye's support for Islamist movements, such as the Muslim Brotherhood, was interpreted by Gulf monarchies as a challenge to their internal stability. Process tracing thus helps to reveal the causal process linking ideological divergence and regime insecurity to the growing strategic rivalry between Türkiye and states like Saudi Arabia and the UAE. This approach not only clarifies the logic behind foreign policy choices but also shows how regime security concerns can override conventional geopolitical interests during periods of regional upheaval.

1.1. Regime Security

The concept of regime security is central to understanding the dynamics of Middle Eastern politics, particularly in the context of the Arab Spring and its aftermath. Proponents of regime security theory argue that threats to domestic stability are the primary drivers shaping a state's security strategies, especially in developing countries where the security of the state and the regime are often intertwined (Job, 1992, p. 15). In the Middle Eastern context, regime security refers to the state in which ruling elites maintain their position against serious internal challenges (Jackson, 2007, p. 148). This concept is particularly relevant to governments that hold power through non-democratic means, as they face persistent challenges related to legitimacy, political fragmentation, and local instability (Ayoob, 1995,

p. 28; Buzan, 1991). Mohammed Ayoob posits that regimes experiencing significant insecurity often perceive internal risks as equally or more important than external threats (Ayoob, 1983, p. 43).

The Arab Spring uprisings brought the issue of regime security into sharp focus, revealing that the most significant threats to regional autocracies were not external actors like Israel or Iran, nor militant jihadist movements, but rather domestic grassroots activism demanding regime change. The rise of Islamist governments in Tunisia and Egypt, particularly the Muslim Brotherhood, led to a convergence of authoritarian regimes in the region seeking collective security (Kaddorah, 2021; Ryan, 2017). This study argues that the regime security paradigm is crucial for understanding the realignment of regional alliances following the Arab Spring. The overthrow of long-standing authoritarian leaders in Tunisia and Egypt through mass protests was interpreted as an existential threat by Saudi Arabia and the UAE. These Gulf states viewed the potential for regional instability and the disruption of the status quo as directly challenging their own regimes' security.

The Muslim Brotherhood's electoral victory in Egypt was particularly alarming to many Gulf Arab regimes, with the notable exception of Qatar. The movement's success in gaining power through popular revolution and democratic elections represented a direct challenge to the legitimacy of authoritarian rule. This led to a rapid reconfiguration of regional alliances, with Egypt, Qatar, and Türkiye forming a closer alliance under Muslim Brotherhood rule, while Saudi Arabia and the UAE aligned against this new axis.

The 2013 military coup in Egypt, which overthrew the democratically elected Muslim Brotherhood government, marked a critical turning point. It led to a further realignment of regional powers, with Saudi Arabia and the UAE providing substantial financial support to the new Egyptian regime under General Abdel Fatah al-Sisi, while Qatar withdrew its backing (Ryan, 2014). In the post-Muslim Brotherhood period, regimes committed to eliminating perceived threats to their security formed stronger alliances. Egypt, Saudi Arabia, and the UAE emerged as key allies united in their opposition to the Muslim Brotherhood, which they viewed as a transnational threat to their legitimacy, security, and stability. These regimes prioritized addressing ideational threats to their rule over responding to other regional crises, such as the Syrian civil war or the rise of extremist groups like the Islamic State. In this regard, this analysis demonstrates how the regime security approach can elucidate the complex interplay between domestic politics and regional alignments in the Middle East. By focusing on the perceived threats to regime stability, we can better understand the motivations behind the shifting alliances and foreign policy decisions of key regional actors in the aftermath of the Arab Spring.

2. THE ROOTS OF CONVERGENCE AND DIVERGENCE IN TÜRKİYE-GULF ARAB STATES RELATIONS

The Arab Spring fundamentally altered the dynamics of regime security politics in the Middle East, profoundly impacting alliance systems in the region. This period witnessed a significant shift in regional power dynamics, with traditional powers losing influence and new actors emerging. The Gulf

Arab states, leveraging their relative domestic stability and substantial material resources, capitalized on the regional disorder to become prominent actors in regional politics (Abdulla, 2012). Their ability to combine soft and hard power capacities, including economic prosperity, media networks, and transnational group affiliations, enhanced their regional influence (Lynch, 2018). Similarly, Türkiye seized the opportunity to advance its regional position by supporting ideologically aligned groups. Its economic development, strong military, and relative stability positioned it as a significant regional player during this turbulent period.

The rise of the Arab Spring and the toppling of authoritarian regimes elevated regime security to the top of the regional agenda (Ryan, 2017). The election of Mohamed Morsi, the Muslim Brotherhood candidate in Egypt, through democratic means alarmed many Arab regimes, with the exception of Qatar. This event catalyzed the formation of a strong alliance among authoritarian regimes determined to contain perceived threats to their rule. Since 2011, Qatar has strengthened its regional influence through close cooperation with Türkiye, sharing a common perspective on supporting Islamist groups, particularly those affiliated with the Muslim Brotherhood. Conversely, Saudi Arabia and the UAE perceived the Muslim Brotherhood and its affiliates as existential threats to their regimes, national security, and regional influence, adopting harsh policies against these groups. The divergence between the Türkiye-Qatar and Saudi Arabia-UAE blocs became increasingly apparent following the 2013 overthrow of Mohamed Morsi's government in Egypt. This military coup, supported by Saudi Arabia and the UAE, replaced the democratically elected Islamist government with a secular-authoritarian military regime, dealing a significant blow to the Türkiye-Qatar alliance that had been shaping regional transformation between 2011 and 2013.

The accession of Salman bin Abdul-Aziz to the Saudi throne in 2015 and the subsequent rise of Crown Prince Mohammed bin Salman (Cordesman, 2015) further galvanized the Saudi-UAE alliance in their efforts to suppress the regional influence of Qatar and Türkiye. The fault line between the two blocs deepened during the 2017 Gulf crisis, in which Saudi Arabia, UAE, Bahrain, and Egypt blockaded Qatar (Kabalan, 2018; Patrick, 2017). Türkiye's response, including the deployment of military forces to Qatar, elevated its relationship with Doha to an unprecedented strategic level while further straining its relations with the Saudi-UAE bloc. Over time, the main fault line in this polarization crystallized between Türkiye and the UAE. The Abu Dhabi administration viewed Ankara as its primary regional rival, while Turkish media portrayed the UAE as an adversary, even attributing the 2016 coup attempt against President Erdoğan to UAE designs (Paksoy, 2017).

The 2018 murder of Saudi journalist Jamal Khashoggi in Istanbul marked a critical juncture in Türkiye-Saudi relations, leading to open hostility between the parties. Ankara's international campaign implicating Crown Prince Mohammed bin Salman in the crime further strained bilateral relations, resulting in economic repercussions and diplomatic tensions. These developments illustrate how ideational factors, particularly the perceived threat of political Islam, interacted with material interests

and regime security concerns to shape the complex and evolving relationships between Türkiye and the Gulf Arab states in the post-Arab Spring era.

3. COMPETITION OVER THE MEDITERRANEAN AND NORTH AFRICA

As the rivalry between Türkiye and the Gulf Arab states intensified, the competition expanded beyond the immediate region and into the Mediterranean and North Africa (Bianco, 2020). This expansion was driven by the Gulf states' regime security concerns and their strategic decision to confront perceived threats at their source. The Eastern Mediterranean region, which became the epicenter of the Arab Spring, emerged as a key battleground for this competition. The Gulf states, particularly Saudi Arabia and the UAE, sought to contain Türkiye's influence and stifle the Arab Spring movements that they perceived as existential threats to their regimes. To achieve these objectives, they pursued alliances with European countries that had ongoing disputes with Türkiye.

A notable example of this strategy was the strengthening of ties between the UAE and France, both of which aimed to counter Türkiye's ambitions in the Mediterranean (Aydıntaşbaş & Bianco, 2021). Concurrently, the UAE and Saudi Arabia developed closer relations with Greece and the Greek Cypriot Administration of Southern Cyprus (GCASC), capitalizing on the tensions between these entities and Türkiye over drilling rights off Cyprus. The UAE's participation in the annual Greek-led military exercise (Iniohos/Bridge) from 2017 onwards, alongside the US and Israel, with Egypt as an observer, further underscored the evolving geopolitical alignments in the region (Ahronheim, 2017; Haaretz, 2018). These developments intensified the competition for regional influence between the Gulf Arab countries and Türkiye, with the Mediterranean basin becoming a focal point of this rivalry.

The concentration of Arab Spring uprisings in Mediterranean countries such as Egypt, Tunisia, Syria, and Libya made this region particularly significant. Two key factors contributed to the Mediterranean's centrality in this competition: first, it housed the primary actors involved in the rivalry (Egypt, Tunisia, Libya), and second, it represented a critical arena where the Gulf states sought to contain Türkiye's expanding influence in the broader Middle East (Cook & Ibish, 2019). This period saw the emergence of two distinct alliance systems: a smaller but more cohesive axis comprising Türkiye, Qatar, and the Libyan Government of National Accord (GNA) (Polat, 2022), opposed by a coalition of Greece, the GCASC, and Israel, supported by Egypt, the UAE, and France. Consequently, the Gulf Arab states, despite not being part of the Eastern Mediterranean regional security complex, became active players in the area's geopolitics. In the North African context, countries like Tunisia and Egypt became pivotal in shaping the trajectory of the Arab Spring. Both Türkiye and the Gulf Arab states invested considerable effort in influencing the political outcomes in these transitional states. Their divergent approaches reflected fundamentally different visions for the region's future.

Türkiye and Qatar supported the Arab Spring protests, democratic transitions, and parties affiliated with the Muslim Brotherhood. In contrast, the Saudi Arabian-UAE bloc backed counter-

revolutionary forces, former regimes, armies, and anti-Islamist parties (Anzola, 2019; Gill, 2019; Lynch, 2016). The Saudi-UAE alliance viewed the resurgence of authoritarianism in the Middle East and North Africa as a guarantee of their own regime security and offered substantial support to like-minded forces (Gardner, 2019; Wehry, 2015).

The overthrow of long-standing authoritarian leaders like Zine al-Abidine Ben Ali in Tunisia and Hosni Mubarak in Egypt through mass protests was interpreted as a critical threat by Saudi Arabia and the UAE. These Gulf states feared that such events could lead to regional instability, disrupt the status quo, and potentially threaten their own regimes. The electoral victories of Muslim Brotherhood-affiliated parties and candidates were seen as direct challenges to their rule. Conversely, Türkiye and Qatar viewed the Muslim Brotherhood movement as an opportunity for regional change that aligned with their interests. They supported the protests and welcomed the electoral successes of Muslim Brotherhood-linked leaders and parties in Egypt, Tunisia, and Morocco. This polarization, rooted in competing visions for a new regional order, continued to intensify until January 2021. However, subsequent developments at local, regional, and global levels began to soften the fierce rivalry between these actors, initiating a process of normalization in their relations.

This analysis demonstrates how the competition over the Mediterranean and North Africa was fundamentally shaped by regime security concerns and ideational factors, particularly the perceived threat or opportunity presented by political Islam. The interplay of these elements with material interests and geopolitical calculations drove the complex and evolving dynamics of regional alignments in the post-Arab Spring era.

4. SOFTENING AND NORMALIZATION IN REGIONAL RELATIONSHIPS

The period beginning in 2021 marked a significant shift in the dynamics of Türkiye-Gulf Arab States relations, characterized by a gradual softening of tensions and movement towards normalization. This transition can be attributed to several interrelated factors, both regional and global, that altered the calculus of regime security and ideational influences in the region. A primary driver of this change was the diminishing influence of the ideational factors that had previously shaped political and geopolitical alignments in the wake of the Arab Spring. The weakening of these ideational threats to regime security facilitated dialogue between previously opposed camps. Specifically, the decline of Political Islam as a potent force in regional politics reduced the perceived existential threat to established regimes, creating space for diplomatic rapprochement.

Several key events contributed to this ideational shift. The 2013 military coup in Egypt, which deposed the Islamist Morsi government (Daragahi & Heba, 2013), the defeat of the Islamist Ennahda movement by the secular Nida Tounes party in Tunisia's 2014 elections (The Times of Israel, 2014), and the devolution of the Syrian revolution into a protracted civil war collectively signaled the reversal of the Arab Spring's transformative potential. By 2021, Political Islam, which had been the most

influential ideational movement of the Arab Spring, no longer posed a significant threat to established regimes. Concurrently, regional competition and global developments exposed the economic vulnerabilities of key actors. The COVID-19 pandemic, in particular, forced a reevaluation of priorities. The economic toll of geopolitical activism, previously overshadowed by ideological and political struggles, became increasingly untenable. This economic pressure manifested as a deepening crisis in Türkiye (Çakmaklı et al., 2021) and significant economic challenges in the UAE, Saudi Arabia, and Egypt (Miller, 2020).

Global political shifts also played a crucial role in this regional recalibration. The election of Joe Biden as the US President in 2020 heralded changes in American regional policy. The Biden administration's departure from the Trump era's "maximum pressure" strategy against Iran and its more measured support for Saudi Arabia and the UAE prompted regional actors to reassess their positions. The US signaling a potential return to the Iran nuclear agreement and a continued reduction in regional engagements led its regional allies to seek alternative strategies, including deepening relations with China and Russia while simultaneously de-escalating tensions with regional rivals (Dalay, 2021). These developments necessitated a restructuring of regional policies among the rival parties (Ataman, 2021, 2022; Yeşiltaş, 2022). As the regional status quo, disrupted by the Arab Spring, began to re-establish itself, Saudi Arabia and the UAE initiated a rapprochement with Qatar and Türkiye, which had previously supported forces of change. The Turkish-Qatari bloc, fatigued by prolonged competition, reciprocated these overtures.

The normalization process gained significant momentum with the 41st Gulf Cooperation Council (GCC) Summit in Al-Ula, Saudi Arabia, on January 5, 2021 (Khalid, 2021). At this summit, Saudi Arabia and the UAE announced the end of their embargo and blockade against Qatar, restoring diplomatic relations (Al-Raşid, 2021; BBC News, 2021; Ulrichsen et al., 2021). Türkiye, as Qatar's strategic partner, welcomed these developments and expressed support for a comprehensive resolution to intra-Gulf conflicts (Battaloğlu, 2021; Çelik, 2021; Ministry of Foreign Affairs of the Republic of Türkiye, 2021). High-level visits following the Al-Ula Agreement further strengthened Riyadh-Doha relations, exemplified by Saudi Crown Prince Mohammed bin Salman's visit to Qatar in December 2021 (Aljazeera, 2021).

The normalization process extended to Türkiye-Gulf relations as well. The visit of UAE Crown Prince Mohammed bin Zayed to Ankara in November 2021, after a decade-long hiatus, marked a turning point in UAE-Türkiye relations (Duran, 2021; Foundation for Political, Economic and Social Research [SETAV], 2021; The Arab Weekly, 2021; Ulrichsen, et al., 2021). This was reciprocated by Turkish President Recep Tayyip Erdoğan's visit to Abu Dhabi in February 2022, during which the two countries signed agreements across various sectors and pledged cooperation against common threats (Duran, 2022; Turak, 2022). Similarly, Türkiye and Saudi Arabia, which had been at odds since the 2013 Egyptian coup and experienced further strain following the Qatar blockade and the Jamal Khashoggi

murder, began normalization talks. President Erdogan's visit to Saudi Arabia in April 2022 and the subsequent visit of Mohammed bin Salman to Ankara in June 2022 signaled a mutual desire to reset bilateral relations (Aljazeera, 2022; Baycar, 2022; Coşkun, 2022; Daily Sabah, 2022; Maher, 2022; Reuters, 2022). This normalization process demonstrates the dynamic nature of regional relationships and the complex interplay between ideational factors, regime security concerns, and material interests. As the perceived ideational threats diminished and economic pressures mounted, pragmatic considerations led to a recalibration of regional alignments, highlighting the fluid nature of Middle Eastern geopolitics in the post-Arab Spring era.

5. CONCLUSION

This study has examined the complex dynamics shaping relations between Türkiye and the Gulf Arab States in the aftermath of the Arab Spring, focusing on the period from 2011 to 2022. By analyzing the interplay of ideational and material factors, with a particular emphasis on regime security concerns, we have sought to elucidate the causal mechanisms behind the fluctuating patterns of rivalry and cooperation in the region. The research demonstrates that the emergence and transformation of intra-regional competition during this period can be effectively explained through a synthesis of ideational and material factors. While ideational elements, particularly those related to political Islam and regime security, played a predominant role, material considerations significantly influenced these dynamics as well. The study's findings support the argument that the rise of ideas potent enough to challenge existing political structures increases the likelihood of regional competition and conflict, while the waning of such ideas facilitates normalization among competing actors.

The Arab Spring served as a critical juncture, reshaping regional alignments and power dynamics. It destabilized traditional Arab powers, creating a vacuum that allowed the Gulf Arab states and Türkiye to assume more prominent roles in regional affairs. The initial phase of the uprisings saw a shift in the balance of power from the Iranian-led resistance axis to the Saudi-led pro-Western bloc, with Türkiye and Qatar aligning more closely with the anti-Iran camp.

The study reveals that the main point of contention between the Turkish-Qatari bloc and the Saudi-UAE bloc stemmed from their divergent approaches to Political Islam during the Arab Spring. Türkiye and Qatar's support for Islamist movements, particularly the Muslim Brotherhood, was perceived as an existential threat by Saudi Arabia, the UAE, and post-2013 coup Egypt. This ideological divide became the primary driver of regional realignments, with regime security concerns at the forefront of foreign policy decision-making for these actors. The research highlights how the concept of regime security, as articulated by scholars such as Ayoob (1983) and Jackson (2007), provides a valuable framework for understanding the motivations behind these regional dynamics. The prioritization of internal threats over external ones by authoritarian regimes in the region aligns with the theoretical

predictions of regime security theory and explains many of the observed patterns of alliance formation and conflict.

The study also demonstrates the evolving nature of these dynamics over time. The gradual decline in the influence of Political Islam, coupled with economic pressures exacerbated by the COVID-19 pandemic and shifts in global politics, led to a recalibration of regional relationships from 2021 onward. This period of softening and normalization underscores the fluid nature of Middle Eastern geopolitics and the pragmatic considerations that can override ideological differences when circumstances change.

By employing a multifaceted approach that combines the regime security framework with process tracing methodology, this research contributes to a more nuanced understanding of regional security dynamics in the Middle East. It fills a gap in the literature by highlighting the crucial role of ideational factors in shaping Türkiye-Gulf relations, an aspect that has been underemphasized in previous studies focusing primarily on material determinants. The findings of this study have significant implications for both academic discourse and policy considerations. They suggest that any comprehensive analysis of Middle Eastern geopolitics must account for the complex interplay between ideational factors, regime security concerns, and material interests. Furthermore, the research highlights the importance of considering the dynamic nature of these relationships, as seemingly entrenched rivalries can give way to pragmatic cooperation when the underlying conditions change.

Future research could build on these findings by exploring how the balance between ideational and material factors might shift in response to emerging regional and global challenges. Additionally, comparative studies examining how these dynamics play out in other regions could provide valuable insights into the broader applicability of this analytical framework. In conclusion, this study offers a comprehensive examination of how the Arab Spring reshaped alignments between Türkiye and the Gulf Arab States, demonstrating the central role of ideational factors and regime security concerns in driving regional dynamics. By illuminating these complex relationships, the research contributes to a deeper understanding of Middle Eastern geopolitics in the post-Arab Spring era and provides a foundation for future scholarly inquiry in this field.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors declare that they have equal contributions to the study.

REFERENCES

- Abdulla, A. (2012). The Arab Gulf moment. In David Held & Kristian Ulrichsen (Eds.), *The Transformation of the Gulf, Politics, Economics and the Global Order* (pp. 106-124). Routledge.
- Ahronheim, A. (2017, March 28). *Israel pilots flying alongside pilots from the UAE in week-long Greek drill*. The Jerusalem Post. <https://www.jpost.com/israel-news/israel-air-force-launches-joint-drill-exercises-with-arab-greek-forces-485391>
- Al-Raşid, A. (2021, December 7). *Al Ula Declaration has turned the page on Gulf Tensions*. Arab News. <https://www.arabnews.com/node/1982621>
- Aljazeera. (2021, December 8). *Saudi Arabia's MBS on first visit to Qatar since end of blockade*. Aljazeera. <https://www.aljazeera.com/news/2021/12/8/saudis-mbs-on-first-visit-to-qatar-since-blockade-lifting#:~:text=Saudi%20Arabia's%20Crown%20Prince%20Mohammed,Qatar%20was%20withdrawn%20in%20January>
- Aljazeera. (2022, June 22). *A new era: Saudi Arabia's MBS in Turkey as nations mend ties*. Aljazeera. <https://www.aljazeera.com/news/2022/6/22/saudi-crown-prince-mbs-visits-turkey-as-countries-normalise-ties>
- Amour, P. O. (2020). Introduction: The regional order in the Gulf Region and the Middle East. In Philipp O. Amour (Ed.), *The regional order in the Gulf Region and the Middle East: regional rivalries and security alliances* (pp. 1-25). Palgrave Macmillan.
- Anzola, A. (2019, January 2). *The beginning of the end of the counter-revolutions*. Middle East Monitor. <https://www.middleeastmonitor.com/20190102-the-beginning-of-the-end-of-the-counter-revolutions/>
- Ataman, M. (2021, January 12). *Körfez'deki normalleşme ve Türkiye*. Kriter. <https://kriterdergi.com/dis-politika/korfezdeki-normallesme-ve-turkiye>
- Ataman, M. (2022, March 1). *Türkiye'nin körfez ülkeleriyle ilişkilerinin yeniden kalibrasyonu*. Kriter. <https://kriterdergi.com/yazar/muhittinataman/turkiyenin-korfez-ulkeleriyle-iliskilerinin-yeniden-kalibrasyonu>
- Aydıntaşbaş, A. & Bianco, C. (2021, March 15). *Useful enemies: How the Turkey-UAE rivalry is remaking the Middle East*. European Council on Foreign Relations. <https://ecfr.eu/publication/useful-enemies-how-the-turkey-uae-rivalry-is-remaking-the-middle-east/>
- Ayoob, M. (1983). Security in the third world: The worm about to turn? *International Affairs*, 60(1), 41-51. <https://doi.org/10.2307/2618929>
- Ayoob, M. (1995). *The third world security predicament: State making, regional conflict, and the international system*. Lynne Rienner Publishers. <https://doi.org/10.1515/9781685853778>
- Battaloğlu, N. H. (2021, January 27). *Katar krizinin çözümü sonrası bölgesel güvenlik ve kimlikler*. Perspektif. <https://www.perspektif.online/katar-krizinin-cozumu-sonrasi-bolgesel-guvenlik-ve-kimlikler/>
- Baycar, H. (2022, June 24). *Saudi-Turkish normalization: More complicated than meets the eye*. Gulf International Forum. <https://gulfif.org/saudi-turkish-normalization-more-complicated-than-meets-the-eye/>
- BBC News. (2021, May 5). *Qatar Crisis: Saudi Arabia and allies restore diplomatic ties with emirate*. BBC News. <https://www.bbc.com/news/world-middle-east-55538792>
- Bennett, A. (2010). From analytic eclecticism to structure pluralism. *Newsletter of APSA Organized Section for Qualitative and Multi-Method Research*, 8(2), 8-17.
- Bianco, C. (2020). *Gulf monarchies and the eastern Mediterranean: Growing ambitions*. ECFR. https://ecfr.eu/special/eastern_med/gcc
- Buzan, B. (1991). *People, states and fear* (2nd edition). Lynne Rienner Publisher.
- Çakmaklı, C., Demiralp, S., Yeşiltaş, S., & Yıldırım, M. A. (2021). *An evaluation of the turkish economy during COVID-19*. Center for Applied Turkey Studies (CATS). https://www.swp-berlin.org/publications/products/arbeitspapiere/CATS__Working_Paper_Nr_1_2021_Cakmakli_Demiralp_Yesiltas_Yildirim.pdf

- Çelik, K. E. (2021). *Katar krizi'nde yumuşama evresi: Türkiye ve bölge perspektifinden bir bakış*. ANKASAM & AHKACAM. <https://www.ankasam.org/anka-analizler/katar-krizinde-yumusama-evresi-turkiye-ve-bolge-perspektifinden-bir-bakis/>
- Checkel, J. T. (2008). Process Tracing. In Klotz, A. & Prakash, D. (Eds.), *Qualitative methods in International Relations: A Pluralist Guide* (pp. 114-130). Palgrave McMillan
- Cook, S. A. & Ibish, H. (2019). *Turkey's resurgence as a regional power confronts a fractured GCC*. AGSIW. https://agsiw.org/wp-content/uploads/2019/12/Steve-Cook_Ibish_Turkey_ONLINE.pdf
- Cordesman, A. H. (2015, January 23). *Saudi Arabia's smooth succession: The King is dead, long live the king*. Center for Strategic and International Studies. <https://www.csis.org/analysis/saudi-arabias-smooth-succession-king-dead-long-live-king>
- Coşkun, O. (2022, April 29). *Erdogan visits Saudi Arabia hoping for new era in ties*. Reuters. <https://www.reuters.com/world/middle-east/turkeys-erdogan-travel-saudi-arabia-thursday-2022-04-28/>
- Daily Sabah. (2022, April 8). *Saudi Arabia visit heralds new era in bilateral ties, Erdogan says*. <https://www.dailysabah.com/politics/diplomacy/saudi-arabia-visit-heralds-new-era-in-bilateral-ties-erdogan-says>
- Delay, G. (2021, December 6). *Ortadoğu'nun 'yeni dönemi'*. Perspektif. <https://www.perspektif.online/ortadogunun-yeni-donemi/>
- Daragahi, B. & Heba, S. (2013, October 31). *Army ousts Egypt's first Islamist president*. Financial Times. <https://www.ft.com/content/2727bb22-e3ca-11e2-b35b-00144feabdc0>
- Duran, B. (2021, December 7). *Katar ziyareti ve Körfez'de yeni dengeler*. Sabah. <https://www.sabah.com.tr/yazarlar/duran/2021/12/07/katar-ziyareti-ve-korfezde-yeni-dengeler>
- Duran, B. (2022, February 18). *Körfez'de yükselen Türkiye etkisi*. Sabah. <https://www.sabah.com.tr/yazarlar/duran/2022/02/18/korfezde-yukselen-turkiye-etkisi>
- Foundation for Political, Economic and Social Research. (2021). *Expert respond: The meaning of the UAE Crown Prince's visit to Turkey*. <https://www.setav.org/en/experts-respond-the-meaning-of-the-uae-crown-princes-visit-to-turkey-what-to-expect/>
- Gardner, D. (2019, July 31). *The long march of autocracy across the Middle East*. Financial Times. <https://www.ft.com/content/70540b82-b2dd-11e9-8cb2-799a3a8cf37b>
- Gill, J. (2019, December 31). *2010-2019: The Middle East's decade of revolution*. Middle East Eye. <https://www.middleeasteye.net/news/middle-east-and-revolution-who-fell-and-who-survived-decade>
- Haaretz. (2018, March 22). *Israel and UAE Fly Together in Annual Joint Exercise in Greece*. HAARETZ. <https://www.haaretz.com/israel-news/2018-03-22/ty-article/in-photos-israel-uae-fly-together-in-annual-joint-exercise-in-greece/0000017f-dba5-df62-a9ff-dff710a50000>
- Hamzaoglu, H. & Merdan, A. S. (2024). The Arab spring and Russia's Middle East policy. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 11(3), 1095-1112. <https://doi.org/10.30798/makuiibf.1451500>
- Hinnebusch, R. (2014). The Arab uprisings and the MENA regional states system. *International Relations*, 11(42), 7-27. <https://doi.org/10.33458/uidergisi.553294>
- Hinnebusch, R. (2019). The Arab uprising and regional power struggle. In Shahram Akbarzadeh (Ed.), *Routledge Handbook of International Relations in the Middle East* (1st ed., pp. 110-124). Routledge.
- Jackson, R. (2007). Regime security. In Alan Collins (Ed.), *Contemporary Security Studies* (pp.146-164). Oxford University Press.
- Job, B. (1992). The insecurity dilemma: National, regime, and state securities in the Third World. In Brian L. Job (Ed.), *The Insecurity Dilemma: National Security of Third World States* (pp. 11-37). Lynne Rienner Publishers. <https://doi.org/10.1515/9781685858346>
- Kabalan, M. (2018). The gulf crisis: The U.S. factor. *Insight Turkey*, 20(2), 33-50.
- Kaddorah, E. Y. (2021). *The rise of the GCC states and Turkey: Convergent and divergent regional agendas*. Cambridge Scholar Publishing.

- Khalid, T. (2021, January 6). *Full transcript of AlUla GCC Summit Declaration: Bolstering Gulf unity*. Al Arabiya News. <https://english.alarabiya.net/News/gulf/2021/01/06/Full-transcript-of-AlUla-GCC-Summit-Declaration-Bolstering-Gulf-unity>
- Lynch, M. (2016, August 11). *The new Arab wars: Uprisings and anarchy in the Middle East*. Public Affairs. https://www.foreignaffairs.com/reviews/capsule-review/2016-08-11/new-arab-wars-uprisings-and-anarchy-middle-east?utm_source=google&utm_medium=cpc&utm_campaign=dsa_middle_east_tfd&gad_source=1&gclid=CjwKCAjwx8nCBhAwEiwA_z__0--xCLhkaNwiRHRXOoqzr-4lopVh8YfD-rjTTDG8NAFC2ee82h5h6RoC7YoQAvD_BwE
- Lynch, M. (2018). The new Arab order: Power and violence in today's middle east. *Foreign Affairs*, 97(5), 116-126.
- Maher, A. (2022, April 28). *Turkish President Erdogan's visit to Saudi Arabia seeks to restore strained relations*. The National Gulf. <https://www.thenationalnews.com/gulf-news/saudi-arabia/2022/04/28/turkish-president-erdogans-visit-to-saudi-arabia-seeks-to-restore-strained-relations/>
- Miller, A. (2020, March 24). *Covid-19 and the Arab World's looming Economic Crisis*. MEDC. <https://mideastdc.org/publication/covid-19-and-the-arab-worlds-looming-economic-crisis/>
- Ministry of Foreign Affairs of the Republic of Türkiye. (2021, January 4). *Körfez ihtilafının çözümüne yönelik kaydedilen gelişmeler hakkında*. Turkish Ministry of Foreign Affairs. https://www.mfa.gov.tr/no_-3_-korfez-ihtilafinin-cozumune-yonelik-kaydedilen-gelismeler-hk.tr.mfa
- Paksoy, Y. (2017, June 13). *UAE allegedly funneled \$3b to topple Erdoğan, Turkish Government*. Daily Sabah. <https://www.dailysabah.com/politics/2017/06/13/uae-allegedly-funneled-3b-to-topple-erdogan-turkish-government>
- Patrick, W. (2017, June 5). *Gulf plunged into diplomatic crisis as countries cut ties with Qatar*. The Guardian. <https://www.theguardian.com/world/2017/jun/05/saudi-arabia-and-bahrain-break-diplomatic-ties-with-qatar-over-terrorism>
- Polat, F. (2022). From brotherhood of the revolution to the struggle for power: Analysis of the Libyan Civil War in the context of the security dilemma. *British Journal of Middle Eastern Studies*, 51(1), 57-72. <https://doi.org/10.1080/13530194.2022.2094890>
- Reuters. (2022, April 28). *Erdogan says Saudi visit shows common will to start new era*. <https://www.reuters.com/world/middle-east/erdogan-says-saudi-visit-shows-common-will-start-new-era-2022-04-28/>
- Ryan, C. R. (2014). Inter-Arab relations and the regional system. In Marc Lynch (Ed.), *The Arab Uprisings explained: new contentious politics in the Middle East* (pp. 110-124). Columbia University Press.
- Ryan, C. R. (2017). *Regime security and shifting alliances in the Middle East*. POMEPS Studies 16. <https://pomeps.org/regime-security-and-shifting-alliances-in-the-middle-east>
- The Arab Weekly. (2021, November 30). *Has Abu Dhabi crown prince's visit to Ankara prompted Erdogan to operate a foreign policy reset?*. <https://theArabweekly.com/has-abu-dhabi-crown-princes-visit-ankara-prompted-erdogan-operate-foreign-policy-reset>
- The Times of Israel. (2014, October 28). *Islamists concede defeat to secular party in Tunisian elections*. The Times of Israel. <https://www.timesofisrael.com/tunisias-secular-party-poised-to-win-elections/>
- Turak, N. (2022, February 27). *Erdogan's celebrity welcome in the UAE affirms a sea-change in relations, lifeline for Turkey's economy*. CNBC. <https://www.cnbc.com/2022/02/15/erdogans-uae-visit-affirms-shift-in-relations-help-for-turkeys-economy.html>
- Üçağaç, A., Kalaycı, R. & Yetim, M. (2022). Unraveling Iraq-Iran relations during turbulent period (1958-1988): Regime security concern in foreign policy. *Eskişehir Osmangazi Üniversitesi İİBF Dergisi*, 17(2), 327-344.
- Ulrichsen, K. C., Harb, I. K., Jahshan, K. E., Macaron, J. & Whitson, S. L. (2021, January 11). *The GCC reconciliation: An assessment*. Arab Center Washington DC. <https://arabcenterdc.org/resource/18767/>
- Wehry, F. (2015). The authoritarian resurgence: Saudi Arabia's anxious autocrats. *Journal of Democracy*, 26(2), 71-85.

Yeşiltas, M. (2022, January 1). *Bölgesel normalleşmenin sınırları*. Sabah.
<https://www.sabah.com.tr/yazarlar/perspektif/murat-yesiltas/2022/01/01/bolgesel-normallesmenin-sinirlari>

Evaluation of Emotional Content Advertisements by Neuromarketing Methods

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Abstract

The purpose of this study is to examine the impact of emotional advertisements on consumers using neuromarketing and traditional research methods. In the study, two emotional advertisements containing elements of sadness and humor were shown to consumers, and their responses to these advertisements were measured. For this purpose, eye tracking, facial expression recognition, galvanic skin response, and recall tests were administered to 34 participants. Additionally, questions related to the advertisements they watched were asked. The data obtained were calculated using SPSS, Excel, and the interfaces of neuromarketing programs. The study included analyses such as frequency and percentage distributions, correlation analysis, t-tests, face coding graphs, heat maps, and consumer attention graphs. The results revealed that emotional advertisements themed around humor and sadness had positive effects on consumers, both advertisements were watched with interest, the interest dropped in certain parts of the advertisements, and the slogans of the advertisements were not sufficiently remembered by the participants.

Keywords: *Emotional Advertising, Neuromarketing, Advertising Effectiveness.*

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1. INTRODUCTION

The advertising industry is evolving due to increasing competition and easier access to consumers. Today's consumers can receive information from various channels. The global advertising market reached \$647.3 billion in 2023. This figure grows every year (Agarwal & Nath, 2023). Promotions carried out in different areas such as social media, billboards, digital channels, and outdoor advertising contribute to the sector and bring forth creative and innovative types of advertisements.

The significant growth of the advertising industry increases competition and makes it more challenging for consumers to be influenced by these promotions. Today, people are exposed to approximately 4,000 advertising messages daily (Flynn, 2023). This situation necessitates the use of various methods to reach consumers. The most effective way to influence people now is through advertisements that connect with them. Companies attempt to engage consumers through emotional appeals, enhancing advertisement appeal with elements such as empathy, love, humor, happiness, excitement, and sadness. Research shows that emotional factors can affect consumers, reduce ad skipping rates, and play a significant role in advertising strategies (Ihsan & Junaidi, 2022; Jeon et al., 2024; Naidu, 2023). According to a study by Nielsen, advertisements that create an above-average emotional impact can influence 31% of consumers and increase sales volume by 23% (B2Press, 2022.).

This study examines the impact of frequently used emotional elements, sadness, and humor, in commercials on consumer perception. It investigates how these two factors, which evoke different emotions, are perceived by consumers and how they affect purchasing behavior. Existing literature shows that the use of humor in advertisements can positively influence consumers' purchasing decisions when combined with informational and persuasive elements (Kewlani et al., 2022). Humor can capture the audience's attention, making the message easier to remember and adopt. Additionally, humor can create an emotional bond, fostering sympathy and trust towards the brand. Studies have shown that when humor in advertisements is effectively combined with information and persuasion, it can positively influence consumers' purchasing decisions (Kewlani et al., 2022). On the other hand, sad advertisements are seen to be more effective in establishing an emotional connection with consumers and facilitating their identification with the brand. A sad story or memory can evoke emotions in the viewer, eliciting feelings of empathy and compassion. These emotions can lead to feelings of sympathy and loyalty towards the brand, influencing purchasing decisions (Becan, 2021; He & Li, 2016).

Emotions used in the advertising industry are at the heart of the relationship between consumers and brands, influencing both conscious and unconscious decisions, making it a vital component of successful advertising (Anuar & Isa, 2022). In this study, neuromarketing devices measuring consumers' physiological responses were used to calculate viewers' emotional changes, attention, and focus levels. After showing the viewers a commercial, a test was conducted to determine the recall rates of the advertisements, followed by a related survey. Thus, the study aimed to understand both the physiological

and cognitive responses of consumers. By using both new and traditional research methods, the effects of sad and humorous elements in advertisements on consumers were explored.

2. LITERATURE REVIEW

2.1. Emotions in Advertisements

In advertisement texts, emotions play a critical role in establishing an emotional connection between consumers and brands, making products memorable and influencing purchasing decisions (Panthen & Germelmann, 2023). Emotional advertising strategies evoke consumers' emotional responses, leaving a lasting impression of the brand in their minds. Scientific research has shown that emotional advertisements increase the likelihood of consumers remembering the ads and influence their purchasing decisions. In this context, the use of emotional advertisements enables consumers to form deep connections with brands and determine their purchasing preferences (B2Press, 2022).

Emotions serve a fundamental role in shaping consumer-brand relationships, influencing both conscious and unconscious decision-making. Effective advertising heavily relies on emotional responses, as emotions are significant factors that influence behavior and decision-making processes (Gumber, 2022). In modern societies, as consumers' tendency to make emotion-based decisions increases, emotional advertising has begun to play an increasingly decisive role in capturing consumer interest (Qutp et al., 2022).

Emotional processing often precedes logical reasoning (Soti, 2022). Consumers often assume that their purchasing decisions are driven by rational analysis of available alternatives. However, emotional reactions occur 3,000 times faster than rational thinking when making purchasing decisions (Kylila & Elgeka, 2024).

Companies use different emotional appeals such as love, humor, happiness, excitement, fear, and sadness in advertisements to influence customers' purchasing decisions (Kamran & Siddiqui, 2019). Such emotional appeals not only exert a stronger impact on the target audience but also enhance the shareability of the advertisement content. While most people may not want to share a video or blog post intended for informational purposes, they are more likely to share something they find funny or uplifting with other consumers. These online shares facilitate increasing brand awareness (Gartlan, 2023).

There are numerous studies on the impact of emotions on the advertising industry and its connection to the purchasing process. In their study, Mishra and Patil (2023) found that consumers in the 21st century tend to make decisions emotionally, moving away from the message-based marketing of the 20th century. This shift has increased the success of advertisements based on human emotions today. Bou Saada et al. (2023) revealed that positive attitudes towards emotional marketing lead to positive actions towards the brand. Hashem et al. (2020) found that emotional marketing plays a significant role in influencing brand loyalty among female consumers in the cosmetics industry. Anwer et al. (2021) showed that positive emotions such as love, laughter, and happiness positively affect

customers' purchase intentions and that there is a significant relationship between emotional advertising and consumer buying behavior. Derinözlü (2019) discovered a positive relationship between emotional advertising appeals and brand preference in his study on luxury products.

The use of emotions in the advertising sector includes positive stimuli such as love, loyalty, humor, and happiness, as well as negative stimuli such as sadness, fear, and hatred (Ateş, 2016). Among these, humor and sadness are particularly opposites. In advertising, the integration of sadness and comedy elements is considered a critical methodology to deeply resonate with consumer sentiments and enhance communication effectiveness. In cultures where emotional dynamics are dominant, sadness has the potential to touch individuals' inner worlds, while comedy adds an attractive and attention-grabbing dimension to advertising content. Scientific studies have shown that these two emotional elements are frequently used methods in advertising strategies to communicate with the target audience and present persuasive messages (Becan, 2021).

2.2. The Sadness Factor Used in Advertising

The use of sadness in advertisements is a strategic method designed to trigger consumers' emotional responses. Existing literature indicates that sad content in advertisements can have a significant impact on consumer behavior (Kemp et al., 2013). It is believed that individuals are more inclined to consume hedonic products when they are sad compared to when they feel fear or anxiety. Additionally, although sadness is generally perceived as a negative emotion, it has been observed to contribute positively to brand attitudes in the context of narrative advertising (Yang, 2022). The strategic integration of sad elements into advertisements suggests that it can help establish stronger emotional connections between consumers and the brand, shaping consumers' brand perceptions positively (Septianto, 2021). Emotional advertisements that evoke sadness often create a powerful message by fostering empathy and a sense of connection, leading to deeper emotional appeal and motivating people to take action (O'Hara et al., 2023).

Brands have recognized the effectiveness of using emotional content to raise social awareness on issues such as violence, gender equality, poverty reduction, migration, and other social topics (Weber, 2024). Although sadness may initially seem less appealing from an advertising standpoint, it can serve as a powerful strategic tool for advertisers to connect with their target audiences on a deeper level (Kemp, et al. 2013).

There are numerous studies on the impact of sadness in the advertising sector. For instance, in the study titled "The Emotional Effectiveness of Advertising," published in *Frontiers in Psychology* by Otamendi and Sutil (2020), cognitive-emotional neuroscience was utilized to measure the effectiveness of advertisements by analyzing individuals' unconscious emotional responses. The study employed a computer program called AFFDEX. The results showed that different age and gender groups developed distinct emotions and reactions in response to the advertisements. In another study by Kang et al. (2022),

the effects of using sad-faced individuals in social welfare advertisements were compared to those of neutral and happy-faced individuals, exploring how these expressions influenced consumers. The data indicated that an image of a sad face not only evoked sympathy but also led to inferences about the company's intention to emotionally influence people.

The study found that sympathy increased charitable donations. In a study by O'Hara et al. (2023) on smoking cessation, it was shown that campaigns with sad messages prompted people to consider quitting smoking, but this did not directly translate into quit attempts.

In his study on the element of sadness in advertisements during the Covid-19 period, Becan (2021) emphasized that social media users exhibited a positive attitude towards the sadness-laden advertisements presented by the relevant brands in the context of the pandemic. Pirus and Zulqahar (2018), through in-depth interviews using qualitative methods, found that sad advertisements were perceived as more appealing by consumers. They also found that advertisers strategically aimed to evoke emotions such as sadness and melancholy to emotionally connect with consumers.

2.3. The Humor Factor Used in Advertising

Humor finds a wide range of applications in advertising. It is frequently used in marketing strategies to attract consumer attention, enhance brand recall, and increase awareness by making the advertisement content shareable on social networks. Scientific studies have shown that humorous content significantly enhances the effectiveness of advertisements, especially when it is consistent with the product (Güz & Atkan, 2021). Humor also creates a positive impact on the target audience, supporting the engagement of the advertisement (Dökeroğlu & Gökçearsan, 2020). However, the misuse or inappropriate use of humor can damage the brand's image and provoke negative reactions from consumers. Therefore, the incorporation of humor in advertising texts should be approached meticulously and strategically (Aksoy, 2015). Companies generally use humor in advertisements for the following reasons:

Creating an Emotional Bond: Humor presented through advertisements has the potential to establish a deep emotional connection between consumers and brands. The positive impact of a humorous ad on viewers allows the ad to occupy a more lasting and meaningful place in their memories, which can contribute to increased sales in the long term.

Attention-Grabbing Ability: The element of humor makes advertisements attention-grabbing, helping products or services to be more easily noticed by consumers. Humor enhances the overall appeal of the ad, attracting consumer interest and making the brand's message stand out (Akbar & El-Gohary, 2021).

Viral Potential: Humorous ads are more likely to be shared on social media platforms. This increases the reach and impact of the ads without requiring additional advertising investment (Bishop, 2014).

Reflecting Brand Personality: Humor reflects the brand's personality, allowing the company to present a more human and approachable image.

Overcoming Sales Resistance: Effectively used humor can reduce consumers' natural resistance during the purchasing process, making the conveyed message clearer (Chelsea et al., 2020).

There are numerous studies on the use of humor in the advertising sector. Solak's (2017) research showed that companies in the banking sector attempt to address potentially intimidating concepts such as high-interest rates, indebtedness, loans, and mortgages through humor. Dökeroğlu and Gökçearslan (2020) noted that using humor in sectors like finance, insurance, and health could harm the brand if the message is misunderstood. They also mentioned that the strong impact of humor could sometimes overshadow the main message the company intends to convey. Tekeli (2017) found that consumers enjoy watching humorous advertisements and remember them better.

Hoang (2013), in his thesis, found that humor in advertisements not only grabs attention and aids recall but also contributes to the likability of both the advertisement and the advertised brand. Kasilingam and Ajitha (2022) demonstrated that the most crucial determinant of attitude towards humorous storytelling advertisements is the emotional response, and these advertisements contribute more to brand attitude formation compared to dramatic storytelling advertisements. Eisend (2009) revealed that using humor in advertising significantly increases attention, positive affect, recall of the advertisement and the brand, and purchase intention.

Kewlani et al. (2022) pointed out that despite the widespread use of humor in advertising, it is not sufficient on its own to influence consumer purchasing decisions. However, when combined with informative and persuasive elements, it can achieve success. Agwu (2022) highlighted the importance of cultural factors in using comedy in advertisements, emphasizing that understanding the varying cultural nuances in different societies is critical for effective advertising strategies. McLeod et al. (2022) found that when humor aligns with the brand's personality, it positively affects brand recall, purchase intention, and attitudes towards the brand. However, mismatches between the type of humor and the brand's personality can lead to confusion and disappointment among the target audience, reducing the advertisement's effectiveness.

Overall, studies indicate that humor is a frequently employed factor by companies in advertisements, enhancing the ad's effectiveness, recall, and purchase intention. It is also essential that humor aligns with the brand and is shaped according to cultural codes, which are crucial strategic considerations.

2.4. Evaluation of Emotional Advertisements Using Neuromarketing Method

Neuromarketing is a discipline that examines brain activities and physiological responses to measure the emotional impact of advertisements. Research in this field provides objective data that can help marketers optimize their ads and evoke the desired emotional responses. This allows

neuromarketing to offer significant advantages over traditional advertising evaluation methods (Anuar & Isa, 2022). Consumers' emotions influence their decision-making processes and behaviors (Pluta-Olearnik, & Szulga, 2022). Neuromarketing explores the emotional dimension of consumer decision-making processes using neuroscience tools, highlighting the importance of emotions and the subconscious mind in purchasing decisions (Birknerová et al., 2022). Various neuromarketing techniques are used to evaluate emotional advertisements.

Among these, the most common ones are:

Electroencephalography (EEG): Measures the brain's electrical activity to evaluate emotional valence (positive or negative) and arousal levels (Muhammad et al., 2023).

Functional Magnetic Resonance Imaging (fMRI): Provides detailed brain activity images showing which areas of the brain are activated by specific advertising elements (Josephs et al., 1997).

Eye Tracking: Monitors which parts of the advertisement viewers pay attention to and for how long. Eye tracking is a state-of-the-art process that follows users' eye movements (Ke et al., 2024)

Facial Expression Analysis: Analyzes viewers' emotional responses based on their facial expressions (Li et al., 2025).

Galvanic Skin Response (GSR): Measures changes in skin conductivity reflecting emotional arousal (Satapathy et al., 2024).

2.5. The Purpose and Significance of the Study

Emotions have a significant impact on human behavior. Studies show that up to 92% of purchasing decisions are based on emotions rather than logic (Xavier, 2023). The primary aim of this study is to evaluate emotionally charged advertisements, expected to influence human behavior, using neuromarketing methods. The study specifically examines two different emotional advertisements: humor and sadness. By doing so, it seeks to explain comparatively how these two contrasting themes emotionally affect consumers. While previous literature has addressed the factors of sadness and humor separately, there has not been a study that compares them and measures their impact using neuromarketing tools. In this respect, the study holds a unique place in the literature.

In 2023, global advertising revenue for media owners is estimated to be around 926 billion dollars (Statista, 2024). The advertising sector is growing each year, making it essential to investigate the extent to which the frequently used emotional factor in advertisements influences consumers. Conducting this research with various measurement methods and techniques will increase its reliability. Therefore, this study combines traditional research methods with neuromarketing techniques.

3. METHOD OF THE RESEARCH

In the study, a combination of a traditional research technique, a questionnaire, Facial Coding, Eye Tracking, and Galvanic Skin Response (GSR) was used. The questionnaire developed for the study consists of three sections. In the first section, participants were asked recall questions related to the advertisement. These questions were adapted from the study by Yıldız and Uztuğ (2017). Additionally, participants were asked which of the two advertisements they watched they liked more in this section. In the second section of the questionnaire, participants were asked questions about their attitudes towards the advertisement and their purchase intentions. The questions in this section were adapted from the studies of Başaran and Yıldız (2022) and Edwards (1995) and were structured using a 5-point Likert scale. In the final section of the questionnaire, there are questions related to the demographic characteristics of the participants. The data obtained from the questionnaire and neuromarketing devices were analyzed using the SPSS 15.0 program, and frequency and percentage distributions, Cronbach's Alpha, Correlation, and Variance analyses were conducted. In the present study, participants' reactions to specific parts of the advertisement (e.g., emotional scenes) were directly measured, and the advertisements were pre-categorized as emotional. Therefore, requesting participants to confirm this classification was deemed unnecessary and considered a redundant procedure. Consequently, manipulation check questions were not included in the questionnaire.

In the study, parametric tests were used to increase the statistical power of the analysis of the questionnaire data. To use these tests, certain prerequisites need to be met, such as having a sample size of over 30, data showing a normal distribution, subjects being independent of each other, and being randomly selected (Can, 2014). Additionally, for the data to show a normal distribution, the Skewness and Kurtosis values of the items on the scale must be within the range of +1.5 to -1.5 (Tabachnick & Fidell, 2013). Since all the necessary prerequisites were met in the study, parametric tests were used.

The primary neuromarketing technique addressed in the study is the Eye Tracking Method. This technique involves the process of tracking eye movements to analyze individuals' visual attention distributions (Ke et al., 2024). In the research, an Eye Tracking application developed by RealEye, which measures via webcam, was used. The RealEye platform provides a test mechanism that can measure eye movements at a speed of 60 Hz per second (RealEye, 2024). This means that the eye-tracking device can detect 60 different positions every second (Farnsworth, 2023). Additionally, the ability to conduct eye-tracking tests over the web, without the need for participants to use an additional device, allows the participants to be in a more comfortable environment during the experiment.

Validity in eye-tracking systems is determined by the extent to which the measurement tool accurately detects gaze points and produces meaningful results. In this context, the RealEye eye-tracking system is considered a valid measurement tool for remote and web-based research.

Internal validation studies conducted on the accuracy of the RealEye system report an average accuracy range of 115-125 pixels. Depending on data quality, the average accuracy for data classified as “good” has been measured at 123 pixels. Furthermore, the highest recorded accuracy level has been determined as 61 pixels. In terms of accuracy distribution across the screen, the best results have been observed in the central-bottom region, whereas the lowest accuracy has been recorded in the bottom-right corner.

Regarding precision, the system’s average precision ranges between 74-77 pixels, with the highest precision recorded at 29 pixels. Particularly in metrics such as attention distribution and gaze duration, RealEye has demonstrated consistent and reliable results depending on data quality. When calibration procedures are carefully applied and appropriate environmental conditions are maintained, the system's accuracy level is reported to fall within acceptable limits (RealEye, 2024). In the study, out of the 34 measurements obtained from participants, 19 were classified as "good" and 15 as "very good" in terms of data quality. These findings indicate that the RealEye eye-tracking data used in the study provide reliable and valid measurements.

This study utilized the facial expression recognition method developed by RealEye, an AI-supported system based on the Facial Action Coding System (FACS). FACS codes facial muscle movements into action units (AUs) and was developed by Hjortsjö (1969) later expanded by Ekman and Friesen (1978), for emotion recognition. The RealEye platform applies FACS to analyze participants’ surprised, happy, and neutral expressions in real time (RealEye, 2024). By tracking facial muscle movements, the system classifies emotions based on responses to stimuli. Compared to traditional self-report methods, this approach enhances the study’s reliability by providing a more objective emotion analysis (Lewinski et al., 2017). In the study, face coding is utilized to analyze participants' facial expressions while watching advertisements, and the extracted data is visualized in a graphical format at the end of the advertisement. The RealEye system is capable of generating these graphs on an individual basis as well as aggregating them as average values obtained from all participants. Additionally, it measures participants' responses to the advertisement on a second-by-second basis, providing a detailed analysis of their emotional reactions throughout the viewing experience.

The third neuromarketing method used in the study is Galvanic Skin Response (GSR). This technique measures the electrical conductivity of the skin, which varies according to moisture levels (Farnsworth, 2023). In neuromarketing, it is used to measure consumers' emotional engagement and arousal levels in response to marketing stimuli (Mancini, 2025). During the experiment, a Grove GSR galvanic skin response detector connected to an Arduino UNO board, managed through the Arduino Integrated Development Environment (IDE) on a laptop, was used. During the measurement process, continuous data was recorded for each participant throughout the advertisement duration and subsequently transferred to Excel. The data were standardized using mean-based normalization to ensure comparability among individuals. The normalization process was conducted through the following

steps: The raw data was measured within the range of 0-600. Then, the maximum and minimum values for each participant were identified, and the data were transformed into z-scores. After normalization, the data became suitable for comparisons between individuals (Yiğit, 2020). The data obtained were analyzed using SPSS 15 software.

The population of the study consists of consumers. In eye-tracking studies and neuromarketing methods such as EEG, 34 participants are sufficient to measure the effectiveness of a commercial with 90% accuracy (Koşar & Tor Kadioğlu, 2020; Şenduran, 2019). Therefore, 34 participants were included in the study. The participants were selected using a simple random sampling method.

While collecting data, participants were included in the study in a quiet room, as free from emotional stimuli as possible, with a standard seating distance of 65 cm from the screen. Additionally, participants were informed about the devices, reassured that the devices posed no health risks, and that the data obtained would be used solely for scientific purposes. They were also given assurances regarding ethical permissions.

In the study, participants were shown two advertisements. The selection of the advertisements was based on the message framing theory. This theory assumes that consumers will react differently to the same topic depending on the framing, aiming to measure behaviors through contrasts such as gain-loss, concrete-abstract, and emotional-rational (Florence et al., 2022). In the research, participants were shown Vodafone's "Mother's Day" advertisement, which contains elements of emotion and sadness, and Profilo's "I Miss My Mom" advertisement, which is entertaining and humorous. Thus, the same topic was evaluated using two advertisements with different emotional characteristics.

In this study, we employed a dual-method validation strategy to determine whether the advertisements effectively conveyed elements of sadness and humor. Initially, a panel of five marketing and advertising academics, recognized experts in their respective fields, assessed the content to ensure it accurately reflected the intended emotional tones. This approach aligns with Lawshe's (1975) content validity framework, which underscores the significance of expert judgment in evaluating the essentiality of content within a specific context. Subsequently, a pre-test was conducted with five participants from the target audience to observe their emotional responses to the advertisements, thereby providing empirical evidence of the advertisements' efficacy in eliciting the desired emotions. The integration of expert evaluation and audience pre-testing fortifies the robustness of our content validation process.

In selecting the advertisements, care was taken to ensure that their durations were relatively similar, with the Profilo advertisement lasting 83 seconds and the Vodafone advertisement 60 seconds. To enhance participant impartiality and ensure each advertisement was viewed objectively, the randomization feature within the Realeye system was activated, resulting in half of the participants viewing the Profilo advertisement first and the other half viewing the Vodafone advertisement first. Additionally, a 10-second black screen was inserted between the two advertisements to balance visual

adaptation and cognitive load. Following the advertisement viewings, participants were administered a series of survey questions.

4. FINDINGS

Of the participants in the study, 58.8% are male, 55.9% are in the 21-30 age range, and 61.8% are university graduates. The proportion of married participants is 23.5%, while the proportion of single participants is 76.5%.

Table 1. Demographic Characteristics of Participants

Variables	N	Percentage (%)	Variables	N	Percentage (%)
Gender			Marital Status		
Male	20	58.8	Married	8	23.5
Female	14	41.2	Single	26	76.5
Total	34	100	Total	34	100
Age Group			Graduate		
10-20	4	11.8	Primary school	1	2.9
21-30	19	55.9	High school	2	5.9
31-40	7	20.6	Associate degree	2	5.9
41-50	4	11.8	Undergraduate	21	61.8
Total	34	100	Postgraduate	8	23.5

4.1. Reliability Analysis

Cronbach's Alpha analysis was conducted to determine the internal consistency and reliability of the questionnaire. Cronbach's Alpha is used to assess the homogeneity of the questionnaire (Yıldız & Uzunsakal, 2018). As a result of the research, the Cronbach's Alpha value of the study was calculated to be 0.909. According to this result, the questionnaire is highly reliable.

4.2. Recall Questions Directed to Participants

Participants were asked four recall questions related to the study. These questions were posed immediately after watching the advertisements. According to Table 2, while most participants remembered which company each advertisement belonged to, they had difficulty recalling the slogans of the advertisements. The company of the second advertisement by Profilo and the slogan of the Vodafone advertisement were remembered slightly more. In the present study, although emotional engagement was found to be strong and brand recall rates were relatively high, slogan recall rates remained notably low.

This finding partially aligns with previous research (Toker & Sulak, 2020), which demonstrated that emotional appeals in advertisements significantly enhance consumers' general memory of brands and advertising content.

However, emotional engagement does not always guarantee the detailed encoding of specific verbal elements such as slogans.

Table 2. Participants' Recall Rates for Advertisements

Statements	Correct (%)	Incorrect/ Do not remember (%)
Which company was the first advertisement from?	79.4	20.6
Which company was the second advertisement from?	82.4	17.6
What was the slogan of the first advertisement?	14.7	85.3
What was the slogan of the second advertisement?	11.8	88.2

4.3. Participants' Attitudes Towards Emotional Advertisements

Participants were asked to rate the advertisements they watched on a scale of 1 to 5, with 1 being the least liked and 5 being the most liked. According to the results, participants gave an average score of 3.82 to the first advertisement, Vodafone's emotional advertisement, and a score of 4.29 to the second advertisement, Profilo's humorous advertisement.

Table 3 shows the participants' attitudes towards the first advertisement, Vodafone's advertisement. According to the table, the statement that participants agreed with the most was "I liked the first advertisement I watched," while the statement they agreed with the least was "I will gather more information about the product/service I saw in the first advertisement."

Table 3. Participants' Attitudes Towards the First Advertisement (Vodafone/Profilo Advertisement)

Statements	N	Vodafone (X)	Vodafone (Standard Deviation)	Profilo (X)	Profilo (Standard Deviation)
Purchase Intent					
I would like to use the product/service I saw in the first advertisement	34	3.15	1.105	3.26	1.263
I will gather more information about the product/service I saw in the first advertisement	34	2.74	1.024	2.91	1.240
I have developed a willingness to purchase the product/service I saw in the first advertisement	34	2.74	1.024	3.03	1.337
Attitude Towards the Advertisement					
I liked the first advertisement I watched	34	2.97	1.114	4.06	1.043
The first advertisement I watched appealed to me	34	3.79	1.067	4.03	1.000
The first advertisement I watched seemed interesting to me	34	3.76	1.075	3.97	.937

4.4. Participants' Attention Averages and Fixation Values for Advertisements

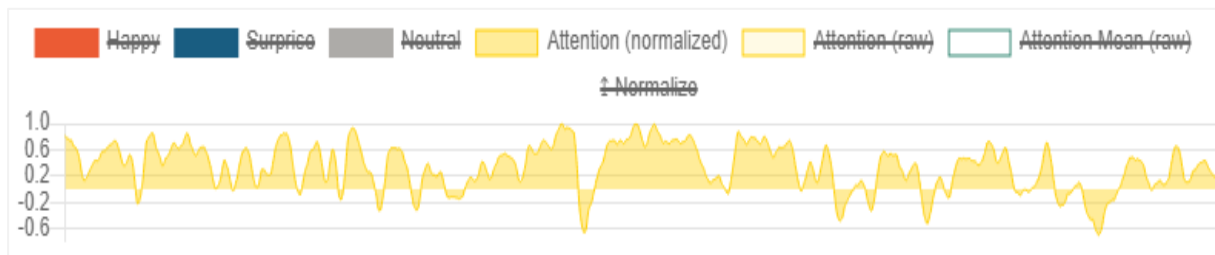
The advertisements shown to the participants in the study had the same theme but differed in content and messages. Table 4 presents the attention and fixation values obtained from the participants.

The average initial fixation time indicates how quickly participants began to focus on the advertisement they watched (Lewandowska, 2023). Participants' initial fixation time for the Vodafone advertisement was 0.76 seconds, while for the Profilo advertisement, it was 0.8 seconds on average. The average time spent represents the average duration participants spent looking at the advertisement (Lewandowska, 2023). Time spent watching the advertisement explains the interest in the ad. The average time spent on the Vodafone advertisement was 52.56 seconds. Considering the advertisement duration was 60 seconds, approximately 87% of the advertisement was actively watched. The total duration of the Profilo advertisement was 87 seconds, with participants spending 72.3 seconds watching it. This means 82% of the advertisement duration was watched with interest. Another important value in eye-tracking studies is the average attention. This value indicates how attentively the advertisement was watched. According to Table 4, the attention value for both advertisements was the same (0.36). The average revisit shows how many times participants returned to look at an area on average. Participants may look repeatedly at an area due to high interest, confusion, or dislike. Therefore, this value can result from positive or negative reasons (Farnsworth, 2023). The average revisit in the Vodafone advertisement was 4.09, whereas in the Profilo advertisement, this value was 10.24.

Table 4. Consumers' Attention and Fixation Values Obtained by Eye Tracking Method

Metrics	Vodafone Advertisement	Profilo Advertisement
Average Initial Fixation Time (seconds)	0.76	0.80
Average Time Spent (seconds)	52.56	72.3
Advertisement Duration (seconds)	60	87
Percentage of Advertisement Actively Watched	87%	82%
Average Attention Value	0.36	0.36
Average Revisit	4.09	10.24

In Figure 1, the attention graph of the first advertisement, the Vodafone advertisement, is shown. Throughout the advertisement, the viewers' attention values generally did not fall below zero. Viewers watched the advertisement more attentively at the beginning and in the middle of the time frame. In the final scene of the advertisement, the "Packshot" section, which contains the main message of the advertisement and usually includes the slogan, viewer interest decreased. This situation is unfavorable for the advertisement.

Figure 1. Consumer Attention Graph (Vodafone ad)

In Figure 2, the attention graph of the Profilo advertisement is shown. According to the figure, participants paid less attention to the advertisement at the very beginning and the end, with attention values dropping below zero during these phases. However, overall attention given to the advertisement remained above zero. Similar to the Vodafone advertisement, the decrease in interest during the "Packshot" section is unfavorable for the advertisement.

Figure 2. Consumer Attention Graph (Profilo ad)

As illustrated in Figures 1 and 2, although participants maintained high levels of visual attention throughout most parts of the advertisements, a significant decline was observed during the final "packshot" sections. According to Florence et al. (2022), the way messages are framed—whether emphasizing gains, losses, or emotional appeals—can significantly influence the depth of cognitive processing and attention allocation. Therefore, the observed decline in attention during the final branding moments suggests that without a strategically framed message that maintains cognitive engagement, critical elements such as slogans may fail to be effectively encoded into memory.

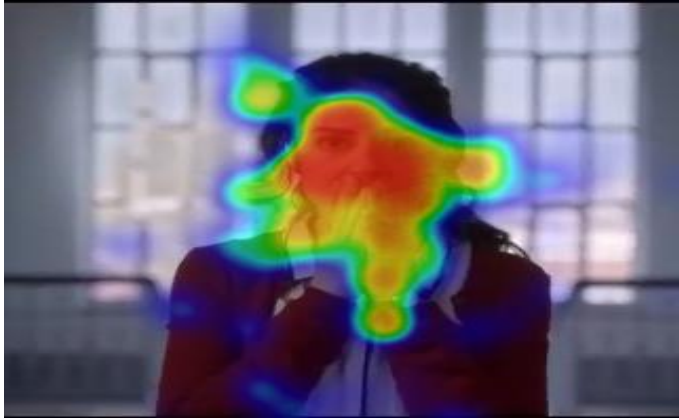
4.5. Heatmaps for Ads

Heat maps are a digital visualization tool that uses color to represent the areas of an advertisement that receive the most and least attention from users, based on temperature degrees. Typically, red and orange tones indicate areas of highest interaction, while blue and green tones represent areas of lesser interest. The sections of the advertisement with the most intense interaction are referred to as "hot spots" (Gasco, 2020; Wedel & Pieters, 2008).

Figure 3 shows the heat map of the most attentively watched scene in the Vodafone advertisement. The most attention-grabbing scene of the Vodafone advertisement occurs at the 31.5-second mark. The average attention value at this point is 1.00. This most attentively watched scene also

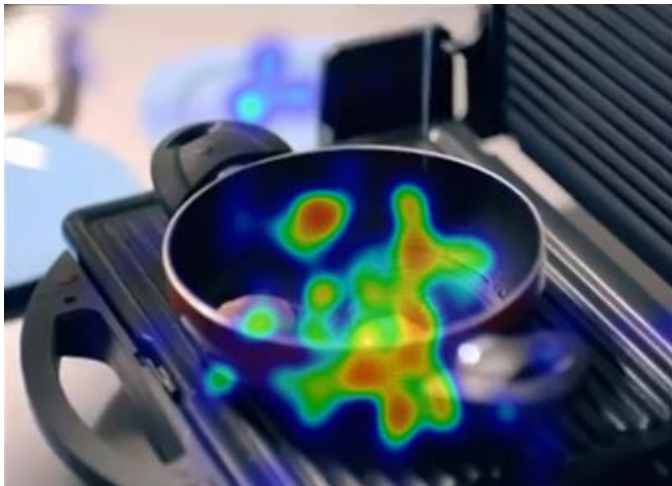
contains one of the most emotional moments of the advertisement. Viewers particularly focused on the face of the female actor in this scene.

Figure 3. Heat Map of The Scene with The Highest Attention Value in The Vodafone Advertisement



In Figure 4, the most attentively watched scene of the Profilo advertisement is shown. At the 38-second mark, the scene where the sausage is being cooked in a toaster has an average attention value of 0.71, making it the most attentively watched scene in the advertisement. Participants found this scene particularly interesting.

Figure 4. Heat Map of The Scene with The Highest Attention Value in The Profilo Advertisement



4.6. Facial Expression Analysis of Participants

Facial expression analysis is a technology aimed at measuring human emotions through facial expressions. This process is carried out by computer algorithms that record and analyze facial expressions via a webcam. The algorithms analyze the movements of the eyebrows, eyes, mouth, and cheek muscles to identify basic emotions such as happiness, sadness, anger, fear, and surprise (<https://en.wikipedia.org>).

Figure 5 shows the happiness and surprise graphs derived from the Facial Expression Analysis of participants watching the emotionally-themed Vodafone advertisement. The red line represents

participants' happiness expressions, while the blue line indicates their surprise expressions. According to the figure, participants exhibited slight happiness expressions, especially towards the end of the advertisement. Since this value is between 0 and 0.1, it is quite limited. The surprise expression is very close to a value of 0. The positive message delivered towards the end of the advertisement caused participants to display expressions of happiness.

Figure 5. Vodafone Advertisement Face Coding Chart

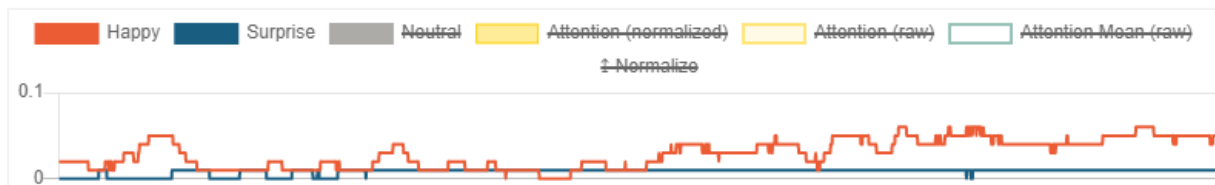
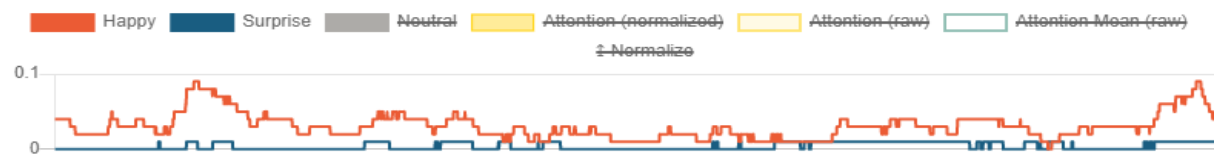


Figure 6 shows the graph of Facial Expression Analysis of participants in response to the humor-themed Profilo advertisement. According to the figure, participants displayed happiness expressions primarily at the beginning and the end of the advertisement, with this value nearing 0.1. The surprise expression remained quite limited throughout the advertisement. It is to be expected that the humor-themed advertisement elicited slightly more happiness expressions from participants compared to the other advertisement. This outcome aligns with the purpose of the advertisement.

Figure 6. Profilo Advertisement Face Coding Chart



4.7. Galvanic Skin Response (GSR) Values and Comparative Analyses Related to Advertisements

The Galvanic Skin Response (GSR) is a method that measures the electrical conductivity of the skin in response to certain stimuli. Especially when people experience something emotional, sweat glands are involuntarily triggered, making the skin more conductive to electricity. GSR measures small changes in the electrical conductivity of our skin in response to stimuli (Albert & Tullis, 2023).

The table below shows the average Galvanic Skin Response values obtained from the participants. According to the results, the average skin conductivity for the sad-themed Vodafone commercial is 0.39, while for the humor-themed Profilo commercial, this value is 0.42 (Table 5). Therefore, the arousal levels of the participants are higher for the Profilo commercial. GSR measurements are used to determine the intensity of emotions, which, although not indicating the direction of the emotions, shows how intensely they are felt. Increases in GSR are directly linked to emotional experiences, highlighting the physiological significance of various emotional responses

(Kreibig, 2010). According to the results obtained from the study, the Profilo commercial caused more emotional experience in the participants.

Table 5. Participants' Mean Galvanic Skin Response Obtained from Advertisements

Advertisement	Average GSR Value
Vodafone (emotional)	0.39
Profilo (humorous)	0.42

Since the GSR technique measures emotional changes, it is believed that the data obtained from it is related to long-term memory. This means that consumers can remember the messages they are exposed to for a long time (Dinç, 2018). Therefore, the recall rates were compared with the GSR values of the participants. According to the correlation analyses shown in Table 6, no relationship was found between the GSR values and recall rates for either advertisement.

Table 6. The Relationship Between Data Conductivity Values (GSR) and Ad Recall Rates

GSR Value		Advertisement Name Recall	Advertisement Slogan Recall
Vodafone	Pearson Correlation	-.006	.002
	Correlation	.975	.992
	N	34	34
Profilo	Pearson Correlation	-.133	-.111
	Correlation	.452	.531
	N	34	34

Table 7 shows the comparison between the participants' liking scores for the advertisements and the emotional changes obtained from the GSR analysis. This analysis investigates whether there is a significant relationship between the liking rates of the advertisements and the emotional changes of the participants. According to the data obtained, there is a positive, linear, and weak relationship between the liking scores and the GSR values of the participants who said they liked the first advertisement. Therefore, as the liking of the sad-themed Vodafone commercial increases, the GSR value, which indicates emotional change, also increases. In other words, those who liked the Vodafone commercial had significantly higher Galvanic Skin Response. However, this relationship was not observed for the second advertisement, the humor-themed Profilo commercial.

Table 7. Relationship Between Data Conductivity Values (GSR) and Advertisement Liking

GSR Value		Advertisement Liking Score
Vodafone	Pearson Correlation	.356*
	Correlation	.039
	N	34
Profilo	Pearson Correlation	.185
	Correlation	.295
	N	34

*Correlation is significant at the 0.05 level (2-tailed).

Table 8 presents the t-Test comparing the GSR values of participants with their gender. There is no statistically significant difference between the GSR values of participants and their gender.

Table 8. t-Test Comparing Skin Conductivity Values (GSR) with Gender

GSR Value	Gender	N	Mean	Standard Deviation	Significance
Vodafone	Female	14	.4064	.13981	.767
	Male	20	.3930	.12092	.733
Profilo	Female	14	.4171	.13680	.843
	Male	20	.4265	.13307	.844

Table 9 presents the relationship between participants' marital status and the GSR values obtained from the study. According to the t-test results, there is no significant relationship between participants' marital status and GSR values.

Table 9. t-Test Comparing Skin Conductivity Values (GSR) with Marital Status

GSR Value	Gender	N	Mean	Standard Deviation	Significance
Vodafone	Married	8	.4288	.12308	
	Single	26	.3892	.12909	.450
Profilo	Married	8	.4013	.07864	
	Single	26	.4292	.14593	.609

Table 10 presents the GSR values obtained while participants were watching advertisements in relation to their ages. According to the t-test results, there is no significant relationship between participants' ages and GSR scores.

Table 10. t-Test Comparing Skin Conductivity Values (GSR) with Age

GSR Value	Gender	N	Mean	Standard Deviation	Significance
Vodafone	10-20	4	.4050	.06245	
	21-30	19	.3774	.14757	
	31-40	7	.4329	.12803	
	41-50	4	.4325	.05737	.739
Profilo	10-20	4	.4300	.12403	
	21-30	19	.4316	.03072	
	31-40	7	.4100	.03000	
	41-50	4	.3950	.04941	.958

5. CONCLUSION

Recent studies have shown that the emotional factor is significant in consumers' purchasing processes. Therefore, companies have started to use emotional elements more frequently in their advertisements (Mishra & Patil, 2023). The increase in the use of emotions as an advertising strategy makes it necessary to research this topic. This study compares two different types of emotional

advertisements, namely sadness and humor. According to the results obtained, while participants remembered which companies the advertisements belonged to, they largely could not recall the slogans within the advertisements. One possible explanation for this finding can be drawn from theoretical frameworks on memory and attention. According to Craik and Lockhart's (1972) Levels of Processing Theory, emotional engagement does not necessarily guarantee deep semantic encoding of verbal elements such as slogans. Emotional stimuli tend to capture attentional resources at a surface level, often at the expense of detailed cognitive processing required for long-term memory retention. In this study, the significant drop in attention levels observed during the "packshot" section—where slogans were presented—supports this interpretation. As also suggested by Nummenmaa et al. (2014), high emotional arousal can modulate attentional allocation, potentially diverting cognitive resources away from detailed verbal information processing. Therefore, while emotional narratives enhance affective engagement, the successful encoding of core messages like slogans requires a strategic integration that maintains cognitive focus at critical moments.

For both studies, the statement that participants agreed with the most was "I liked the first advertisement I watched." The statement they agreed with the least was "I will gather more information about the product/service I saw in the first advertisement." This indicates that while consumers liked the advertisements, it does not necessarily mean they will specifically research the products later.

According to eye-tracking data, the attention values of both advertisements were the same. Additionally, 87% of the Vodafone advertisement and 82% of the Profilo advertisement were actively watched. The eye-tracking values for other metrics were also very close to each other. Based on the results obtained, both advertisements were followed with almost the same level of interest. From this perspective, advertisements containing elements of sadness and humor did not have a superiority over each other.

When looking at the attention graph throughout the advertisement, participants watched the Vodafone commercial without dropping into negative (-) values for a long time, but their attention values significantly decreased towards the end of the ad. In the Profilo commercial, consumer interest was low at the beginning and end but higher in the middle sections. Therefore, the "Packshot" section, which contains the main message at the end of both advertisements, was ineffective. The reason participants could not recall the advertisement slogans in the recall questions might be due to the low interest shown in this section.

The most frequently viewed segments included the emotionally intense moment in the Vodafone commercial where the actor looks at his students after opening the door and the humorous scene in the Profilo advertisement featuring sausages being cooked in a toaster. In the Vodafone commercial, the interest level reached 1.00, while in the Profilo commercial, it remained at 0.71. In the Vodafone commercial, participants watched some scenes with very high interest due to the high emotional

intensity, but their interest decreased in other scenes. Participants generally followed the Profilo commercial, which displayed comedic elements throughout, with moderate attention that was not very high. In the Vodafone commercial, participants showed expressions of happiness in the final part where the narrative developed positively and warm emotional messages were given instead of sad elements, whereas in the Profilo commercial, this expression was used more frequently. This result can be attributed to the humorous elements in the Profilo commercial.

Looking at the Galvanic Skin Response (GSR) values of the study, it was observed that the Profilo commercial caused slightly more emotional change. However, it should be noted that the specific emotion causing this change (e.g., happiness, sadness, anger, surprise, disgust, fear) is not known. This variation does not differ based on gender, age, or marital status. No relationship was found between the recall rates of the advertisements and the GSR values. However, a significant relationship was found between the liking rates of the advertisements and the GSR values. Specifically, there was a positive, weak relationship between liking the Vodafone commercial and the GSR values. This means that individuals who experienced more emotional change while watching the commercial tended to like it more. No such relationship was established for the other commercial. Therefore, it is understood that individuals who were more affected by the sad/emotional elements in the Vodafone commercial liked the advertisement more.

In our study, to minimize the influence of cultural factors and maintain demographic consistency, participants were selected from a single district and comprised individuals with similar socio-cultural backgrounds. The fact that most of the sample falls within a similar age range (21-30 years, 55.9%) and educational level (bachelor's degree, 61.8%) limits the variability in the perception of humor and sadness themes that may arise from cultural differences. Additionally, the study environment and data collection process were standardized, thereby minimizing the impact of inter-individual cultural differences. While it is acknowledged that emotional responses to humor and sadness may vary depending on cultural context, this study focuses on individuals who share common social norms, consume similar media content, and possess a shared cultural background. In this regard, the sampling strategy employed in the research largely controls for cultural factors, enhancing the internal validity of the findings. However, it should also be noted that a more comprehensive examination of cultural factors would require a large-scale study encompassing individuals from different regions and diverse demographic characteristics.

When compared to previous studies in the literature, this study has yielded similar findings. In particular, the results align with prior research indicating that emotional advertisements have a strong impact on consumers (Dökeroğlu & Gökçearslan, 2020; Yang, 2022). Participants expressed their appreciation for both humorous and sad-themed advertisements, which supports the existing literature suggesting that emotional advertisements foster positive consumer attitudes (Kemp et al., 2013; Pirus & Zulqahar, 2018). Specifically, the fact that the humorous advertisement received a higher rating

confirms the argument put forth by Tekeli (2017) and Hoang (2013) that humor enhances attention and memorability. However, when examining the effect of emotional advertisements on purchase intention, it is noteworthy that although participants liked the advertisements, they assigned relatively moderate scores to their purchase intentions. This finding suggests that while humor and sadness can capture consumer interest, they may not necessarily be sufficient to influence purchasing behavior.

Furthermore, the literature indicates a significant relationship between emotional elements in advertisements and advertisement recall (Toker & Sulak, 2020). However, in this study, while participants could recall the brands featured in the advertisements, they had difficulty remembering the slogans. This finding is particularly noteworthy, as it suggests that although humorous and sad-themed advertisements generate emotional engagement, they may not always be effective in facilitating detailed information recall. Thus, this result highlights that, in addition to the emotional impact of advertisements, the extent to which the message is cognitively processed plays a crucial role in recall.

The eye-tracking and Galvanic Skin Response (GSR) measurements used in this study provide valuable insights into the physiological responses of consumers to advertisements. According to GSR data, the humorous advertisement elicited a higher level of arousal. This finding is consistent with Kreibig (2010), who suggested that emotional intensity leads to physiological changes. However, no significant correlation was found between GSR measurements and advertisement recall. This contradicts previous research suggesting that emotional responses are directly associated with message retention in memory (Dinç, 2018).

On the other hand, eye-tracking data indicate that participants exhibited similar levels of attention to both advertisements. However, the humorous advertisement had a longer average viewing time and received more revisit fixations. This suggests that humor attracts more attention and prompts viewers to refocus on different points within the advertisement. This finding supports the argument by McLeod et al. (2022) that humor enhances audience engagement and increases the overall effectiveness of an advertisement.

Based on the results obtained from the study, the following recommendations can be made to firms related to the subject:

The Packshot section, which is the final part of the advertisement, needs to be designed more effectively. Participants' attention decreases during this section. Since the message and slogan of the advertisement are presented in this part, companies and advertising agencies should pay special attention to this area.

Emotional advertisements are understood to have a positive impact on consumers. However, this does not mean that consumers will later want to gather more information about the product. Advertisements need to be more engaging in this regard.

Delivering emotional content only in a specific part of the advertisement while focusing on different messages in other parts reduces the effectiveness of the advertisement. It is necessary to create a narrative that can keep the participants' interest alive throughout the advertisement.

If the advertisement slogan is not correctly and effectively placed within the advertisement, participants may not remember it. This could reduce the desired impact of the advertisement on people.

By adopting a strategic approach and creating an appropriate communication language, using methods like neuromarketing, emotional advertisements can help firms establish a close relationship with their target audience and create an emotional bond with consumers.

This study has some limitations. Firstly, the study was conducted on a narrow sample. The study can be repeated with a larger sample and different demographic characteristics of consumers. Additionally, neuromarketing devices like EEG and fMRI can be used. Qualitative research methods, such as interviews, can be included in the research. Both quantitative and qualitative analyses can be conducted. The effects of emotional advertisements on consumers can be measured through promotional methods such as posters and banners.

Ethics committee approval for the study was obtained from the Afyon Kocatepe University Ethics Committee on June 26, 2024, with document number 27.06.2024-277980.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors declare that they contributed equally all processes of research.

REFERENCES

- Agarwal, D., & Nath, S. (2023). What's real and what's fake: A study on the use of deep fake technology in advertising. *Management Journal for Advanced Research*, 3(1), 15-20.
<https://doi.org/10.54741/mjar.3.1.3>
- Agwu, E (2022). Strategic importance of humorous advertisement on consumer purchase decisions. *International Journal of Innovation in the Digital Economy*, 13(1), 1-18.
<https://doi.org/10.4018/IJIDE.292492>
- Akbar, T. A., & El-Gohary, H. (2021). *Brand humour advertisements on a social network platform and their impact on online consumer engagement: The case of Instagram in GCC countries*. In Research Anthology on Social Media Advertising and Building Consumer Relationships. IGI Global.
<https://doi.org/10.13140/RG.2.2.24081.76648>
- Aksoy, S. (2015). *A critical analysis of the use of humor in television advertisements* [Unpublished doctoral dissertation]. Akdeniz University.
- Albert, W., & Tullis, T. S. (2023). *Measuring the user experience: Collecting, analyzing, and presenting UX metrics* (3rd ed.). Morgan Kaufmann.

- Anuar, N. N. A., & Isa, S. M. (2022). Consumer emotion – A neuromarketing research. *International Journal of Education, Psychology and Counselling (IJEPC)*, 7(47), 28-34. <https://doi.org/10.35631/IJEPC.747004>
- Anwer, A., Farooq, M., Minhas, S., & Butt, H. R. (2021). The impact of emotional advertising on consumer buying behavior for apparel products in Gujranwala. *Revista Geintec-Gestao Inovacao E Tecnologias*, 11(4), 5873-5888. <https://doi.org/10.47059/revistageintec.v11i4.2642>
- Ateş, S. (2016). The use of emotional appeal in political advertisements: Analysis of advertisements produced by political parties in the June 7, 2015 general elections. *Karadeniz Technical University Faculty of Communication Electronic Journal*, 3(12), 85-103.
- B2Press (2022, July 20). *Duygusal reklamcılık nedir ve nasıl kullanılır?* B2Press <https://tr.b2press.com/kutuphane/107/duygusal-reklamcilik-nedir-ve-nasil-kullanilir>
- Başaran, Ü., & Yıldız, M. (2022). Analysis of the effects between advertisement engagement, attitude towards advertising, and purchase intention: The mediating role of brand attitude. *Turkey Communication Research Journal*, 40(1), 173-195. <https://doi.org/10.17829/turcom.1051482>
- Becan, C. (2021). Sadness appeal as a social emotion in advertising: Emotion analysis of advertisements published during the pandemic. *Turkish Online Journal of Design Art and Communication*, 11(4), 1239-1262. <https://doi.org/10.7456/11104100/003>
- Birknerová, Z., Miško, D., Ondriřová, I., & Ćigarská, B. N. (2022). Analysis of consumer awareness of neuromarketing. *TEM Journal*, 11(2), 870-875. <https://doi.org/10.18421/TEM112-47>
- Bishop, E. (2014, March 19). *Five reasons comedy belongs in advertising*. Spinsucks. <https://spinsucks.com/marketing/five-reasons-comedy-belongs-in-advertising/>
- Bou Saada, R., Bou-Hamad, I., & Harajli, D. (2023). Influence of emotional marketing on consumer behavior towards food and beverage brands during the COVID-19 pandemic: A study from Lebanon. *Journal of Marketing Communications*, 29(8), 822-839. <https://doi.org/10.1080/13527266.2022.2088600>
- Can, A. (2014). *Data analysis in scientific research process with SPSS*. Pegem Akademi.
- Chelsea, L., Ratcliff, R., & Ye, S. (2020). Overcoming resistance through narratives: Findings from a meta-analytic review. *Human Communication Research*, 46(4), 412-443. <https://doi.org/10.1093/hcr/hqz017>
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11(6), 671–684. [https://doi.org/10.1016/S0022-5371\(72\)80001-X](https://doi.org/10.1016/S0022-5371(72)80001-X)
- Derinözlü, E. (2019). *The effect of emotional advertising appeals on brand preference in luxury brand communication and an application* [Unpublished doctoral dissertation]. Virginia University.
- Dinç, E. E. (2018). *A practical research on measuring and comparing the sensory and emotional responses of the Turkish people to global and local brands using neuromarketing methods* [Unpublished doctoral dissertation]. Üsküdar University.
- Dökeroğlu, O. T., & Gökçearslan, A. (2020). An evaluation of the use of humor in print advertising. *Journal of Arts*, 3(4), 313-332. <https://doi.org/10.31566/arts.3.021>
- Edwards, S. M. (1995). *Consumers' attitudes toward advertising and purchase intentions regarding direct response advertisements in a multicultural market* [Unpublished master's dissertation]. California State University.
- Eisend, M. (2009). A meta-analysis of humor in advertising. *Journal of the Academy of Marketing Science*, 37, 191-203. <https://doi.org/10.1007/s11747-008-0096-y>
- Ekman, P., & Friesen, W. V. (1978). Facial action coding system (FACS): A technique for the measurement of facial action. *Palo Alto: Consulting Psychologists Press*.
- Farnsworth, B. (2023, December 9). *10 most used eye tracking metrics and terms*. iMotions. <https://imotions.com/blog/learning/10-terms-metrics-eye-tracking/#1-fixations-and-gaze-points>
- Florence, E. S., Fleischman, D., Mulcahy, R., & Wynder, M. (2022). Message framing effects on sustainable consumer behavior: A systematic review and future research directions for social marketing. *Journal of Social Marketing*, 12(4), 623-652. <https://doi.org/10.1108/JSOCM-09-2021-0221>
- Flynn, J. (2023, June 19). *35 + Amazing advertising statistics [2023]: Data + trends*. Zippia. <https://www.zippia.com/advice/advertising-statistics/>

- Gartlan, D. (2023, September 12). *Emotional advertising: How brands use feelings to get people to buy*. Stevens&Tate. <https://stevens-tate.com/articles/emotional-advertising/>
- Gasco, V. (2020, January 20). *How heatmaps and eye tracking help to optimize sales*. <https://blog.saleslayer.com/how-heat-maps-eye-tracking-optimize-sales>
- Gumber, S. (2022). Navras: Reflections of emotions in advertising. *Journal of Visual and Performing Arts*, 3(1), 232-243. <https://doi.org/10.29121/shodhkosh.v3.i1.2022.87>
- Güz, H., & Atkan, B. (2021). Humor in television advertisements: Semiotic analysis. *Kastamonu Communication Research Journal*, (7), 27-47.
- Hashem, T. N., Ali N. N., & Allan, M. (2020). Influence of emotional marketing on brand loyalty among females in the field of cosmetics: Mediating role of customer satisfaction. *International Journal of Management*, 11(9), 1245-1260.
- He, M., & Li, A. (2016). The impact of sad-spending on emotional recovery process. *Psychology*, 7(1), 85-91. <https://doi.org/10.4236/psych.2016.71010>
- Hjortsjö, C. H. (1969). *Man's Face and Mimic Language*. Lund: Studentlitteratur. <https://diglib.uibk.ac.at/download/pdf/782346.pdf>
- Hoang, A. T. (2013). *Impact of humor in advertising on consumer purchase decision* [Unpublished master's thesis] Saimaa University.
- Ihsan, R. K., & Junaidi, F. (2022). A content analysis of advertising appeal in free to play mobile game ads. *Symposium of Literature Culture and Communication (SYLECTION) 2023*, 1(1), 28. <https://doi.org/10.12928/sylection.v1i1.11277>
- Jeon, Y. A., Ryoo, Y., & Yoon, H. J. (2024). Increasing the efficacy of emotional appeal ads on online video-watching platforms: The effects of goals and emotional approach tendency on ad-skipping behavior. *Journal of Advertising*, 53(1), 1-18. <https://doi.org/10.1080/00913367.2022.2073299>
- Josephs, O., Turner, R., & Friston, K. (1997). Event-related fMRI. *Human Brain Mapping*, 5(4), 243-248. [https://doi.org/10.1002/\(SICI\)1097-0193\(1997\)5:4<243::AID-HBM7>3.0.CO;2-3](https://doi.org/10.1002/(SICI)1097-0193(1997)5:4<243::AID-HBM7>3.0.CO;2-3)
- Kamran, Q., & Siddiqui, D. A. (2019). The impact of emotional advertising on consumer buying behavior for home appliance products in Pakistan. *Business and Management Horizons*, 7(1), 23-48. <https://doi.org/10.5296/bmh.v7i1.14410>
- Kang, I. H., Leliveld, M. C., & Ferraro, R. (2022). The impact of facial emotional expression on the effectiveness of charitable advertisements: The role of sympathy and manipulative intent. *Journal of Behavioral Decision Making*, 35(5), e2281. <https://doi.org/10.1002/bdm.2281>
- Kasilingam, D., & Ajitha, S. (2022). Storytelling in advertisements: Understanding the effect of humor and drama on the attitude toward brands. *Journal of Brand Management*, 29(4), 341-362. <https://doi.org/10.1057/s41262-021-00253-7>
- Ke, F., Liu, R., Sokolikj, Z., Dahlstrom-Hakki, I., & Israel, M. (2024). Using eye-tracking in education: Review of empirical research and technology. *Educational Technology Research and Development*, 72, 1383-1418. <https://doi.org/10.1007/s11423-024-10342-4>
- Kemp, E., Chapa, S., & Kopp, S. W. (2013). Regulating emotions in advertising: Examining the effects of sadness and anxiety on hedonic product advertisements. *Journal of Current Issues & Research in Advertising*, 34(1), 135-150. <https://doi.org/10.1080/10641734.2013.754719>
- Kewlani, D., Gulabwani, G., & Purohit, K. (2022). Impact of humor in advertising on consumer purchasing decisions. *International Journal of Management Public Policy and Research*, 1(1), 15-28. <https://doi.org/10.55829/ijmpr.v1i1.13>
- Koşar, A., & Tor Kadioğlu, C. (2020). *Türkiye’de nöropazarlama alanındaki lisansüstü tezlerin içerik analizi yöntemiyle incelenmesi*. İksad Yayınevi.
- Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, 84(3), 394-421. <https://doi.org/10.1016/j.biopsycho.2010.03.010>
- Kylila, A., & Elgeka, H. W. S. (2024). The dynamic of decision-making: Effect of intertemporal choice on clothing products. *Humanitas: Indonesian Psychological Journal*, 21(1), 26-39. <https://doi.org/10.26555/humanitas.v21i1.387>

- Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, 28(4), 563-575.
- Lewandowska, B. (2023). *What is AOI?* RealEye. <https://support.realeye.io/what-is-aoi>
- Lewinski, P., Trzaskowski, R., & Sorokowski, P. (2017). Automated facial coding: Validation of basic emotions classifications in practical applications. *Frontiers in Psychology*, 8, 2406. <https://doi.org/10.3389/fpsyg.2017.02406>
- Li, S. Z., Jain, A. K., Tian, Y. L., Kanade, T., & Cohn, J. F. (2005). *Facial expression analysis*. Springer. https://doi.org/10.1007/0-387-27257-7_12
- Mancini, M. (2025). *What is the Galvanic Skin Response (GSR) and how to use it in Neuromarketing*. Marco Mancini. <https://mancinimarco.com/what-is-the-galvanic-skin-response-gsr-and-how-to-use-it-in-neuromarketing/>
- McLeod, B. T., Houghton, D. M., & Saavedra, J. L. (2022). Developing a sense of humor: Congruence between humor type and brand personality. *Journal of Marketing Development & Competitiveness*, 16(4), 34-48. <https://doi.org/10.33423/jmdc.v16i4.5751>
- Mishra, R., & Patil, D. Y. (2023). A study on the impact of emotional advertising in the 21st century. *CEMJ*, 31(1), 73-89. <https://doi.org/10.57030/23364890.cemj.31.1.8>
- Muhammad, R., Ali, A., Anwar, M. A., Soomro, T. A., AlShorman, O., Alshahrani, A., Masadeh, M., Ashraf, G. M., Ali, N. H., Irfan, M., Alexiou, A. T. (2023). Design and development of low-cost wearable electroencephalograms (EEG) headset. *Intelligent Automation & Soft Computing*, 35(3), 2821-2835. <https://doi.org/10.32604/iasc.2023.026279>
- Naidu, C. (2023). Impact of emotional advertising on consumer purchase buying behavior in Delhi/NCR. *International Journal of Financial Management and Economics*, 6(1), 201-205.
- Nummenmaa, L., Hyönä, J., & Calvo, M. G. (2014). Eye movement assessment of selective attentional capture by emotional pictures. *Emotion*, 6(2), 257-268. <https://doi.org/10.1037/1528-3542.6.2.257>
- O'Hara, B. J., Owen, K. B., Bauman, A. E., Dunlop, S., Phongsavan, P., Furestad, E., Nicola, S., & Freeman, B. (2023). Hope and sadness: Balancing emotions in tobacco control mass media campaigns aimed at smokers. *Health Promotion Journal of Australia*, 34(4), 856-866. <https://doi.org/10.1002/hpja.683>
- Otamendi, F. J., & Sutil Martín, D. L. (2020). The emotional effectiveness of advertisement. *Frontiers in Psychology*, 11, 2088. <https://doi.org/10.3389/fpsyg.2020.02088>
- Panthen, M., & Germelmann, C. C. (2023). Marketing and the commercialization of emotions. In *Marketing and the Commercialization of Emotions*. De Gruyter Brill. https://doi.org/10.30965/9783657795795_002
- Pirus, M. S. M., & Zulqahar, S. Y. (2018). The understanding of sad appeal in emotional advertisement among audiences in Klang Valley, Malaysia. *Jurnal Komunikasi: Malaysian Journal of Communication*, 34(4), 319-336. <https://doi.org/10.17576/JKMJC-2018-3404-19>
- Pluta-Olearnik, M., & Szulga, P. (2022). The importance of emotions in consumer purchase decisions—A neuromarketing approach. *Marketing of Scientific and Research Organizations*, 44(2), 87-104. <https://doi.org/10.2478/minib-2022-0010>
- Qutp, M. M., Abodonia, S. H., & El Sharkawy, A. Z. (2022). The emotional communication effectiveness of advertising on consumer behavior. *International Design Journal*, 12(6), 271-280. <https://doi.org/10.21608/idj.2022.267603>
- RealEye (2024). *RealEye accuracy on computers*. RealEye. https://support.realeye.io/realeye-accuracy?utm_source=chatgpt.com
- Satapathy, C., Gokhale, H., Syed, A. Z., & Nersisson, R. (2024). Galvanic skin response based stress level detection using supervised machine learning approach. In *AIP Conference Proceedings* (Vol. 2966, No. 1). AIP Publishing.
- Septianto, F. (2021). Anxiety, sadness, and emotion specificity: The role of music in consumer emotion and advertisement evaluation. *ASEAN Marketing Journal*, 5(2). <https://scholarhub.ui.ac.id/amj/vol5/iss2/2/>
- Şenduran, F. (2019). The use of eye-tracking system (Eye Tracker) in sports science: A guide for new researchers. *Ankara University Faculty of Sports Sciences SPORMETRE Journal of Physical Education and Sports Sciences*, 17(4), 1-13. <https://doi.org/10.33689/spormetre.528980>

- Solak, B. B. (2017). *Using humor and humorous characters in Tv Ads: Analysis on bank commercials*. [Unpublished master's thesis]. Akdeniz University.
- Soti, R. (2022). The impact of advertising on consumer behavior. *World Journal of Advanced Research and Reviews*, 14(3), 706-711. <https://doi.org/10.30574/wjarr.2022.14.3.0577>
- Statista. (2024). *Global advertising spending from 2000 to 2024*. Statista. <https://www.statista.com/statistics/236943/global-advertising-spending/>
- Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics (6th ed.)*. Pearson.
- Tekeli, Y., (2017). *The role of humor as an advertising appeal in the consumer purchasing decision process*. [Unpublished doctoral dissertation]. Marmara University.
- Toker, A., & Sulak, H. (2020). A study on the types of appeals used in commercial advertisements and their effects on consumers. *Suleyman Demirel University Visionary Journal*, 11(Special Issue), 117-133. <https://doi.org/10.21076/vizyoner.727107>
- Weber, I. (2024). *Eleven effective emotional advertising examples brands are using*. Creatopy. https://www.creatopy.com/blog/emotional-advertising-examples/?utm_source=chatgpt.com
- Wedel, M., & Pieters, R. (2008). Eye tracking for visual marketing. *Foundations and Trends in Marketing*, 1(4), 231-320. <http://dx.doi.org/10.1561/17000000011>
- Xavier, L. (2023, May 15). *Beyond logic. How emotions drive our buying decisions*. LinkedIn. <https://www.linkedin.com/pulse/beyond-logic-how-emotions-drive-our-buying-decisions-ludymilla-xavier/>
- Yang, Q. (2022). *How sadness in narrative advertising influences brand attitude and purchase intention of audiences* [Unpublished doctoral dissertation]. The University of Texas at Austin.
- Yiğit, M. G. (2020). *The role of dissociation and rumination in the formation of intrusive memories* [Unpublished doctoral dissertation]. Ankara University.
- Yıldız D, & Uzunsakal E. (2018). Comparison of reliability tests in field research and an application on agricultural data. *Applied Social Sciences Journal*. 2(1), 14-28.
- Yıldız, S., & Uztuğ, F. (2017). The effects of absurdity in advertising on attitude and recall towards the advertisement. *Karadeniz Technical University E-Journal of Faculty of Communication*. 7(1), 96-117.

Deep Neural Networks in Predicting Financial Volatility: An Application on Cryptocurrencies

Cemile ÖZGÜR¹

Abstract

The main aim of this research is to obtain daily volatility predictions of cryptocurrencies by using the Deep Belief Network – Deep Neural Network (DBN-DNN) and Backpropagation Neural Network (BPNN) algorithms as well as the traditional Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and one of its asymmetric variants, the Exponential GARCH models. The research data consists of daily price series of the most well-known two cryptocurrencies (Bitcoin and Ethereum) for the period of 4 July 2022 and 3 February 2024. Performance of the out-of-sample volatility forecasts of the models are compared by using three different metrics, that are Root Mean Squared Error (RMSE), R squared (R^2) and Mean Absolute Error (MAE). According to the obtained performance measures estimated from the out-of-sample period of 11 October 2023 and 3 February 2024, DBN-DNN and BPNN yielded the best RMSE and MAE values of Bitcoin, respectively. On the other hand, DBN-DNN obtained the best RMSE and R^2 among the Ethereum volatility predictions. Overall, the findings of this research reveal a promising cryptocurrency volatility forecasting ability in favor of the applied deep neural networks, since they managed to obtain most of the best as well as the second-best performance metrics of both cryptocurrencies.

Keywords: *Cryptocurrency, Volatility, Deep Belief Network, Deep Neural Networks.*



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1. INTRODUCTION

Modelling and forecasting volatility of financial time series is a long-standing and challenging research subject. Additional to the well-known financial assets, cryptocurrencies, that are digital currencies supported by the blockchain technology, gained a prominent attention by the researchers. The first cryptocurrency proposed by Nakamoto (2008) is Bitcoin. Following the invention of Bitcoin (BTC), numerous cryptocurrencies are developed and traded at markets reaching billion dollars of market capitalizations. However, modelling volatility of cryptocurrencies is a trivial task, especially when the high volatility and chaotic patters of the price series are considered (Lahmiri & Bekiros, 2018; Liu, 2019; Pratas et al., 2023).

In economics and finance literature, Autoregressive Conditional Heteroskedasticity (ARCH) (Engle, 1982) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) (Bollerslev, 1986) processes are the most popular volatility modelling tools. After Engle (1982) and Bollerslev (1986), an increasing number of asymmetric variants of GARCH models are proposed (e.g. Exponential GARCH (Nelson, 1991), Threshold GARCH (Zakoian, 1994) and so on). Additional to the econometric methods, currently academic researchers and/or practitioners are looking forward to use the technological development and utilize various machine and/or deep learning algorithms to predict the volatility of financial time series. Deep learning (DL) is a subclass of Machine Learning (ML) defining deeper Artificial Neural Network (ANN) structures that have many layers. As a tool capable of modelling complex and nonlinear dependencies, employing DL to predict cryptocurrency volatility is an important and a challenging research subject. Nevertheless, there are still a few papers employing DL algorithms to model and predict volatility of cryptocurrencies (see for example discussion of Wang et al. (2023) and García-Medina and Aguayo-Moreno (2024) about the research gap on the subject). Moreover, the ones focusing on volatility mainly employ only BTC or concentrated on the applications of Long Short-Term Memory (LSTM) and/or Recurrent Neural Networks (RNN).

In this paper, daily volatility of two cryptocurrencies (BTC and Ethereum (ETH)) is predicted by Backpropagation Neural Network (BPNN) as well as Deep Neural Networks (DNN) using weights trained by Deep Belief Networks (DBN) that are called DBN-DNN (Deng, 2014). Out-of-sample volatility predictions of BPNN and DBN-DNN with two different activation functions (either the sigmoid or the hyperbolic tangent activation function) are compared with the traditional volatility forecasting tools, GARCH and Exponential GARCH (EGARCH), using the commonly employed performance measures of Root Mean Squared Error (RMSE), R^2 and Mean Absolute Error (MAE).

While there are various applications of Deep Belief Networks for example in biomedical engineering (Abdel-Zaher & Eldeib, 2016), meteorology (Du et al., 2018) as well as in economics and finance (Chen et al., 2019; Karathanasopoulos, 2017; Li & Sun, 2023), any published research focusing on cryptocurrency volatility is not found. It is also important to note that some papers do not differentiate DBN from DBN-DNN and call the whole process of weight initialization of DNN using DBN as a DBN

network, see also the discussion of Deng (2014) on the subject. Moreover, research papers that use DBN or DBN-DNN, calibrate optimal parameters of the algorithms without a consistent parameter selection method, such as the time series cross-validation (ts-cv) approach (Hyndman & Athanasopoulos, 2018). As a result, the main contribution of this research paper relies on the uniqueness of its methodology to predict volatility of the two cryptocurrencies.

The following sections of this paper give a brief review of the literature and explain the research methodology. The experimental design section consists of the description of the data, data pre-processing, volatility predictions as well as the calibration of the algorithms. The last two sections report the empirical findings and conclude the paper with the final remarks.

2. LITERATURE REVIEW

Utilizing ML in various fields/tasks of finance is a fast-developing and a prominent research topic, see for example Nazareth and Ramana Reddy (2023)'s paper in which the authors give an extensive review on the financial applications of ML algorithms. However, applications of ML and/or DL to especially model and predict financial volatility of cryptocurrencies are still scarce. One of the early works on this subject is Shah and Zhang (2014)'s work in which the authors predicted the future Bitcoin price variation. On the other hand, Pichl and Kaizoji (2017) employed the Heterogeneous Autoregressive model for Realized Volatility (HARRVJ) RV with jumps and the Artificial Neural Networks (ANN) to predict realized volatility and price of bitcoin, respectively. The research results indicate the well ability of the applied models to capture the dynamics of Bitcoin price and realized volatility series.

Peng et al. (2018) predicted daily and hourly volatility of three cryptocurrencies (Bitcoin, Ethereum, Dash) by employing the GARCH processes (EGARCH, GARCH and gjrGARCH) as well as Support Vector Regression (SVR) and combinations of GARCH and SVR models, which they called SVR-GARCH. According to the estimated performance metrics, the researchers argue that the applied SVR-GARCH models were able to outperform volatility forecasting performance of all the rest GARCH processes (EGARCH, GARCH and gjrGARCH using either Normal, Student's t or Skewed Student's t distributions). Moreover, Kristjanpoller and Minutolo (2018) predicted Bitcoin price volatility by using a combination of GARCH and ANN consisting of Principal Component Analysis (PCA) as a pre-processing step. The researchers evaluated and compared performance of twelve hybrid models with the predictions of the best GARCH process (the one with the lowest MSE) for three different volatility windows (10-day, 22-day and 44-day volatility). According to the obtained empirical results, the authors argue in favor of the applied hybrid ANN models consisting of technical indicators as model inputs and a PCA pre-processing step.

Jang and Lee (2018) applied Bayesian Neural Networks (BNN) and Support Vector Regression (SVR) to predict Bitcoin price and volatility by employing blockchain data (e.g. hush rate, trading

volume, average block size), exchange rates (GBP/USD, JPY/USD, EUR/USD, CNY/USD, CHF/USD) and macroeconomic variables (such as, Crude oil, gold, and VIX) as model features. Two performance measures that are RMSE and MAPE are used to compare volatility predictions of BNN, SVR and Linear Regression. According to the results of the research, the authors stress that BNN can be considered as a more reliable model for defining the log volatility of Bitcoin compared to the applied benchmark models. Miura et al. (2019) employed several machine learning algorithms (Ridge Regression, LSTM, ANN, GRU and SVM) to predict realized volatility (RV) of Bitcoin. RV prediction performance of the applied algorithms is evaluated by using the mean squared error (MSE) and root mean squared error (RMSE) metrics. Overall, the researchers argue that Ridge regression can be classified as the best and SVM as the worst performer in predicting RV of Bitcoin.

Seo and Kim (2020) also employed a hybrid of ML (ANN, Higher Order Neural Network (HONN)) and GARCH models to predict realized volatility of Bitcoin. Prediction performance of the applied models is compared with the RMSE, MAE and MAPE measures as well as the Model Confidence Set test. The results of the research point out that volatility prediction accuracy of the HONN based hybrid models is better than the rest applied in the paper. Furthermore, Shen et al. (2021) compared out-of-sample Bitcoin volatility and Value at Risk (VaR) predictions of GARCH as well as EWMA models to the predictions of Recurrent Neural Networks (RNN). The researchers used RMSE and MAE performance metrics to compare the applied models' volatility forecasts. On the other hand, they employed unconditional coverage (Kupiec, 1995) and conditional coverage (Christoffersen, 1998) tests to back test model specific VaR predictions. According to the estimated out-of-sample performance metrics, RNN is found to outperform GARCH and EWMA in terms of the MAE metric. However, GARCH and EWMA outperformed RNN in terms of the RMSE metric as well as the applied VaR back tests.

Zahid et al. (2022) is also among the researchers applying a hybrid of GARCH models (EGARCH, GARCH and gjrGARCH) and deep learning (DL) algorithms (Long Short-Term Memory (LSTM), Bidirectional LSTM (BiLSTM) and Gated Recurrent Unit (GRU)) to forecast realized volatility of Bitcoin. The results of this research are also in favor of the constructed GARCH-DL hybrid models by reporting a better forecasting accuracy than the single GARCH models. D'Amato et al. (2022) employed a Jordan Neural Network (JNN) to predict daily as well as intraday volatility of three cryptocurrencies (Bitcoin, Ethereum and Ripple). The researchers compared volatility predictions of JNN to the Non-Linear Autoregressive Neural Network (NLANN) and SETAR models by using the MSE and MAPE performance measures. Overall, results of the research classify JNN as a better volatility predictor than the SETAR and NLANN both for daily and intraday observations.

Wang et al. (2023) applied Random Forest (RF) and LSTM to predict volatility of four cryptocurrencies (Bitcoin, Ripple, Ethereum and Litecoin) for three different time horizons (daily, weekly, and monthly). The researchers used directional accuracy, RMSE, MAPE and NMSE metrics to

compare volatility prediction performance of the applied models. Research results of Wang et al. (2023) indicate an outperformance of the applied ML algorithms with especially additional determinants (internal and/or determinants from several cryptocurrencies) compared to the traditional GARCH. Pratas et al. (2023) employed several DL algorithms (LSTM, RNN and MLP) to forecast and compare return volatility of Bitcoin to the forecasts of the traditional ARCH and GARCH processes. As in many of the reviewed papers, the researchers used MAE and MAPE metrics to compare volatility prediction performance of the models. Moreover, the Diebold–Mariano test is also applied for the statistical significance of the predictions. According to the estimated performance metrics, the authors argue that the applied DL algorithms managed to produce superior volatility forecasts, especially in the short-term. Therefore, DL should be considered in predicting complex volatility dynamics of not only cryptocurrencies but also the other financial time series.

On the other hand, Khan et al. (2023) applied three ML algorithms (NNETAR, GMDH-NN and CSS) to forecast volatility of Bitcoin, Tether, XRP and Ethereum considering the period of 14 April 2017 to 30 October 2020. According to the estimated RMSE and MAE values, the authors were not able to rank a specific algorithm as the best volatility forecaster for all the four cryptocurrencies uniformly. While cubic smoothing spline (CSS) obtained the best error metrics of Bitcoin and XRP, NNETAR was the best performer of Ethereum's volatility predictions and GMDH-NN was the winner in case of Tether. García-Medina and Aguayo-Moreno (2024) also employed deep learning algorithms (MLP, LSTM), the traditional GARCH models (EGARCH, gjrGARCH) and their hybrids (LSTM-EGARCH and LSTM-gjrGARCH) to forecast volatility of ten cryptocurrencies. According to the empirical findings, the authors argue that since MLP was able to outperform the rest, simple learning models can be mostly sufficient to model and predict cryptocurrency volatility.

Dudek et al. (2024) conducted extensive comparative research among twelve statistical and ML models for the task of predicting daily and weekly volatility of four cryptocurrencies, that are Bitcoin, Monero, Ethereum and Litecoin. The researchers used MSE, MAE as well as the model confidence set test to compare performance of the cryptocurrency specific volatility predictions of the models. Referring to the obtained empirical results, the researchers point out that performance of the models are not uniform across cryptocurrencies as well as the applied performance measures. Different models ranked as the best depending on the error metric and cryptocurrency. Moreover, the researchers argue that simple and linear ML models can produce volatility forecasts as well as their more complex counterparts. Table 1 presents a methodological review of the cryptocurrency volatility prediction literature employing various ML and/or DL algorithms. Additionally, one can also consult to Ozbayoglu et al. (2020) and Zhang et al. (2024)'s studies in which the researchers supplied a comprehensive literature review on various applications of ML and/or DL in cryptocurrencies.

Table 1. Methodological Review of the Literature

Authors	Predicted Variable(s)	Methods	Performance Metrics
Pichl and Kaizoji (2017)	Bitcoin (BTC) price and volatility	Heterogeneous Autoregressive model for Realized Volatility, Artificial Neural Network (ANN)	Comparison of the actual and predicted vales, metrics are not specified
Vo and Xu (2017)	BTC returns and volatility	ARMA(1,2)-fGARCH(2,2)/TGARCH using the GHYP distribution, Support Vector Machine (SVM), Neural Networks (NN)	Residual Sum of Squares, Normalized Residual Mean Square Error
Guo et al. (2018)	BTC volatility	Temporal Mixture models, GARCH, Random Forests (RF), Extreme Gradient Boosting, Elastic-Net, LSTM	Root Mean Squared Error (RMSE), Mean Absolute Error
Jang and Lee (2018)	BTC price and volatility	Linear Regression, Bayesian Neural Networks (BNN), Support Vector Regression (SVR)	RMSE, Mean Absolute Percentage Error (MAPE)
Kristjanpoller and Minutolo (2018)	BTC price volatility	Hybrid of ANN-GARCH with PCA pre processing	Mean Squared Error (MSE), the Model Confidence Set (MCS)
Peng et al. (2018)	Volatility of BTC, ETH, Dash	EGARCH, GARCH, gjrGARCH, SVR and combinations of GARCH and SVR models	RMSE, Mean Absolute Error (MAE), Diebold-Mariano test
Miura et al. (2019)	BTC volatility	Ridge Regression, LSTM, ANN, Gated Recurrent Unit (GRU), SVM	MSE, RMSE
Seo and Kim (2020)	BTC volatility	Hybrid of ANN, Higher Order Neural Network and GARCH models	RMSE, MAE, MAPE, MCS
Shen et al. (2021)	BTC volatility	EWMA, GARCH, Recurrent Neural Networks (RNN)	RMSE, MAE
D'Amato et al. (2022)	Volatility of BTC, ETH, XRP	Jordan Neural Network (JNN), Non-Linear Autoregressive Neural Network (NLANN)	MSE, MAPE
Zahid et al. (2022)	BTC volatility	Hybrid of EGARCH, GARCH, gjrGARCH and LSTM, BiLSTM, GRU	Heteroscedasticity adjusted MSE and Heteroscedasticity adjusted MAE
Azizi et al. (2023)	BTC volatility	Differential equation + Artificial Neural Network (ANN), ARCH, GARCH, Deep Learning (DL)	Relative error
Khan et al. (2023)	Volatility of BTC, Tether, XRP, ETH	Neural Network Autoregressive (NNETAR), Group Method of Data Handling Neural Network, Cubic Smoothing Spline (CSS)	RMSE, MAE
Pratas et. al. (2023)	BTC volatility	ARCH, GARCH, Multilayer Perceptron (MLP), RNN, LSTM	MAE, MAPE, Diebold-Mariano test
Wang et al. (2023)	Volatility of BTC, Ripple, ETH, Litecoin	RF, Long Short-Term Memory (LSTM)	Directional accuracy, RMSE, MAPE, Normalized Mean Squared Error
Abarghouie et al. (2024)	Volatility of eight cryptocurrencies	Long Short-Term Memory (LSTM)	MSE, RMSE
Dudek et al. (2024)	Volatility of BTC, Monero, ETH, Litecoin	Autoregressive Fractionally Integrated Moving Average (ARFIMA), GARCH, Ridge Regression, RF, MLP, SVR, LSTM	MSE, MAE, MCS
Garcia-Medina and Aguayo-Moreno (2024)	Volatility of ten cryptocurrencies	EGARCH, gjrGARCH, MLP, LSTM, LSTM-EGARCH, and LSTM-gjrGARCH	HAE, HSE, Diebold-Mariano test

3. RESEARCH METHODOLOGY

3.1. ARMA(P,Q)

The ARMA(P,Q) process modelling the conditional mean (μ_t) in Equation 1 can be defined as follows:

$$y_t = \mu_t + \epsilon_t \quad (1)$$

$$\mu_t = \varphi_0 + \sum_{k=1}^P \varphi_k y_{t-k} + \sum_{s=1}^Q \theta_s \epsilon_{t-s} \quad (2)$$

Where y_t is the return of a cryptocurrency observed at time t . φ_k and θ_s are the cryptocurrency specific parameters of the conditional mean equation.

3.2. GARCH(p,q)

Following the Autoregressive Conditional Heteroskedasticity (ARCH) model of Engle (1982), the Generalized Autoregressive Conditional Heteroskedasticity (GARCH(p,q)) definition of Bollerslev (1986) can be written as:

$$\epsilon_t = \sigma_t z_t \quad (3)$$

$$\sigma_t^2 = \omega + \sum_{l=1}^p \beta_l \sigma_{t-l}^2 + \sum_{j=1}^q \alpha_j \epsilon_{t-j}^2 \quad (4)$$

In Equations 1 to 4, ϵ_t defines the error term distributed according to distribution $\mathcal{D}$ ($\epsilon_t \sim \mathcal{D}(0, \sigma_t^2)$). σ_t^2 is the conditional volatility satisfying $\omega > 0$ and $\alpha, \beta \geq 0$. The Exponential GARCH (EGARCH) model of Nelson (1991) can be defined as:

$$\ln(\sigma_t^2) = \omega + \sum_{l=1}^p \beta_l \ln(\sigma_{t-l}^2) + \sum_{j=1}^q g_j(z_{t-j}) \quad (5)$$

$$\text{where } g_j(z_{t-j}) = \alpha_j z_{t-j} + \gamma_j (|z_{t-j}| - E|z_{t-j}|).$$

3.3. Backpropagation Neural Networks

Dating back to the 1940s, the development of Artificial Neural Networks (ANN) arises from the ideas of being able to model biological neural networks with computation and logic (Carbonell et al., 1983). Since Rosenblatt (1962), who introduced the simplest neural networks (perceptron), various ANN network structures with several layers and different learning algorithms are developed.

Back Propagation Neural Network (BPNN) is a feed-forward ANN trained by the error back-propagation algorithm. In a typical ANN, network weights are randomly initialized and a feed-forward computation is followed:

$$y_h = f\left(\sum_{j=1}^m (x_j * \omega_{jh}) - \vartheta_h\right) \quad (6)$$

Where y_h and x_j are the outputs of the hidden and input layers, respectively. ϑ_h is the bias term and $f(\cdot)$ is the activation function. In this research sigmoid as well as the hyperbolic tangent activation

functions are employed. The following Equation 7 defines the feed-forward output value (o_o) of the output layer.

$$o_o = f(\sum_{h=1}^n (y_h * \omega_{ho}) - \vartheta_o) \quad (7)$$

Once the output of feed-forward ANN is computed, the backpropagation (BP) algorithm propagates the network error backwards from the output to the hidden layers modifying the layer weights to reduce the error. The algorithm employs the gradient descent method to minimize the network error (Li et al., 2012). Following BP, the updated network weights can be expressed as:

$$\omega'_{jh} = \omega_{jh} + \Delta\omega_{jh} \quad \wedge \quad \Delta\omega_{jh} = -\eta * \partial\mathcal{L}/\partial\omega_{jh} \quad (8)$$

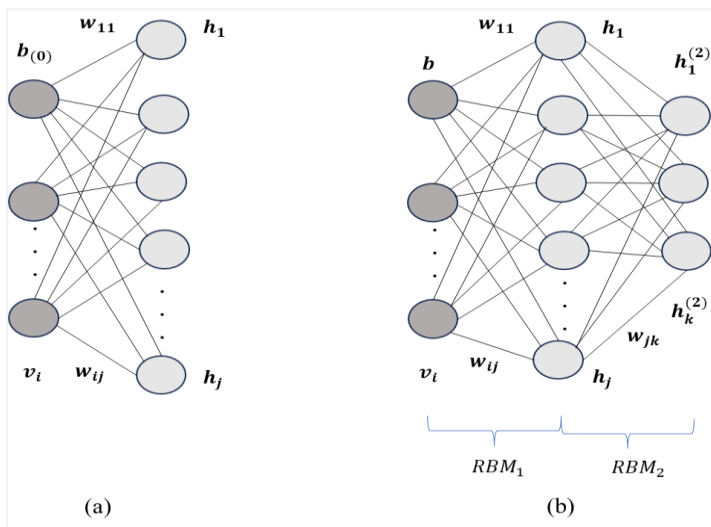
$$\omega'_{ho} = \omega_{ho} + \Delta\omega_{ho} \quad \wedge \quad \Delta\omega_{ho} = -\eta * \partial\mathcal{L}/\partial\omega_{ho} \quad (9)$$

where η is the learning rate and $\mathcal{L}$ is the difference between the actual network output and the expected (desired) level of output. The training process of error back propagation is carried until the network error converges to an acceptable level.

3.4. Deep Belief Network

Deep Belief Network (DBN), proposed by Hinton et al. (2006), is a composite multi-layer neural network with directed and undirected layer connections. DBN can be defined as a “Bayesian probabilistic generative model” constructed by stacking several layers of simple models that are called Restricted Boltzmann Machines (RBM) (Deng, 2014). On the other hand, RBM is a Boltzmann Machine with a restriction of not having connections between the hidden units as well as within the same layer. Figure 1 shows an illustration of a typical RBM that has a visual (v) and a hidden layer (h). While visual layer consists of input data, the hidden layer represents the set of features that can define the data specific dependencies.

Figure 1. An illustration of RBM (a) and DBN (b)



Source: Author's own illustration

A RBM can be trained using the Gibbs sampling and the Contrastive Divergence (CD) algorithm. Once a layer of RBM is trained, the output of the layer is used as an input to the next layer. This greedy layer-by-layer training process is called pretraining. The unsupervised pretraining process of each RBM proceeds sequentially until the last one of the DBN network is trained. Figure 1 also illustrates a DBN stacked by two RBM. Following the pretraining, weight updates of DBN can be written as:

$$\Delta\omega_{ij} = \eta \left[(v_i h_j)_0 - (v_i h_j)_1 \right] \quad (10)$$

where η , v and h are the learning rate, visual and hidden units, respectively. ω_{ij} is the weight between visual unit i and hidden unit j . Furthermore, as mentioned in the previous section, the initial weights of a neural network are randomly generated. Instead, the updated weights of DBN can be utilized as the initial weights of a Deep Neural Network (DNN). DNN is a multi-layer ANN that has many hidden units as well as layers. If a DNN uses the weights of DBN to initialize its training, then the network is named as DBN-DNN (Deng, 2014).

4. EXPERIMENTAL DESIGN

4.1. Data

This research employs daily closing price series of two cryptocurrencies (Bitcoin (BTC-USD) and Ethereum (ETH-USD)) for the period of 4 July 2022 and 3 February 2024. While BTC is currently (as of 1st of July 2024) trading on 11363 markets with a volume of 21.55 billion dollars, ETH is trading on 9108 markets with a volume of 10.73 billion dollars. The data consisting of 580 observations of both cryptocurrencies is downloaded from the open source of Yahoo Finance (www.finance.yahoo.com) website. Daily returns are estimated from:

$$r_{t,d} = \ln(P_{t,d}/P_{t-1,d}) \quad (11)$$

Where $P_{t,d}$ is the daily closing price of cryptocurrency $d \in \{1,2\}$. Descriptive statistics of the data including the returns is given in Table 2.

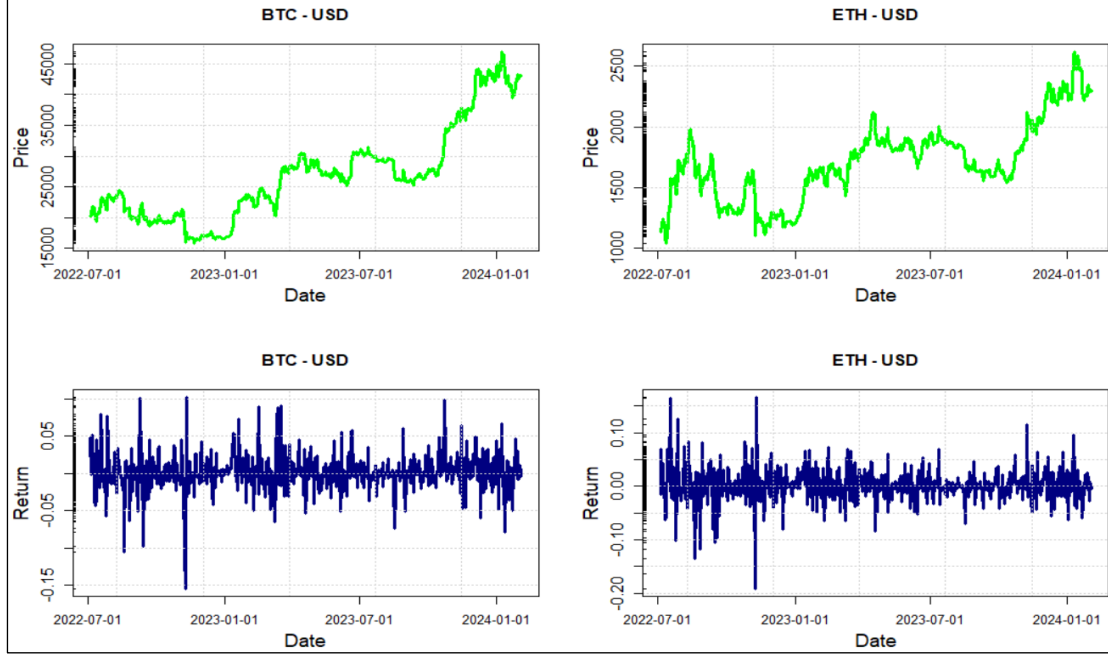
Table 2. Descriptive Statistics – Prices and Returns

Data	Mean	Stand. Dev.	Jarque-Bera (p val.)	ADF	LB(Q10)	LM(Q10)
BTC	26,816	7,589	62.83 (0.000) ***	0.655	0.000 ***	0.000 ***
ETH	1,709	320	10.06 (0.007) ***	0.357	0.000 ***	0.000 ***
BTCR	0.0014	0.0253	706.38 (0.000) ***	0.01 **	0.904	0.000 ***
ETHR	0.0013	0.0326	985.65 (0.000) ***	0.01 **	0.134	0.000 ***

Notes: *** and ** indicate significance at 1% and 5% levels, respectively. BTCR and ETHR refer to the return series of BTC and ETH, respectively. ADF is the Augmented Dickey-Fuller Test (Said & Dickey, 1984). Estimated p – values of ADF, LB (Ljung-Box (Ljung & Box, 1978)) and LM (Lagrange Multiplier test for autoregressive conditional heteroscedasticity (ARCH) of Engle (1982)) tests are reported.

As can be seen from Table 2, both price series violate the normal distribution assumption. Moreover, prices are non-stationary with the properties of serial auto-correlation and heteroskedasticity. Similarly, both return series are heteroskedastic as well as non-normally distributed. On the other hand, cryptocurrency returns do not have unit root and serial auto-correlation. Additionally, time series plots of the daily closing prices and the returns are given in Figure 2.

Figure 2. Time Series Plots of the Cryptocurrencies



Source: Author's own illustration

4.2. Data preparation

The estimated cryptocurrency returns are divided into train and test samples. 80% of the data (464 observations) of each cryptocurrency is employed to train the algorithms, the rest unseen 20% (116 out-of-sample observations) is left for the performance evaluation.

The train data of each cryptocurrency is corrected for outliers by using the Inter Quartile Range (IQR) estimate as follows:

$$IQR_d = Q_{3,d} - Q_{1,d} \quad (12)$$

$$r'_{t,d} = \begin{cases} Q_{1,d} - 1.5 * IQR_d & \text{if } r_{t,d} < Q_{1,d} - 1.5 * IQR_d \\ Q_{3,d} + 1.5 * IQR_d & \text{if } r_{t,d} > Q_{3,d} + 1.5 * IQR_d \\ r_{t,d} & \text{else} \end{cases} \quad (13)$$

where $Q_{1,d}$ and $Q_{3,d}$ are the first and third quartiles of the returns of cryptocurrency $d \in \{1,2\}$, respectively.

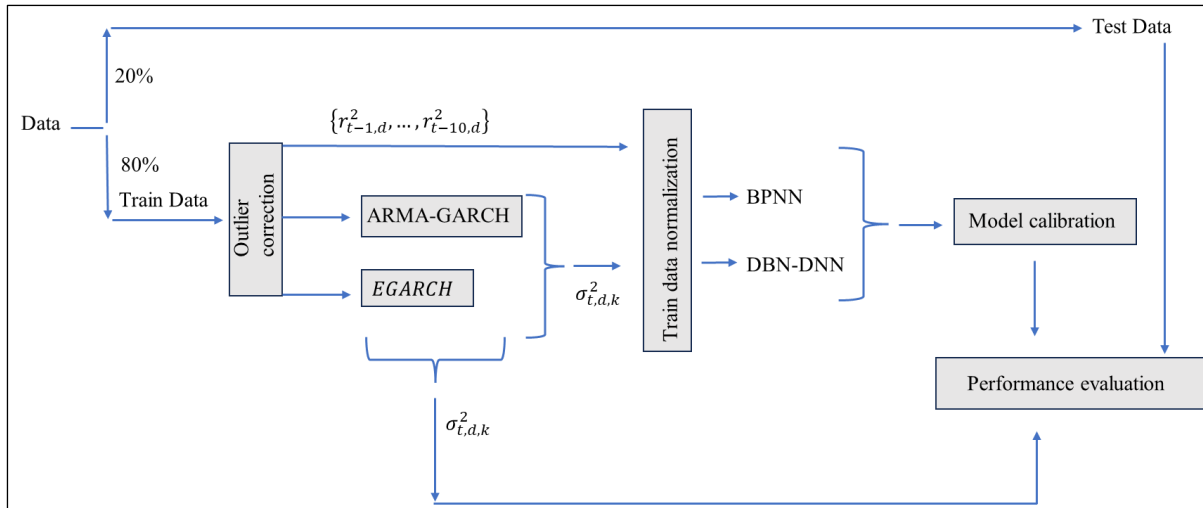
4.3. Volatility predictions

Conditional volatility forecasts of the ARMA(P,Q)-GARCH(p,q) and EGARCH(1,1) processes are obtained by using one-day ahead rolling windows approach as follows:

- Each estimation window consisting of 464 observations is corrected for outliers as explained in Equation 13 for a total of 116 windows.
- EGARCH(1,1) with student-t innovations is fitted to each window.
- The window specific (P,Q) and (p,q) orders of the ARMA-GARCH processes with either normal or student-t innovations are determined according to AIC criteria [$p, q \in \{0,1,2,3\}$ and $P, Q \in \{0,1,2\}$].
- Residuals of the fitted ARMA(P,Q)-GARCH(p,q) and EGARCH(1,1) processes are controlled for the remaining auto-correlation and heteroskedasticity. The orders of conditional mean and/or volatility are increased by one in case of remaining auto-correlation and/or heteroskedasticity.
- One-day ahead out-of-sample volatility forecasts are obtained.

The remaining algorithm's (BPNN and DBN-DNN) volatility predictions are obtained by using one of the commonly employed volatility proxies, daily squared returns. Figure 3 gives a clear overview of the methodology of this paper.

Figure 3. Overview of the Prediction Framework



Source: Author's own illustration

BPNN and DBN-DNN algorithms' one-day ahead volatility (squared return) predictions are obtained by employing squared cryptocurrency returns' own lagged values as well as volatility forecasts of the ARMA-GARCH and EGARCH as input variables (features). The steps are as follows:

- Train data is corrected for outliers as explained in Equation 13. Test data is left untouched.

- Train and test data are normalized by using only the train data normalization parameters to prevent leakage from the test data.
- Period specific volatility predictions of the algorithms are obtained by:

$$\hat{r}_{t,d}^2 = f(r_{t-1,d}^2, \dots, r_{t-10,d}^2, \sigma_{t,d,k}^2) + \varepsilon_t \quad (14)$$

where $r_{t-1,d}^2$ is the one-day lagged squared returns of cryptocurrency $d \in \{1,2\}$. Moreover, $\sigma_{t,d,k}^2$ is the day t volatility forecast of GARCH process k [$k \in \{ARMA - GARCH, EGARCH\}$].

4.4. Model calibration and performance

Parameters of the employed algorithms that are fine-tuned are summarized in Table 3. The optimal parameters are selected with a time series cross-validation (ts-cv) approach (Hyndman & Athanasopoulos, 2018) which keeps the order of the training data unchanged. Both BPNN and DBN-DNN algorithms are trained with a fixed rolling-window and validation samples of 116 days ($h = 116$). Parameters that minimize mean of the RMSE of validation samples are selected for out-of-sample volatility forecasts. The sigmoid as well as hyperbolic tangent activation functions are used both by BPNN and DBN-DNN networks. R software (R Core Team, 2019) is employed to obtain volatility predictions of the algorithms.

Table 3. Hyper-parameters of the Algorithms

Crypto	Model	Act. Func.	Learning Rate	Hidden Layers	Units of HL	Epoch
BTC	BPNN	Sigmoid	0.95	2	11/20	3
	BPNN	H. tangent	0.95	2	12/20	37
	DBN-DNN	Sigmoid	0.90	1	6	35
	DBN-DNN	H. tangent	0.95	2	9/16	48
ETH	BPNN	Sigmoid	0.95	2	8/19	3
	BPNN	H. tangent	0.95	2	8/19	27
	DBN-DNN	Sigmoid	0.95	2	17/20	3
	DBN-DNN	H. tangent	0.90	2	13/19	29

Notes: Hidden Layers refers to the number of hidden layers of the network. Units of HL indicates the number of units of each hidden layer. For example, the network design of BPNN (BTC), with the sigmoid activation function, has two hidden layers with 11 (Layer 1) and 20 (Layer 2) units. Moreover, DBN-DNN (BTC) with the sigmoid activation function, has one hidden layer consisting of 6 units. Epoch defines the iteration number of samples.

Period specific performance of the out-of-sample volatility forecasts of the models are compared with the well-known metrics of:

$$RMSE = \left(\sum_{t=1}^N (r_{t,d}^2 - \hat{r}_{t,d}^2)^2 / N \right)^{1/2} \quad (15)$$

$$R^2 = 1 - \left(\sum_{t=1}^N (r_{t,d}^2 - \hat{r}_{t,d}^2)^2 / \sum_{t=1}^N (r_{t,d}^2 - \bar{r}_d^2)^2 \right) \quad (16)$$

$$MAE = \sum_{t=1}^N |r_{t,d}^2 - \hat{r}_{t,d}^2| / N \quad (17)$$

where $r_{t,d}^2$ and $\bar{r}_d^2$ refer to the observed and mean of the observed out-of-sample squared returns of cryptocurrency d , respectively. $\hat{r}_{t,d}^2$ is the volatility prediction of a model. N is the number of observations.

5. EMPIRICAL RESULTS

Once the algorithms are calibrated, cryptocurrency specific out-of-sample volatility predictions of the models are obtained. Table 4 and Table 5 report the estimated performance measures for BTC and ETH, respectively.

Table 4. Performance Metrics - BTC

Method	RMSE	R ²	MAE
ARMA-GARCH	0.0013604	0.0024790	0.0006900
EGARCH	0.0013638	0.0134340	0.0006917
BPNN*	0.0013329	0.0021690	0.0006493
BPNN**	<i>0.0013319</i>	<i>0.0118286</i>	<i>0.0006560</i>
DBN-DNN*	0.0013391	0.0053625	0.0006739
DBN-DNN**	0.0013300	0.0000352	0.0006637

Notes: The best and second-best metrics are shown in bold and italics, respectively. * and ** indicate the algorithms that use either the sigmoid (*) or the hyperbolic tangent (**) activation functions.

According to Table 4, DBN-DNN with the hyperbolic tangent activation function yielded the best RMSE value of BTC. On the other hand, EGARCH obtained the best R² and BPNN algorithm that use the sigmoid activation function yielded the smallest MAE metric of BTC. While different algorithms are ranked as the best depending on the performance metric, BPNN with the hyperbolic tangent activation function yielded the closest as well as the second-best values of all the three metrics of BTC.

Table 5. Performance Metrics - ETH

Method	RMSE	R ²	MAE
ARMA-GARCH	0.0017355	0.0020939	0.0007846
EGARCH	0.0017237	0.0035364	<i>0.0007888</i>
BPNN*	<i>0.0017045</i>	0.0032395	0.0008268
BPNN**	0.0017053	0.0028780	0.0008226
DBN-DNN*	0.0017039	<i>0.0056355</i>	0.0008258
DBN-DNN**	0.0017346	0.0092906	0.0008629

Notes: The best and second-best metrics are shown in bold and italics, respectively. * and ** indicate the algorithms that use either the sigmoid (*) or the hyperbolic tangent (**) activation functions.

When the ETH volatility predictions of the applied algorithms are compared with the same performance metrics, in this case, DBN-DNN that use the sigmoid activation function yielded the best and the second-best RMSE and R^2 values, respectively. However, DBN-DNN with the hyperbolic tangent activation function had the best R^2 of ETH. Moreover, ARMA-GARCH and EGARCH processes obtained the best and the second-best MAE. Compared to the metrics of BTC reported in Table 4, BPNN with the hyperbolic tangent activation function did not rank as the best or the second-best in any of the performance measures of ETH.

6. CONCLUSION

In this research, one-day ahead volatility predictions of BPNN and DBN-DNN deep learning algorithms that use either the sigmoid or the hyperbolic tangent activation functions, are obtained for two different cryptocurrencies, Bitcoin and Ethereum. While it is easier to find research papers employing various deep learning algorithms to forecast price or price direction of a financial asset, the research focusing on predicting cryptocurrency volatility is still scarce. As mentioned by Zahid et al. (2022) only 13.8% of published papers, which conducted research on cryptocurrencies during 2013 and 2019 used deep learning algorithms. Moreover, most of them (most of the 13.8%) that use deep learning algorithms are mainly focused on predicting price or price direction of cryptocurrencies.

In this paper, out-of-sample volatility prediction performance of BPNN and DBN-DNN are measured by using several error metrics (RMSE, R^2 and MAE) and compared to the most frequently applied volatility modelling tools in economics and finance literature, that are the (ARMA-)GARCH and EGARCH processes. From the estimated performance measures, DBN-DNN algorithm yielded the lowest RMSE values both for Bitcoin and Ethereum. While DBN-DNN still yielded the best as well as the second-best R^2 of Ethereum, EGARCH was the winner in case of R^2 of Bitcoin. Moreover, BPNN yielded the best value of MAE of Bitcoin and ARMA-GARCH had the best MAE of Ethereum. These results are in line with the works of Kristjanpoller and Minutolo (2018) as well as Zahid et al. (2022) who reported an enhanced performance when a combination of GARCH and deep learning algorithms are used to predict volatility of cryptocurrencies. Overall, this research indicates a promising volatility forecasting ability in favor of the applied deep neural networks, since they managed to obtain most of the best as well as the second-best performance metrics of both Bitcoin and Ethereum.

Future research could assess volatility prediction performance of DBN-DNN and the other underexplored deep learning algorithms by using various conventional cryptocurrencies as well as the decentralized finance (DeFi) tokens that are emerged as a new asset class (Huang & Hsu, 2024). Moreover, it would also be interesting first to explore various drivers of cryptocurrency volatility including the DeFi tokens, and then to investigate the structure of the dependence between them. Finally, ML and/or DL algorithms yielding superior volatility predictions could be employed in portfolio risk

management and asset allocation context since accurate risk prediction is vital for both investors and regulators.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Abarghouie, M. O., Alizadeh, S. H., & Khademzadeh, A. (2024). Cryptocurrency volatility prediction based on price, return and volatility cross-correlation using LSTM. In *2024 11th International Symposium on Telecommunications (IST)* (pp. 309–318). IEEE. <https://doi.org/10.1109/IST64061.2024.10843571>
- Abdel-Zaher, A. M., & Eldeib, A. M. (2016). Breast cancer classification using deep belief networks. *Expert Systems with Applications*, 46, 139–144. <https://doi.org/10.1016/j.eswa.2015.10.015>
- Azizi, S. P., Huang, C. Y., Chen, T. A., Chen, S. C., & Nafei, A. (2023). Bitcoin volatility forecasting: An artificial differential equation neural network. *AIMS Mathematics*, 8(6), 13907–13922.
- Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31, 307–327.
- Carbonell, J. G., Michalski, R. S., & Mitchell, T. M. (1983). An overview of machine learning. In R.S. Michalski, J.G. Carbonell, & T.M. Mitchell (Eds.), *Machine Learning* (pp. 3–23). Morgan Kaufmann.
- Chen, J.-H., Hao, Y.-H., Wang, H., Wang, T., & Zheng, D.-W. (2019) Futures price prediction modeling and decision-making based on DBN deep learning. *Intelligent Data Analysis*, 23, 53–65. <https://doi.org/10.3233/IDA-192742>
- Christoffersen, P.F. (1998). Evaluating interval forecasts. *International Economic Review*, 39(4), 841–862. <https://doi.org/10.2307/2527341>
- D’Amato, V., Levantesi, S., & Piscopo, G. (2022). Deep learning in predicting cryptocurrency volatility. *Physica A: Statistical Mechanics and its Applications*, 596, 127158. <https://doi.org/10.1016/j.physa.2022.127158>
- Deng, L. (2014). A tutorial survey of architectures, algorithms, and applications for deep learning. *APSIPA Transactions on Signal and Information Processing*, 3(1), 1–29. <https://doi.org/10.1017/atsip.2013.9>
- Du, J., Liu, Y., & Zhijun, L. (2018). Study of precipitation forecast based on deep belief networks. *Algorithms*, 11(9), 132. <https://doi.org/10.3390/a11090132>
- Dudek, G., Fiszeder, P., Kobus, P., & Orzeszko, W. (2024). Forecasting cryptocurrencies volatility using statistical and machine learning methods: A comparative study. *Applied Soft Computing*, 151, 111132. <https://doi.org/10.1016/j.asoc.2023.111132>
- Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50(4), 987–1007.
- García-Medina, A. & Aguayo-Moreno, E. (2024). LSTM–GARCH hybrid model for the prediction of volatility in cryptocurrency portfolios. *Computational Economics*, 63, 1511–1542. <https://doi.org/10.1007/s10614-023-10373-8>

- Guo, T., Bifet, A., & Antulov-Fantulin, N. (2018). Bitcoin volatility forecasting with a glimpse into buy and sell orders. In *2018 IEEE International Conference on Data Mining (ICDM)* (pp. 989–994). IEEE. <https://doi.org/10.1109/ICDM.2018.00123>
- Hinton, G. E., Osindero, S., & Teh, Y. (2006). A fast learning algorithm for deep belief nets. *Neural Computation*, 18(7), 1527–1554. <https://doi.org/10.1162/neco.2006.18.7.1527>
- Huang, C. C., & Hsu, C. C. (2024). Evaluating dependence between DeFi tokens and conventional cryptocurrencies. *Applied Economics Letters*, 32(7), 1053–1059.
- Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and practice* (2nd ed.). OTexts.
- Jang, H., & Lee, J. (2018). An empirical study on modeling and prediction of Bitcoin prices with Bayesian neural networks based on blockchain information. *IEEE Access*, 6, 5427–5437.
- Karathanasopoulos, A. (2017). Modelling and trading commodities with a new deep belief network. *Economics and Business Letters*, 6(2), 28–34.
- Khan, F.U., Khan, F., & Shaikh, P.A. (2023). Forecasting returns volatility of cryptocurrency by applying various deep learning algorithms. *Future Business Journal*, 9(1), 25. <https://doi.org/10.1186/s43093-023-00200-9>
- Kristjanpoller, W., & Minutolo, M. C. (2018). A hybrid volatility forecasting framework integrating GARCH, artificial neural network, technical analysis and principal components analysis. *Expert Systems with Applications*, 109, 1–11. <https://doi.org/10.1016/j.eswa.2018.05.011>
- Kupiec, P. (1995). Techniques for verifying the accuracy of risk measurement models. *The Journal of Derivatives*, 3(2), 73–84.
- Lahmiri, S., & Bekiros, S. (2018). Chaos, randomness and multi-fractality in bitcoin market. *Chaos Solitons Fractals*, 106, 28–34.
- Li, J., Cheng, J.-h., Shi, J.-y., & Huang, F. (2012). Brief introduction of back propagation (BP) neural network algorithm and its improvement. In D. Jin & S. Lin (Eds.) *Advances in Computer Science and Information Engineering. Advances in Intelligent and Soft Computing* (169, pp. 553–558). Springer. https://doi.org/10.1007/978-3-642-30223-7_87
- Li, J., & Sun, Z. (2023). Application of deep learning in recognition of accrued earnings management. *Heliyon*, 9, e13664. <https://doi.org/10.1016/j.heliyon.2023.e13664>
- Liu, W. (2019). Portfolio diversification across cryptocurrencies. *Finance Research Letters*, 29, 200–205. <https://doi.org/10.1016/j.frl.2018.07.010>
- Ljung, G.M., & Box, G.E.P. (1978). On a measure of lack of fit in time series models. *Biometrika*, 65(2), 297–303. <https://doi.org/10.2307/2335207>
- Miura, R., Pichl, L., & Kaizoji, T. (2019). Artificial neural networks for realized volatility prediction in cryptocurrency time series. In H. Lu, H. Tang, & Z. Wang (Eds) *Advances in Neural Networks – ISNN 2019. Lecture Notes in Computer Science* (11554, pp. 165–172). Springer. https://doi.org/10.1007/978-3-030-22796-8_18
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized Business Review*, 21260.
- Nazareth, N., & Ramana Reddy, Y. V. (2023). Financial applications of machine learning: A literature review. *Expert Systems with Applications*, 219, 119640. <https://doi.org/10.1016/j.eswa.2023.119640>
- Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica*, 59(2), 347–370.
- Ozbayoglu, A. M., Gudelek, M. U., & Sezer, O. B. (2020). Deep learning for financial applications: A survey. *Applied Soft Computing Journal*, 93, 106384. <https://doi.org/10.1016/j.asoc.2020.106384>
- Peng, Y., Albuquerque, P. H. M., de Sá, J. M. C., Padula, A. J. A., & Montenegro, M. R. (2018). The best of two worlds: Forecasting high frequency volatility for cryptocurrencies and traditional currencies with support vector regression. *Expert Systems with Applications*, 97, 177–192. <https://doi.org/10.1016/j.eswa.2017.12.004>
- Pichl, L., & Kaizoji, T. (2017). Volatility analysis of bitcoin. *Quantitative Finance and Economics*, 1(4), 474–485. <https://doi.org/10.3934/QFE.2017.4.474>

- Pratas, T. E., Ramos, F. R., & Rubio, L. (2023). Forecasting bitcoin volatility: Exploring the potential of deep learning. *Eurasian Economic Review*, 13(2), 285–305. <https://doi.org/10.1007/s40822-023-00232-0>
- R Core Team. (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.r-project.org/>
- Rosenblatt, F. (1962). *Principles of neurodynamics: Perceptrons and the theory of brain mechanisms*. Spartan.
- Said, S. E., & Dickey, D.A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, 71(3), 599–607.
- Seo, M., & Kim, G. (2020). Hybrid forecasting models based on the neural networks for the volatility of bitcoin. *Applied Sciences*, 10(14), 4768. <https://doi.org/10.3390/app10144768>
- Shah, D., & Zhang, K. (2014). Bayesian regression and bitcoin. In *2014 52nd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*, (pp. 409–414). IEEE. <https://ieeexplore.ieee.org/abstract/document/7028484>
- Shen, Z., Wan, Q., & Leatham, D. J. (2021). Bitcoin return volatility forecasting: A comparative study between GARCH and RNN. *Journal of Risk and Financial Management*, 14(7), 337. <https://doi.org/10.3390/jrfm14070337>
- Vo, N. N. Y., & Xu, G. (2017). The volatility of Bitcoin returns and its correlation to financial markets. In *2017 International Conference on Behavioral, Economic, Socio-cultural Computing (BESCom)* (pp. 1–6). IEEE. <https://doi.org/10.1109/BESCom.2017.8256365>
- Wang, Y., Andreeva, G., & Martin-Barragan, B. (2023). Machine learning approaches to forecasting cryptocurrency volatility: Considering internal and external determinants. *International Review of Financial Analysis*, 90, 102914. <https://doi.org/10.1016/j.irfa.2023.102914>
- Zahid, M., Iqbal, F., & Koutmos, D. (2022). Forecasting bitcoin volatility using hybrid GARCH models with machine learning. *Risks*, 10(12), 237. <https://doi.org/10.3390/risks10120237>
- Zakoian, J.-M. (1994). Threshold heteroskedastic models. *Journal of Economic Dynamics and Control*, 18(5), 931–955.
- Zhang, J., Cai, K., & Wen, J. (2024). A survey of deep learning applications in cryptocurrency. *iScience*, 27(1), 108509. <https://doi.org/10.1016/j.isci.2023.108509>

The Human Factor in Green Transformation: The Impact of Empowering Leadership, Green Passion and Customer Pressure

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Abstract

Sustainability, which has gained importance in modern businesses, is crucial for enhancing employees' environmental awareness and creativity. The banking sector, a branch of the finance sector, also pays attention to raising its personnel's ecological awareness and innovative skills to promote the sector's sustainability. This study examines the mediating roles of empowering leadership, green passion and customer pressure in influencing the green creative behavior of bank personnel. Within the scope of the study, an online survey was administered to 403 bank personnel working in Balıkesir Province and Bandırma District, using the convenience sampling method. Partial Least Squares (PLS) based Structural Equation Modeling was used to analyze the study's data. In the study, it was found that empowering leadership has a significant impact on the green creative behavior of bank personnel and this effect is partially mediated by green passion and customer pressure. This situation reveals that environmental creativity is a phenomenon that is sensitive to both leadership approaches and individual motivation elements, as well as external environmental dynamics, in the organizational context.

Keywords: *Banking Sector, Customer Pressure, Empowering Leadership, Green Creative Behavior, Green Passion.*

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1. INTRODUCTION

Today, global environmental challenges are escalating. Businesses are compelled to integrate sustainability into their operations. The banking sector also strives to minimize consumer ecological footprints and provide sustainable financial products. Consequently, financial institutions need to enhance their workforce's environmental awareness and implement innovative ecological practices. The empowering leadership model articulated by Zhang and Bartol (2010) emphasizes a leadership approach that nurtures creativity by granting autonomy to employees. Amundsen and Martinsen (2014) contend that this leadership style enhances job performance by boosting employee self-confidence.

Conversely, Delmas and Montiel (2007) assert that consumer pressures enhance corporate environmental performance. Conversely, Yen and Yen (2012) contend that consumer expectations may impede innovative and sustainable practices. Research, including Chavez et al. (2016) and Shafiq et al. (2020), examines the intricate impact of consumer pressures on green creativity. Robertson and Barling (2013) define employees' environmental awareness as green passion. Jiang et al. (2019) posit that passion is vital for green creativity and enhances intrinsic motivation for sustainable product development. This study examines the relationships between empowering leadership, customer pressures and green passion for green creativity. This research is novel in that it concurrently assesses the mediating roles of empowering leadership, green passion and customer pressures on bank employees' green creativity. The study's significance lies in providing insights that aid banking institutions in developing sustainability strategies and understanding employee contributions to green transformation. The findings meaningfully advance academic literature and the banking industry, fostering the creation of effective strategies for a sustainable future.

2. CONCEPTUAL FRAMEWORK

2.1. Customer Pressures

Customer pressures are a primary element of external organizational stakeholders, defined as "the pressures organizations receive from customers during business transactions." Customer pressures that drive organizations to adopt new technologies are also known as "customer demands," "customer expectations," and "customer purchasing behavior." Delmas and Montiel (2007) argue that customer pressures can positively influence suppliers' decisions to adopt eco-friendly standards, such as ISO 14001, as these environmental demands increase suppliers' dependency on these standards. However, firms in the manufacturing and service sectors face difficulties implementing ecological standards due to these customer pressures. Organizations may prefer to meet customer demands and expectations regardless of their environmental impact. Yen and Yen (2012) highlight the adverse effects of customer pressures, as they can pose significant barriers to the adoption of eco-friendly innovations and changes. Since 2015, empirical studies on customer pressures have received increasing attention (Chavez et al., 2016; Shafiq et al., 2020).

Customer pressures are considered under the Stakeholder Value Theory, which, rooted in economics, asserts that profit is necessary to increase the economic value of corporate social responsibility from the customers' perspective. This "shareholder value-oriented" approach is generally associated with Agency Theory (Ross, 1973), where owners are considered principals and managers are viewed as agents. Growing demands from various stakeholders have led organizations to adopt sustainable supply chain management. Stakeholder theorists, such as Clarkson (1995), distinguish between primary stakeholders (customers, suppliers and regulators), who are essential for organizational survival and secondary stakeholders (media and NGOs), who influence but are not essential for survival.

In academic discourse, customer pressure refers to the expectations regarding an organization's environmental performance. Ateş et al. (2012) view customers as critical organizational assets necessitating strategic management. In contemporary contexts, heightened environmental consciousness positions customers as influential stakeholders exerting impactful, non-regulatory pressure on ecological stewardship. Ilieska (2013) defines a customer as an entity that procures goods or services to satisfy its requirements. Nevertheless, the existing literature highlights that customers transcend traditional consumer roles, making significant contributions to organizational sustainability objectives. Zhu and Sarkis (2007) highlight customers as a driving force behind proactive environmental strategies and organizational investments. Ateş et al. (2012) describe four recent customer pressures related to environmental activities:

- Pressure to meet customers' environmental requirements,
- Providing information on environmental performance,
- Demands for organizations to achieve waste reduction goals,
- Requirements for organizations to implement recycling, remanufacturing and reuse.

Stakeholder theory suggests that various stakeholders have unique needs and expectations, leading organizations to establish distinct social contracts with each group. This theory, which also explains the relationship between stakeholder perceptions and organizational reporting strategies, posits that customer pressures influence an organization's reporting approach. Fernandez-Feijoo et al. (2014) highlight customer pressure as a determinant of transparency levels and sustainability reporting. Freeman et al. (2010) underscore organizations' multiple customer responsibilities, suggesting that customer pressures improve work standards and productivity, benefiting employees and customers.

2.2. Green Creative Behaviors of Employees

Green creative behaviors entail formulating innovative and beneficial concepts with eco-friendly implications for business outputs. The cultivation of green creativity is contingent upon the synergy of an entity's environmental strategies and aligned human resources practices. An organization must promote active employee engagement to realize efficient environmental governance and foster

green creativity (Boselie et al., 2005). The AMO framework (Ability-Motivation-Opportunity) asserts that capabilities, motivation and opportunities enhance organizational performance. This perspective highlights the interaction between employee traits and organizational context in shaping behavior and outcomes. Specifically, creativity, defined as the production of novel and valuable ideas, is affected by AMO elements. Colbert (2004) indicates that individual abilities, motivation and organizational opportunities jointly determine employees' innovative potential. Integrating innovation and development makes green creativity an effective means of eliminating environmental and resource bottlenecks, thereby promoting sustainable development (Chen, 2008). Green creativity, which refers to innovative ideas and practices within production and service processes, emphasizes an organization's environmentally friendly actions (Chen, Y. S. & Chang, K. C., 2013). Green performance management and reward systems are crucial for enhancing employees' eco-creative outputs. Aligning performance assessments with strategic green goals helps promote environmentally responsible behavior. Green HR aims to reward employees' green creativity behaviors and activities. Moreover, employees who receive clear information from green HR can better understand the strategic goals of the organization's green initiatives, thereby clarifying their roles in the environmental management process (Bret Becton et al., 2008).

Green creativity entails the development of environmentally friendly products and services through innovative ideas. Creativity relates to the psychological behaviors of individuals, where an individual's experience and knowledge serve as significant indicators of how managers can enhance employee creativity. If an organization possesses innovative ideas and employees committed to producing eco-friendly products/services, it can be considered dedicated to green creativity. This signifies that organizations can contribute to environmentally oriented activities end-to-end. Managers and employees committed to green creativity aim to improve economic and social performance while maintaining a long-term commitment to environmental preservation. High levels of green creativity significantly improve sustainable business performance and enhance organizational competitive advantage in the long term (Setyaningrum et al., 2023). Green creative behaviors refer to environmentally conscious actions exhibited by employees within organizations. Thus, employees should be allowed to embrace and implement eco-friendly policies actively. From product and process development activities, creating a shared consciousness is crucial to aligning organizational goals with environmental considerations. Environmentally aware management must lead by example, promoting actions that mitigate ecological impact while eliminating detrimental practices (Yüksel et al., 2022).

2.3. Empowering Leadership

Empowering leadership is a concept in which leaders share legitimate power with subordinates, granting them autonomy and responsibility to foster experiences of empowerment. This leadership concept includes enhancing psychological empowerment, increasing the meaningfulness of work, encouraging subordinates to express their opinions, facilitating participation in decision-making, sharing

information and easing knowledge management (Zhang & Bartol, 2010). Empowering leaders enhances psychological empowerment within the organization, enabling employees to make informed decisions in fulfilling their tasks. These leaders positively influence employees' behaviors and attitudes by instilling a belief in their ability to carry out tasks and granting autonomy in decision-making within work processes (Amundsen & Martinsen, 2014). Empowering leadership involves sharing power through specific leader behaviors that aim to motivate. This style of leadership separates empowerment into two main approaches. The first, structural empowerment, focuses on leaders' empowering behaviors, such as providing guidance, participative decision-making, coaching, information-sharing and attentiveness, as core dimensions of empowering leadership. Another approach, psychological empowerment, emphasizes the feelings of empowerment among employees.

In this context, empowering leadership grants employees autonomy beyond bureaucratic restrictions encourages participation in decision-making processes, increases the meaningfulness of work and instills a sense of confidence in high performance (Conger & Kanungo, 1988). In organizations, delegation of authority should be considered not only to reduce the leader's workload but also as a conscious strategy that supports the development and motivation of employees (Tian & Zhang, 2020). The goal here is to instill trust, enhance organizational commitment, maintain the leader's authority, grant autonomy to employees and improve perceived control and accountability for organizational sustainability. This way, employees will align their interests with the organization's, gaining intrinsic motivation to expand market share. Such a leadership profile extends beyond ethical and responsible leadership, fostering a positive and future-oriented outlook within organizations (Redelinghuys et al., 2020). Leadership behavior plays a crucial role in effectively guiding employees' eco-friendly behaviors. Numerous studies have shown that positive leadership styles have a favorable impact on employee behavior (Khatoon et al., 2022; Wang et al., 2022). Since the 21st century, as the external environment has grown increasingly dynamic and complex, organizations have focused on self-management among employees to adapt. Thus, empowering leadership, which offers the advantage of developing employees' self-leadership abilities, has garnered the attention of researchers (Bernoff & Schadler, 2010). Studies on empowering leadership suggest that this form fosters a sense of value and trust among employees, promoting positive and effective leadership that invigorates the organization. Empowering leadership, a significant and upbeat leadership style, has been proven to positively impact employee behaviors, such as organizational citizenship, environmental behavior and innovative behavior (Jiang et al., 2019).

Empowering leadership provides more autonomy in organizational decision-making processes, removing barriers to employee performance and sharing power with personnel. This leadership style enables employees to understand the significance of their work better, highlighting the importance of their roles and behaviors in driving organizational development (Wen et al., 2023). It encourages employees to voice their ideas, grants them greater autonomy in decision-making and aids in developing

their competencies. According to social exchange theory, employees are more likely to reciprocate when they feel motivated and trusted by their leaders (Wang et al., 2023). Specifically, empowering leadership stimulates employees' intrinsic motivation to contribute to the organization. Subsequently, employees will go beyond role boundaries, protecting the organization's interests to uphold its vision. Thus, empowering leaders are perceived as individuals inclined to foster behaviors conducive to eco-friendly organizational development. Furthermore, empowering leaders mitigate employees' work-related concerns, enabling them to engage in environmentally responsible behaviors (Yue et al., 2022).

Empowering leadership encompasses a set of leadership behaviors that aim to share power and control, foster trust, set high expectations and encourage greater self-direction among employees (Sharma & Kirkman, 2015). Many scholars argue that empowering leadership consistently yields positive results. Using conservation of resources theory, Zheng et al. (2023) assert that empowering leadership enhances project performance by motivating employees' creative self-efficacy. However, some researchers contest this view outside of project environments. Conger and Kanungo (1988) indicate that unregulated empowerment can lead to overconfidence among subordinates, potentially resulting in strategic errors over time. Zheng et al. (2023) suggest that empowered employees may resort to unethical behaviors due to increased responsibilities. Employees view empowerment positively as a situational factor and a unique incentive under empowering leadership. Also known as enabling leadership, employees hold a favorable perspective toward empowering leaders (Kehoe & Collins, 2017). Also referred to as super-leadership, empowering leaders seek to cultivate their followers' potential leadership capabilities, refraining from issuing direct orders. This style of leadership allows employees to manage and control their behaviors. Consequently, leaders should be empowered to assign responsibilities and remind employees of their control over their actions, emphasizing their roles as self-leaders (Yun et al., 2006). Characteristics of an effective empowering leader include a focus on addressing employee concerns, maintaining and upholding respect within the organization, sincerity, a thorough understanding of employees for effective coaching, offering opportunities for experiential learning and being understanding of potential mistakes (Cevahir, 2004). Leader behavior and attitudes are critical in empowering employees within organizations. Among the opportunities that empowering leaders provides, including authority delegation, responsibility, information sharing, innovative performance and independent decision-making, the most crucial element that accelerates work processes is authority delegation. Through responsibility, leaders persuade employees to strive toward organizational goals (Bayrakdar, 2014). Leaders thus hold employees accountable for outcomes related to organizational activities. In independent decision-making, leaders demonstrate trust in employees' decisions, while with information-sharing, they allow error tolerance, fostering development. Overall, empowerment entails both behavioral and cognitive aspects. Considering this perspective, encouraging behaviors that promote employees' self-efficacy and free will can benefit organizational empowerment (Bolat et al., 2009).

2.4. Employees' Green Passion

Green passion is a positive feeling that motivates employees to engage in environmentally friendly behaviors within organizations (Robertson & Barling, 2013). Passion plays a crucial role in employees' dedication to diverse organizational activities. Employees often express passion by showing positive emotions, developing meaningful connections with various work tasks and feeling internally motivated to fulfill these tasks (Li et al., 2020). Employees' green passion signifies their emotional engagement with organizational environmental practices, serving as a motivational driver for pro-environmental actions (Vallerand, 2012). Individuals exhibiting high green passion engage in eco-sensitive behaviors, demonstrate persistent commitment and self-identify as environmentally conscious. Here, the leader's role involves reinforcing green passion among employees, which may, over time, encourage excessive eco-friendly behaviors (Afsar et al., 2016).

The goal of green passion is to convert this positive feeling into environmentally conscious behaviors, as employees' green passion influences their ecological conduct. Employees dedicated to the environment value recycling and identify themselves as environmental enthusiasts (Sembiring et al., 2020). According to Turaga et al. (2010), green passion significantly, if not more strongly than intrinsic motivation, influences employees' involvement in environmentally friendly behaviors. Passion represents a person's strong inclination to devote time to an activity they love and consider important (Vallerand, 2012). Vallerand's Dualistic Model of Passion, based on self-determination theory, distinguishes between obsessive and harmonious passion and links it to green passion. Obsessive passion arises from a controlled internalization process whereby individuals feel compelled to engage in an activity due to external factors, such as seeking social acceptance or self-esteem (Vallerand, 2012), often resulting in heightened psychological stress. In contrast, harmonious passion emerges due to an activity's autonomous internalization within one's identity, where individuals freely engage without feeling forced (Vallerand, 2012). Thus, a strong and harmonious environmental passion is related to positive affect, psychological well-being and job performance and can be applied to both work and non-work domains (Hoe et al., 2018). Harmonious environmental passion is essential for predicting excessive eco-friendly behaviors as it triggers positive emotions that motivate employees toward environmentally conscious actions. Employees with a strong, harmonious green passion are energetic and determined to contribute to environmental improvement initiatives, freely dedicating time and effort to ecological activities without conflicts arising with other daily tasks (Afsar et al., 2016). In short, harmonious passion for the environment fosters motivation among employees to engage in environmentally friendly behaviors actively (Robertson & Barling, 2013).

Eco-friendly behaviors aim to mitigate adverse environmental impacts. Therefore, green passion signifies an intrinsic desire or commitment toward eco-friendly practices, influencing tangible eco-friendly behaviors (Robertson & Barling, 2013). Green passion is related to employees' concern levels about the impact of environmental issues on their current and future well-being, with those more

environmentally aware inclined to practice eco-friendly behaviors (Gatersleben et al., 2002). Four key reasons suggest that green passion leads to eco-friendly employee behaviors (Afsar et al., 2016). The first is that green passion encompasses positive emotions and inspires an experience that promotes environmental protection. Second, green passion is viewed as a moral behavior, much like the influence of moral actions on eco-friendly behaviors. Third, positive emotions such as happiness and satisfaction influence employees' eco-friendly behaviors, reinforcing green passion as a positive emotion. The fourth reason is that employees experiencing strong emotions, such as green passion, feel they make a difference, are motivated, gain energy and feel inspired (Sembiring et al., 2020). Based on these reasons, green passion can be said to trigger environmentally friendly activities, facilitating the motivation to make a difference.

3. METHOD OF THE RESEARCH

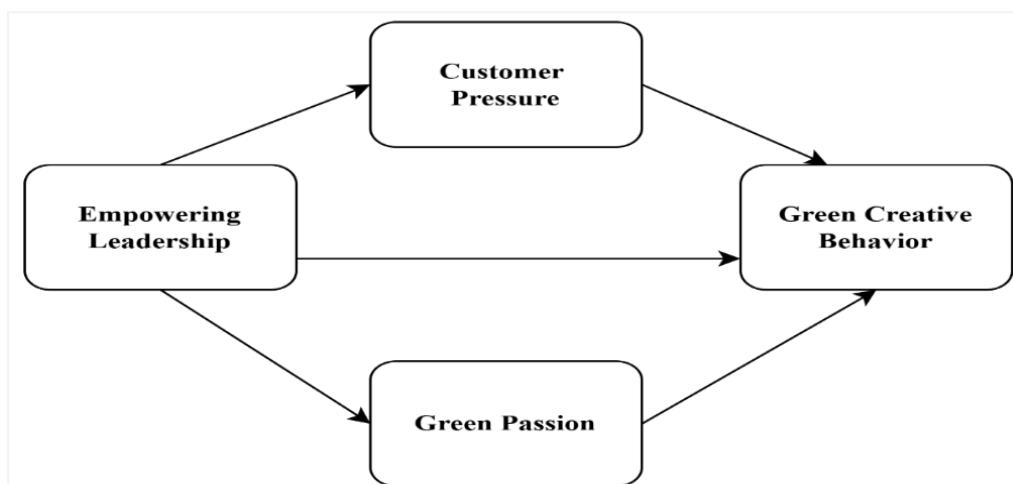
In the study, the mediating roles of customer pressure and green passion in the effect of empowering leadership on bank personnel's green creative behavior were evaluated. While the study universe comprised 1,800 personnel working in Balıkesir province and its districts, the study sample consisted of 403 bank personnel working in Balıkesir province and Bandırma district. Considering the number of items (questions) used in the study, the sample size is more than 10 times the number of items. Studies in the literature have suggested that, especially for factor analysis and similar multivariate techniques, the sample size should be at least 5 to 10 times the number of variables or items (Hair, Black, et. al., 2019). Based on this, the current sample size is considered to be sufficient and statistically reliable for the analyses performed. In this study, an online survey was conducted and approval was received from the ethics committee of the relevant university. Partial Least Squares (PLS) based Structural Equation Modeling was used to analyze the research data. Partial Least Squares (PLS-Partial Least Squares) is robust to the complexity of scales and model. Thanks to this feature, PLS can work with small samples and complex models (Purwanto & Sudargini, 2021; Ringle et al., 2020). For this reason, the data obtained in the study were analyzed with Partial Least Squares (PLS) based Structural Equation Modeling. A four-item scale developed by Ahearne et al. (2005) was used to assess the empowering leadership used in the study, a six-item scale developed by Chen, Y. S. and Chang C. H. (2013) was used to determine green creative behavior, a four-item scale developed by Cho & Yoo (2021), Jia et al. (2018) for green passion and a three-item scale developed by Yen & Yen (2012) for customer pressure.

3.1. Hypotheses of The Study

Green creative behavior in organizations encompasses original, new and valuable ideas generated by individuals within the organizational context. It is recognized as the first critical stage of innovation, which fosters growth. Empowering leaders with high idealized influence and intellectual stimulation encourages people to creatively solve environmental problems. It directs employees to prioritize corporate social responsibility and ecological sustainability over their interests. Therefore, the aspects of ability, opportunity and motivation theory will affect the production of new and valuable

environmental ideas created through the interaction between individual and situational factors. This theory is used to identify the factors that contribute to high performance within an organization. An organization that considers the ability, motivation and possible opportunities an employee can capitalize on will reach its organizational goals more efficiently, as it will enhance its operations (Boselie et al., 2005). Organizational leaders use this model (ability, opportunity and motivation theory) to influence the performance of employees. An organization that prioritizes all three elements can achieve more success than an organization that prioritizes only one or two elements. Organizations optimize employees' abilities, motivations and potential opportunities to increase employee performance and achieve their goals. Therefore, this research uses the theory of ability, opportunity and motivation to analyze employees' green creative behaviors within the organization (Colbert, 2004). Social exchange theory, linked to Albert Bandura, posits that individuals learn through observing and imitating the behaviors of others. Bandura states that knowledge and skills are acquired through direct experience and observing the actions and outcomes of others. According to social exchange theory, employees are more likely to provide positive feedback when their leaders motivate and trust them. According to social exchange theory, individuals who perceive that they will receive positive outcomes at the end of the interaction process tend to adopt a different approach to exchange than those who anticipate adverse outcomes (Doğan & Sökmen, 2021). The significance of role models, social dynamics and context in influencing sustainability behaviors and attitudes is highlighted. Researchers use this theory to analyze current dynamics and recommend encouraging sustainable practices in the sector. The core tenet of conservation theory, known as motivation theory, posits that individuals are driven to safeguard existing resources while also seeking new ones. Individuals become aware that they must allocate resources to maintain their current resources and acquire new ones. For this reason, they realize that their excess resources make them robust against stress (Hobfoll, 2001). The hypotheses and model of the research, prepared within the scope of ability, opportunity, motivation theory, social exchange theory and conservation theory of resources, are presented below.

Figure 1. Research Model



The hypotheses of the research are stated below.

H₁: Empowering leadership among bank employees significantly influences green creative behavior.

H₂: Bank employees' customer pressure partially mediates in the relationship between empowering leadership and green creative behavior.

H₃: Bank employees' green passion partially mediates in the relationship between empowering leadership and green creative behavior.

4. FINDINGS OF THE RESEARCH

Within the scope of the research findings, the demographic information of the bank personnel, descriptive statistics of the scales and normality tests were included. Additionally, exploratory factor analysis was conducted. Then, Partial Least Squares (PLS) based Structural Equation Modeling was used to analyze the research data.

Table 1. Demographic Information of Bank Personnel

Variables	Subgroups	Frequency	Percentage (%)
Gender	Female	205	50.9
	Male	198	49.1
Age	22-26 between ages	24	6.0
	27-31 between ages	41	10.2
	32-36 between ages	109	27.0
	37-41 between ages	121	30.0
	42 and above	108	26.8
Educational Status	Associate Degree	61	15.1
	Licence (Bachelor's)	277	68.7
	Postgraduate	65	16.2
Total		403	100

Fifty percent of the bank personnel participating in the research are female and 49.1% are male. 30.0% of the participants are between the ages of 37-41. 68.7% of the bank's personnel have a bachelor's degree.

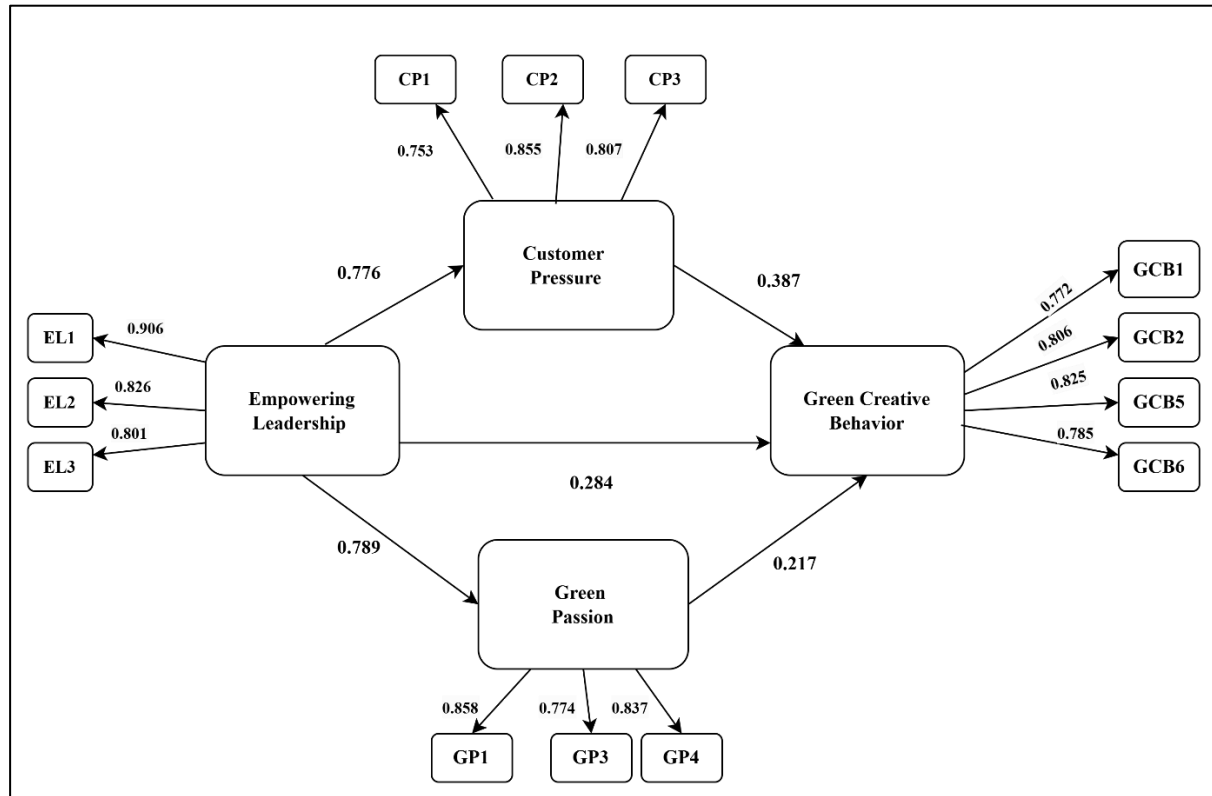
Table 2. Descriptive Statistics of the Scale and Normality Test

Scale	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
EL	3.63	1.037	1.00	5.00	-1.327	.187
GCB	3.54	.965	1.00	5.00	-.916	-.374
CP	3.56	1.002	1.00	5.00	-.992	-.414
GP	3.63	1.010			-1.141	.131

Table 2 shows EL: empowering leadership, GCB: green creative behavior, CP: customer pressure, GP: green passion. Some researchers assume that kurtosis and skewness values should be between -1.5 and +1.5 (Tabachnick et al., 2013). According to this assumption, it was determined that

the scales in the study exhibited a normal distribution. In the research, the mediating roles of customer pressures and green passion in the effect of empowering leadership by bank personnel on green creative behavior were evaluated. The multi-factor model of the research is shown below.

Figure 2. Model of Mediation Model



Item 4 in the empowering leadership scale, items 3 and 4 in the green creative behavior scale and item 2 in the green passion scale were removed from the model because these items affected the significance of the model. Internal consistency reliability, convergent validity and discriminant validity were evaluated by testing the multi-factor model of the confirmatory factor analysis measurement and are expressed below.

Table 3. Results of Multi-Factor Measurement Model

Variable	Coefficients	Cronbach's Alpha	rho A	Reliability Value	
				CR	AVE
Empowering Leadership		0.800	0.817	0.882	0.715
EL1	0.906				
EL2	0.826				
EL3	0.801				
Green Creative Behavior		0.809	0.809	0.875	0.636
GCB1	0.772				
GCB2	0.806				
GCB5	0.825				
GCB6	0.785				

(Table 3 cont.)

Variable	Coefficients	Cronbach's Alpha	rho A	Reliability Value	
				CR	AVE
Customer Pressure		0.729	0.734	0.847	0.650
CP1	0.753				
CP2	0.855				
CP3	0.807				
Green Passion		0.762	0.765	0.863	0.678
GP1	0.858				
GP3	0.774				
GP4	0.837				

As a result of multivariate analyses, it was determined that the created model was internally consistent and accurately represented the concepts it intended to measure. Internal consistency coefficients, such as Cronbach's Alpha, rho A and CR and convergent validity indices, such as AVE, support the model's reliability. In addition, the fact that the factor loadings obtained in the pls-sem analysis were at the expected level confirms the structural validity of the model. In line with the criterion suggested by Fornell and Larcker (1981), the discriminant validity of the model was achieved. These findings demonstrate that the model possesses a theoretically and empirically solid structure, as per the validity and reliability criteria specified by Hair et al. (2014) and Hair, Ringle et. al. (2019). Table 9 presents the analysis results of the model regarding the Fornell and Larcker criterion.

Table 4. Fornell and Larcker Criterion

	Empowering Leadership	Green Creative Behavior	Customer Pressure	Green Passion
Empowering Leadership	0.846			
Customer Pressure	0.789	0.806		
Green Passion	0.702	0.776	0.824	
Green Creative Behavior	0.713	0.756	0.760	0.797

Analyses performed according to the Fornell and Larcker criterion show that the variables in the model are measured independently of each other and thus have discriminant validity. The Q² metric assessed the model's predictive efficacy. R² statistics quantified the variance explained by independent variables on the dependent variable. Standardized beta coefficients indicated the relative significance of the independent variables within the model. The VIF value was examined to detect the multicollinearity problem and the f² value expresses the magnitude of the effect of each independent variable on the dependent variable (Hair et al., 2014).

Table 5. Model Results

	VIF	R ²	Q ²	f ²	β	Standard Deviation	t	P
EL -> GCB	3.573	0.663	0.567	0.067	0.284	0.025	31.830	0.000
EL -> CP	1.000	0.602	0.599	1.516	0.776	0.028	27.631	0.000
MB -> GCB	2.657	0.819		0.167	0.387	0.054	7.172	0.000
EL -> GP	1.000	0.623	0.620	1.650	0.789	0.025	31.830	0.000
GP -> GCB	2.799			0.050	0.217	0.056	3.894	0.000
EL ->CP -> GCB					0.301	0.044	6.893	0.000
EL ->GP -> GCB					0.171	0.045	3.774	0.000

The R² values obtained in the research model indicate that 66.3% of the variance in empowering leadership among bank personnel and 60.2% of the variance in customer pressure are explained by green creative behavior. This finding reveals that the empowering leadership of bank personnel and customer pressure significantly affect their green creative behavior. The fact that the VIF values used to evaluate the linearity assumption of the model are below five indicates that there is no multicollinearity problem and that the model's estimates are reliable (Henseler et al., 2015). The fact that the Q² values are above 0.35 indicates that the model's predictive power on new data is high and supports the structural validity of the model (Hair et al., 2014). However, the f² values above 0.002 indicate that the effect of the independent variables on the dependent variable is statistically significant (Hair et al., 2014).

It was determined that the empowering leadership of bank personnel has a positive and significant effect on green creative behavior ($\beta = 0.284$, $p < 0.01$). According to this result, hypothesis H1 was accepted. It was determined that the empowering leadership of bank personnel has a substantial effect on customer pressure ($\beta = 0.776$, $p < 0.01$). It was determined that customer pressure on bank personnel has a significant effect on green creative behavior ($\beta = 0.387$, $p < 0.01$). It was determined that the empowering leadership of bank personnel has a partial mediating role in the relationship between customer pressure and green creative behavior ($\beta = 0.301$, $p < 0.01$) and hypothesis H2 was accepted. The significant effect of empowering leadership on green creative behavior, as shown in the first model, remains substantial when the customer pressure variable is added to the model, indicating that this variable plays a partial mediating role. Therefore, it was determined that customer pressure has a partial mediating role in the relationship between empowering leadership and green creative behavior.

When the mediation effect of green passion on the green creative behavior of bank personnel, empowered by leadership, was evaluated, it was determined that the leadership of bank personnel had a positive and significant effect on green creative behavior ($\beta = 0.284$, $p < 0.01$). It was found that the empowering leadership of bank personnel had a positive and significant impact on green passion ($\beta = 0.789$, $p < 0.01$). It was found that the green passion of bank personnel had a positive and significant effect on green creative behavior ($\beta = 0.217$, $p < 0.01$). In the final stage of the mediation model, it was found that green passion played a partial mediating role in the effect of empowering leadership on bank personnel's green creative behavior ($\beta = 0.171$, $p < 0.01$) and thus hypothesis H3 was accepted. The first

model examines the significant effect of empowering leadership on green creative behavior among bank personnel. The fact that the green passion variable remained substantial when added to the model indicates that this variable has a partial mediating role.

5. CONCLUSION

The study assessed customer pressure and green passion as mediators between empowering leadership and green creative behavior. An online survey was conducted among 403 bank employees from Balıkesir Province and Bandırma District. Data analysis employed Partial Least Squares (PLS) based structural equation modeling. Results indicate a significant positive relationship between empowering leadership and the green creative behavior of bank personnel ($\beta = 0.284$, $p < 0.01$). Thus, hypothesis H1 received confirmation. This result aligns with previous research by Khattak et al. (2023), Badar et al. (2023), Edosomwan et al. (2023) and Zhang & Bartol (2010).

Additionally, empowering leadership has a significant influence on customer pressure ($\beta = 0.776$, $p < 0.01$). This aligns with the findings of Dong et al. (2015) and Namasivayam et al. (2014). Furthermore, customer pressure on bank personnel has a significant impact on green creative behavior ($\beta = 0.387$, $p < 0.01$). This result corroborates Cho & Yoo's (2021) and Khattak et al. (2022) studies. Additionally, customer pressure is found to partially mediate the relationship between empowering leadership and the green creative behavior of bank personnel ($\beta = 0.301$, $p < 0.01$), thus supporting hypothesis H2. The integration of customer pressure within the model preserves the statistical significance of empowering leadership's effect on green creative behavior, demonstrating its partial mediating role.

It was determined that green passion has a significant positive effect ($\beta = 0.284$, $p < 0.01$) on the mediating effect of empowering leadership on the green creative behavior of bank employees. This result aligns with Elsaied (2022) and Hao et al.'s (2018) findings. Furthermore, the green passion of bank employees has a positive impact on their green creative behavior ($\beta = 0.217$, $p < 0.01$). This finding aligns with the similar causal relationship established in the research of Jia et al. (2018) and Shah et al. (2023). In the concluding phase of the mediation model, green passion was identified as a partial mediator between empowering leadership and the green creative behavior of bank employees ($\beta = 0.171$, $p < 0.01$), thereby affirming hypothesis H3. The initial model's significant effect of empowering leadership on green creative behavior remained, indicating a partial mediation effect when the green passion variable was added.

In previous studies, customer pressure has generally been considered an external, compelling factor influencing sustainability performance (Zhu & Sarkis, 2007; Gualandris & Kalchschmidt, 2014). However, its psychological impact on employees' green creative behavior at the individual level has been largely overlooked. Similarly, among the mechanisms explaining the relationship between empowering leadership and green creative behavior, variables such as organizational support (Mittal &

Dhar, 2016) or environmental values (Chen, Y. S. & Chang, C. H., 2013) have been examined more frequently; the impact of external social factors such as customer pressure on creative environmental behavior at the employee level has not been investigated in sufficient detail. Our study fills a significant gap in the current literature. Given the high level of customer contact and service orientation in the banking sector, it is essential to evaluate the impact of customer demands and expectations on employees' psychological processes (Luo et al., 2012). In this context, the study shows that customer pressure can play a mediating role in the behaviors of bank employees not only at the institutional level but also at the individual level.

The recommendations presented to managers within the framework of the results are as follows.

- An organizational culture fostering proactivity and creativity among bank staff is essential. Inclusion in decision-making and autonomy are vital for attaining sustainability objectives.
- Sustainability training should be planned and awareness initiatives implemented to enhance the environmental sensitivity of bank personnel.
- Monitoring customer expectations and analyzing the demand for environmentally friendly products and services is recommended.
- Mechanisms must be developed to facilitate the exchange of ideas with banking staff regarding sustainability targets.
- Leaders are expected to guide bank employees in adopting a culture of sustainability, promoting environmental awareness among all staff.

This study cannot be generalized, as it was conducted on a specific sample and sector. The study is being implemented in the banking sector and the results may differ when applied to other industries and with varying sample sizes.

Ethics committee approval for the study was obtained from the Bandırma Onyedi Eylül University Ethics Committee on December 12, 2023, with decision number 2023-10.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all processes of the research.

REFERENCES

- Afsar, B., Badir, Y., & Kiani, U. S. (2016). Linking spiritual leadership and employee pro-environmental behavior: The influence of workplace spirituality, intrinsic motivation, and environmental passion. *Journal of Environmental Psychology*, 45, 79-88.

- Ahearne, M., Mathieu, J., & Rapp, A. (2005). Satış gücünüzü güçlendirmek mi güçlendirmemek mi? Liderlik güçlendirme davranışının müşteri memnuniyeti ve performansı üzerindeki etkisinin ampirik bir incelemesi. *Uygulamalı Psikoloji Dergisi*, 90(5), 945.
- Amundsen, S., & Martinsen, Ø. L. (2014). Empowering leadership: Construct clarification, conceptualization, and validation of a new scale. *The Leadership Quarterly*, 25(3), 487-511.
- Ateş, M. A., Bloemhof, J., Van Raaij, E. M. & Wynstra, F. (2012). Proactive environmental strategy in a supply chain context: The mediating role of investments. *International Journal of Production Research*, 50(4), 1079-1095.
- Badar, K., Kundi, Y. M., Siddiquei, A. N., & Abualigah, A. (2023). Linking environmentally-specific empowering leadership to hotel employees' green creativity: Understanding mechanisms and boundary conditions. *Journal of Service Theory and Practice*, 33(3), 412-435.
- Bayrakdar, M. (2014). *Çalışanların liderlik özellikleri ile örgüte bağlılıkları arasındaki ilişkinin incelenmesi*. [Unpublished master's thesis], Turkish Aeronautical Association University.
- Bernoff, J., & Schadler, T. (2010). Empowered. *Harvard Business Review*, 88(7/8), 94-101.
- Bolat, O. İ., Bolat, T., & Seymen, O. A. (2009). Güçlendirici lider davranışları ve örgütsel vatandaşlık davranışı arasındaki ilişkinin sosyal mübadele kuramından hareketle incelenmesi. *Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 12(21), 215-239.
- Boselie, P., Dietz, G., & Boon, C. (2005). Commonalities and contradictions in HRM and performance research. *Human Resource Management Journal*, 15(3), 67-94.
- Boselli, A. M., Caravello, G. U. & Baroni, A. (2005). The upper mustang (Nepal) ecosystem: Population, water quality and tourism. *Aquatic Ecosystem Health & Management*, 8(3), 285-291.
- Bret Becton, J., Giles, W. F. & Schraeder, M. (2008). Evaluating and rewarding OCBs: Potential consequences of formally incorporating organisational citizenship behaviour in performance appraisal and reward systems. *Employee Relations*, 30(5), 494-514.
- Cevahir, H. (2004). *Güçlendirici liderlik davranışları ile örgütsel bağlılık ve iş tatmini arasındaki ilişki üzerine bir araştırma*, [Unpublished master's thesis], Gebze Technical University.
- Chavez, R., Yu, W., Feng, M., & Wiengarten, F. (2016). The effect of customer-centric green supply chain management on operational performance and customer satisfaction. *Business Strategy and the Environment*, 25(3), 205-220.
- Chen, Y. S. (2008). The driver of green innovation and green image-green core competence. *Journal of Business Ethics*, 81, 531-543.
- Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance: Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of Business Ethics*, 116(1), 107-119.
- Chen, Y. S., & Chang, K. C. (2013). The nonlinear effect of green innovation on the corporate competitive advantage. *Quality & Quantity*, 47, 271-286.
- Cho, M., & Yoo, J. J. E. (2021). Customer pressure and restaurant employee green creative behavior: Serial mediation effects of restaurant ethical standards and employee green passion. *International Journal of Contemporary Hospitality Management*, 33(12), 4505-4525.
- Clarkson, M. E. (1995). A stakeholder framework for analyzing and evaluating corporate social performance. *Academy of Management Review*, 20(1), 92-117.
- Colbert, B. A. (2004). The complex resource-based view: Implications for theory and practice in strategic human resource management. *Academy of Management Review*, 29(3), 341-358.
- Conger, J. A., & Kanungo, R. N. (1988). The empowerment process: Integrating theory and practice. *Academy of Management Review*, 13(3), 471-482.
- Delmas, M. A., & Montiel, I. (2007). The adoption of ISO 14001 within the supply chain: When are customer pressures effective?
- Doğan, M., & Sökmen, S. (2021). Turizm araştırmalarında sosyal değişim teorisi'nin çeyrek yüzyılı. *Türk Turizm Araştırmaları Dergisi*, 5(2), 1220-1237.

- Dong, Y., Liao, H., Chuang, A., Zhou, J., & Campbell, E. M. (2015). Fostering employee service creativity: Joint effects of customer empowering behaviors and supervisory empowering leadership. *Journal of Applied Psychology, 100*(5), 1364-1375.
- Edosomwan, H. S., Oguegbe, T. M., & Joe-Akunne, C. O. (2023). Workplace well-being in manufacturing organizations in Nigeria: Do employee green behavior, core self-evaluations and empowering leadership matter? *International Journal of Occupational Safety and Health, 13*(1), 97-107.
- Elsaied, M. M. (2022). The mechanism underlying the relationship between empowering leadership and work passion. *Human Systems Management, 41*(1), 59-72.
- Fernandez-Feijoo, B., Romero, S. & Ruiz, S. (2014). Effect of stakeholders' pressure on transparency of sustainability reports within the GRI framework. *Journal of Business Ethics, 122*, 53-63.
- Fornell, C. & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research, 18*(3), 382-388.
- Freeman, R. E., Harrison, J. S., Wicks, A. C., Parmar, B. L. & De Colle, S. (2010). Stakeholder theory: The state of the art. *The Academy of Management Annals, 3*(1), 403-445.
- Gatersleben, B., Steg, L. & Vlek, C. (2002). Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior, 34*(3), 335-362.
- Gualandris, J., & Kalchschmidt, M. (2014). Customer pressure and innovativeness: Their role in sustainable supply chain management. *Journal of Purchasing and Supply Management, 20*(2), 92-103.
- Hair, Jr J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis*. Prentice Hall.
- Hair, Jr. J. F., Risher, J. J., Sarstedt, M. & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2-24.
- Hair, Jr J. F., Sarstedt, M., Hopkins, L. & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review, 26*(2), 106-121.
- Hao, P., He, W., & Long, L. R. (2018). Why and when empowering leadership has different effects on employee work performance: The pivotal roles of passion for work and role breadth self-efficacy. *Journal of Leadership & Organizational Studies, 25*(1), 85-100.
- Henseler, J., Ringle, C. M. & Sarstedt, M. (2015). A New criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of The Academy of Marketing Science, 43*, 115-135.
- Hobfoll, S. E. (2001). The influence of culture, community, and the nested-self in the stress process: Advancing conservation of resources theory. *Applied Psychology, 50*(3), 337-421.
- Hoe, V. C., Urquhart, D. M., Kelsall, H. L., Zamri, E. N., & Sim, M. R. (2018). Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers. *Cochrane Database of Systematic Reviews, 10*, 1-12.
- Ilieska, K. (2013). Customer satisfaction index - as a base for strategic marketing management. *TEM Journal, 2*(4), 327-331.
- Islam, T., Khan, M. M., Ahmed, I., & Mahmood, K. (2021). Promoting in-role and extra-role green behavior through ethical leadership: Mediating role of green HRM and moderating role of individual green values. *International Journal of Manpower, 42*(6), 1102-1123.
- Jia, J., Liu, H., Chin, T., & Hu, D. (2018). The continuous mediating effects of GHRM on employees' green passion via transformational leadership and green creativity. *Sustainability, 10*(9), 32-37.
- Jiang, M., Wang, H., & Li, M. (2019). Linking empowering leadership and organizational citizenship behavior toward environment: The role of psychological ownership and future time perspective. *Frontiers in Psychology, 10*, 2612-2625.
- Kehoe, R. R., & Collins, C. J. (2017). Human resource management and unit performance in knowledge-intensive work. *Journal of Applied Psychology, 102*(8), 1222-1235.
- Khatoon, A., Rehman, S. U., Islam, T., & Ashraf, Y. (2022). Knowledge sharing through empowering leadership: The roles of psychological empowerment and learning goal orientation. *Global Knowledge, Memory and Communication, 1*, 1-12.

- Khattak, M. A., Ahmad, F. & Khan, N. A. (2022). Do banks enjoy technology under competitive pressures? Cross-country evidence. *Technology Analysis & Strategic Management*, 1, 1-16.
- Khattak, M. A., Rehman, Z. U., & Hashmi, S. H. (2023). Role of empowering leadership in inducing employee green creative behavior in hotel and restaurant industry: a moderated-moderated mediation model. *Environment, Development and Sustainability*, 1, 1-32.
- Li, W., Bhutto, T. A., Xuhui, W., Maitlo, Q., Zafar, A. U., & Bhutto, N. A. (2020). Unlocking employees' green creativity: The effects of green transformational leadership, green intrinsic, and extrinsic motivation. *Journal of Cleaner Production*, 255, 120-129.
- Luo, X., Homburg, C., & Wieseke, J. (2012). Customer satisfaction, analyst stock recommendations, and firm value. *Journal of Marketing Research*, 49(2), 175-187.
- Mittal, S., & Dhar, R. L. (2016). Effect of green transformational leadership on green creativity: A study of tourist hotels. *Tourism Management*, 57, 118-127.
- Namasivayam, K., Guchait, P., & Lei, P. (2014). The influence of leader empowering behaviors and employee psychological empowerment on customer satisfaction. *International Journal of Contemporary Hospitality Management*, 26(1), 69-84.
- Purwanto, A., & Sudargini, Y. (2021). Partial least squares structural equation modeling (PLS-SEM) analysis for social and management research: A literature review. *Journal of Industrial Engineering & Management Research*, 2(4), 114-123.
- Redelinghuys, K., Rothmann, S., & Botha, E. (2020). Outcomes of leader empowering behaviour in a retail organisation. *South African Journal of Business Management*, 51(1), 1-6.
- Ringle, C. M., Sarstedt, M., Mitchell, R., & Gudergan, S. P. (2020). Partial least squares structural equation modeling in HRM research. *The International Journal of Human Resource Management*, 31(12), 1617-1643.
- Robertson, J. L., & Barling, J. (2013). Greening organizations through leaders' influence on employees' pro-environmental behaviors. *Journal of Organizational Behavior*, 34, 176-194.
- Ross, S. A. (1973). The economic theory of agency: The principal's problem. *The American Economic Review*, 63(2), 134-139.
- Sembiring, M. J., Eliyana, A., & Wibawa Ningrum, L. S. (2020). Effect of Workplace Spirituality on Pro-Environmental Behaviour Mediated by Environmental Passion. *Systematic Reviews in Pharmacy*, 11(11), 1282-1292.
- Setyaningrum, R. P., Kholid, M. N. & Susilo, P. (2023). Sustainable SMEs performance and green competitive advantage: The role of green creativity, business independence and green IT empowerment. *Sustainability*, 15(15), 1-11.
- Shafiq, A., Ahmed, M. U. & Mahmoodi, F. (2020). Impact of supply chain analytics and customer pressure for ethical conduct on socially responsible practices and performance: An exploratory study. *International Journal of Production Economics*, 225, 107-121.
- Shah, S. H. A., Fahlevi, M., Rahman, E. Z., Akram, M., Jamshed, K., Aljuaid, M., & Abbas, J. (2023). Impact of green servant leadership in Pakistani small and medium enterprises: Bridging pro-environmental behaviour through environmental passion and climate for green creativity. *Sustainability*, 15(20), 147-159.
- Sharma, P. N., & Kirkman, B. L. (2015). Leveraging leaders: A literature review and future lines of inquiry for empowering leadership research. *Group & Organization Management*, 40(2), 193-237.
- Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (Vol. 6, pp. 497-516). Pearson.
- Tian, G., & Zhang, Z. (2020). Linking empowering leadership to employee innovation: The mediating role of work engagement. *Social Behavior and Personality: An International Journal*, 48(10), 1-8.
- Turaga, R. M. R., Howarth, R. B., & Borsuk, M. E. (2010). Pro-environmental behavior: Rational choice meets moral motivation. *Annals of the New York Academy of Sciences*, 1185(1), 211-224.
- Vallerand, R. J. (2012). The role of passion in sustainable psychological well-being. *Psychology of Well-Being: Theory, Research and Practice*, 2(1), 1-21.

- Wang, S., De Pater, I. E., Yi, M., Zhang, Y., & Yang, T. P. (2022). Empowering leadership: Employee-related antecedents and consequences. *Asia Pacific Journal of Management*, 39(2), 457-481.
- Wang, H., Zhang, Y., Li, P., & Henry, S. E. (2023). You raise me up and I reciprocate: linking empowering leadership to organizational citizenship behavior and unethical pro-organizational behavior. *Applied psychology*, 72(2), 718-742.
- Wen, J., Huang, S. S., & Teo, S. (2023). Effect of empowering leadership on work engagement via psychological empowerment: Moderation of cultural orientation. *Journal of Hospitality and Tourism Management*, 54, 88-97.
- Yen, Y. X. & Yen, S. Y. (2012). Top-management's role in adopting green purchasing standards in high-tech industrial firms. *Journal of Business Research*, 65(7), 951-959.
- Yue, T., Gao, C., Chen, F., Zhang, L., & Li, M. (2022). Can empowering leadership promote employees' pro-environmental behavior? Empirical analysis based on psychological distance. *Frontiers in Psychology*, 13, 774-791.
- Yun, S., Cox, J., & Sims Jr, H. P. (2006). The forgotten follower: A contingency model of leadership and follower self-leadership. *Journal of Managerial Psychology*, 21(4), 374-388.
- Yüksel, A., Uçkun, S. & Uçkun, C. G. (2022). Çalışanların yeşil örgütsel davranışlarına ilişkin bir araştırma. *International Academic Social Resources Journal*, 7(43), 1380-1387.
- Zhang, X., & Bartol, K. M. (2010). Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement. *Academy of Management Journal*, 53(1), 107-128.
- Zheng, J., Gu, Y., Zhang, Z., Xie, H., Li, P., & Li, H. (2023). The relationship between empowering leadership and project performance: A resource perspective. *Engineering, Construction and Architectural Management*, 30(7), 2969-2990.
- Zhu, Q. & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research*, 45(18-19), 4333-4355.

The Effect of Social Capital on Individual Disaster Resilience: The Mediating Role of Fear of Crime *

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Abstract

Disaster resilience is a multifaceted and complex concept influenced by factors such as a society's level of development, sociodemographic characteristics, vulnerability, disaster awareness, disadvantaged groups, and social capital. Social capital is an essential element of disaster resilience, but today's conditions can transform communities into fearful and risky societies, negatively impacting social capital and reducing disaster resilience. Interdisciplinary studies are necessary to better understand and examine social capital and fear of crime as social components of disaster resilience. This cross-sectional research design investigates the mediating role of fear of crime in the impact of social capital on individual disaster resilience. This study employs face-to-face surveys conducted between June and September 2021 with 1040 participants residing in the Burdur and Antalya provinces of Türkiye. The data were analyzed using a structural equation model. Given the findings, it was determined that social capital increases individuals' disaster resilience and decreases their fear of crime. However, individuals' fear of crime negatively affects their disaster resilience and partially mediates the effect of social capital on individual disaster resilience. Individuals with high social capital are more resilient to disasters, whereas fear of crime reduces this resilience. Therefore, this study emphasizes that policies that strengthen social capital and reduce fear of crime are essential in increasing disaster resilience and offer recommendations.

Keywords: *Social Capital, Fear of Crime, Disaster Resilience, Mediation Effect.*

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1. INTRODUCTION

In 2023, 399 disasters caused by natural hazards occurred worldwide, causing 86,473 deaths, affecting 93.1 million people, and economic damages reaching \$202.7 billion. The occurrence, number of deaths, and financial losses in 2023 exceeded the twenty-year average by disaster type. The major earthquakes that hit Türkiye and Syria were impactful here. Due to the earthquakes on February 6, 2023, 50,783 people died in Türkiye alone, and a total economic loss of 34 billion US dollars in damage occurred (Centre for Research on the Epidemiology of Disasters [CRED], 2024). More than 1,300 earthquakes occurred only in Türkiye in 2023; floods in the Western Black Sea region, major fires in Antalya and Muğla, and landslides in various areas had severe social and economic impacts. In addition, approximately 70% of the surface area of Türkiye is at risk of first and second-degree earthquakes, placing the country at high risk of disaster (Disaster and Emergency Management Authority [AFAD], 2024). These data reveal that disasters are multidimensional phenomena that need to be combated both physically and socially. On the other hand, CRED data only covers natural and technological disasters and do not include human-induced crises such as war, conflict, migration, and epidemics. Therefore, the real burden of disasters on society is far beyond the statistics presented.

Many catastrophic events that occurred worldwide during the past two decades caused significant damage to the sustainable development of societies, prompting global interest and emphasis on creating disaster-resilient societies, cities, and people (United Nations Office for Disaster Risk Reduction [UNDRR], 2015b, 2015a). These concerns are further exacerbated by contemporary global challenges that deepen vulnerabilities and threaten collective resilience. The world faces various challenges, such as the COVID-19 pandemic, migration crises, wars in Ukraine and the Middle East, global financial crises, hunger, and drought, all of which have profoundly impacted people. More than 775 million cases of COVID-19 were confirmed, resulting in severe economic and social consequences. It also led to the first-ever decline in the global Human Development Index (HDI) and increased perceived insecurity even in countries with high HDI scores (World Health Organization [WHO], 2024). On the other hand, the World Migration Report highlights that international migration has risen due to war, economic and political instability, and climate change (International Organization for Migration [IOM], 2024). In 2022, Russia's invasion of Ukraine resulted in tens of thousands of civilian casualties, displacement of millions of people, and the destruction of infrastructure, triggering one of the fastest-growing refugee crises since the Second World War. These challenges have resulted in a global humanitarian crisis requiring immediate attention (World Bank, 2022).

Türkiye stands out with its low level of social capital. Given the seventh wave of the World Values Survey (WVS) (2017-2022), the general level of trust among individuals in Türkiye is still low. Only 12.4% of the survey participants responded that “most people can be trusted,” whereas 86.3% said that “One should be very careful in relationships” (World Values Survey [WVS], 2023). These rates indicate that Türkiye has limited social capital and that a widespread environment of insecurity prevails

in social relations. Rapid and unregulated urbanization, socioeconomic inequalities, high migration rates, and perceived crime, especially in metropolitan cities. For example, Türkiye has become the 18th most populous country out of 194 countries worldwide. Accordingly, the rate of people living in provincial and district centers in Türkiye has increased to 93% in 2023, while the rate of people living in towns and villages has decreased to 7% (Turkish Statistical Institute, 2024). According to the most up-to-date data from the Directorate of Migration Management, approximately 2.8 million Syrians are temporarily protected in Türkiye (Republic of Türkiye Ministry of Interior, 2025). This mass mobility created a heterogeneous population, particularly in metropolitan cities, increasing the risks such as social differences, security problems, and social exclusion (Karakuş, 2013; Kul, 2009; Öztürk, 2016). Association membership rate is only 14% among the general population in Türkiye, indicating that civic participation remains limited (Republic of Türkiye Ministry of Interior, 2024). Karagül (2012) reported that economic and political insecurities increase crime rates, undermine social trust, and weaken social capital. On the other hand, as social structures become more heterogeneous, norms of association and reciprocity weaken, and social solidarity and trust decline accordingly (Field, 2016). In these respects, the Turkish example provides an important context that can contribute to disaster resilience discussions shaped around social capital, trust, and fear of crime locally and globally.

It is projected that 68% of people on Earth will reside in cities by 2050. The risk of disasters causing severe damage also increases with the increasingly urbanizing world. The challenges growing cities face (population growth, migration, inadequate infrastructure, and substandard buildings) disproportionately affect poorer countries, leading to a higher level of loss of life and property in disasters. Moreover, cities with low social capital are particularly vulnerable to catastrophe. Urban areas will only become riskier without addressing these vulnerabilities. The United Nations (UN) HABITAT III New Urban Agenda predicts that the urban population will double by 2050, bringing economic, social, and cultural density. However, the UN warns that this growth also presents significant sustainability challenges, including housing, infrastructure, and security (United Nations [UN], 2017). It is well-known that a significant portion of the urban population residing in developing countries has been victimized by various criminal activities at least once within the last five years. The rapid urbanization in these regions has led to an alarming rise in the crime rate. Moreover, women and children often face barriers to accessing essential urban services, which creates further exclusion and vulnerability. Unfortunately, the limited success of poverty reduction policies may hinder progress in addressing this issue, potentially leaving the problem unresolved (UN-Habitat, 2022, 2024). As a result, in today's disaster century, factors such as the growing effects of disasters, urbanization, poverty, safety, and globalization negatively affect the sustainable development of societies. However, building disaster-resilient societies is the best strategy to protect a community's future. Therefore, there is an increasing global interest in improving resilience to disasters with a proactive approach.

Disaster resilience is shaped by a combination of social, economic, and environmental factors, with social capital playing a critical role among these factors. Within this comprehensive approach, the relationship between social capital and fear of crime is decisive in strengthening disaster resilience. In societies with high social capital, individuals' fear of crime decreases, positively affecting disaster resilience. Since a high fear of crime limits individuals' social interactions and information sharing, it weakens the social support mechanisms needed in disaster situations. By fostering trust and cooperation, social capital is considered a key factor in enhancing disaster resilience (Bolger & Bolger, 2019; Han, 2021; Sargeant et al., 2017). High fear of crime limits individuals' participation in social activities, weakens social ties, and reduces the collective action capacity required during disasters (Farmer et al., 2018; Weil, 2020). In addition, high fear of crime delays the reintegration of individuals into society in the post-disaster period, increases social isolation and withdrawal behaviors, and consequently slows down society's post-disaster recovery process (Hino et al., 2018). Therefore, policies strengthening social capital and reducing fear of crime play a critical role in increasing community resilience to disasters (Monteil et al., 2020; Pfefferbaum et al., 2017).

This study aims to examine the mediating role of fear of crime in social capital's effects on individual disaster resilience. Many studies have examined the effects of social capital on disaster resilience, but the mediating role of fear of crime has yet to be analyzed. This study addresses this gap in the literature and is essential in creating disaster management strategies by considering disaster resilience more broadly. In this context, the following research questions were established:

- Does individuals' social capital enhance their disaster resilience?
- Does individuals' social capital reduce their fear of crime?
- Does fear of crime decrease individuals' disaster resilience?
- Does fear of crime mediate the effect of social capital on disaster resilience?

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Social Capital and Disaster Resilience

Disaster resilience refers to society's ability to cope with disasters, recover from minor damage, and quickly return to routine life (Lucini, 2014). Disaster-resistant societies can withstand disasters with minimal effects and quickly recover (Mayunga, 2007). Social capital plays an important role in recovering quickly after disasters and becoming more resilient (Kim et al., 2017; Lucini, 2014).

Pierre Bourdieu (Bourdieu, 1986), the first contemporary theorist of social capital, defines social capital as "the collection of actual or potential resources linked to having a durable network of more or less institutionalized relationships of mutual acquaintance or recognition." Coleman, another social capital theorist, believes that social capital relies on the structure of actors and the relationships between them. Therefore, social capital is a tool individuals or communities use to achieve specific goals, and it explains how people work together. Moreover, social capital is not something an individual can have

independently; rather, it originates from individual relationships and is determined by reciprocity and trust (Coleman, 1988). Putnam, the theorist who introduced the most well-known and widely used definition of social capital, defines it as “the characteristics of social organization, such as networks, norms, and social trust, that facilitate coordination and cooperation for mutual benefit” (Putnam, 1995). Francis Fukuyama, another social capital theorist, defines social capital as embodied and informal norms that create cooperation. At the same time, he emphasizes that social capital can be gained when individuals take collective actions by adopting standard norms based on a sense of trust. As stated by him, social capital is a capacity arising from the prevailing trust in a society or community (Fukuyama, 2000).

Societies with solid social capital have diverse social networks and civil associations. They are in a stronger position to fight poverty, reduce vulnerability, resolve conflicts, and benefit from new opportunities. Aldrich (2011) emphasizes that social capital is the most important and solid element of the recovery of societies after disasters. Accordingly, social capital can prevent individuals or communities from being marginalized, encourage preparedness and risk awareness, and facilitate access to various resources such as information, social support, and financial assistance. Therefore, it can also reduce societies’ vulnerability to disasters (Aldrich, 2011). Particularly before, during, and after disasters, trust, a fundamental component of social capital, is necessary for coordination, collaboration, and communication. As a result, it influences individual and group behavior and promotes the involvement of many stakeholders in decision-making (Monteil et al., 2020). However, some studies show that strong social networks are not always inclusive in disaster response and recovery processes. In particular, groups with high levels of social capital can exclude other groups from relief processes, which can increase social inequalities in disaster resilience (Aldrich & Crook, 2008). This finding suggests that the effects of social capital may vary depending on the context.

Regarding disaster management, different forms of social capital play essential roles in increasing disaster resilience. Accordingly, bonding social capital constitutes the assistance provided by the closest individuals to each other after disasters. Strong bonding social capital enhances recovery efforts and reduces dependency on external support. Bridging social capital is the support disaster survivors receive from local social services and health, religious, commercial, and other service provider groups. Here, bridging social capital affects the post-disaster period by organizing volunteers, raising awareness, preparing the community for future disasters, and providing them with access to resources. Therefore, high levels of bridging social capital increase disaster resilience by improving disaster preparedness and access to information and resources during recovery. Bonding social capital is particularly valuable because it gives individuals access to authorities and institutions. Accordingly, bonding social capital positively affects the community’s recovery due to the connection between the people in the government or other positions of power in the community (Hsueh, 2019; Kim et al., 2017; Monteil et al., 2020; Pfefferbaum et al., 2017). Therefore, bonding social capital plays a vital role in the

short-term post-disaster recovery period, whereas bridging and unifying social capitals play an important role in the long-term recovery period, increasing disaster resilience. However, some studies indicate that social ties may weaken, and the effect of social capital on recovery may be limited, particularly in regions with severe disasters (Xiong & Li, 2024). Such findings suggest that the impact of social capital on disaster resilience is not linear but contextual.

Other elements that explain the relationship between social capital and disaster resilience are collective effectiveness and active participation. Social capital enables citizens to solve their common problems more efficiently. Since groups have a more significant impact than individuals working alone, and their performance increases, a framework that encourages community participation can effectively increase community resilience (Pfefferbaum et al., 2017). In disaster situations, many families, groups, and organizations instinctively communicate, cooperate, and help others in the community. Especially after a disaster, victims first turn to their close circle, such as their family and friends, for emergency support. Afterward, they are frequently inspired to collaborate to rebuild their communities. Therefore, societies with substantial social capital can return to their everyday life sooner by encouraging active participation and collective actions during the post-disaster recovery period (Kim et al., 2017).

The most resilient communities are those with high social capital that work together towards a common goal (Mayunga, 2007; Pfefferbaum et al., 2017). In short, social capital promotes adaptive capacities in societies, aiding their coordination in disaster contexts. For this reason, social capital and networks are becoming more important in enhancing disaster resilience (Karunaratne & Lee, 2019). Therefore, the weakness of social capital is a factor that increases society's vulnerability. Previous studies also support this discourse. Kirschenbaum (2004) states that social networks, an important part of social capital, can share knowledge on survival strategies, offer the tools to deal with emergencies, and significantly improve catastrophe behaviors, instilling a sense of reassurance and optimism. Therefore, it states that the disaster behaviors of individuals in societies with strong ties and social networks are also positively affected. In his study, Yamamura (2010) investigates how disaster damage is influenced by social capital. The study provides two significant findings. First, social capital can minimize the harm that disasters wreak. Second, social capital is more effective in preventing disasters because it encourages people to cooperate. In their study examining the effects of social capital after Hurricane Katrina, Hawkins and Maurer (2010) report that many participants benefited from social capital. People first received help from their close networks and then assisted others. It also played a psychological role in developing resilience. Social capital has also been adequate for preparation and providing mutual aid during the early warning period before the hurricane.

Studies show that social capital positively affects disaster resilience. Thus, individuals with high social capital are more prepared for disasters, and as social capital increases, society's disaster resilience also grows (Aldrich & Meyer, 2015; Cutter et al., 2016; Hsueh, 2019; Kim et al., 2017; Kirschenbaum, 2004; Mayunga, 2007; Monteil et al., 2020). Social capital enhances resilience by fostering mutual trust

and cooperation, which are vital during disasters (Kim et al., 2017; Lucini, 2014; Mayunga, 2007). Sharing information and fostering social solidarity through social capital expedite disaster preparedness and recovery phases. Based on these dynamics, social capital is expected to increase disaster resilience. Consequently, it is hypothesized that **H1(a): Social capital positively affects individual disaster resilience**, as individuals with greater social capital are more likely to benefit from the collective support and resources necessary for effective disaster management.

2.2. Social Capital and Fear of Crime

The emotion of fear is a fundamental aspect of human nature that is influenced by various factors. Crime and related symbols are one such factors that can trigger this emotion. Since ancient times, individuals have been worried about exposure to criminal activities. However, nowadays, the fear of crime is a social issue due to technological advancements, poverty, increased migration, changing societal values, urbanization, and declining trust (Öztürk, 2016). Ulrich Beck, a prominent sociologist, characterizes modern society as a “risk society” where dangers and uncertainties rise due to rapid modernization. He highlights that the typical slogan of such societies is “I am afraid” and that anxiety is rampant in these communities (Beck, 2009).

Even though there are various definitions of fear of crime in the literature, many studies rely on Ferraro’s (1995) concept. Ferraro (1995) describes the fear of crime as “an emotional anxiety or fear response that individuals develop towards crime or symbols associated with crime” (p.23). Additionally, Ferraro notes that fear of crime is both an emotional and a physiological response to impending danger (Ferraro, 1995). The fear of crime can be considered a state of concern about victimization or a perception of the risk of victimization. One’s perceived risk of victimization is important in fear of crime since it affects the degree of fear an individual experience. In other words, the probability of being victimized (perceived risk) influences the level of fear one has of crime. Thus, perceived risk is the likelihood of victimization, and fear of crime is an emotional reaction to the possibility of victimization (Rader, 2017; Rader et al., 2012).

Fear of crime is an emotional response that people develop due to different types of victimization. There are several theories aiming to explain the fear of crime and reduce it by taking precautions. These theories consider direct and indirect victimization, risk perception, environmental factors, and restrictive behaviors. It is essential to address all these aspects to better understand the fear of crime (Ferraro, 1995, 1996). The vulnerability model is one of the theories related to an individual’s fear of crime. As emphasized in this theory, people who perceive themselves as physically or socially disadvantaged are more vulnerable to potential victimization, and they believe that they cannot afford the damages if they become victims of crime. This theory suggests that people who lack social and physical tools to protect themselves from crime and cope with it are more likely to experience fear of crime. The theory highlights individual demographic characteristics such as age, ethnicity, gender, and

economic status that can explain the fear of crime (Ferraro, 1996; Kul, 2009; Rader, 2017). The second one is the victimization model, which associates victimization and fear and argues that the individual's direct and indirect victimization experiences have an impact on the fear of crime. Accordingly, individuals who are directly or indirectly exposed to crime experience fear, anxiety, and insecurity about future exposure to crime. These individuals experience effects such as being unable to go out alone, changing the neighborhood or even the city they live in, approaching everyone with suspicion, and focusing on crime news in the media (McGarrell et al., 1997; Rader, 2017).

The disorder model, the third theory explaining the fear of crime, is also considered an ecological approach because it associates the fear of crime with environmental factors rather than individuality. This theory, put forward by Chicago school theorists, is based on the relationship between the city's structure and crime. Accordingly, factors such as the heterogeneous structure of the city, poverty, rapid population mobility, and the loss of functionality of the family institution lead to social disintegration, weakening of traditional and social control mechanisms, negative impact on social capital, formation of crime-prone subcultures, and environmental irregularities. When an environment is aesthetically pleasing, it causes people to perceive that there is no crime and that it is a safe area. However, physical irregularities, such as garbage on the streets, abandoned buildings, junk cars, inadequate street lighting, and collapsed walls, and social irregularities, such as the presence of street gangs, drunk people, strangers, and drug use on the streets indicate that local social control and traditional norms are weakening. Therefore, environmental and social irregularities increase the fear of crime in society (Bolger & Bolger, 2019; Lagrange et al., 1992; McGarrell et al., 1997; Öztürk, 2016).

Finally, the community concern model, closely related to dysregulation theory, is also known as the social interest perspective, a social control model. Unlike the dysregulation approach, this theory addresses the anxiety states of those living in a particular environment. Accordingly, he argues that the existence of harmony, trust, and peace at the local level is very effective in reducing the fear of crime. In addition, factors such as dissociations, disharmony in society, weakening of social networks, and social exclusion increase anxiety levels and fear of crime in societies. Therefore, in the community concern model, concepts such as interpersonal trust, social control, social capital, and social harmony are the focus (McGarrell et al., 1997; Öztürk, 2016). The social change experienced, particularly in heterogeneous societies, the weakening of interpersonal relationships and mutual trust, and social separations negatively affect individuals, such as introversion, withdrawal, and fear of strangers, ultimately resulting in a decrease in social capital. Therefore, in such societies, formal and informal social control mechanisms, some of the most important preventive factors of crime, are disrupted. As social control decreases, it becomes easier for criminals to engage in criminal activities. At the same time, individuals fear being left without environmental support when experiencing a crime (Ferraro, 1995; Kul, 2009).

As reported in many studies, social capital directly affects fear of crime. Accordingly, the fear of crime decreases with increasing social capital (Han, 2021; Hernández et al., 2020; Matsukawa & Tatsuki, 2018; Öztürk, 2016; Sargeant et al., 2017). However, some studies indicate that social capital-based security approaches are effective in reducing only certain types of crimes (e.g., street crime) and they have limited effects on other kinds of crimes, such as property crimes (Matsukawa & Tatsuki, 2018). In addition, the sense of security provided by social capital may not always be sustainable (Hernández et al., 2020). These findings also suggest that the relationship between social capital and fear of crime may be contextual and limited. In societies with substantial social capital, social control mechanisms work more effectively, social trust increases, and individuals' perceptions of threats to their environment decreases (Han, 2021; Sargeant et al., 2017). This reduces individuals' fear of crime and supports their participation in social life. In this context, social capital is predicted to reduce the fear of crime. Therefore, the following hypothesis is proposed: H1(b), which states that social capital negatively affects fear of crime, as individuals with higher social capital generally experience lower fear of crime.

2.3. Disaster Resilience and Fear of Crime

Studies on the relationship between disasters and fear of crime focus primarily on the fear of crime experienced during and after the disaster. These studies generally report that disaster areas with a high capacity for social control mechanisms have less fear of crime and recover more quickly. Accordingly, despite the destruction caused by disasters, if the social organization structure of the society is solid, the return of that society to everyday life is faster (Farmer et al., 2018; Hino et al., 2018; Tierney, 2011). The increasing need for security elevates people's fear of crime, especially after disasters, increases in crime rates, or crime news. For example, during and after Hurricane Katrina, news outlets frequently reported crime and acts of violence. Moreover, reports immediately following the hurricane included more examples of violence, panic, looting, and severe disorder. This situation has increased people's fear of crime and perceived victimization (Farmer et al., 2018).

Some studies examine the existence of crimes that may occur after disasters and the fear of crime experienced by individuals in this context. As reported in a study on the fear of crime experienced by evacuees after the Great Japan Earthquake in 2011, many of those living in evacuation shelters feared theft in their abandoned homes. At the same time, women in evacuation shelters experience more fear of crime, especially sexual crimes (Hino et al., 2018). In a study conducted after Hurricane Katrina, individuals living in New Orleans experienced a higher level of fear of crime as crime rates grew. Increased fear of crime created a sense of insecurity among people, decreasing social solidarity and the willingness of neighbors to help each other. People who left their homes were hesitant to return due to increased fear of crime. Therefore, it weakened disaster resilience by making it difficult for individuals to recover and rebuild after the hurricane (Weil, 2020). In another study, many participants stated that they did not initially choose to use shelters during Hurricane Katrina mainly because they were more

concerned about security than about the cleanliness and durability of shelters. People fear crime due to the unsafe conditions of the shelters. Women, especially, stated their fear of being victimized by sexual crimes in shelters (Farmer et al., 2018). Finally, in a study on Hurricane Katrina evacuees, 22% reported being threatened with violence in shelters. This situation prevented effective hurricane evacuation and shelter access (Brodie et al., 2006).

As can be seen, increased crime rates and fear of crime after a disaster can delay the return to everyday life, causing isolation and withdrawal from society and hindering access to information and social networks. For this reason, it is important to encourage community development informed by knowledge and participation to increase the disaster resilience of societies (Lucini, 2014) because disaster resilience depends on accessing, processing, understanding, and mobilizing information (DiTirro, 2018). However, it was stated that this relationship does not work in the same way in every disaster context. In some disasters, rapid provision of security measures or high social solidarity can prevent the spread of fear of crime. The social context and institutional interventions shape the fear of crime after a disaster. Fear of crime negatively impacts post-disaster recovery processes by reducing individuals' social interactions, restricting access to information, and weakening social support mechanisms (Farmer et al., 2018; Weil, 2020). The weakening of ties to society reduces disaster resilience. Therefore, fear of crime is expected to negatively impact individual disaster resilience. Hence, the following hypothesis is proposed: **H1(c): Fear of crime negatively affects individual disaster resilience**, as higher levels of fear can erode social cohesion and obstruct recovery efforts by diminishing community engagement and access to essential resources.

2.4. Mediation Effect of Fear of Crime

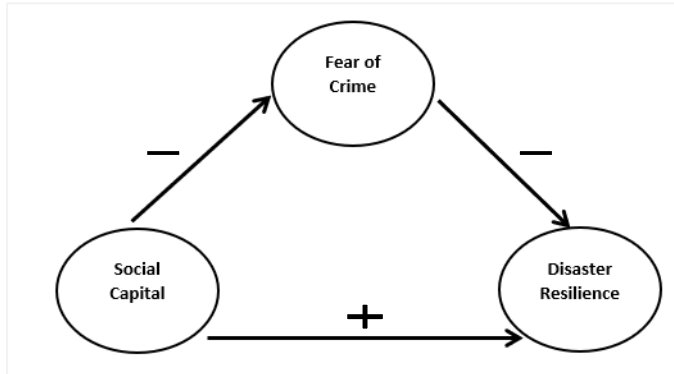
The literature review revealed that social capital positively affects disaster resilience (Cutter et al., 2016; Hsueh, 2019; Kim et al., 2017; Monteil et al., 2020). However, fear of crime negatively affects the quality of life in every way by causing distrust, anxiety, asociality, alienation, and psychological disorders in people. It weakens interpersonal relationships, damages social trust, and thus weakens social capital (Han, 2021; Hernández et al., 2020; Matsukawa & Tatsuki, 2018). People with lower levels of fear of crime are more likely to make good use of their social capital during the recovery phase of a disaster by joining groups and reaching out to support systems. On the other hand, studies have shown that fear of crime negatively affects disaster resilience (Farmer et al., 2018; Hino et al., 2018; Weil, 2020).

Considering the effects stated in the literature review, while social capital reduces fear of crime, fear of crime also affects individual disaster resilience negatively. In this context, fear of crime is expected to mediate the effect of social capital on individual disaster resilience. Thus, the effect of social capital on disaster resilience may be partially mediated through its influence on reducing fear of crime. The literature frequently examines direct relationships between social capital and disaster resilience or

fear of crime. Still, the mediating role of fear of crime has not been empirically tested. This study is one of the first models to address this deficiency and evaluate the triple relationship holistically; it offers an original contribution to the literature. Based on this understanding, the following hypothesis is proposed:

H1(d) – Fear of crime mediates the effect of social capital on individual disaster resilience.

Figure 1. Research Model



Based on the hypotheses, the model is structured and shown in Figure 1.

- H1(a): Social capital (SC) → Individual disaster resilience (IDR)
- H1(b): Social capital (SC) → Fear of crime (FC)
- H1(c): Fear of crime (FC) → Individual disaster resilience (IDR)
- H1(d): Social capital (SC) → Fear of crime (FC) → Individual disaster resilience (IDR) (mediating effect)

3. MATERIALS AND METHODS

3.1. Instruments and Data Collection

After obtaining ethics committee approval and all participants' informed consent, Data were collected between June and September 2021. The study population consists of people aged older than 18 years who live in Burdur and central Antalya, two nearby cities south of Türkiye. A random sampling method was used. When calculating the number of samples, a margin of error of 5% at a confidence level of 95% was used. Researchers collected data through a face-to-face survey. Surveys were conducted in open areas where the public is densely populated, such as parks, main streets, and public institutions in the central districts of Burdur and Antalya. Participants were randomly selected and invited to participate in these areas voluntarily. Throughout the data collection process, mask use and social distancing rules were meticulously followed as part of the measures against the COVID-19 pandemic.

The survey form was prepared utilizing the most widely preferred scales in the literature regarding the variables (social capital, fear of crime, and individual disaster resilience), with these scales having been tested for validity and reliability. The scales used in this study are tools validated in the literature, align with the study's theoretical model through their multidimensional structures, and are

widely used in disaster, security, and social structure research. The scales' conceptual scope and methodological suitability were effective for their intended purpose in the context of this research.

The Social Capital Scale (SC) was developed by Onyx and Bullen (2000) and adapted to Turkish by Ardahan (2012). This scale assesses levels of participation in social networks, norms of mutual trust and cooperation, and frequency of social engagement. Each item is rated on a five-point Likert scale, addressing the intensity of respondents' agreement or disagreement. It consists of 28 items and nine sub-dimensions, and Cronbach's alpha (α) coefficient is 0.711 (Ardahan, 2012). The subdimension of participation in local committees (PLC) refers to individuals' involvement in formal or informal local governance activities that positively influence community dynamics and social life. Neighborhood Relations (NR) represent the connections individuals maintain with their community members. Sense of Belonging (SB) reflects individuals' feelings of attachment to their workplace, school, or team. Tolerance for diversity (TD) indicates individuals' acceptance and sensitivity towards personal differences from culture, gender identity, lifestyle, or religion. Membership in civil society organizations (MCSO) represents formal non-governmental organization (NGO) involvement and active participation. Trust in people (TP) measures individuals' confidence in others within their social environment, while trust in the environment (TE) assesses the perceived safety of the physical surroundings. Social initiative (SI) reflects individuals' acceptance of others, respect for their opinions, and willingness to take social action when needed. Finally, social representation (SR) captures individuals' assumption of roles and responsibilities within their community, including areas beyond their direct responsibility. The scale was administered using a 5-point Likert format and was designed to assess social capital at the individual level (Ardahan, 2012; Onyx & Bullen, 2000).

Fear of Crime Scale (FC) was originally developed by Ferraro (1995) and adapted to Turkish by Kul (2009). This scale measures the degree of fear individuals experience concerning general crime, as well as specific types of crime. The scale effectively captures the respondents' perceptions and emotional responses to crime, reflecting the multidimensional nature of fear. The Cronbach's alpha coefficient of the 11-item scale was 0.93 (Ferraro, 1995; Kul, 2009).

Individual Disaster Resilience Scale (IDR) was developed by DiTirro (2018) and adapted to Turkish by Şen (2022). This scale measures individuals' resilience to disasters. The multidimensional approach of this scale allows for a comprehensive assessment of disaster resilience at the individual level. The Cronbach's alpha (α) of the IDR scale with four sub-dimensions and 19 items is 0.896. The Knowledge Coping (KC) dimension focuses on the knowledge that the individual has as a result of their individual or educational experiences in the pre-disaster period. Accordingly, it is valuable for an individual to cope with disasters with the knowledge he has acquired. The Informational Coping (IC) dimension measures the individual's ability to obtain up-to-date information about disasters, evaluate the information received, and take action. The Communal Coping (CC) dimension focuses on the social support an individual can access and use during a disaster. Finally, the Affective Coping (AC) dimension

relates to how well individuals can manage their emotional states during disasters (DiTirro, 2018; Şen, 2022). In the AMOS model, the subdimensions of the scales were represented using specific abbreviations for ease of analysis.

Data were gathered through face-to-face surveys between June and September 2021. Before data collection, ethical approval was obtained from the relevant ethics committee, and all participants provided informed consent. The research population consists of people over eighteen who live in Burdur and central Antalya, two nearby cities south of Türkiye. The sampling method used was random sampling. When calculating the number of samples, a margin of error of 5% at a confidence level of 95% was used.

3.2. Data Analysis

The data obtained from 1040 participants were analyzed using SPSS (Statistical Package for Social Sciences) for Windows, 25.0, and the AMOS (Analysis of Moment Structures) 24.0 program. The validity and reliability of the scales were assessed using Confirmatory Factor Analysis (CFA). The factor loadings of each item on the scales and Cronbach's alpha coefficients were examined to ensure structural reliability. Additionally, composite reliability (CR) and average variance explained (AVE) values were also examined. A CR value higher than 0.70 indicates the structure's reliability, and an AVE value higher than 0.50 indicates sufficient convergent validity (Fornell & Larcker, 1981).

The goodness of fit indices was used to assess the measurement model's overall fit. The following fit standards for the model are acceptable: χ^2/df (Chi-square/Degrees of Freedom) should be ≤ 5 , GFI (Goodness-of-Fit Index), AGFI (Adjusted Goodness-of-Fit Index), CFI (Comparative Fit Index), IFI (Incremental Fit Index), and TLI (Tucker-Lewis Index) should all be ≥ 0.80 , SRMR (Standardized Root Mean Square Residual) should be ≤ 0.10 , and RMSEA (Root Mean Square Error of Approximation) should be between 0.05 and 0.08 (Dehon et al., 2005; Hooper et al., 2008; Hu & Bentler, 1999; Schermelleh-Engel et al., 2003; Shevlin et al., 2000; Simon et al., 2010).

Following the validation of the measurement model, the proposed hypotheses were statistically tested using structural equation modeling (SEM) and the AMOS 24 software. SEM prevents inaccurate standard error predictions and offers a thorough discovery and analysis of the proposed hypothetical model. The mediation effect was tested using bootstrapping methods. This method yields substantial estimates and confidence ranges for the mediation effect, enabling a thorough analysis of direct and mediated connections within the model. The results of both direct and mediated relationships within the model were reported with standardized path coefficients (β), standard errors (SE), t-values, and p-values. All analyses were conducted with a significance level set at $p < 0.05$.

4. RESULTS

4.1. Descriptive Statistics

The participants' sociodemographic data are shown in Table 1. Accordingly, 51.2% of the participants were female, and 48.8% were male. The mean age of the participants was 36.06 ± 11.00 . The age distribution revealed that 6.9% were 20 years or younger, 29.4% were aged 21-30 years, 29.6% were aged 31-40 years, 23.2% were aged 41-50 years, and 10.9% were 51 years or older. Participants were almost evenly distributed across two provinces, with 40.8% from Burdur and 59.2% from Antalya. Regarding marital status, 63.1% were married, and 36.9% were single. Educational level varied, with 9.9% with a secondary school graduation or below, 20.5% with a high school graduation, 13.8% with an associate degree, 43.8% with a bachelor's degree, and 12.0% with a postgraduate degree. Employment status revealed that 35.9% worked in the public sector, 26.8% in the private sector, 15.3% were unemployed, and 22.0% were categorized as "other" (e.g., retired or running their own business). Regarding income levels, 42.2% of participants reported high incomes, 16.5% identified as having medium incomes, and 5.9% fell into the low-income group.

Table 1. Distribution of Participants by Sociodemographic Characteristics

Variables		n	%
Gender	Female	533	51.2
	Male	507	48.8
Age ($X \pm SS$, 36.06 ± 11.64)	20 years and younger	72	6.9
	21-30	306	29.4
	31-40	308	29.6
	41-50	241	23.2
	51 years and older	113	10.9
Province	Burdur	424	40.8
	Antalya	616	59.2
Marital status	Married	656	63.1
	Single	384	36.9
Education level	Secondary School Graduate and Below	103	9.9
	High-School Graduate	213	20.5
	Associate's Degree	144	13.8
	Bachelor's Degree	455	43.8
	Postgraduate Degree	125	12.0
Working Status	Work in the Public Sector	373	35.9
	Work in the Private sector	279	26.8
	Unemployed	159	15.3
	Other (Retired, own business)	229	22.0
Income Groups	Low	61	5.9
	Low-medium	204	19.6
	Medium	172	16.5
	High-medium	164	15.8
	High	439	42.2
Previous disaster exposure	Yes	440	42.3
	No	600	57.7
Receiving disaster training	Yes	574	55.2
	No	466	44.8
Total		1,040	100.0

In addition to sociodemographic information, participants were also asked about their experiences with disasters and their disaster preparedness. While 42.3% of the participants reported having experienced a disaster before, 57.7% had not. Additionally, 55.2% of the participants reported having attended a training or awareness program on disasters.

4.2. Validity and Reliability of Scales

Table 2 provides a comprehensive summary of the internal consistency and construct validity of the scales used in this study.

Table 2. Summary of Scale Validity and Reliability Findings

Variable	Items	Factor Loadings	CR	AVE	Cronbach Alfa (α)	χ^2/df ≤ 5	GFI ≥ 0.80	AGFI ≥ 0.80	CFI ≥ 0.80	IFI ≥ 0.80	TLI ≥ 0.80	SRMR ≥ 0.10
Social Capital (SC)	sc1	0.848	0.979	0.619	0.938	4.028	0.921	0.896	0.949	0.949	0.937	0.043
	sc2	0.878										
	sc3	0.863										
	sc4	0.853										
	sc5	0.844										
	sc6	0.619										
	sc7	0.661										
	sc8	0.849										
	sc9	0.765										
	sc10	0.761										
	sc11	0.605										
	sc12	0.714										
	sc13	0.753										
	sc14	0.784										
	sc15	0.883										
	sc16	0.884										
	sc17	0.919										
	sc18	0.931										
	sc19	0.712										
	sc20	0.704										
	sc21	0.804										
	sc21	0.830										
	sc22	0.818										
	sc23	0.664										
	sc24	0.719										
	sc25	0.753										
	sc26	0.609										
	sc27	0.790										
	sc28	0.848										
Fear of Crime (FC)	fc1	0.848	0.980	0.819	0.954	10.127	0.925	0.879	0.900	0.901	0.086	0.086
	fc2	0.891										
	fc3	0.920										
	fc4	0.856										
	fc5	0.849										
	fc6	0.926										
	fc7	0.919										
	fc8	0.940										
	fc9	0.984										
	fc10	0.971										
	fc11	0.837										

(Table 2 cont.)

Variable	Items	Factor Loadings	CR	AVE	Cronbach Alfa (α)	$\chi^2/df \leq 5$	GFI ≥ 0.80	AGFI ≥ 0.80	CFI ≥ 0.80	IFI ≥ 0.80	TLI ≥ 0.80	SRMR ≥ 0.10
Individual Disaster Resilience (IDR)	idr1	0.640	0.967	0.612	0.896	11.011	0.858	0.812	0.898	0.898	0.879	0.076
	idr2	0.617										
	idr3	0.810										
	idr4	0.759										
	idr5	0.697										
	idr6	0.822										
	idr7	0.858										
	idr8	0.902										
	idr9	0.913										
	idr10	0.778										
	idr11	0.813										
	idr12	0.918										
	idr13	0.891										
	idr14	0.750										
	idr15	0.822										
	idr16	0.784										
	idr17	0.515										
	idr18	0.617										
	idr19	0.810										

For the SC scale, the factor loadings range between 0.605 and 0.931, the AVE was 0.619, and the CR was 0.979. The Cronbach's alpha value was 0.937, and the model fit indices (GFI=0.921, CFI=0.949, TLI=0.937, SRMR=0.043) were within acceptable ranges. For FC scale, the factor loadings were in the range of 0.837-0.984, AVE was 0.819, and CR was 0.980. The scale's Cronbach's alpha value was 0.954, and the model fit indices (GFI=0.925, CFI=0.900, TLI=0.866, SRMR=0.086) were within acceptable ranges. Finally, for IDR the factor loadings were in the range of 0.515-0.918, AVE was 0.612, and CR was 0.967. The Cronbach's alpha value was 0.896. The fit indices (GFI=0.858, CFI=0.898, TLI=0.879, SRMR=0.076) were within acceptable limits.

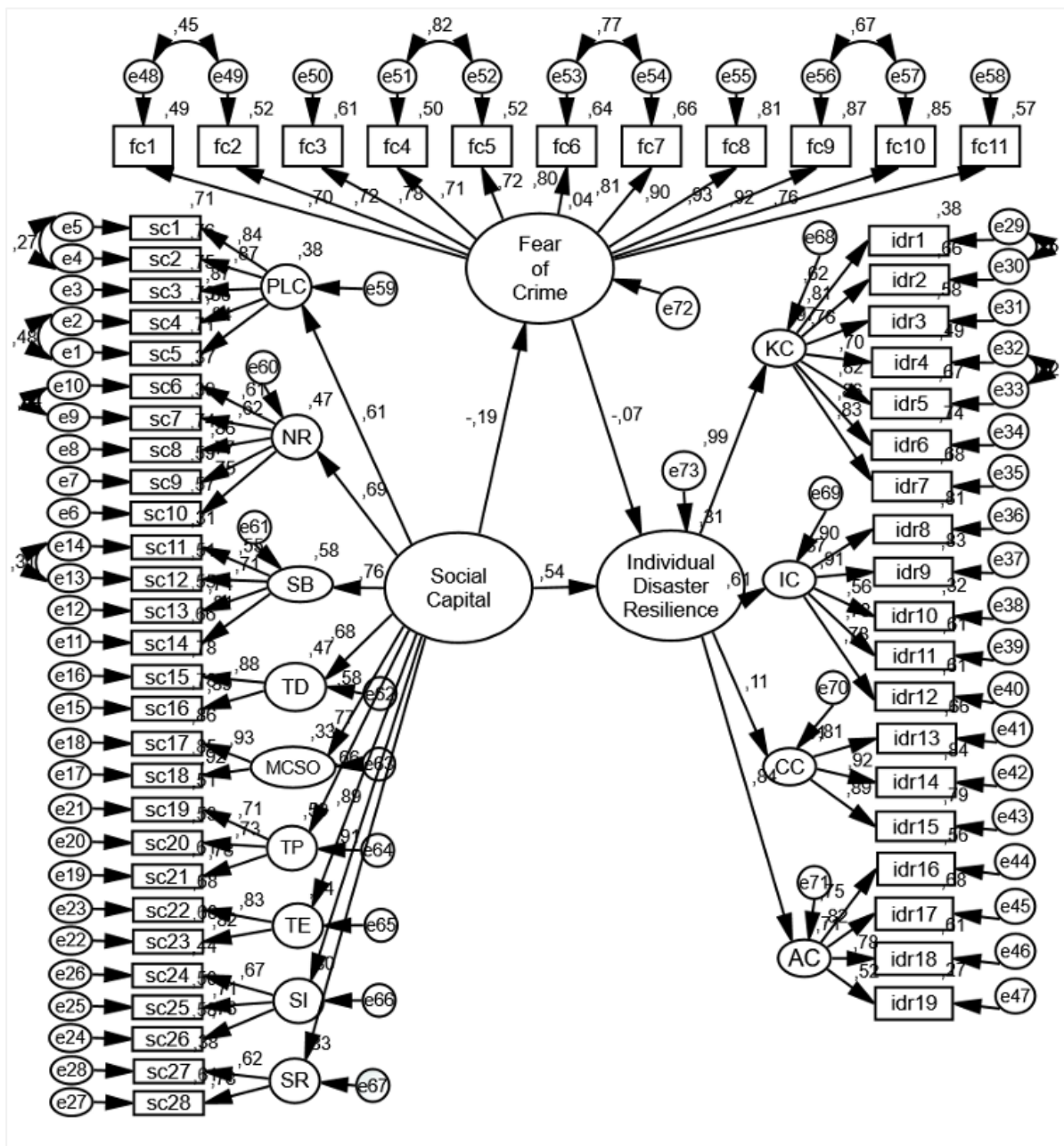
As a result, Cronbach alpha values and CR values of all scales used in the model are greater than 0.70, and factor loadings and AVE values are higher than 0.50. The goodness-of-fit indices were within acceptable limits, suggesting a good fit for the model. Only the chi-square test was above the expected value, because it is sensitive to sample size. For a sample size of 200 or higher, the χ^2 value can be high (Schumacker & Lomax, 2010), therefore, the χ^2/df value may be higher than 5. Overall, the results show high reliability and validity of the posited measurement model.

4.3. Mediating effect analysis

A latent variable path analysis was conducted to examine the mediating role of fear of crime between social capital and individual disaster resilience. Figure 2 illustrates the path diagram, Table 3 shows the mediation analysis and model fit indices, and Table 4 summarizes the hypothesis testing results. The model fit indices indicate that the model demonstrates an adequate fit, as the values fall within the recommended thresholds.

As shown in Figure 2 and supported by the hypothesis testing results in Table 4, social capital has a significant positive effect on individual disaster resilience ($\beta = 0.54$, $p < 0.05$), supporting H1a. Additionally, social capital significantly negatively affects fear of crime ($\beta = -0.19$, $p < 0.05$), supporting H1b. Moreover, fear of crime negatively impacts individual disaster resilience ($\beta = -0.07$, $p < 0.05$), supporting H1c. According to the structural model analysis, social capital's positive effect on individual disaster resilience and the negative effect on fear of crime was significant. In addition, the negative effect of fear of crime on disaster resilience was confirmed. These findings show that social capital affects disaster resilience directly and indirectly and supports this study's theoretical framework.

Figure 2. Path Analysis of Fear of Crime's Mediating Role in the Effect of Social Capital on Individual Disaster Resilience



Regarding mediation, Table 3 indicates that the direct effect of social capital on individual disaster resilience is significant, and an indirect effect analysis was conducted as part of the mediation test. The 95% confidence interval does not include zero (0.002, 0.029), confirming the presence of a mediating effect, thus supporting H1d. Further analysis shows that the direct effect remains significant but with a reduced effect size ($\beta = 0.54$, $p < 0.05$), indicating partial mediation. Therefore, fear of crime partially mediates the effect of social capital on individual disaster resilience, underscoring the complex pathways through which social capital enhances resilience by reducing fear of crime.

Table 3. Mediation Model of Fear of Crime in the Effect of Social Capital on Individual Disaster Resilience

Effects	β	SE	t	p	Decision
Social Capital → Individual Disaster Resilience	0.55	0.050	12.236	***	Accepted
Direct Effect	β	SE	t	p	Decision
Social Capital → Fear of Crime → Individual Disaster Resilience	0.54	0.052	11.697	***	Accepted
Indirect Effect	β		95% CI		Decision
Social Capital → Fear of Crime → Individual Disaster Resilience	0.014		(0.002, 0.029)		Meaningful
Goodness-of-fit values: χ^2/df : 5.337; RMSEA: 0.065; CFI: 0.860; IFI: 0.861; TLI: 0.853; SRMR: 0.086					

*** $p < 0,05$

As a result, all hypotheses created within the scope of the research model were accepted (Table 4).

Table 4. Summary of Hypothesis Testing Results

Hypothesis	Result
H1(a): (SC) → (IDR)	Accepted
H1(b): (SC) → (FC)	Accepted
H1(c): (FC) → (IDR)	Accepted
H1(d): (SC) → (FC) → (IDR) (Mediating effect)	Accepted

The most striking finding obtained in this study is that fear of crime plays a partial mediating role in the effect of social capital on individual disaster resilience. According to this finding, social capital can indirectly increase disaster resilience by reducing individuals' fear of crime. Therefore, disaster resilience is based on physical and social resources and individuals' psychological security. This result reflects the original contribution of the study to the literature.

5. DISCUSSION

This study examined how fear of crime mediates the effect of social capital on disaster resilience. All the scales used in the study were highly reliable and structurally valid. Given the results achieved, all hypotheses were accepted.

Social capital is one of the fundamental elements of disaster resilience. Accordingly, societies and individuals with high social capital are more resilient to disasters because of their excellent social networks, trust, and community participation (Kim et al., 2017; Lucini, 2014; Mayunga, 2007; Pfefferbaum et al., 2017). As stated in a study examining disaster resilience in America, social capital in rural areas has been the essential driving force of disaster resilience. The more robust social networks and environment of trust in rural areas in comparison to urban areas increased disaster resilience. A study that reported similar results found that communities in rural areas were more resilient to disasters due to their strong social networks. In contrast, those living in urban areas are more vulnerable due to their isolation from various social networks (Straub et al., 2020). In their study, Nakamura and Kanemasu (2020) attribute the high disaster resilience of the Fijian people, who are exposed to cyclones yearly, to the knowledge they have gained from their past experiences and the long-standing tradition of mutual aid within the society. Therefore, individuals with solid networks and relationships perform better at every stage of the disaster cycle, from planning to reconstruction.

As in this study, many studies reported that people with high social capital are better prepared for disasters. Therefore, disaster resilience increases as social capital strengthens. Dokhi et al. (2017) showed that social capital positively affects disaster preparedness knowledge. Accordingly, people with high levels of trust, tolerance, social networking, and participation in collective action are inclined to have better awareness of disaster preparedness. Li and Tan (2019) found that the pre-disaster social networks of the villagers had a significant effect on post-earthquake community participation. Therefore, they suggest that local government should pay close attention to constructing and integrating social networks in earthquake-affected areas to improve community social capital. Similarly, Xiong and Li (2024) stated that social capital positively affects disaster resilience. Still, this significant effect decreases in regions severely affected by disasters and suffering considerable damage. This phenomenon, known as the “retreat effect,” happens when people or communities that had previously reacted to a hazard with resilience and solidarity become less eager to participate in preparedness efforts. Therefore, the study indicated that the impact of social capital on disaster resilience is highly complex, and its psychological basis should be addressed when developing it. Although the results achieved reveal that social capital plays a vital role in disaster resilience, it should be noted that its effect is not always linear and can vary depending on specific contexts. The “retreat effect,” particularly emphasized in the literature, shows that a decrease in individuals’ solidarity and preparedness efforts after a disaster can weaken resilience gains from social capital. Similarly, the exclusionary nature of social capital implies that marginalized groups without strong local networks may exhibit lower resilience to disasters. Therefore, for social capital’s positive impact on disaster resilience to be sustainable and inclusive, it is critical to increase the social inclusion of marginalized groups in these networks.

Another aspect demonstrating the complexity of social capital in disaster resilience is that it may have an exclusionary effect. Aldrich and Crook (2008), in their examination of New Orleans’ post-

Katrina recovery efforts, reported that local solid networks only helped certain societal groups. Accordingly, while social networks provide rapid and effective recovery for a sizable portion of the populace, they have tended to exclude outsiders. Again, Aldrich (2011) stated that following the 2004 tsunami in the Indian Ocean, villages with high social capital recovered more quickly. However, minorities and outsiders in these villages were excluded from the aid process. In another study, the positive effects of high social capital were observed in rescue efforts immediately after the Nepal earthquake. Nevertheless, this situation changed with the arrival of foreign aid. During the recovery period, marginalized groups with low social capital had access to fewer aid materials and funding support (Panday et al., 2021). While the disaster resilience of groups with high social capital is positively affected, the disaster resilience of marginal groups with weak social capital may decline. Plans and strategies to improve disaster resilience should address this situation.

Aside from its effects on disaster resilience, social capital is essential in addressing social problems such as fear of crime. Accordingly, individuals feel safer, and the fear of crime decreases in societies where social cohesion, trust, social control, and social networks are strong (Bolger & Bolger, 2019; Han, 2021; Öztürk, 2016). The literature indicates that social capital has a negative impact on this fear, similar to the results achieved. A study in Kyoto investigated the effects of social capital and community-based crime prevention activities on fear of crime. Accordingly, social capital, which increased community participation, effectively reduced street crimes and fear of crime. However, it did not significantly affect property crimes such as theft (Matsukawa & Tatsuki, 2018). Similarly, Sargeant et al. (2017) examined the relationship between social capital and fear of crime in Brisbane. They reported that fear of crime was lower in neighborhoods where solidarity, mutual aid, and social trust between neighbors were high. In contrast, another study carried out in Peru on the relationship between fear of crime, social capital, different types of crime, and social inequalities indicated that security measures based on social capital had a negative relationship with fear of crime. However, the study emphasized that security measures based on social capital did not wholly reduce fear of crime and only provided temporary relief, and it also emphasized that more sustainable social capital strategies were needed to increase social trust and solidarity to reduce fear of crime (Hernández et al., 2020).

Due to the fear of crime, people become lonely, withdrawn, socially isolated, and afraid of strangers. Thus, they cannot use their social networks or benefit from the necessary information sources (Vauclair & Bratanova, 2017). However, disaster resilience depends on the degree to which a person obtains, processes, understands, determines, and mobilizes the necessary information to cope with disasters (DiTirro, 2018). Therefore, the disaster resilience of individuals who experience fear of crime will also be negatively affected. Fear of crime partially mediates the relationship between social capital and disaster resilience, which reveals that we must evaluate individuals' resilience against disasters through social ties and their sense of emotional security. This result is consistent with the fact that fear of crime delays post-disaster recovery processes, as stated in a previous study (Farmer et al., 2018).

Similarly, other studies noted that increased fear of crime after a disaster leads individuals to withdraw from social life and thus weakens disaster resilience (Hino et al., 2018; Weil, 2020).

Some studies showed that crime rates and fear of crime increase post-disaster. This situation negatively affects the post-disaster recovery period, delays the transition of societies to everyday life, and reduces disaster resilience (Brodie et al., 2006; Farmer et al., 2018; Hino et al., 2018; Weil, 2020). Accordingly, a study carried out during the aftermath of the Great East Japan Earthquake also revealed that fear restricted access to shelters and essential resources, exacerbating social withdrawal and weakening community ties (Hino et al., 2018). Another study emphasizes that the increased fear of crime in the region after Hurricane Katrina damaged the sense of trust and cooperation, making the post-disaster recovery process more complex, and thus reducing individuals' disaster resilience (Weil, 2020). Therefore, increasing fear of crime will reduce a society's social capital and thus reduce disaster resilience. As emphasized in the literature, fear of crime negatively affected individual disaster resilience in this study.

Moreover, as revealed in this study, fear of crime partially mediated the effect of social capital on individual disaster resilience. In other words, fear of crime reduces the positive impact of social capital on individual disaster resilience. Even if individuals have a high level of social capital, their resilience to disasters diminishes to some degree if they fear crime. This finding indicates that efforts aiming to increase disaster resilience should not be limited to strengthening social capital alone; strategies to reduce individuals' fear of crime should also be developed. Accordingly, communication campaigns can be organized to increase the perception of security to strengthen social solidarity in post-disaster periods, and social programs that will support the public's sense of trust (e.g., establishing neighborhood solidarity centers and holding regular information meetings) should be implemented. In this way, the positive effect of social capital on disaster resilience can emerge more effectively without being weakened by the adverse impact of fear of crime.

This study fills an essential gap in the literature by addressing the relationship between social capital and disaster resilience through the fear of crime variable. While the literature usually analyzes the direct relationships between these two structures (Aldrich & Meyer, 2015; Cutter et al., 2016), this study develops a more holistic model by analyzing the intervening effect of fear of crime. Considering the findings achieved, it can be stated that social capital increases individuals' preparedness, resilience, and access to information against disasters, whereas fear of crime weakens this positive effect and negatively affects individuals' resilience. The present study reveals that disaster management policies should include physical resilience, social trust, and dimensions of security perception.

6. LIMITATIONS

Even though this study presents significant data, it also has several limitations. Firstly, the most fundamental limitation is that it was carried out in 2021 in the provinces of Burdur and Antalya, which

have not experienced a disaster that would mobilize social capital and make people fear crime. This limits the generalizability of the findings to different regions and post-disaster conditions.

Second, using face-to-face surveys as a data collection method may limit data objectivity and accuracy. Third, this study focused on the direct and indirect relationships between social capital, fear of crime, and disaster resilience. The impact of demographic and socioeconomic variables on the participants was excluded from the primary focus. More comprehensive models can be developed in future studies by adding such variables. Considering the limitations, it is recommended that subsequent studies expand their scope to include broader geographical areas and varied cultural contexts to strengthen the applicability and validity of the findings.

7. CONCLUSION AND IMPLICATIONS

This study answered all the intended questions with the findings that social capital increases individual disaster resilience (H1a) and decreases fear of crime (H1b), that fear of crime decreases individual disaster resilience (H1c), and that fear of crime plays a partial mediating role in the relationship between social capital and individual disaster resilience (H1d). The research questions posed at the beginning of the study were answered, and the findings were discussed in comparison with the literature. The partial mediation effect particularly underscores the critical importance of addressing the fear of crime to fully harness the benefits of social capital, with practical implications for disaster management and community development. These findings suggest that social capital is not only a predictor of disaster resilience but also plays a key role in reducing the negative psychological and social effects of the fear of crime. This bidirectional effect suggests that disaster resilience is based on physical capacities and individuals' emotional security and social connectedness levels. Thus, these psychosocial dimensions should be integrated into disaster resilience models.

The findings achieved in this study reveal that disaster management strategies should not be limited to physical measures but should also include approaches to create an environment of social trust and to reduce fear of crime. Policy recommendations to increase disaster resilience and reduce the fear of crime should be based on concrete steps. In Türkiye, establishing neighborhood-based disaster volunteer groups and their active participation in disaster preparedness processes will strengthen social capital. To reduce security concerns, it is very important to increase temporary security patrols and establish community-based communication networks in cooperation with local governments and law enforcement agencies after a disaster. In addition, municipalities should organize community workshops and disaster awareness training for target groups to ensure the participation of marginalized groups in disaster processes. By providing accurate, timely, and transparent information, the public administration will also increase social trust by preventing post-disaster information pollution. Training programs should include disaster risks and the culture of community solidarity, trust building, and joint action. Thus, disaster resilience will be strengthened not only in physical but also in social dimensions.

Another problem that should be highlighted here is that the images of looting during disasters keep the fear of crime alive in society. Moreover, disasters may be associated with possible looting in societies with low social capital. For this reason, preventive measures against the risk of looting, which can be considered a social problem, may positively affect social capital and disaster resilience. Therefore, future studies should analyze the relationships between crime, looting, and disaster resilience. In this context, future studies on the relationships between looting, crime perception, and disaster resilience will significantly contribute to understanding the dynamics of psychosocial resilience, especially in urban communities with low social capital. Future research should focus on disadvantaged groups, such as ethnic minorities, refugees, and older individuals, since investigating the unique experiences of these groups in disaster processes will contribute to a better understanding of structural inequalities in disaster risk reduction efforts. In addition, it is important to carry out long-term studies to monitor the changes in social capital and fear of crime before, during, and after disasters. Finally, more attention paid to the social and emotional impacts of disasters on individuals and communities would help deepen the understanding of the multidimensional nature of disaster resilience.

Ethics committee approval for the study was obtained from the Dokuz Eylül University Ethics Committee on April 27, 2021, with decision number E-87347630-640.99-48796.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

REFERENCES

- Aldrich, D. P. (2011). The externalities of strong social capital: post-tsunami recovery in Southeast India. *Journal of Civil Society*, 7(1), 81–99. <https://doi.org/10.1080/17448689.2011.553441>
- Aldrich, D. P., & Crook, K. (2008). Strong civil society as a double-edged sword: Siting trailers in post-Katrina New Orleans. *Political Research Quarterly*, 61(3), 379–389. <https://doi.org/10.1177/1065912907312983>
- Aldrich, D. P., & Meyer, M. A. (2015). Social capital and community resilience. *American Behavioral Scientist*, 59(2), 254–269. <https://doi.org/10.1177/0002764214550299>
- Ardahan, F. (2012). Adaption of “social capital scale”: Validity and reliability study. *International Journal of Human Sciences*, 9(2), 773–789.
- Beck, U. (2009). Critical Theory of world risk society: A cosmopolitan vision. *Constellations*, 16(1), 3–22. <https://doi.org/10.1111/j.1467-8675.2009.00534.x>
- Bolger, M. A., & Bolger, P. C. (2019). Predicting fear of crime: Results from a community survey of a small city. *American Journal of Criminal Justice*, 44(2), 334–351. <https://doi.org/10.1007/s12103-018-9450-x>

- Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Eds.), *Handbook of theory and research for the sociology of education* (pp. 241–258). Greenwood.
- Brodie, M., Weltzien, E., Altman, D., Blendon, R. J., & Benson, J. M. (2006). Experiences of hurricane Katrina evacuees in Houston shelters: Implications for future planning. *American Journal of Public Health*, 96(8), 1402–1408. <https://doi.org/10.2105/AJPH.2005.084475>
- Centre for Research on the Epidemiology of Disasters. (2024). *CRED Crunch 74—Disaster Year In Review 2023*. https://files.emdat.be/reports/2023_EMDAT_report.pdf
- Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, 94, S95–S120.
- Cutter, S. L., Ash, K. D., & Emrich, C. T. (2016). Urban-rural differences in disaster resilience. *Annals of the American Association of Geographers*, 106(6), 1236–1252.
- Dehon, C., Weems, C. F., Stickle, T. R., Costa, N. M., & Berman, S. L. (2005). A cross-sectional evaluation of the factorial invariance of anxiety sensitivity in adolescents and young adults. *Behaviour Research and Therapy*, 43(6), 799–810. <https://doi.org/10.1016/j.brat.2004.06.008>
- Disaster and Emergency Management Authority. (2024). *AFAD strategic plan 2024–2028*. Republic of Türkiye Ministry of Interior, Disaster and Emergency Management Authority. <https://www.afad.gov.tr/stratejik-planlar>
- DiTirro, L. (2018). *Conceptualizing individual disaster resilience: Benchmarking tools for individual and social coping capacity for a disaster resilient society* [Doctoral dissertation, Purdue University]. ProQuest Dissertations Publishing. https://docs.lib.purdue.edu/open_access_dissertations/1716
- Dokhi, M., Siagian, T. H., Utomo, A. P., & Rumanitha, E. (2017). Social capital and disaster preparedness in Indonesia: A quantitative assessment through binary logistic regression. In R. Djalante, M. Garschagen, F. Thomalla, & R. Shaw (Eds.), *Disaster risk reduction in Indonesia: Progress, challenges, and issues* (pp. 589–608). Springer. https://doi.org/10.1007/978-3-319-54466-3_24
- Farmer, A. K., Zelewicz, L., Wachtendorf, T., & DeYoung, S. E. (2018). Scared of the shelter from the storm: fear of crime and hurricane shelter decision making. *Sociological Inquiry*, 88(2), 193–215. <https://doi.org/10.1111/soin.12187>
- Ferraro, K. F. (1995). *Fear of crime: Interpreting victimization risk*. State University of New York Press.
- Ferraro, K. F. (1996). Women’s fear of victimization: Shadow of sexual assault? *Social Forces*, 75(2), 667–690. <https://doi.org/10.2307/2580418>
- Field, J. (2016). *Social capital* (3rd ed.). Routledge. <https://www.routledge.com/Social-Capital/Field/p/book/9780415703437>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.2307/3151312>
- Fukuyama, F. (2000). Social capital and civil society. *Social Science Research Network*. www.semanticscholar.org
- Han, S. (2021). Compositional and contextual associations of social capital and fear of crime. *Deviant Behavior*, 42(6), 718–732. <https://doi.org/10.1080/01639625.2020.1789295>
- Hawkins, R. L., & Maurer, K. (2010). Bonding, bridging and linking: How social capital operated in New Orleans following Hurricane Katrina. *The British Journal of Social Work*, 40(6), 1777–1793. <https://doi.org/10.1093/bjsw/bcp087>
- Hernández, W., Dammert, L., & Kanashiro, L. (2020). Fear of crime examined through diversity of crime, social inequalities, and social capital: An empirical evaluation in Peru. *Australian & New Zealand Journal of Criminology*, 53(4), 515–535. <https://doi.org/10.1177/0004865820954466>
- Hino, K., Tanaka, Y., & Schneider, R. H. (2018). Characteristics of fear of crime in evacuation shelters after the Great East Japan Earthquake. *Environmental Hazards*, 17(5), 456–469. <https://doi.org/10.1080/17477891.2018.1461605>
- Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Evaluating Model Fit: A synthesis of the Structural Equation Modelling Literature.

- Hsueh, H.-Y. (2019). The role of household social capital in post-disaster recovery: An empirical study in Japan. *International Journal of Disaster Risk Reduction*, 39(101199), 1–12. <https://doi.org/10.1016/j.ijdr.2019.101199>
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- International Organization for Migration. (2024). *World migration report 2024* (M. McAuliffe & L. A. Oucho, Eds.). <https://worldmigrationreport.iom.int/>
- Karagül, M. (2012). *Sosyal Sermaye—Kapitalizmin Kör Noktası*. Nobel Akademik Yayıncılık.
- Karakuş, Ö. (2013). Sociological predictors of fear of crime: Is it social capital or social control? *Eskişehir Osmangazi University Journal of Social Sciences*, 14(1), Article 1.
- Karunaratne, A. Y., & Lee, G. (2019). Traditional social capital and socioeconomic networks in response to flood disaster: A case study of rural areas in Sri Lanka. *International Journal of Disaster Risk Reduction*, 41, 101279. <https://doi.org/10.1016/j.ijdr.2019.101279>
- Kim, C., Nakanishi, H., Blackman, D., Freyens, B., & Benson, A. M. (2017). The effect of social capital on community co-production: Towards community-oriented development in post-disaster recovery. *Procedia Engineering*, 180, 901–911. <https://doi.org/10.1016/j.proeng.2017.04.251>
- Kirschenbaum, A. (2004). Generic sources of disaster communities: A social network approach. *International Journal of Sociology and Social Policy*, 24(10/11), 94–129. <https://doi.org/10.1108/01443330410791073>
- Kul, M. (2009). *The structuration of fear of crime in the society* [Doctoral dissertation, Ankara University]. Council of Higher Education National Thesis Center. <https://tez.yok.gov.tr/>
- Lagrange, R. L., Ferraro, K. F., & Supanic, M. (1992). Perceived risk and fear of crime: Role of social and physical incivilities. *Journal of Research in Crime and Delinquency*, 29(3), 311–334. <https://doi.org/10.1177/0022427892029003004>
- Li, Z., & Tan, X. (2019). Disaster-recovery social capital and community participation in earthquake-stricken Ya'an Areas. *Sustainability*, 11(4), Article 4. <https://doi.org/10.3390/su11040993>
- Lucini, B. (2014). *Disaster resilience from a sociological perspective: Exploring three Italian earthquakes as models for disaster resilience planning*. Springer.
- Matsukawa, A., & Tatsuki, S. (2018). Crime prevention through community empowerment: An empirical study of social capital in Kyoto, Japan. *International Journal of Law, Crime and Justice*, 54, 89–101. <https://doi.org/10.1016/j.ijlcj.2018.03.007>
- Mayunga, J. S. (2007). *Understanding and applying the concept of community disaster resilience: A capital-based approach*. In *Summer Academy for Social Vulnerability and Resilience Building* (pp. 1–16). United Nations University – Institute for Environment and Human Security (UNU-EHS).
- McGarrell, E. F., Giacomazzi, A. L., & Thurman, Q. C. (1997). Neighborhood disorder, integration, and the fear of crime. *Justice Quarterly*, 14(3), 479–500. <https://doi.org/10.1080/07418829700093441>
- Monteil, C., Simmons, P., & Hicks, A. (2020). Post-disaster recovery and sociocultural change: Rethinking social capital development for the new social fabric. *International Journal of Disaster Risk Reduction*, 42, 101356. <https://doi.org/10.1016/j.ijdr.2019.101356>
- Nakamura, N., & Kanemasu, Y. (2020). Traditional knowledge, social capital, and community response to a disaster: Resilience of remote communities in Fiji after a severe climatic event. *Regional Environmental Change*, 20(1), 23. <https://doi.org/10.1007/s10113-020-01613-w>
- Onyx, J., & Bullen, P. (2000). Measuring social capital in five communities. *The Journal of Applied Behavioral Science*, 36(1), 23–42. <https://doi.org/10.1177/0021886300361002>
- Öztürk, M. (2016). An analysis of fear of crime in the context of disorder and community concern model: Mersin example. *Cumhuriyet University Faculty of Letters Journal of Social Sciences*, 40(1), 281–291.
- Panday, S., Rushton, S., Karki, J., Balen, J., & Barnes, A. (2021). The role of social capital in disaster resilience in remote communities after the 2015 Nepal earthquake. *International Journal of Disaster Risk Reduction*, 55, 102112. <https://doi.org/10.1016/j.ijdr.2021.102112>

- Pfefferbaum, B., Van Horn, R. L., & Pfefferbaum, R. L. (2017). A conceptual framework to enhance community resilience using social capital. *Clinical Social Work Journal*, 45(2), 102–110. <https://doi.org/10.1007/s10615-015-0556-z>
- Putnam, R. D. (1995). Bowling alone: America's declining social capital. *Journal of Democracy*, 6(1), 223–234.
- Rader, N. E. (2017). Fear of crime. *Oxford Research Encyclopedia of Criminology*. <https://doi.org/10.1093/acrefore/9780190264079.013.10>
- Rader, N. E., Cossman, J. S., & Porter, J. R. (2012). Fear of crime and vulnerability: Using a national sample of Americans to examine two competing paradigms. *Journal of Criminal Justice*, 40(2), 134–141. <https://doi.org/10.1016/j.jcrimjus.2012.02.003>
- Republic of Türkiye Ministry of Interior. (2024). *Statistics on associations, foreign NGOs, political parties and trade unions*. Directorate General for Civil Society Relations. <https://www.siviltoplum.gov.tr/>
- Republic of Türkiye Ministry of Interior. (2025). *Presidency of migration management-statistic*. <https://en.goc.gov.tr/temporary-protection27>
- Sargeant, E., Liu, Y., St John, N., Fong Hong, N., Huu, T., Chen, J., & Mazerolle, L. (2017). Social capital and fear of crime in Brisbane. *Journal of Sociology*, 53(3), 637–652. <https://doi.org/10.1177/1440783317704992>
- Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research*, 8(2), 23–74.
- Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling* (3rd ed.). Routledge.
- Şen, G. (2022). *Disaster resilience in terms of fear of crime and social capital dynamics in society: The case of Burdur-Antalya city center* [Doctoral dissertation, Dokuz Eylül University]. Council of Higher Education National Thesis Center. <https://tez.yok.gov.tr/>
- Shevlin, M., Miles, J., & Lewis, C. (2000). Reassessing the fit of the confirmatory factor analysis of the multidimensional students life satisfaction scale: Comments on 'confirmatory factor analysis of the multidimensional Students' Life Satisfaction Scale'. *Personality and Individual Differences*, 28(1), 181–185.
- Simon, D., Kriston, L., Loh, A., Spies, C., Scheibler, F., Wills, C., & Härter, M. (2010). Confirmatory factor analysis and recommendations for improvement of the Autonomy-Preference-Index (API). *Health Expectations*, 13(3), 234–243. <https://doi.org/10.1111/j.1369-7625.2009.00584.x>
- Straub, A. M., Gray, B. J., Ritchie, L. A., & Gill, D. A. (2020). Cultivating disaster resilience in rural Oklahoma: Community disenfranchisement and relational aspects of social capital. *Journal of Rural Studies*, 73, 105–113. <https://doi.org/10.1016/j.jrurstud.2019.12.010>
- Tierney, K. (2011). Social inequality, hazards, and disasters. In R. Kasperson & M. Berberian (Eds.), *Social inequality, hazards, and disasters* (pp. 109–128). University of Pennsylvania Press. <https://doi.org/10.9783/9780812205473.109>
- Turkish Statistical Institute. (2024). *Population and demography*. <https://www.tuik.gov.tr/>
- UN-Habitat. (2022). *World cities report 2022: Envisaging the future of cities*. <https://unhabitat.org/wcr/>
- UN-Habitat. (2024). *Urban Safety*. <https://unhabitat.org/topic/urban-safety>
- United Nations Office for Disaster Risk Reduction. (2015a). *Disaster risk reduction and resilience in the 2030 agenda for sustainable development*. UNDRR. <http://www.undrr.org/publication/disaster-risk-reduction-and-resilience-2030-agenda-sustainable-development>
- United Nations Office for Disaster Risk Reduction. (2015b). *Sendai framework for disaster risk reduction 2015-2030*. UNDRR. <http://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- United Nations. (2017). *The new urban agenda—habitat III*. <https://www.habitat3.org/the-new-urban-agenda>
- Vauclair, C.-M., & Bratanova, B. (2017). Income inequality and fear of crime across the European region. *European Journal of Criminology*, 14(2), 221–241. <https://doi.org/10.1177/1477370816648993>

- Weil, F. D. (2020). Researching crime after a disaster: What we can learn from a large survey in New Orleans after Hurricane Katrina. *American Behavioral Scientist*, 64(8), 1111–1128.
<https://doi.org/10.1177/0002764220938107>
- World Bank. (2022). *Poverty and shared prosperity 2022*. World Bank.
<https://www.worldbank.org/en/publication/poverty-and-shared-prosperity>
- World Health Organization. (2024). *COVID-19 cases | WHO COVID-19 dashboard*.
<https://data.who.int/dashboards/covid19/cases>
- World Values Survey. (2023). *World values survey wave 7 (2017-2022)*.
<https://www.worldvaluessurvey.org/WVSDocumentationWV7.jsp>
- Xiong, A., & Li, Y. (2024). The role of social capital in building community disaster resilience –empirical evidences from rural China. *International Journal of Disaster Risk Reduction*, 110, 104623.
<https://doi.org/10.1016/j.ijdr.2024.104623>
- Yamamura, E. (2010). Effects of interactions among social capital, income and learning from experiences of natural disasters: A case study from Japan. *Regional Studies*, 44(8), 1019–1032.
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Evaluation of Service Quality with SERVQUAL-ENTROPY Integrated Method: Application of Eskisehir Metropolitan Municipality *

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Abstract

This study aims to measure the quality of public services provided by Eskişehir Metropolitan Municipality by using the SERVQUAL measurement model and the Entropy method together. The study examines citizens' perceptions of the services provided by Eskişehir Metropolitan Municipality and supports the results by analyzing the extent to which citizens' expectations are met and the difference between expectations and perceptions in terms of service quality using the Entropy method. An integrated approach provides certainty in identifying strategic priority areas for the municipality. The research surveyed 1,158 citizens who received services from Eskişehir Metropolitan Municipality. The results show that most of the quality deficiencies are related to parking, transport, traffic, regulations and resource use. The study combines subjective perception with data-driven analysis. It thus contributes to the literature with a hybrid methodology that increases the robustness of municipal service evaluations. The study aims to provide strategic recommendations to improve the quality of municipal services and increase citizen satisfaction.

Keywords: Service Quality, Metropolitan Municipality, Servqual, MCDM, Entropy.

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1. INTRODUCTION

Public services are services provided by public institutions, especially local governments, and developed to meet the expectations of citizens. Determining the expectations of citizens and meeting these expectations leads to the perception of the quality of services. In this study, SERVQUAL measurement model and Entropy method were used together to measure the quality of the services provided by Eskişehir Metropolitan Municipality and the results were evaluated. SERVQUAL measurement model, which is one of the measurement models frequently used in the measurement of service quality, measures the expectations about the services provided and the extent to which these expectations can be met, that is, the perception formed. However, this measurement model has been criticized for evaluating expectations and perceptions only through arithmetic averages. In order to eliminate this limitation in the study, a more objective weighting approach has been put forward by preferring to use the Entropy method together with the SERVQUAL measurement model. Thus, the findings related to service quality were evaluated on a more reliable basis.

When the findings obtained as a result of the analyses are examined, it is seen that there are significant differences between expectations and perceptions about municipal services. It has been observed that the expectations of citizens especially on issues such as car parking, public transport and transportation cannot be met. Apart from this, it has been determined that the quality is low in terms of being effective in the use of resources, fulfilling the promises made and making efforts to solve existing problems. The use of the Entropy method together with the SERVQUAL measurement model in determining these problems contributed to the correct determination of the sources of the heterogeneity of the Service Quality Scores (SQS) calculated with perception and expectation scores. Thus, it has contributed to providing important information on which strategic priorities will be chosen. It has been determined that it is important for the municipality to pay attention to issues such as strengthening transport and infrastructure services, planning resources and services more effectively and efficiently, and fulfilling the promises made to the citizens about the services on time.

The SERVQUAL model evaluates the difference between respondents' expectations and perceptions only through arithmetic averages, ignoring the heterogeneity of the data. In this study, the entropy method was integrated into the SERVQUAL model to measure the diversity of information and inconsistencies in the participants' responses. This made the measurements more objective and robust. The studies conducted in Türkiye to measure the service quality of local governments generally use the adapted version of the SERVQUAL scale for local governments or other conventional satisfaction surveys. This study differs from others in that it is integrated with multicriteria decision-making (MCDM) techniques and provides data-based solutions. As such, it provides practitioners with a new perspective on strategic planning. In the literature, there is a limited number of studies that use the entropy method to evaluate the quality of public services. From this point of view, the study is one of

the rare examples demonstrating the applicability of the entropy method in the public sector. The study, which will contribute to the literature in this area, is a methodological reference for future research.

2. QUALITY CONCEPT

The concept of quality is a concept that has emerged as a result of humankind's desire always to reach the better and has been shaped by the concept of "excellence". Since quality, just like excellence, is relative and subjective, it can be interpreted differently depending on the perception of the person. For this reason, it is difficult to make a clear definition of the concept. The level of fulfilment of the expectation expresses the perception of quality shaped by expectation. The first historical record of this expectation, which is thought to have emerged with the existence of human beings and the concept of quality, which is the result, is the Code of Hammurabi. In the laws written in 2000 BC, it was stated that the master builder would be responsible for the problems that would arise in the buildings of the period and would be punished (Şale, 2004). Similarly, the fact that the Romans built their buildings in accordance with certain specifications reflects the understanding of quality at that time. Quality, which we encounter in many historical records in the past, started to gain its current meaning after the Industrial Revolution. In this period, organizations established quality control units in order to strictly control the goods they produce (Şimşek, 2002). Quality, which is one of the most important factors influencing customer satisfaction (Ab. Karim et al., 2025), is a concept that indicates the extent to which a product or service meets specified needs and expectations (Singharia & Gupta, 2025). The efficiency and effectiveness studies of Taylor and Fayol, the pioneers of the classical management approach, are considered to be the first systematic analyses on quality. In the same period, issues such as "suitability for use and suitability for purpose", which were discussed by researchers such as Deming and Juran, made significant contributions to the development of the concept (Koç, 2017). The concept of quality, which was defined only in terms of products, became important in the service sector in the 1990s with the acceleration of the service sector, and quality service delivery has become the key to success and sustainability for organizations today (Usta & Memiş, 2009).

3. DEFINITION OF SERVICE CONCEPT

Basic needs, which constitute the essence of people's needs, are met by both private and public institutions. The concept of service, which is an important element for ensuring the continuity of life and increasing its quality, is a concrete concept. It consists of activities such as entertainment, health and comfort, which require immediate consumption when the concept, which expresses some spiritual pleasures, is produced (Quinn et al., 1987). Since service is a comprehensive concept, many different definitions have been made. When these definitions are analyzed, it is seen that the concept has a complex and multidimensional structure. Despite all this diversity, the concept of service can be defined as a set of actions that develop between an organization and a needy person (customer), have an economic value and provide benefit and pleasure to the recipient (Evans & Lindsay, 1999; Murdick, 1990). In addition to this definition, it should be noted that services consist of activities used in solving

problems related to human life (Yücel et al., 2012). Therefore, services are intangible products produced to meet the expectations of customers (Neal et al., 1994). The intangibility of services makes it difficult for the producer to understand to what extent the expectations of those who consume them are met and what kind of perception the consumption creates in the customer. This difference between expectation and perception is an important issue to be emphasized in terms of service quality (Parasuraman et al., 1985).

One of the reasons why a customer's perception of a service is negative is that the difference between the organizational strategic intention and the customer expectation and the need for this expectation is high. Therefore, in order to avoid this difference, correct evaluations should be made while answering the what and how questions asked in service design (Goldstein et al. 2002). How the activities related to the service provided in the service delivery process are perceived by the service receivers and to what extent their expectations are met before the service process is an important component in determining the service quality. Increasing expectations of customers and consumers becoming more conscious increase the importance of the concept of service quality (Kayral, 2015).

Services are realized to meet a need. Therefore, maturing a service is a time-consuming and challenging process. The difficulties of service design arise from various factors such as (1) effective design problems arising from the inviolable nature of services, (2) difficulties in imitating and protecting the service, (3) difficulties in determining quality and value due to the lack of trial opportunities, (4) difficulties in balancing customer satisfaction and organizational efficiency (Zeithaml et al., 2009).

4. SERVICE QUALITY

The concept of service quality, which is one of the concepts that has attracted significant attention both in academic literature and in practice since the 1990s, has risen to an important position with the internationalization of services (Öztürk, 2016). For service organizations, service quality has become a concept related to strategic goals such as gaining/increasing market share, profit, productivity, customer loyalty/loyalty and competitive advantage (Kayral, 2015). Unlike physical products that are consumed after production, services are first sold and then produced. Consumption takes place at the same time as production. Therefore, the quality of the service cannot be controlled before sales (Zeithaml et al., 1985). Service quality plays a crucial role in the evaluation of services, which, unlike tangible products, have characteristics such as intangibility, simultaneity, variability and absence (Palamidovska-Sterjadovska et al., 2024). Service quality should be seen as a concept that is not only result-oriented but should be considered as a satisfaction measure that covers all processes of service delivery (Ab. Karim et al., 2025). In order to increase the quality of services, it is necessary to define the concept correctly and make it measurable. When the definitions related to service quality are analyzed, it is seen that two basic elements come to the fore. These are customer expectations and customer perception/satisfaction (Özer & Önen, 2016). The difference between these two basic elements

refers to quality. However, determining an acceptable quality can often show personal differences. It has been determined that these differences, which are shaped according to individual standards, are generally related to the fact that the service cannot be provided professionally and that it is presented with a personal approach instead of an objective presentation (Garvin & Quality, 1984). Therefore, it is challenging to ensure continuous quality in services that come to life with individual performance. The intangible nature of the service and the variability of the personal emotional states of both the service provider and the service recipient create difficulties in the continuity of service quality (Öztürk, 2016). As can be understood from all these, the most important factor determining the quality of a service is human. Considering that both parties in service delivery are human, it is seen that service quality emerges with the interaction of the parties. The obvious influencer of this interaction is the party providing the service. It is challenging to control the performance of the personnel providing a service (Zeithaml et al., 1988).

Three basic characteristics determine service quality. These characteristics, each of which is derived from a different aspect of the service, are as follows (Pérez et al., 2007); (1) since services are consumed immediately after they are produced, service consumers can perceive all defects related to the quality of the service, (2) the main determinant of service quality is the interaction between the service provider and the service receiver, (3) customers' previous experiences play an important role in determining service quality.

Service quality, which is an abstract and variable concept, is the rate of transformation of customer expectation into perception. Customers' expectations are shaped mainly by experiences, information obtained from other sources and the image of the organization in terms of service (Sütütemiz, 2015). Accordingly, customers who make evaluations pay attention to how the service is finalized, the way the service is provided, and who provides the service. They evaluate what they get as a result of the service, how they act while obtaining it, and the image of the service provider (Koç, 2017). It is possible to say that the expectations of customers have become much more differentiated in recent years. Especially with the effect of social media, experience sharing has increased and these shares have shaped organizational images. Therefore, one of the important determinants of service quality in recent years is the widespread use of technology and social media.

Service quality has two important components. These components are the quality of the service and the quality of the presentation (Esin, 2004). There are many skills and features within these two components. If the organization develops these, it increases the service quality. The capabilities and features of these two components are speed, price, flexibility, innovation, trust, communication, etc. and their development will increase customer satisfaction and thus the quality of service (Acuner & Şebnem, 2001).

The quality of a service can be revealed by the difference between the customer's expected satisfaction and perceived satisfaction. Both expectation and perception may result in different evaluations in the same situations. For example, the expectation of a person who goes to a hospital to receive health services for routine controls will be different from the expectation of the hospital he/she goes to as a result of an emergency case. Another reason for the difference between expectation and perception is the service itself. The unexpectedness of the way the service emerges, the fact that it cannot be compared with other services, and whether the customer is involved in the service process are the factors that arise from the essence of the service and cause differences in its evaluation (İslamoğlu & Aydın, 2016). Managers have important duties in increasing service quality and transforming it into an understanding that spreads throughout the organization. Managers who adopt the understanding of quality are generally (1) able to explain the aims of the understanding of quality to the whole organization, (2) increase organizational commitment by motivating employees to achieve organizational goals, (3) impose obligations as well as responsibilities on employees in ensuring quality, (4) set an example for the organization by fulfilling their duties and responsibilities in terms of quality, (5) know that there are no limits in terms of quality, (6) follow customer feedbacks about the services provided and evaluate them (Uraltaş & Ekici, 2013).

The concept of service quality has evolved over time. It is no longer just about customer satisfaction but has become a concept related to multidimensional elements such as digitalization, process quality, physical and technical equipment, security and personalization (Walke & Winkler, 2024). Recent studies on service quality show that the dimensions of service quality have changed with the spread of digitalization and technological services. It is emphasized that in sectors such as banking, where digitalization is intensively used, elements such as system quality, information quality and user experience have emerged as dimensions that directly affect service quality (Palamidovska-Sterjadovska et al., 2024; Deng, Liu & Liu, 2023).

The concept of service quality is a concept that has different meanings from different perspectives. While customers make evaluations according to the degree to which their expectations are met in service quality, they make evaluations from the perspective of establishing service standards for organizations and carrying out activities based on them. For public administration, the concept of quality is related to the quality of life to be increased and more effective services such as education, health and transport (Örs, 2007). In order to measure the quality of public services, it is not enough to fulfil the expectations from the service alone because there are different determinants such as different needs, different priorities, correct use of resources, equality, impartiality and accountability in public services (Galloway, 1998).

5. SERVICE QUALITY IN LOCAL GOVERNMENTS

Local services, in common parlance, municipal services are a showcase of general public services. Therefore, it is necessary to maintain the satisfaction levels of citizens who benefit from the service (Usta & Memiş, 2010). Today, with the changing dynamics, a citizen-oriented approach has been adopted in public services. Citizens not only accept the services offered to them but also participate actively in the processes of determining, preparing and providing these services (Çetinkaya et al., 2016).

When the performance management process, which focuses on the effectiveness and efficiency of municipal services, is considered, the fact that one of the performance criteria is citizen satisfaction and that citizen satisfaction can be achieved through the provision of quality services is an important point (Boyne, 2002). With this approach, it becomes possible both to use resources more efficiently in the services provided by municipalities and to provide services that are more appropriate to the needs of citizens.

With the new understanding of public administration, the concept of quality is defined as the quality of the services provided to meet the needs of citizens and the provision of these services through the units closest to the citizens. This understanding has placed an important responsibility on municipalities in terms of quality and made it obligatory for them to provide quality services. In the services provided by municipalities; (1) it has become an obligation to take into account the changing social expectations and pressures and to provide quality services, (2) if the services are of high quality, the awareness and recognition of the municipality increases, (3) providing quality services contributes to solidarity and rapprochement by increasing trust and support for the municipality (Gaster, 1996).

However, today's rapid change, social and environmental problems make it difficult for municipalities to understand and fulfil citizen expectations. In addition, various legal regulations and scarce resources are recognized as important problems that slow down the efforts of municipalities to improve the quality of services (Kurgun et al., 2008). For this reason, local governments are struggling to fulfil these activities with limited resources while endeavoring to provide quality services with external pressures on the one hand. This dilemma forces local governments to put forward innovative approaches to use resources more efficiently and access new resources.

There are various factors affecting the quality of local services and citizen satisfaction. These factors include; (1) previous service experiences of citizens, (2) demographic characteristics such as age, gender, occupation, and education level, (3) communication level of local governments with citizens, (4) technological infrastructure used in service provision, (5) correct and efficient use of resources, (6) the rate of reflection of citizen expectations on service policies, (7) acting in accordance with the principle of equality in service provision, and (8) the thoughts that service providers are/are not in a relationship of interest with third parties (Sevimli, 2006; Adaman & Çarkoğlu, 2000; Akyıldız, 2012).

6. SERVICE QUALITY MEASUREMENT MODELS

It is very difficult to define and measure the concept of service quality, which is formed by the combination of abstract concepts such as service and quality, which may differ according to the person. The difficulty of determining different expectations and meeting them with a single service makes it difficult to measure quality. Despite all these difficulties, service quality is an indispensable element for the success of organizations providing services. The essentiality of measuring this element has led to the development of many models to measure service quality. When these models are analyzed, it is seen that the basic elements are; (1) being market-oriented, (2) being customer-oriented, (3) motivating employees for service delivery, (4) determining the factors that affect service quality positively/negatively, (5) performing measurements accurately and effectively, (6) receiving feedback from customers, (7) ensuring efficiency and continuity in customer relations (Seth et al., 2005).

The number of models developed to determine the level of service quality based on these fundamental elements is quite high. These models include Kano model, gap/difference model, three-dimensional service quality model, performance model, IT adaptation model, hierarchical approach service quality model, electronic service quality model. In this section, the Gap/Difference Model (SERVQUAL), which forms the basis of the study and is one of the frequently used methods in service quality measurement, will be emphasized.

The SERVQUAL model developed by Parasuraman et al. (1988) is a model that focuses on identifying and analyzing gaps/differences in service quality. The model measures the differences between customers' service expectations and their perceptions after the service. It focuses on five basic dimensions. These dimensions are reliability, assurance, tangible/physical elements, empathy and responsiveness. The scale provides valid and reliable solutions to service organizations and can be applied in many service areas (Parasuraman et al., 1988). A major advantage of SERVQUAL is that it can determine customer expectations. Thus, service quality can be determined by comparing expectations with post-service perceptions (Asubonteng et al., 1996).

SERVQUAL is a common quality measurement model used to measure service quality in many different sectors (banking, education, health, transport, etc.) (Zhang & Song, 2024). According to some researchers, taking the difference between expectation and perception with the SERVQUAL scale is seen as a disadvantage. The basis of the criticism is that difference scores may create statistical problems in validity and reliability analyses (Brown et al., 1993). Parasuraman et al. (1994), responded to the criticisms by stating that expectations and perceptions can be re-evaluated over time and changes can be monitored (Parasuraman et al., 1994). Another criticism about the scale is that the SERVQUAL scale is not suitable for all service organizations. The criticisms are that the five dimensions determined for the scale do not address every type of service. Especially in organizations offering multiple services, the difficulties of making measurements for each service have been pointed out (Carman, 1990). Another criticism about the dimensions is that the results obtained are abstract because the dimensions are not

concrete. This intangibility may make it difficult to identify specific deficiencies in service delivery clearly. For example, the scale may reveal that the behavior of the service personnel is perceived as negative, but it cannot determine which behavior leads to this negative perception, thus making it difficult to take corrective steps (Öztürk, 2000).

Despite all these criticisms, the SERVQUAL scale is valuable in that it can be applied among both old and new customers, changes in customer expectations can be monitored and organizations have the opportunity to improve service quality accordingly. Moreover, since the cost of application is low, it facilitates comparison with other organizations (Asubonteng et al., 1996).

7. SCOPE AND DATA

One of the most frequently used and accepted scales in service quality measurement is the SERVQUAL scale. Although it has been widely used since it was introduced to the literature, some criticisms have been brought to the scale. One of the parts where these criticisms are concentrated is service quality scoring. Service quality scoring is calculated by the difference between the average expectation value and the average perception value. This calculation is performed separately for each item in the scale. The quality is evaluated by taking into account the negative and large size of the score obtained. In the evaluation made by Babakus and Boller (1992) on this scoring and evaluation, they stated that when participants are asked to report the level of expectation and perception to measure service quality, the difference between expectation and perception may become suspicious due to some psychological pressures. Similarly, Teas (1994) argued that the difference between expectation and perception is based on people's experiences and therefore the difference between expectation and perception is not clear. In parallel, Buttle (1996) emphasized the inadequacy of taking the difference between these two values in the calculation of expected and perceived service quality. Souca (2011) argued that the measurement of the expectation part of the SERVQUAL scale is difficult. Therefore the results obtained in the calculation of the service quality score may not be reliable enough. Therefore, it is seen as a strong possibility that various problems may occur during the conversion of participants' thoughts and criticisms into scores in the SERVQUAL scale (Tsaur et al., 2002). Taking these criticisms into consideration, Augustyn and Seakhwa-King (2005) stated that the quality results obtained as a result of service quality measurement with the SERVQUAL scale will not fully reflect the perception of quality, and that different tools should be used to measure quality adequately / clearly.

When the literature is examined, it is seen that there has been an increase in the studies in which SERVQUAL scale and Multicriteria Decision Making (MCDM) techniques have been used together, especially in recent years. Lee and Kim (2012) Data Envelopment Analysis (DEA), Stević et al. (2021) The Delphi and Full Consistency Method (FUCOM), Adebisi et al. (2022) Fuzzy Analytical Hierarchy Process (FAHP) and VIKOR, Xie et al. (2022) Decision Making Trial and Evaluation Laboratory

(DEMATEL), Al Awadh (2023) Analytical Hierarchy Process (AHP) techniques and SERVQUAL model. There is a common opinion that the results obtained in the studies are more reliable.

In the light of this information, the study aims to evaluate the service quality scores obtained by SERVQUAL technique together with the results of Entropy method, which is one of the objective weighting methods among MCDM methods, and to measure the quality measurement more clearly and easily. For this purpose, SERVQUAL scale was applied to citizens living in Eskişehir and benefiting from municipal services. The sample volume required for the application was calculated with the help of equation (1) below.

$$n = \frac{N \cdot p \cdot (1 - p)}{(N - 1) \cdot \left(\frac{d}{z_{1-\alpha/2}} \right)^2 + p \cdot (1 - p)} \quad (1)$$

Here n , sample size; N , the population size; z , the table value of the confidence level (such as 1.64; 1.96; 2.57); p , the probability of the examined event occurring; $1 - p$, the probability of the examined event not occurring, and d whereas the tolerance level (0.05 or 0.01). Accordingly, when the tolerance level is 0.05, the minimum sample size required for the study is calculated as follows.

$$n = \frac{696060 \cdot 0.5 \cdot (1 - 0.5)}{(688989 - 1) \cdot \left(\frac{0.05}{1.96} \right)^2 + 0.5 \cdot (1 - 0.5)} \cong 384$$

The calculation was made by taking into account the number of voters in the General Election of Local Authorities held on 31 March 2024 in Eskişehir, which was determined as the main population. It was concluded that at least 384 participants should be surveyed within the scope of the study. As a result of the fieldwork, accurate and complete returns were obtained from a total of 1,158 participants. Therefore, it is possible to say that the number of participants participating in the study represents the main population quite well. In determining the participants, convenience sampling method was used.

8. METHODOLOGY

In the study, it is aimed to evaluate SERVQUAL service quality scores (SQS) and the weights obtained by Entropy method together. In this section, brief information about Entropy, one of the MCDM methods, is given.

8.1. Entropy Method

Entropy weighting is a method that eliminates the intervention of decision makers in criterion weightings since it determines criterion weights without subjective approaches of decision makers. Entropy weighting is a multicriteria decision-making method used to determine the weight of a decision criterion by relating the weighting of a criterion directly to the information of that criterion (Bazzazi, et al., 2011). In order to determine the objective weights by entropy method, each criterion in the decision matrix in equation (2) should be normalized as follows (Deng, Yeh, & Willis, 2000):

$$p_{ij} = \frac{x_{ij}}{\sum_{p=1}^n p_{ij}} \quad i = 1, 2, \dots, n; j = 1, 2, \dots, m \quad (2)$$

As a result of the operations in Equation (2), a normalized decision matrix representing the relative performance of the alternatives is obtained as follows.

$$P = \begin{bmatrix} p_{11} & p_{12} & \dots & p_{1j} \\ p_{21} & p_{22} & \dots & p_{2j} \\ \dots & \dots & \dots & \dots \\ p_{i1} & p_{i2} & \dots & p_{ij} \end{bmatrix} \quad (3)$$

In the light of the information contained in the normalized decision matrix in Equation (3), entropy values for each criterion (e_j) is calculated by means of equation (4).

$$e_j = -k \sum_{i=1}^n p_{ij} \ln p_{ij} \quad (4)$$

In Equation (4) $k = 1/\ln(n)$ expression $0 \leq e_j \leq 1$ means a constant that satisfies the condition. The degree of divergence of the average information contained in each criterion (d_j) can be calculated as follows:

$$d_j = 1 - e_j \quad (5)$$

The distance between the alternative scores for the criteria, calculated in equation (5) d_j has a structure directly proportional to its values. This means that d_j As the value increases, the distance between the scores of the alternatives and accordingly the uncertainty increases. In the entropy method, criterion weights are calculated at the last stage. This calculation is made as in equation (6).

$$w_j = \frac{1 - e_j}{\sum_{i=1}^n 1 - e_j} \quad (6)$$

In equation (6) above w_j , shows the weight values, which are the indicators of the importance levels of the criteria. It should be noted here that all w_j of the sum of the values ($w_1 + w_2 + \dots + w_n$) is equal to 1.

9. FINDINGS

As a result of the reliability analysis performed on the data of the study with the SPSS program, it was seen that the study was 98% reliable. Therefore, it is concluded that the scale applied on the determined sample indicates high reliability. During the reliability analysis, all of the statements in the scale were taken into consideration. In other words, both the statements related to expectation and the statements related to perception were evaluated.

9.1. Descriptive Findings

The presentation of the findings started with the demographic characteristics of the participants. 57.3% of the participants were male and 42.7% were female. In the city, which has a young population, the age group with the highest rate of participation was citizens between the ages of 18-25 with a rate of 25%. When the educational status of the participants is analyzed, it is seen that high school and undergraduate graduates are in the majority. When the occupational distribution is analyzed, it is determined that self-employed people are in the first place and public employees are in the second place. 52% of the participants reside in Tepebaşı district and 48% in Odunpazarı district.

Table 1. Descriptive Results

Feature	Category	Number of People	Per cent
Gender	Woman	495	42.7
	Male	663	57.3
Age	18-25 years old	290	25.0
	26-30 years old	128	11.1
	31-35 years old	102	8.8
	36-40 years old	128	11.1
	41-45 years	120	10.4
	46-50 years old	133	11.5
	51-55 years	108	9.3
	56-60 years	92	7.9
	61-65 years	23	2.0
	66 years and over	34	2.9
Education Status	Primary School	65	5.6
	Middle School	74	6.4
	High School	399	34.5
	Associate degree	176	15.2
	Licence	353	30.5
	MA/PhD	91	7.9
Employment Status	Public Sector	284	24.5
	Private Sector	185	16.0
	Self-employment	308	26.6
	Student	136	11.7
	Pensioner	138	11.9
	Other	107	9.2
Income Status	10,000 TL and below	242	20.9
	Between 10,001 TL-20,000 TL	265	22.9
	20,001 TL-35,000 TL	339	29.3
	35,001 TL-50,000 TL	211	18.2
	50,001 TL-75,000 TL	69	6.0
	75,001 TL and above	32	2.8
Physical Disability Status	Yes	33	2.8
	No	1,125	97.2
District of Residence	Tepebasi	602	52.0
	Odunpazari	556	48.0

9.2. Findings Related to Service Quality

In this section, in addition to the expectation and perception averages for all items in the scale, the AQS, entropy weights of the participants' expectations and entropy weights of the participants'

perceptions were calculated. All calculations were performed with the help of MS Excel. The findings obtained are presented in Table 2.

Table 2. SQS and Entropy Weights

Question No	Question	Expectation Average	Current Situation Average	SQS	Expectation Weights	Perception Weights
1	The Municipality has modern working environments, modern tools and equipment.	4.05	2.87	-1.1805	0.03910	0.02815
2	Municipality employees are clean and neat in appearance.	4.21	3.14	-1.0708	0.02708	0.02364
3	The municipality fulfils its promises on time.	4.16	2.44	-1.7237	0.04020	0.03646
4	The municipality endeavors to solve the problems of the people.	4.26	2.58	-1.6831	0.03580	0.03477
5	The municipality serves the first time and right.	4.19	2.58	-1.6071	0.03408	0.03233
6	The public is sufficiently informed about the municipality's activities.	4.20	2.65	-1.5449	0.03494	0.03262
7	The municipality keeps careful records of the work done.	4.26	2.87	-1.3912	0.02951	0.02459
8	Municipality employees have sufficient knowledge and skills and are willing to help citizens.	4.29	2.77	-1.5173	0.02823	0.02993
9	Municipality staff inspire confidence in the public and are respectful towards the public.	4.32	2.85	-1.4724	0.02780	0.03004
10	The municipality takes care of every citizen and treats them fairly.	4.29	2.56	-1.7314	0.03179	0.03413
11	The working hours of the municipality are determined in accordance with the citizens.	4.25	2.98	-1.2660	0.02949	0.02823
12	The municipality pays due attention to environmental and cleaning services.	4.32	2.81	-1.5095	0.02987	0.03329
13	The time and conditions under which cleaning services are provided are appropriate.	4.25	2.93	-1.3178	0.03011	0.02952
14	The municipality pays enough attention to the inspection services necessary for the citizens.	4.24	2.69	-1.5518	0.03213	0.03203
15	The manner in which the Municipality carries out its audit activities is appropriate and correct.	4.21	2.71	-1.5069	0.03244	0.03181

(Table 2 cont.)

Question No	Question	Expectation Average	Current Situation Average	SQS	Expectation Weights	Perception Weights
16	It is easy to reach the person or unit to whom complaints about the municipality will be forwarded.	4.29	2.71	-1.5786	0.03081	0.03299
17	The municipality takes complaints seriously and evaluates them.	4.32	2.65	-1.6684	0.03002	0.03377
18	The Municipality resolves complaints in an appropriate time.	4.27	2.58	-1.6952	0.03225	0.03443
19	Zoning services are carried out in accordance with the law and fairly.	4.28	2.55	-1.7332	0.03280	0.03466
20	The municipality's zoning services are sufficient to meet the needs.	4.22	2.49	-1.7297	0.03505	0.03550
21	The municipality will not allow any construction that will spoil the appearance of the city.	4.31	2.67	-1.6468	0.03054	0.03642
22	Municipality is in cooperation with relevant institutions in infrastructure works.	4.26	2.58	-1.6788	0.03232	0.03517
23	The number of public transport vehicles and their routes and stops are sufficient.	4.22	2.42	-1.8005	0.03696	0.03854
24	The municipality deals with the car parking problem and seeks to resolve this problem.	4.23	2.22	-2.0026	0.03943	0.04280
25	The Municipality shall organize a sufficient number of useful social and cultural activities.	4.24	2.95	-1.2953	0.03249	0.03221
26	Municipality organizes activities such as panels, seminars, theatre, concerts for the public.	4.26	3.17	-1.0889	0.03108	0.02752
27	The municipality endeavors to facilitate student life.	4.30	2.83	-1.4646	0.03071	0.03202
28	The municipality takes care to meet the vital needs of the elderly and infirm.	4.29	2.92	-1.3748	0.03059	0.02973
29	The municipality contributes to the promotion of the city through its activities.	4.31	3.15	-1.1598	0.02854	0.02761
30	The resources of the municipality are sufficient.	4.26	2.85	-1.4111	0.03090	0.02938
31	Uses municipal resources effectively and efficiently.	4.29	2.57	-1.7150	0.03293	0.03570

The weights of AQS, weights of expectations and weights of perception were calculated separately and summarized in Table 2. The calculated entropy weights provide information about the heterogeneity or homogeneity of the answers given to the related item. Higher entropy weights indicate that there is heterogeneity in the answers given to the related item, while lower weights indicate that the answers are relatively more homogeneous. When determining the source of heterogeneity, it is seen that this situation is shaped in accordance with the nature of "expectation" and "perception" situations. While heterogeneities in expectation weights are realized on values smaller than the average by nature, heterogeneity in perception weights is concentrated on values larger than the average. In order to make the comparisons more understandable for the purpose of the study, the rankings of all questions in terms of AQS and weights are as shown in Table 3.

Table 3. Ranking of Items According to SQS and Entropy Weights

Question No	Question	Ranking According to SQS	Ranking According to Expectation Weights	Ranking According to Perception Weights
1	The Municipality has modern working environments, modern tools and equipment.	28	3	27
2	Municipality employees are clean and neat in appearance.	31	31	31
3	The municipality fulfils its promises on time.	6	1	3
4	The municipality endeavours to solve the problems of the people.	9	5	8
5	The municipality serves the first time and right.	13	8	16
6	The public is sufficiently informed about the municipality's activities.	16	7	15
7	The municipality keeps careful records of the work done.	23	26	30
8	Municipality employees have sufficient knowledge and skills and are willing to help citizens.	17	29	22
9	Municipality staff inspire confidence in the public and are respectful towards the public.	20	30	21
10	The municipality takes care of every citizen and treats them fairly.	4	16	11
11	The working hours of the municipality are determined in accordance with the citizens.	27	27	26
12	The municipality pays due attention to environmental and cleaning services.	18	25	13
13	The time and conditions under which cleaning services are provided are appropriate.	25	23	24

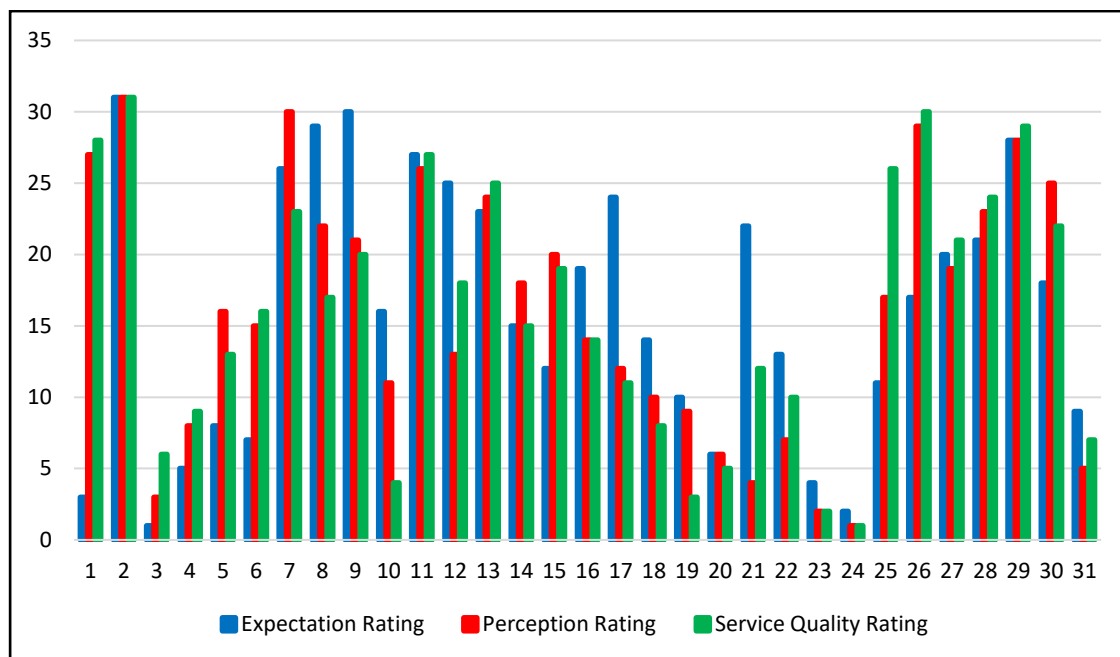
(Table 3 cont.)

Question No	Question	Ranking According to SQS	Ranking According to Expectation Weights	Ranking According to Perception Weights
14	The municipality pays enough attention to the inspection services necessary for the citizens.	15	15	18
15	The manner in which the Municipality carries out its audit activities is appropriate and correct.	19	12	20
16	It is easy to reach the person or unit to whom complaints about the municipality will be forwarded.	14	19	14
17	The municipality takes complaints seriously and evaluates them.	11	24	12
18	The Municipality resolves complaints in an appropriate time.	8	14	10
19	Zoning services are carried out in accordance with the law and fairly.	3	10	9
20	Municipality's zoning services are sufficient to meet the needs.	5	6	6
21	The municipality will not allow any construction that will spoil the appearance of the city.	12	22	4
22	Municipality is in cooperation with relevant institutions in infrastructure works.	10	13	7
23	The number of public transport vehicles and their routes and stops are sufficient.	2	4	2
24	The municipality deals with the car parking problem and seeks to resolve this problem.	1	2	1
25	The Municipality shall organise a sufficient number of useful social and cultural activities.	26	11	17
26	Municipality organizes activities such as panels, seminars, theatre, concerts for the public.	30	17	29
27	The municipality endeavors to facilitate student life	21	20	19
28	The municipality takes care to meet the vital needs of the elderly and infirm.	24	21	23
29	The municipality contributes to the promotion of the city through its activities.	29	28	28
30	The resources of the municipality are sufficient.	22	18	25
31	Uses municipal resources effectively and efficiently.	7	9	5

When the findings obtained in Table 3 are evaluated, it is seen that the first five prioritized items in the AQS are listed as items 24, 23, 19, 10 and 20, respectively. Based on this ranking, it is seen that

both expectation and perception weights of items 24 and 23 are parallel to the AQS. However, in items numbered 19, 10 and 20, there were noticeable differences between the SQS and the expectation and perception weights in terms of rankings. The main reason for this situation is that arithmetic averages are directly considered in the calculation of the AQS. In contrast, in the entropy method, the related items are subjected to normalization within themselves. Therefore, it is seen that evaluating the entropy weights together with the service quality scores in determining the priority areas is an important and necessary issue for reliable results. In order to have a more detailed and broad perspective, the results obtained are presented graphically in Figure 1.

Figure 1. Graphical Representation of SQS and Entropy Weights Rankings



Paying attention to two points in the interpretation of Figure 1 may enable more accurate identification of priority areas. These points can be explained as the lengths of the columns should be parallel to each other and these columns should be as short as possible since the column lengths show the rankings. As of the results in Table 2, it is seen that items 24 and 23 are both graphically parallel to each other (in terms of AQS, expectation weight and perception weight) and they are quite short. For this reason, it is possible to say that these two items are prioritized areas. However, the items that can be considered more appropriate to follow these two items are items 3, 31 and 4, respectively. Therefore, it is concluded that prioritizing the areas numbered 24, 23, 3, 31 and 4 in Eskişehir can increase the service quality faster.

10. DISCUSSION

Examining the results of the study, it was found that the lowest performance of public services provided by Eskişehir Metropolitan Municipality is in the areas of parking, transport and timely service delivery. In another study conducted with the integrated SERVQUAL-CCDM model developed by

Stević et al. (2021), in parallel with these findings, it was found that the biggest gaps in service quality are in the basic operational dimensions such as 'reliability' and 'timely service'. Therefore, it can be seen that the basic functions of public services have shortcomings in satisfying citizens.

In this study conducted in Eskişehir, the aim is to measure service quality with SERVQUAL scale. SERVQUAL scale, which is used to measure service quality, is one of the traditional quality measurement methods. Although this method is often preferred in studies, it has been criticized with the emphasis that the method needs more objectivity in weighting and prioritization processes and the belief that its use alone is not sufficient in quality measurement. In the study by Ciavolino and Calcagni (2015), a new integrated model was proposed and applied, taking into account the methodological criticisms made in the literature for SERVQUAL. The entropy method used in our study takes into account the variability of respondents' answers by assigning objective, data-driven weights. This methodological choice is in line with the "Generalized Cross Entropy" approach proposed by Ciavolino and Calcagni (2015). In the aforementioned study, the SERVQUAL scale was statistically enriched, emphasizing that service quality gaps can be measured more accurately. Similarly, in our study, in addition to the SERVQUAL scale, weights were determined using the entropy method, one of the objective weighting methods. This increased the reliability of the measurement by taking into account the homogeneity/heterogeneity differences in the participants' responses.

Again, the SERVQUAL-FAHP-TOPSIS model developed by Luyen and Thanh (2022) is an important study that demonstrates the multiple benefits of CRM methods in measuring service quality. The study highlights the contribution of fuzzy logic and weighting to the decision making process in determining the relative importance levels of service quality. Our study, which was conducted in Eskişehir, reinforced this approach with the entropy method more simply and directly and presented an accessible and effective solution model in both academic and applied fields. Wang and Dong (2023) combined SERVQUAL with entropy weighting and TOPSIS methods in their study to evaluate the quality of e-commerce logistics services. This enabled them to rank the service providers. In this study, as in our study, service quality scores in dimensions such as 'reliability' and 'empathy' were low and identified as the weakest aspects of quality.

As a result, this study, which aims to measure the quality of public services provided by Eskişehir Metropolitan Municipality, was integrated with the Entropy method, which is one of the CRM models, in order to complete the deficiencies of the SERVQUAL scale mentioned in the literature. In this way, it contributed to a more realistic, objective and decision-maker-oriented evaluation of the public services provided. Compared to similar studies in the literature, the study stands out for its unique data set, its focus on local government and its integrated methodological approach, as well as for its theoretical and practical contributions. It is one of the pioneering studies that puts into practice the aspects suggested by many studies on service quality measurement and presents the results with a sample application in Türkiye. Going beyond traditional SERVQUAL applications, a data-based, objective and

multicriteria analysis perspective has been presented, thus making a significant contribution to quantitative analysis-based service quality assessment in public services.

11. CONCLUSION

SERVQUAL method is the most frequently used method in service quality measurement today as it has been for many years. Although there are criticisms of the SQS part, recent studies have taken these criticisms into consideration and contribute to making the service quality results evaluated with the SERVQUAL scale more reliable. In the literature, the integration of MCDM methods in these evaluations is a very common situation. In the studies, it is generally emphasized that service quality measurements increase reliability with the integration of MCDM methods. However, in most of the related studies, the SQS specific to the SERVQUAL scale is not taken into consideration. The arithmetic mean method used in the calculation of the SDQ is affected by extreme values, which reduces the reliability of the results. Within the scope of the study, it is aimed to contribute to the literature to eliminate this unreliability by integrating entropy with the proposed service quality score. With the approach discussed in the study, the evaluation of the heterogeneity of participant responses as additional information will provide decision makers with the opportunity to make important determinations. The results obtained show that the combined evaluation of the calculated service quality score and the entropy weights of expectations and perceptions helps to focus on more sensitive and accurate areas. In addition, with this integrated approach, it is possible to say that the computational difficulties and complexity that may be encountered in considering different MCDM methods alone can be avoided.

Ethics committee approval for the study was obtained from the Anadolu University Ethics Committee on January 31, 2024, with protocol number 688833.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

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REFERENCES

- Ab. Karim, S. N., Mustafa, M., Haron, S., & Rusli, R. (2025). Service quality attributes affecting the satisfaction of KTM Komuter services. *Transportation Planning and Technology*, 48(1), 131–152.
<https://doi.org/10.1080/03081060.2024.2331208>
- Acuner, T., & Şebnem, A. A. (2001). Toplam hizmet kalitesi yönetimi ve müşteri memnuniyetini sağlamadaki rolü. *Pazarlama Dünyası*, 13(17), 61-64.
- Adaman, F., & Çarkoğlu, A. (2000). *Türkiye'de Yerel ve Merkezi Yönetimlerde Hizmetlerden Tatmin, Patronaj İlişkileri ve Reform*. TESEV.

- Adebiyi, S. O., Akinrinmade, O. J., & Amole, B. B. (2022). Optimizing service quality management of the bus rapid transport system in lagos using the multicriteria decision analysis. *Scientific Journal of Silesian University of Technology, Series Transport* (116), 5-23.
- Akyıldız, F. (2012). Belediye hizmetleri ve vatandaş memnuniyeti: Uşak Belediyesi örneği. *Yaşar Üniversitesi E-Dergisi*, 7(26), 4415-4436.
- Al Awadh, M. (2023). Assessing the quality of sustainable airline services utilizing the multicriteria decision-making approach. *Sustainability*, 15(9), 1-19.
- Asubonteng, P., McCleary, K. J., & Swan, J. E. (1996). Servqual revisited: A critical review of service quality. *Journal of Services Marketing*, 10(6), 62-81.
- Augustyn, M. M. and Seakhoa-King, A. (2005), Is the SERVQUAL scale an adequate measure of quality in leisure, tourism and hospitality?. In J. Chen (Eds.), *Advances in hospitality and leisure volume 1*. (pp. 3-24). Emerald Group Publishing Limited.
- Babakus, E., & Boller, G. W. (1992). An empirical assessment of the SERVQUAL scale. *Journal of Business Research*, 24(3), 253-268.
- Bazzazi, A. A., Osanloo, M., & Karimi, B. (2011). Deriving preference order of open pit mines equipment through MADM methods: Application of modified VIKOR method. *Expert Systems with Applications*, 38(3), 2550-2556.
- Boyne, G. A. (2002). Theme: Local government: Concepts and indicators of local authority performance: An evaluation of the statutory frameworks in England and Wales. *Public Money and Management*, 22(2), 17-24.
- Brown, T. J., Churchill Jr. G. A., & Peter, J. P. (1993). Improving the measurement of service quality. *Journal of Retailing*, 69(1), 127-139.
- Buttle, F. (1996). SERVQUAL: Review, critique, research agenda. *European Journal of Marketing*, 30(1), 8-32.
- Carman, J.M. (1990). Consumer perceptions of service quality: An assessment of the Servqual Dimensions. *Journal of Retailing*, 66(1), 33-55.
- Çetinkaya, Ö., Korlu, K. R., & Eroğlu, E. (2016). Belediye hizmetlerinin kalitesi ve vatandaşların algı düzeyi: Bursa Büyükşehir Belediyesi örneği. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 21(4), 1251-1273.
- Ciavolino, E., & Calcagni, A. (2015). Generalized cross entropy method for analysing the SERVQUAL model. *Journal of Applied Statistics*, 42(3), 520-534. <https://doi.org/10.1080/02664763.2014.963526>
- Deng, H., Yeh, C. H., & Willis, R. J. (2000). Inter-company comparison using modified TOPSIS with objective weights. *Computers & Operations Research*, 27(10), 963-973.
- Deng, X., Liu, L., & Liu, X. (2023). Research on service quality of professional education based on the PZB service quality model. *Frontiers in Education*, 8:1325256. 1-12. <https://doi.org/10.3389/educ.2023.1325256>
- Esin, A. (2004). *ISO 9001: 2000'nin ışığında hizmette toplam kalite*. ODTÜ.
- Evans, J. R., & Lindsay W. M. (1999). *The Management and Control of Quality and Performance Excellence*. South-Western Company.
- Galloway, L. (1998). Quality perceptions of internal and external customers: A case study in educational administration. *The TQM magazine*, 10(1), 20-26.
- Garvin, D. A., & Quality, W. D. P. (1984). Really mean. *Sloan Management Review*, (25), 25-43.
- Gaster, L. (1996). Quality services in local government: A bottom-up approach. *Journal of Management Development*, 15(2), 80-96.
- Goldstein, S. M., Johnstone, R., Duffy J., & Rao, J. (2002). The service concept: The missing link in service design research?. *Journal of Operations Management*, (20), 121-134.
- İslamoğlu, H., & Aydın K. (2016). *Hizmet pazarlaması*. Beta Basım A.Ş.
- Kayral, İ. H. (2015). *Beklenen-gerçekleşen-algılanan hizmet kalitesi ve sağlık hizmetlerinde çok boyutlu kalite*. Detay Yayıncılık.

- Koç, E. (2017). *Hizmet pazarlaması ve yönetim*. Seçkin Yayıncılık.
- Kurgun, A., Özdemir, A., Kurgun, H., & Bakıcı, Z. (2008). Belediyelerde hizmet yeterliliğinin ve hizmet kalitesinin artırılmasını etkileyen faktörlerin analizi: İzmir Karşıyaka Belediyesinde uygulama. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 10(2), 29-54.
- Lee, H., & Kim, C. (2012). A DEA-SERVQUAL approach to measurement and benchmarking of service quality. *Procedia-Social and Behavioral Sciences*, (40), 756-762.
- Luyen, L. A., & Thanh, N. V. (2022). Logistics service provider evaluation and selection: Hybrid SERVQUAL–FAHP–TOPSIS model. *Processes*, 10(1024), 1-12. <https://doi.org/10.3390/pr10051024>
- Murdick, R. G. (1990). *Service operation management*. Allyn and Bacon.
- Neal, G. T., Naoko, O., & Genevieve, A. G. (1994). Job satisfaction among nurse assistants employed in nursing homes: An analysis of selected job characteristics, *Journal of Aging Studies*, 3(4), 369-383.
- Örs, H. (2007). *Hizmet pazarlama etkinliği ve kalite*. Gazi Kitabevi.
- Özer, M. A., & Önen, S. M. (2016). *200 soruda yönetim kamu yönetimi*. Gazi Kitabevi.
- Öztürk, S. A. (2000). Hizmet kalitesi ölçümünde yeni bir yaklaşım: Kritik olaylar tekniği. *Anatolia: Turizm Araştırmaları Dergisi*, 11(2), 57-68.
- Öztürk, S. A. (2016). *Hizmet pazarlaması kuram, uygulama ve örnekler*. Ekin Basım Yayın Dağıtım.
- Palamidovska-Sterjadovska, N., Rasul, T., Lim, W. M., Ciunova-Shuleska, A., Ladeira, W. J., Santini, F. O., & Bogoevska-Gavrilova, I. (2024). Service quality in mobile banking: A systematic review. *International Journal of Bank Marketing*. 1-36. <https://doi.org/10.1108/IJBM-02-2024-0105>
- Parasuraman, A., Zeithaml, V. A., & Berry L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49(4), 41-50.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). Servqual: A multiple-item scale for measuring consumer perc. *Journal of Retailing*, 64(1), 12-40.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1994). Alternative scales for measuring service quality: A comparative assessment based on psychometric and diagnostic criteria. *Journal of Retailing*, 70(3), 201-230.
- Pérez, S. M., Carlos Gázquez A. J., Carrillo, M. M. G. & Sánchez Fernández, R. (2007). Effects of service quality dimensions on behavioural purchase intentions: A study in public-sector transport. *Managing Service Quality: An International Journal*, 17(2), 134-151.
- Quinn, J. B., Baruch, J. J., & Paquette, P. C. (1987). Technology in services. *Scientific American*, 257(6), 50-58.
- Şale, İ. (2004). *ISO 9001:2000 Kalite yönetim sistemi ve uygulamaları*. Seçkin Yayıncılık.
- Seth, N., Deshmukh, S. G., & Vrat, P. (2005). Service quality models: A review. *International Journal of Quality & Reliability Management*, 22(9), 913-949.
- Sevimli, S. (2006). *Hizmet sektöründe kalite ve hizmet kalitesi ölçümü üzerine bir uygulama* [Unpublished master's thesis]. Dokuz Eylül University.
- Şimşek, M. (2002). *Toplam kalite yönetiminde başarının anahtarı: İnsan faktörü*. Babıali Kültür Yayıncılığı.
- Singharia, K., & Gupta, G. (2025). Music streaming app service quality (MSASQ) scale: Service quality dimensions for music streaming apps. *Benchmarking: An International Journal*. 1-30. <https://doi.org/10.1108/BIJ-01-2024-0051>
- Souca, M. L. (2011). SERVQUAL – Thirty years of research on service quality with implications for customer satisfaction. In I. Plăiaş & R. Ciornea (Eds.), *International Conference Marketing from Information to Decision 4th Edition*, (pp. 420-429). Risoprint Cluj-Napoca.
- Stević, Ž., Tanackov, I., Puška, A., Jovanov, G., Vasiljević, J., & Lojaničić, D. (2021). Development of modified SERVQUAL–MCDM model for quality determination in reverse logistics. *Sustainability*, 13(5734), 1-17. <https://doi.org/10.3390/su13105734>
- Sütütemiz, N. (2015). Hizmet pazarlaması ve stratejileri. In R. Altunışık (Eds.), *Hizmet kalitesi yönetimi ve gap modelleri*, (pp. 59-99). Beta Basım.

- Teas, R.K. (1994). Expectations as a comparison standard in measuring service quality: An assessment of a reassessment. *Journal of Marketing*, 58(1), 132-139.
- Tsaur, S. H., Chang, T. Y., & Yen, C. H. (2002). The evaluation of airline service quality by fuzzy MCDM. *Tourism Management*, 23(2), 107-115.
- Uraltaş, N. T., & Ekici K. M. (2013). *Hizmet pazarlaması*. Yargı Yayınevi.
- Usta, R., & Memiş, L. (2009). Belediyelerde hizmet kalitesinin seçmen bağlılığı üzerinde etkisi. *Sosyal Bilimler Dergisi*, 11(1), 213-235.
- Usta, R., & Memiş, L. (2010). Belediye hizmetlerinde kalite: Giresun Belediyesi örneği. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 15(2), 333-355.
- Walke, F., & Winkler, T. J. (2024). Process quality matters: Investigating the inherent characteristics of quality and performance in digital, physical and omnichannel services. *International Journal of Quality and Service Sciences*, 16(5), 1-15. <https://doi.org/10.1108/IJQSS-06-2023-0077>
- Wang, L., & Dong, M. (2023). An entropy weight-TOPSIS based method for e-commerce logistics service quality evaluation. *Tehnički vjesnik – Technical Gazette*, 30(4), 1253–1256. <https://doi.org/10.17559/TV-20230306000408>
- Xie, S., Wang, X., Yang, B., Li, L., & Yu, J. (2022). Evaluating and visualizing QoS of service providers in knowledge-intensive crowdsourcing: A combined MCDM approach. *International Journal of Intelligent Computing and Cybernetics*, 15(2), 198-223.
- Yücel, N., Yücel, A., Gültür, E., & Ak M. (2012). Belediyelerde hizmet pazarlaması: Elazığ Belediyesi örneği. *Niğde Üniversitesi İİBF Dergisi*, 5(2), 150-164.
- Zeithaml, V. A., Berry, L. L., & Parasuraman, A. (1988). Communication and control processes in the delivery of service quality. *Journal of Marketing*, 52(2), 35-48.
- Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. (2009). *Services marketing*. Mc Graw Hill.
- Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1985). Problems and strategies in services marketing. *Journal of Marketing*, 49(2), 33-46.
- Zhang, H., & Song, M. (2024). Elevating service startup survival through strategic service quality. *International Journal of Quality and Service Sciences*, 16(3), 372–388. <https://doi.org/10.1108/IJQSS-07-2022-0067>

The Ideology of Liberal Nationalism and Halide Edip Adıvar's Yeni Turan *

Oğuzhan GÖKSEL¹

Abstract

This article discusses the novel *Yeni Turan* written by Halide Edip Adıvar during the Second Constitutional Era, within the framework of the liberal nationalism argument. The main purpose of this study is to shed light on Halide Edip's nationalist ideas during the Second Constitutional Monarchy Period by examining whether the utopia created in the novel *Yeni Turan* is consistent with the basic arguments of the liberal nationalist ideology. Liberal nationalism is a conception of nationalism in which liberal values are dominant. Liberal nationalists work from the idea that the world is divided into nations, each with a unique personality and character that deserve respect. The liberal nationalist argument considers the preservation and development of national identities as important. According to liberal nationalists, this means that national identities should have the right to self-determination. Additionally, liberal nationalists see an environment that nurtures national identities as compatible with democratic practices if individuals share the same beliefs as those representing them, this indicates to the members of that nation that they are part of an active community. The clearest way to ensure this is for nations to have a government of their own choosing. This perspective sheds light on the relationship between nationalism and democracy. Thus, a political structure where sovereignty is shared under a federal umbrella would be a governance model aligned with the ideology of liberal nationalism. Halide Edip's goal as a nationalist intellectual was to find a foundation on which the Turkish national identity, which at the time was struggling under the shadow of the Ottomanism movement, could be strengthened. Throughout the novel, she manifests this goal through her imagining of Türkiye. Her utopia is based on the concept of decentralization. A democratic, federal, and liberal political system is envisioned in the novel, where every nation in the empire can experience its nationalism, and women can gain their rights. It is concluded that Halide Edip Adıvar is a liberal nationalist intellectual of the Second Constitutional Monarchy Period with her novel *Yeni Turan*, which describes a utopia she established.

Keywords: *Halide Edip Adıvar, Liberal Nationalism, Yeni Turan.*



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1. INTRODUCTION

The views among the Young Turks in the early 1900s, in which liberal thinking was defended in the economy and the concept of the national economy was defended as an opposition, progressively evolved beyond economics and became a social and political discussion of centralization and decentralization (İnsel, 2021, p. 56). At the 1902 Young Turk Congress, the differences between the positivist Ittihadist wing led by Ahmet Rıza and the liberal wing led by Prince Sabahattin surfaced resulting in the division of the Committee of Union and Progress (Kadıoğlu, 1999, p. 78).

Following the declaration of The Second Constitutional Monarchy, divergence manifested itself as two distinct political party programs. The liberal views of the liberal wing, such as individualism, private enterprise, and decentralization under the “*Private Enterprise and Decentralization League*” (Ottoman Turkish: *Teşebbüs-ü Şahsi ve Adem-i Merkeziyet Cemiyeti*), became a party under the name of the Liberty Party (Ottoman Turkish: *Ahrar Fırkası*) (İnsel, 2021, p. 56). Prince Sabahattin’s Science Sociale doctrine, which he shaped under the influence of Le Play and Demolins, incorporated the idea of private enterprise and decentralization and formed the basis of the program of the Liberal Party. In Turkish thinking, this perspective has always been in opposition and has never gained power (Tunaya, 1988, p. 11). Even though there are individuals, groups, and political parties who can be described as liberal during the War of Independence and the early Republican period, liberal ideology has not been able to achieve a significant position in Turkish politics. A communitarian culture that glorifies the state could not accommodate liberal themes, which contain elements “*foreign*” to the Turkish social and cultural structure. As a result of both Ottoman heritage and the sociological structure of society, the “*individual*” has always been placed at the back of society, preventing the creation of an environment conducive to the development of liberal values. Kemalist ruling elites, born and raised in the social and political heritage of the late Ottoman period, found a means to surviving through modernization and nationalism, and accordingly developed practices based on a strong, centralized state’s imagination. It is natural that “*decentralization*” was excluded from Turkish political thought.

The purpose of this article is to analyze Yeni Turan, a utopian political novel written during the Second Constitutional Monarchy of the Ottoman Empire when late Ottoman intellectuals were seeking a “*remedy*” for the depression that had plagued them. The novel Yeni Turan was first published in the Tanin Newspaper in 1911. It is in this novel that Halide Edip attempts to synthesize the idea of Turkism with the idea of decentralization. Halide Edip is known as an “*American mandate advocate*” and the author of novels such as “*Ateşten Gömlek*”, “*Türk’ün Ateşle İmtihanı*”, “*Vurun Kahpeye*”, and “*Sinekli Bakkal*”. In addition to these images of Halide Edip as a mandate advocate and novelist, Çetinsaya reminds us that Halide Edip was a feminist who defended women’s rights, a nationalist who shouted at the Sultan Ahmet demonstration against the occupation of İzmir, a corporal in the National Struggle, an exile, a humanist, and a politician, and reveals the conservative aspects of Halide Edip’s thoughts in her

work (Çetinsaya, 2005, p. 11). Aside from all these titles and images, the article argues that Halide Edip was a “*liberal nationalist*” thinker with her utopic novel during the Second Constitutional Monarchy.

There are a limited number of studies on liberal nationalism in literature. There is no detailed analysis specific to Halide Edip's novel *Yeni Turan*. Halide Edip represents one of the closest figures to the tradition of liberal thought in the early years of Turkish nationalism. During the Second Constitutional Monarchy and the early periods of the Republic, Halide Edip was one of the thinkers who emphasized the individual and his freedom the most. These liberal values also influence her idea of nationalism. According to Akyol (2020), Halide Edip is one of the few figures in Turkish nationalist history who most strongly emphasizes democracy and liberalism (p. 734). Similarly, Türk (2021) points out that she made a significant contribution to the subjective history of the development of liberalism in Türkiye (p. 135). Indeed, Halide Edip's statement that “where there is no individual, society is a herd, where there is no right, duty is a drudgery,” when contrasted with Ziya Gökalp's assertion that “there is no individual, only society; there is no right, only duty,” reveals how close she was to the tradition of liberal thought (Adıvar, 2009, pp. 326–327).

2. LIBERALISM AND NATIONALISM

According to ancient Greek philosophy, human beings are social creatures and can exist within the society in which they reside. Continuing in this vein, in medieval Christian philosophy, society is regarded as more important than the individual. There is no value and importance to an individual as a being on its own. An individual's identity is only determined by the existence of the society to which he or she belongs and is expressed through that society. An individual's gradual self-existence is the basis for modern political thought. Science and art have contributed to the weakening of the authority of the church in the West, and increased trade and industrialization have created an environment conducive to modern political thought. Social changes resulted in the abandonment of collectivist and scholastic ideologies in the Middle Ages in favor of a rational paradigm in which liberal ideology would flourish. It is considered to be a libertarian ideology that limits the role of the state and emphasizes the autonomy of the individual.

A second phenomenon that emerged in this climate was nationalism. It was the rational thought that developed in the West that contributed to the weakening of dynasties that were based on blood and religious ties. As a result of the ongoing process of modernization, the nation-state and the modern nation were created as a result of the new paradigm. Nationalists claimed that people were divided into distinct nations and that the borders of a political unit should coincide with the boundaries of those nations. Despite the ongoing debate over nationalism, it was generally accepted that nationalism was a modern concept. As such, it can be argued that liberal thought and nationalism were born and coexisted during these periods.

The French Revolution plays a significant role in shaping the concept of the free and autonomous individual as well as the modern nation. There is one basic reason for the formation of both ideologies: modernization. As a result of modernization, the concept of the individual and freedom of the individual opened the door to the idea of modern society. Such a society embodies both national and liberal values. Taking a look at the last two centuries in Western history, two distinct trends are evident: first, a political realignment of almost universal proportions from a complex spectrum of empires, kingdoms, city-states, protectorates and colonies to a system of nation-states oriented toward nation-state building policies that promote the propagation of a common national identity, culture, and language; second, the almost universal replacement of all pre-liberal or non-democratic forms of government (e.g. monarchies, oligarchies, theocracies, military dictatorships, communist regimes, etc.) by liberal democracies. The relationship between nation-states and liberal democracy can therefore be viewed as a congruence (Kymlicka, 2001, p. 224).

However, nationalism and liberalism are generally viewed as opposing ideologies. Essentially, liberalism is an individualist ideology, while nationalism is a socialist ideology. Liberals emphasize the diversity of concepts of the “good” adopted by individuals. On the other hand, nationalists emphasize the social dimension of individual identity. According to nationalists, integrating with a nation, serving it, and adhering to its traditions is the only way for individuals to achieve their full potential. This perspective suggests that national goals are more valuable than individual goals and that individual freedom can only be achieved by identifying with and submitting to the “*national will*” (Tamir, 1993, p. 17). It is claimed by nationalists that individual identity is determined by nations and that the nation shapes individual identity rather than ascribing meaning to it. Here, the contradiction between nationalism and individual autonomy is highlighted. However, liberal nationalists hold a different view: having a national identity and sharing a national culture facilitates the exercise of individual freedom.

2.1. Liberal Nationalism

Due to the tensions inherent in the theoretical foundations of the two ideologies, the notion of a nation compatible with liberal principles is discussed. Liberal philosophy is universalist, whereas the nationalist philosophy opposes it (McCarthy, 1999, p. 175). While liberalism emphasizes individual rights and freedoms, nationalism prioritizes collective identity, national autonomy, and cultural integrity (Çiçek, 2024, p. 239). Liberal interpretations of nationalism, however, maintain that this tension is unnecessary, noting that liberal principles have historically emerged and been accepted within the framework of nationalism. In liberal societies, political legitimacy is closely related to the idea of a nation (Karabulut, 2014, pp. 876-877). Liberal nationalism represents an approach that protects individual freedoms and recognizes the importance of national identity. Liberal nationalists defend the role of national identity in the social life and self-development of individuals and claim that this identity does not contradict liberal values. The liberal nationalist view of national identity is not one of oppression, but rather one of individual freedom and democratic participation (Çiçek, 2024, p. 240). The

nation-state represents the social and political conditions in which liberal democracies are most likely to flourish. It is in the nation-state that the basic principles and goals of liberal democracy can be most effectively realized (Tok, 2007, p. 89). Canovan (1996, pp. 72-80) describes the nation as the “battery” that powers liberal democracy. The liberal-democratic political process is dependent upon the development of a strong sense of “we”, and national borders provide the most effective means of establishing a collective political identity.

As Tamir argues, although often viewed as opposites, the liberal tradition, which emphasizes individual rights and freedoms, and the nationalist tradition, which stresses belonging, loyalty, and solidarity, can actually complement one another (Tamir, 1993, p. 6). Moreover, MacCormick (2002, p. 174) defends liberal nationalism and takes a positive stance towards the liberal conception of nationalism. Considering this form of nationalism to be important for the modern world, he emphasizes the need for vigorous debate about it.

Although nationalism is generally regarded as an authoritarian ideology, some scholars emphasize its progressive and liberal characteristics. In Heywood's view, a liberal conception of nationalism is an expression of Western liberalism. The roots of this form of nationalism can be traced back to the French Revolution, and liberal nationalism incorporates many of the values of that revolution. Heywood (2013) argues that, in continental Europe in the mid-19th century, being a nationalist was the equivalent of being a liberal (p. 116).

Nodia (1999) views nationalism as an integral part of liberal democracies and argues that nationalism would be impossible without democracy, just as democracy would not be possible without liberalism (p. 86). The sovereignty of the people and the fundamental equality between citizens, which are the basis of the modern concept of nationality, are also fundamental principles of democracy. The meaning of nationalism is the foundation of democracy. The two ideologies are intrinsically intertwined, and neither can be fully understood without the other. It is through nationalism that democracy appears throughout the world (Greenfeld, 2017, pp. 28-29). Based on this perspective, Nodia (1999, pp. 87-89) argues that democratic enterprises require a sense of nationalism to shape their political structures.

Individuals make their choices within the framework of their cultural heritage. In this regard, it is essential to protect and respect national cultures. In practice, this implies that the community should have the right to self-determination (Miller, 2006, p. 535). The notion that liberal thought and nationalism can be compatible ideologies is illustrated by the argument that “*the concept of nationhood also has a natural connection with the human personality*”. This argument distinguishes conscious nationalism from ethnic classifications. In essence, ethnic categorization aims to transpose the family institution on a macro-social scale. A nation, on the other hand, views itself not as a family, but as a person with a unique personality. In general, a modern nation is similar to a modern individual (unlike older ethnic groups), in that it is organized around the concept of self-determination, obeys only the

rules that it approves, and rejects the rules imposed by others (Nodia, 1999, p. 93). According to Nodia (1999), the Francization of peasants and their naturalization are one and the same process. As far as he is concerned, the demands for the establishment of democracy provide incentives for the creation of a nation based on existing ethnic material. It is for this reason that nascent democracy and independence movements are often viewed as one and the same. Both movements are driven by self-determination: We, the citizens - that is, we the nation - will determine our own destiny, we will abide by the rules we set, and we will not be ruled by anybody without our consent (pp. 90-91). The right of nations to self-determination is valuable. The reason for this is that it corresponds to the idea that they are an active community in the minds of the people, even if they recognize that their representatives are acting on their behalf. People can be said to be self-determining and acting when their core beliefs are expressed in their representatives' actions. Having an elected government is the most obvious way to ensure this, and this explains the frequent observation of a link between nationalist and democratic ideals (Miller, 1994, p. 140). According to Tamir (1993), the membership requirements prevalent in liberal states reinforce the idea that the state is more than just a collection of random individuals brought together by a formal agreement. At this point, two fundamental issues force liberals to resort to nationalist ideas: as liberalism does not offer a theory of border demarcation, the idea of national self-government must be strengthened, and liberal states should be conceived as permanent communities and not as temporary associations that can be arbitrarily dissolved (p. 121). Being a nation is a modern condition. In a sense, nation and nationalism are forms of solidarity that are appropriate for dynamic societies, in which clans and villages are no longer the primary forms of community. As a result of such societies, people remain connected to each other in an egalitarian manner, with collective loyalty serving as the central focus (Miller, 1995, pp. 184-185). It was the classical liberals of the 19th century who used the power of the modern state to destroy or weaken local communities and regional ties. This contributed to the development of the autonomous individual. So, autonomous individuals arose within and as a product of the national cultures of modern European nation-states. As a result of nation-building, modern states have enabled liberal thought and autonomous individuals in practice. The national cultures constructed by modern sovereign states are characterized by one way of life, that of autonomous individuals (Gray, 2003, pp. 114-115). By freeing people from the bonds of community in which they were imprisoned, and giving them a national identity, the nation-state enables the individual to become a member of the nation as well as a free and equal citizen (Tok, 2007, p. 90).

As with other forms of nationalism, liberal nationalism assumes that humanity is divided into nations, each with its own identity. The distinctive feature of liberal nationalism is that it combines Rousseau's idea of popular sovereignty with the concept of nation. US President Woodrow Wilson's Fourteen Principles provide the clearest expression of liberal nationalism. Originally drafted in 1918, these principles were proposed as a basis for Europe's reconstruction after the First World War (Heywood, 2013, p. 116). Wilson's principle that "*every nation should be free and have the right to self-*

government in the areas where it has the majority” is at the heart of the liberal nationalist concept of dividing the world into separate, equal, and free countries.

Miller (2006, p. 532) emphasizes the importance of culture in creating a national identity. It is cultural characteristics that make up a nation. In this regard, liberal nationalism generally accepts the concept of a linguistic-cultural nation and a liberal-constitutional state. As of today, the linguistic-cultural nation is generally accepted as the basis for political community. Because it is the largest private community that still inspires emotional loyalty and the smallest comprehensive community that still has the characteristics of universality, uniting all classes of society. The nation is a “*little humanity*” and a “*great association*”. According to Tocqueville, few people are filled with a love for all humanity. It would be better to give each individual a nation rather than to try to inflame his passion for all humanity in this case (Lind, 1994, p. 94). In Miller’s view (1995, p. 184), individuals value the cultural heritage they receive from membership in a nation, and they want to be able to see continuity between themselves and their ancestors. There is no appeal for us in the idea of considering national identities as merely historical accidents and abandoning national identities in favor of a common identity for all humanity.

The liberal nationalism movement has attempted to reconcile a moderate and reasonable nationalist sentiment with a more socially sensitive form of liberalism. In the liberal nationalist case, three main elements are emphasized. Our first encounter is with the communitarian view that we are social beings. It is through society and its values that human beings exist (Vincent, 1997, pp. 279-280). Accordingly, MacCormick (2002, p. 176) advocates social or contextual individualism rather than atomistic individualism. He believes that an individual cannot be evaluated without taking into account their social relationships and the context in which they live. The definition of a good society for MacCormick (1982, p. 247) is one in which each individual is taken seriously, each person has a fair share of material well-being and civil liberty, and these elements are essential to the flourishing of each individual. Rather than relying on classical liberalism’s understanding of the individual and society, liberal nationalism theory may be built on social liberalism’s understanding. The reason for this is that classical liberalism places the individual above any collective element. Conversely, social liberalism assigns certain duties to the state to ensure social welfare and social justice. In this regard, social liberalism cannot ignore the social context in which the individual exists.

The classical liberal theory has been criticized for ignoring the social context in which individuals develop their identities. Often, it is criticized for placing abstract individual rights above the social context that shapes personal identity (Tamir, 1993, pp. 17-18). It should be noted, however, that individuals live within a specific cultural environment that is historically and socially determined. As a result, a link exists between the formation of an individual’s identity and the social environment in which that individual socializes. Having a sense of cultural belonging is crucial when it comes to presenting meaningful options to individuals (Karabulut, 2014, p. 877). In MacCormick’s opinion, membership in groups - including nations - allows individuals to transcend the limitations of time and space; each

person, as an individual, can only have a short lifespan and can only be in one place at a time. As a result, the nation can provide us with a conceptual framework that allows us to view our existence in both time and space as a continuum. Those who realize that their existence is sustained by a community feel a sense of pride (MacCormick, 1982, p. 251). Additionally, Miller accepts the communitarian claim of contextual individualism. Faith is the basis of national communities, not race or language, according to Miller. Miller also acknowledges the artificiality of nationalist thought at this point (Vincent, 1997, p. 281).

Miller (1995) asserts that “we have certain obligations toward those of the same nationality as us that are not applicable to other people” (p. 49). The cultivation of this nationalism of mutual social responsibilities can contribute to the rebuilding of social solidarity. As a result of grounding such responsibilities in values such as norms, traditions, lifestyles, a shared past, and a desire for a better future, the social fabric will be strengthened (Tamir, 2019, p. 173). Welfare state practices require individuals to make sacrifices on behalf of individuals who are ethnically and religiously different from themselves, whom they have never met or recognized. At this point, the presence of a common national identity unites citizens in such a way that sacrifices made for the unknown become sacrifices made for “*one of us*” (Kymlicka, 2001, p. 225).

MacCormick (2002) emphasizes the importance of respect for nations as the second component of liberal nationalism. As part of respect for the individual, MacCormick believes that national identities should also be respected. Nations are an integral part of our identity, and our identity deserves respect. Ideally, morally justifiable political principles should take into account a sense of national identity that is inherent in the fabric of individual identity (p. 183).

The third component of liberal nationalism consists of recommendations on political arrangements. MacCormick (2002) views nationalism as a political program. It is intended to establish liberal nationalism through the establishment of political institutions. In the process of creating social laws, MacCormick places a high value on individual autonomy. Individuals who determine their autonomy participate in determining the social context within which they realize themselves (pp. 183-184).

As a matter of liberal nationalist theory, national communities formed on the basis of a common culture are collective subjects entitled to self-determination in the political sphere. As a consequence of the notion that national borders should correspond to the boundaries of the political unit, liberal nationalists think of the relationship between nation and state. The thesis of overlapping national and political borders does not imply that every nation should have an independent state, according to liberal nationalists. Under the umbrella of a single state, more than one nation may be able to exercise its right to self-government and self-determination autonomously (Karabulut, 2014, p. 878). Additionally, Miller (1994) argues that “each nation’s claim to self-government must include the requirement that it respects

the equal claims of others that may be affected by its actions". However, he is of the opinion that the concept of the nation-state has no direct relationship to sovereignty at this time. There may be some compromises to be made. At some points, it may be appropriate to cede sovereignty to a confederal structure. Thus, sovereignty should not become an obsession (pp. 141-147). According to Kymlicka (2001), national identities are important, and it is useful to create political units within which nations can govern themselves. These political units, however, should not be considered states. Instead of thinking of a world of nation-states, we should consider a world of multinational states. The traditional goal of liberal nationalism, namely the desire for a common nation within each state, must be abandoned if liberal nationalism is to be a viable and defensible approach in today's world. As a result, we should view states as federations, in which borders are drawn, and powers are distributed so that national groups can govern themselves (pp. 233-234).

In today's world of many different cultures, Miller (2006) argues that some form of nationalism will inevitably arise. Individuals are offered responsibility and a sense of belonging through nationalism. Additionally, it provides individuals with a sense of self-determination. It is also possible for nationalism to breed indifference or even hostility towards others; it can be difficult to integrate groups that do not share the same national identity; and it can have destabilizing effects when political and national boundaries differ. As a guide for political practice, liberal nationalism seeks - given favorable conditions - to overcome weaknesses while preserving strengths (p. 544). When nation and state do not coincide, Miller differentiates between ethnicity and nationalism. It is possible for a nation to contain more than one ethnic group, he argues. According to Miller (1994, p. 152), by clarifying the distinction between ethnicity and nationality, we can avoid the mistake of believing that the principle of national self-government requires each cultural group to have its own state. Whenever a state accommodates two or more groups with different and irreconcilable national identities, the question of self-government arises. In this context, irreconcilable is understood as both taking different religions as constitutive elements of their identity, or both including their separation from the other as part of their historical self-understanding.

According to Miller (2006, p. 536), there are three main criticisms of liberal nationalism. First, liberal nationalists object to the notion that personal autonomy requires a secure cultural background that nationality provides. The proponents of this critique argue that autonomy often consists of selecting elements from different cultures and that the more cultures one is exposed to, the more culturally specific traditions one will be able to follow independently.

In the second argument, the premise is again that contemporary societies are multicultural, and therefore individuals typically possess multiple identities. The concept of nationalism implies the privilege of one identity over another. Cultures of national origin are recognized by the public and are supported by the state, often to the detriment of minority cultures. Consequently, some citizens perceive

that the state affirms their primary identity, while others do not, thereby violating the principle of equal citizenship (Miller, 2006, p. 537).

Furthermore, it is possible to challenge the assertion that democracy and social justice require a shared sense of nationality. Many liberal critics have argued that citizens need only identify with and feel loyalty to their political community, which can be a purely political identification without the burden of cultural identity. The concept of constitutional patriotism is often used in this context. It is claimed that such loyalty can serve as a sufficient basis for democratic institutions and policies relating to social justice; there is no need for thicker social cement (Miller, 2006, p. 537).

Liberal nationalism's fundamental arguments are generally confusing and unpersuasive to many people. The complex nature of the individual's social structure is smoothly assumed. It does not seem satisfactory to argue that respect should be transmitted from individual to nation. It should also be noted that the concept of self-determination is extremely difficult and elusive, particularly when it is transferred to nations and states (Vincent, 1997, pp. 294-295). Despite the fact that the debate over whether cultural harmony or cultural mix is more supportive of individual autonomy has not been settled between liberal nationalist thinkers and those opposing them, liberal nationalists have attracted attention to an important issue: The conditions under which liberalism can be regarded as a viable political belief rather than merely an abstract ideal (Miller, 2006, p. 537).

3. LIBERAL NATIONALISM AND YENİ TURAN

As a result of developing political and social events, the post-Second Constitutional Monarchy period marked a period of radical changes in Turkish political life. The requirement to save the state and the question of how to accomplish this led to a period of volatile and turbulent intellectual atmosphere. Due to the spread of nationalism even among Muslims such as Arabs and Albanians, and because Ottomanism and Islamism had almost collapsed due to the Balkan Defeat, Turks had no choice but to turn to the idea of Turkism. In the political atmosphere of the Second Constitutional Monarchy, nationalism among Turks was still a new concept and its characteristics were not yet clear.

In the political atmosphere of the Second Constitutional Monarchy Period, during the Balkan Wars, Halide Edip Adivar's novel *Yeni Turan*, published in Tanin Newspaper in 1912, is a novel that depicts the conflicts of ideas of the Second Constitutional Monarchy Period. *Yeni Turan* represents an ideological utopia. The novel attempts to synthesize the idea of "*Decentralization*", one of the discussed intellectual movements of the period, with the idea of "*Turkism*". Throughout the novel, a political struggle between two different political parties, the New Ottoman Party and the Yeni Turan Party, is presented within a love story. In the novel, the Yeni Turan Party is the representative of change, innovation and dynamism, while the New Ottoman Party is the representative of tradition and the old order.

There are many issues that have been discussed since the Second Constitutional Monarchy in *Yeni Turan*. The dominant ideas of the period are centered around two figures in particular: Ziya Gökalp and Prince Sabahattin. The Turkish Hearth (*Turkish: Türk Ocağı*) aimed to achieve a broad cultural breakthrough and to instill Turkism within the people with the support of the Union and Progress Party. Additionally, the Union and Progress Party was also responsible for protecting the empire's borders. However, the Tripolitan War in 1911 and the Balkan War in 1912 made it clear that this was not possible. In this instance, it appeared that Ottomanism could not be reconciled with nationalist ideology. Nevertheless, Prince Sabahattin proposed the idea of decentralization. The novel *Yeni Turan* generally supports the idea of decentralization. There is, however, a combination of decentralization and Turkism. This influence can be explained by the title of the novel (Enginün, 2007, pp. 123-125). While the title of the novel refers to the ideal of "*Turan*", it does not present an idea of a political *Turan*.

A rivalry between two political parties is central to the plot of the novel. Hamdi Pasha, leader of the Neo-Ottoman Party, is a traditional Ottoman statesman who supports centralization. Oğuz, the leader of the *Yeni Turan* Party, on the other hand, advocates decentralization and private enterprise. *Yeni Turan* attempts to synthesize these views with the Turkism movement. The party's program and activities place a great deal of emphasis on the education and rights of women. The public is very supportive of *Yeni Turan*. Hamdi Pasha has imprisoned Oğuz to stop the rise of *Yeni Turan*. Kaya, the woman Oğuz loves, asks Hamdi Pasha to release Oğuz. Meanwhile, Hamdi Pasha proposes to Kaya for Oğuz's release. Kaya gives up her love for *Yeni Turan* and marries Hamdi Pasha. Hamdi Pasha conceals the murder of Oğuz after his release. Kaya is even more enraged by this. She leaves, shouting all her feelings and thoughts at Hamdi Pasha. The events are narrated through the words of Hamdi Pasha's nephew Asım.

Oğuz, the leader of *Yeni Turan*, invites citizens to the path of *Yeni Turan* during his election campaigns (Adivar, 2021, p. 34):

Do not think that I am inviting only the children of *Turan*, my Turkish brothers and sisters, to this path. No, I am inviting all of them, all the children of Turkey, all the children of the land of Turkey who keep their past, their life, their ancestors and their history in this land, in this country; Kurds, Arabs, Armenians, Greeks, I am inviting them all and I claim that this is the path of salvation for all of them today.

In this invitation, Oğuz states that the Turks, whom he characterizes as the original children of *Turan*, should be as strong as other citizens, and have the power and unity to keep other citizens together (Adivar, 2021, p. 34). Oğuz explains that the Ottoman-Turkish government was established by gathering Greeks and other tribes around Turks, and that an organization similar to the American system was established on the basis of equality and justice regardless of religious and sectarian differences. But later on, he says, this force that governed all races and governments became lazy, heavy and deviated

from its purpose. Oğuz then turns his attention to the Second Constitutional Monarchy. He says that the sovereignty of the nation that the Turks had achieved created difficulties, that Greeks, Arabs, Albanians, Bulgarians and Turks understood it differently, and that the Turks were left with a meaningless and incomprehensible “*centralization*”. At this point, Oğuz states that Türkiye has two paths to salvation and that these are the path of the new Ottomans and the path of the Yeni Turan (Adıvar, 2021, pp. 37-40). He then describes the path of the Yeni Turan.

According to Yeni Turan, the non-Turkish population constitutes a significant portion of the Turkish population at that time. There is a strong feeling of nationalism among a significant portion of this population. In spite of the fact that they belong to the same religion, people are divided on the issue of race. As a result, Turks, Arabs, Armenians, Greeks, etc. must share a common interest and affection. As a result, each element should love this land as a country that they govern, live in, and die in, and not hate the Turk, who died for every race other than his own but who has no share in this land. Turkish farmers who cannot cultivate their fields while they await the border, who contribute to the roads and education of other countries, but whose own country remains desolate and dark, should not be regarded as unjust oppressors because they do not contribute to the development of their own race and civilization due to the fact that their most capable sons are deployed abroad in an army or province. (Adıvar, 2021, pp. 41-42).

It is believed that to accomplish this, each element must be able to manage its own, separate, small country and race in the concept of an overall homeland. Unless this policy of centralization is reversed, the Turks will disappear from the country twenty years from now (Adıvar, 2021, p. 42). These ideas of Yeni Turan suggest the establishment of a federative government with a decentralized structure. Taking this perspective, one can observe the arguments of liberal nationalism in Halide Edip’s novel Yeni Turan, which concedes the right of nations to self-government and self-determination.

The novel describes how non-Turks and non-Muslims who find decentralization pleasant even though Turkish nationalism touches their nerves join the Yeni Turan Party as a result of Yeni Turan’s idea of decentralization. After the elections, Yeni Turan is elected and begins to implement the decentralization policy (Adıvar, 2021, p. 72). Under the condition that it is valid for the first twenty years of decentralization, Yeni Turan grants some privileges to Turks, including the prohibition of recruiting soldiers from Turkish landowners, redirecting road, railway, and school allocations previously allocated to Rumelia to Anatolia, and exempting students who teach in Turkish villages from military service (Adıvar, 2021, pp. 83-84). According to the logic behind this regulation, which will remain in effect for twenty years, Turks are considered to be backwards compared to other groups and the aim is to ensure equality between them. As a reflection of the mindset of the Turkish intellectuals during the Second Constitutional Monarchy era, this is remarkable.

The Chamber of Deputies was established, and the cabinet was composed of ministers representing different communities. A Neo-Ottoman leader, Hamdi Pasha, described decentralization and nationalism as a scourge during the debates on the law of the Ministry of Internal Affairs and considered the construction of decentralization as a result of the nationalist movement as a disaster during his speech. As a result of renouncing Ottomanism, Turkishness dissolves the bonds with other citizens. Disintegration was a result of decentralization (Adivar, 2021, pp. 91-93).

According to Oğuz, decentralization will not result in disasters and divisions, contrary to Hamdi Pasha's assertion. Nationalists do not give birth to decentralization nor do decentralists give birth to nationalism, in his view. There is no doubt that all nations go through a revolution of nationalism (Adivar, 2021, p. 94). He compares each nation to an individual with a distinct personality in his speech saying,

In fact, just like today's 'individualism' started as a dream of great educators and judges, and has since taken root and has dragged every individual to say, 'I am a person who owns my life, my development, my everything, and is responsible for everything,' the nationalist movement has been an inevitable movement within the society of what was born in the individual. The administration created by several nationalist nations together does not necessarily result in disintegration, just as an individualistic upbringing does not necessarily lead to anarchy in a country's order and administration. It is more likely that their joint administration will not fall apart if they are bound by a common political interest, a bond that they believe to be essential for their continued existence (Adivar, 2021, p. 94).

The concept of nationalism, like the concept of individualism, is irrepressible at this point. Nations can also come together with their own personalities and political interests in common, just as a society composed of individuals does not disintegrate and disappear. It is reasonable to interpret Oğuz's remarks as reminiscent of the liberal nationalist argument in which nations are equated with respectable personalities, such as individuals.

Oğuz says that because nationalism movements have now spread to all nations, it is impossible for the Ottoman bond to hold the nations together, therefore the nations are at each other's throats, and this causes the Turks to be oppressed and victimized. Turkish citizens will be able to benefit from the same right to live that is granted to every element and nationality. In the view of the Nationalist Turkish Party (*Yeni Turan*), decentralization represents a means to avoid disintegration and extinction (Adivar, 2021, pp. 95-96).

When Halide Edip Adivar entered the writing and intellectual milieu during the Second Constitutional Monarchy Period, she became acquainted with the nationalist ideas around the Turkish Heart, especially those of Ziya Gökalp. *Yeni Turan* is a novel in which this influence is observed. In her memoir "*Mor Salkımlı Ev*", Halide Edip noted that Gökalp had influenced their early works, particularly

“*Yeni Turan*” (Adivar, 2020, p. 194). While Halide Edip’s views were aligned with the dominant paradigm of nationalism at that time, the liberal ideas at the foundation of her worldview prevented her views from completely aligning with it. Moreover, Halide Edip, in her English memoirs about her understanding of Turkism, stated that she did not believe in the idea of uniting Turks politically. Considering that nationalism should be restricted to cultural and regional boundaries, Halide Edip stated that Central Asian Turks differed from Ottoman Turks in terms of their national identity. Assuming that both elements had a large and free space to pursue individual cultures and progress, the desired political bond could only blossom in the distant future as a federation (Adivar, 2004, p. 315).

In shaping her national feelings and nationalism, Halide Edip’s humanist personality played a significant role. Her view, which reflected a liberal understanding of nationalism, can be seen in the following passage (Adivar, 2020, p. 228):

I believed that nationalism would create a nation filled with affection and mutual understanding. In my experience, however, when people went beyond the limits of nationalism, they began to strangle one another and turned the earth into a slaughterhouse. Nevertheless, any ideologies of the right or left that went beyond their bounds created a bloodier, more disastrous world that overshadowed nationalism.

Halide Edip’s conception of nationalism generally portrays a vision of nationalism in which each nation recognizes its own identity and recognizes mutual rights with other nations.

4. CONCLUSION

By the end of the 20th century, the number of works on nationalism increased rapidly, which led to the emergence of liberal nationalist literature. Several scholars have argued that nationalism can be compatible with liberal values, including David Miller, Yael Tamir, and Neil MacCormick. Although the individualist and universalist qualities of liberalism and the local and communitarian character of nationalism were considered to be contradictory, liberal nationalist theorists argued for a nationalism compatible with liberal values on the basis of the points where these two ideologies were compatible. Consequently, liberal nationalism emphasizes respect for national identities, rejects the pure individualism of classical liberalism, and recognizes that the autonomous individual is embedded within the cultural values of his or her society. According to liberal nationalist ideology, respect for the individual includes respect for cultural identities. Furthermore, liberal nationalists believe that the government of a society by people who share the same beliefs reinforces the idea that an individual exists in the mind of an individual. The liberal nationalist argument respects the right of each nation to self-determination from a political perspective.

Halide Edip Adivar’s novel *Yeni Turan*, written during the Second Constitutional Monarchy Period, was written during a time when nationalism was just emerging and could not be completely distinguished from the Ottomanism movement. The author attempts to synthesize the ideas of Turkism

and decentralization in her utopia depicting the year 1931. The idea of decentralization and the Turkish ideas of the period play a prominent role in this novel. This novel, taken as a whole, can be understood as an expression of the intellectual struggles of the Second Constitutional Monarchy era, which reflects their state of mind. It is because the state is disintegrating, and the Turks are very backward. Halide Edip is aware in this novel of the spread of nationalism to the nations within the Ottoman Empire and realizes that this trend cannot be reversed. The goal, according to Halide Edip, is to gain ground that will strengthen Turkish national identity, which remains in the shadow of the Ottoman movement and has been reluctant to express itself. Halide Edip conveys this longing through her metaphorical expression in her novel *Yeni Turan*. Her use of character names in the novel, the portrayal of the Ottoman-Turkish dichotomy, and the nationalistic emphasis she reflects are all intended to create a sense of national belonging for the Turkish people. Through decentralization, she lays the foundation for this utopia. It is a democratic, federal, and liberal political system in which all nations can express their nationalism, and women can achieve their rights. Many arguments of the liberal nationalist ideology, in which liberalism and nationalism are attempted to be synthesized, can be witnessed in the utopian political novel *Yeni Turan* by Halide Edip Adivar, one of the intellectuals of the Second Constitutional Monarchy Period. In her novel, Halide Edip envisions a federative state in which each nation has the right to self-government.

Many nationalist intellectuals shared these ideas, which Halide Edip discussed in a utopian novel at the time. According to Çalen (2025), the Turkist figures of the period - primarily Gökâlp and Akçura - envisioned the dissolution of the empire and the transition to a nation-state based on three hypotheses. The Turkists, according to him, believed firstly that the era of empires in the world was over, and that the Ottoman Empire would fall. As a second point, Turkist intellectuals of that period aspired, albeit without open expression, to free the Turks from the oppression imposed by empire politics and to establish a Turkish nation-state within the framework of nationalism based on a territorial model. Finally, under imperial conditions, the only way to envision a Turkish nation-state was through a federative system, which was constituted by what was then known as decentralization (p. 31). The views and thoughts of Halide Edip, one of the leading nationalist intellectuals of the period, especially her utopia in *Yeni Turan*, can also be discussed within the context of Çalen's remarks. She does not refrain from explicitly stating that the Turks are oppressed by the policies of the Empire in her novel. *Yeni Turan* depicts the privileges that are given to the Turks as an equalization of inequalities created by oppression, whereby the Turks gain their rights.

According to Çalen (2025), Halide Edip's utopia is based on the structure of a nation-state. She traces this design along two paths: "Ottoman-Turkish contradiction" and "decentralization" (p. 34). His view was that Halide Edip, as in Akçura, could not openly declare that the empire should be dissolved, so she could only use the national utopia as a "*literary smuggling*" of decentralization and conceal it behind a symbolic universe saying:

Hey, New Turan, dear country, tell me where is the way to you? There are six centuries; in foreign provinces, on distant roads, on waterless plateaus; you have wandered in shadowless mountains, you have dried up like barren trees in arid deserts. Tell me, where is your life-giving river, where is your green homeland? (Çalen, 2025, p. 36)

What Halide Edip says in the words of Oğuz, the protagonist of the novel, is meaningful. In the course of twenty years, concessions would be extended to the Turkish homeland within the Federation to build a liberated Turkish homeland within the empire (Çalen, 2025, p. 36).

Liberal nationalism advocates the autonomy of each nation as a modern individual and stresses respect for national identities. Consequently, the views of Yeni Turan are similar to the argument that each nation has its own culture and that those cultures should be respected. In terms of a liberal nationalist perspective, the Yeni Turan Party envisions all nations living together in a decentralized system. Every nation will maintain its national identity, live according to its own values, and govern itself. Considering this, Halide Edip Adivar's utopian political novel exhibits many of the qualities of the liberal nationalist arguments that begin to emerge afterwards.

The author describes the aim of the book as:

Liberal and democratic Turkey, a Turkey that does not tolerate chauvinism in its administrative system and moves toward labor and simplicity, a Turkey that seeks a sort of united nations in the Near East was the primary objective of this book. It is evident that the love story was included simply because it was a novel. (Adivar, 2020, p. 199)

Halide Edip indeed declares in her Turkish memoirs that this novel is a utopia and that its goals are unattainable; however, in the English version of her memoirs, she states that Yeni Turan is a political and national utopia, but its goals are not as distant as a utopia could be. In this novel, Halide Edip envisions a Türkiye that is forward-looking. There should be a Türkiye where women can vote, a Türkiye that is culturally national, politically liberal, and democratic. According to Halide Edip, at least some of the ideals she elaborates in detail in the book will become a reality (Adivar, 2004, p. 332).

Based on the author's memoirs, the purpose of the novel and the Türkiye imagined in the novel embody many of the arguments of liberal nationalism, which gained prominence in the literature of nationalism much later. As a portrait of Turkish nationalism of the period, this novel presents nationalist thoughts and feelings within a liberal decentralized system. It can be stated that Halide Edip Adivar represents a liberal nationalist intellectual within her utopia that aims to integrate all of these nationalist and liberal values.

As stated by Miller, another aspect of the Yeni Turan that should be highlighted is the "*problem of self-governance*". In a similar manner to the contradictions and tensions inherent in the liberal nationalist argument, Halide Edip presents an imaginary of a federal state in which nations are decentralized within a picture in which political borders do not correspond with national ones. In light

of the liberal understanding of nationalism, different ethnic groups can have self-government under one roof and that complete political sovereignty can sometimes be sacrificed. There is, however, no explanation in the novel as to why this is necessary. Further, Miller suggests that if a political structure consists of two or more “irreconcilable” groups, and the existence of one depends upon the enmity of the other, the problem of self-government arises. There is a question at this point as to which and/or how many of the decentralized nations in Halide Edip's utopia are compatible with Turkish national identity.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Adivar, H. E. (2004). *Memoirs of Halide Edib*. Gorgias Press.
- Adivar, H. E. (2009). *Türkiye’de şark-garp ve Amerikan tesirleri*. Can Yayınları.
- Adivar, H. E. (2020). *Mor salkımlı ev*. Can Yayınları.
- Adivar, H. E. (2021). *Yeni Turan*. Can Yayınları.
- Akyol, T. (2020). Liberalizm ve milliyetçilik. In T. Bora (Eds.), *Modern Türkiye’de siyasi düşünce: Milliyetçilik* (6th ed., Vol. 4, pp. 731–750). İletişim Yayınları.
- Canovan, M. (1996). *Nationhood and political theory*. Edward Elgar Publishing.
- Çalen, M. K. (2025). Bir ulus-devlet ütopyası olarak ‘uç tarz-ı siyaset’ ve ‘Yeni Turan’ üzerine notlar. *Türk Yurdu*, 451, 30–39.
- Çetinsaya, G. (2005). Muhafazakar bir siyasi düşünür olarak Halide Edip Adivar. *Muhafazakar Düşünce Dergisi*, 2(5), Article 5.
- Çiçek, A. (2024). Balancing identity and liberty: A comprehensive analysis of liberal nationalism. *Milliyetçilik Araştırmaları Dergisi*, 6(2), 237-270.
- Enginün, İ. (2007). *Halide Edip Adivar’ın eserlerinde doğu ve batı meselesi* (3rd ed.). Dergah Yayınları.
- Gray, J. (2003). *Liberalizmin iki yüzü* (K. Değirmenci, Trans.). Dost Kitabevi Yayınları.
- Greenfeld, L. (2017). *Milliyetçilik: Moderniteye giden 5 yol - İngiltere, Fransa, Rusya, Almanya ve Amerika örnekleri* (A. Yılmaz, Trans.). Alfa Yayınları.
- Heywood, A. (2013). *Politics* (4th ed.). Palgrave Macmillan.
- İnsel, A. (2021). Türkiye’de liberalizm kavramının soyçizgisi. In M. Yılmaz (Eds.), *Modern Türkiye’de siyasi düşünce: Liberalizm* (1st ed., Vol. 7, pp. 41–74). İletişim Yayınları.
- Kadioğlu, A. (1999). *Cumhuriyet iradesi demokrasi muhakemesi: Türkiye’de demokratik açılım arayışları* (1st ed.). Metis Yayınları.

- Karabulut, T. (2014). Yurttaşlığın krizini yeniden düşünmek: Liberal milliyetçilik ve anayasal yurtseverlik kuramları. *Ankara Üniversitesi SBF Dergisi*, 69(4), Article 4.
- Kymlicka, W. (2001). *Politics in the vernacular: Nationalism, multiculturalism, and citizenship*. Oxford University Press.
- Lind, M. (1994). In defense of liberal nationalism. *Foreign Affairs*, 73(3), 87.
- MacCormick, N. (1982). *Legal right and social democracy: Essays in legal and political philosophy*. Clarendon Press.
- MacCormick, N. (2002). *Questioning sovereignty: Law, state, and nation in the European commonwealth*. Oxford University Press.
- McCarthy, T. (1999). On reconciling cosmopolitan unity and national diversity. *Public Culture*, 11(1), 175-208.
- Miller, D. (1994). The nation-state: A modest defence. In C. Brown (Ed.), *Political Restructuring in Europe*. Routledge.
- Miller, D. (1995). *On nationality*. Oxford University Press.
- Miller, D. (2006). Nationalism. In *Oxford Handbook of Political Theory* (pp. 529-545). Oxford University Press.
- Nodia, G. (1999). Milliyetçilik ve demokrasi. In A. Yayla (Eds.), *Sosyal ve siyasal teori seçme yazılar* (2nd ed.). Siyasal Kitabevi.
- Tamir, Y. (1993). *Liberal nationalism*. Princeton University Press.
- Tamir, Y. (2019). *Why nationalism*. Princeton University Press.
- Tok, N. (2007). Çokkültürcülüğün meydan okuduğu milliyetçilik kimlik siyaseti: Ulus, ulus-devlet ve liberal demokrasi. *Demokrasi Platformu*, 3(10), Article 10.
- Tunaya, T. Z. (1988). *Türkiye’de siyasi partiler Cilt 1: İkinci Meşrutiyet dönemi* (2nd ed.). Hürriyet Vakfı Yayınları.
- Türk, H. B. (2021). Halide Edip Adıvar’ın liberalizmle imtihanı. In M. Yılmaz (Eds.), *Modern Türkiye’de siyasi düşünce: Liberalizm* (1st ed., Vol. 7, pp. 119–138). İletişim Yayınları.
- Vincent, A. (1997). Liberal nationalism: An irresponsible compound? *Political Studies*, 45(2), 275-295.

Effect of Job Insecurity on Unethical Pro-Organizational Behavior: Mediating Role of Job Stress

Ezgi Fatma ERBAŞ KELEBEK¹

Abstract

Employees occasionally engage in unethical behavior intended to benefit their organization despite the moral ambiguity of such actions. This phenomenon, known as (UPB), is often motivated by a desire to shield the organization from external criticism and align with its interests. However, not all questions about the antecedents of UPB, its consequences and the boundary conditions have yet been answered. This study analyzes the effects of job insecurity and job stress on UPB. Within this context, the mediating role of job insecurity and the moderating role of job experience are explored. Research data were gathered from 202 sales and marketing employees (% 73.3 male, SD: 0.73; mean age: 37, SD: 0.444) through face-to-face surveys. Research hypotheses were tested by structural equation modeling (SEM). The results indicate that job insecurity exerts positive effects on job stress and UPB. In addition, job stress fully mediates the effect of job insecurity on UPB. Thus, it was concluded that work experience is one of the boundary conditions of UPB intention among employees. This study contributes to UPB literature by showing what consequences the interaction of job stress and perceived job insecurity can have on employees. In addition, this study offers a new perspective on coping strategies for UPB.

Keywords: *Job Insecurity, Unethical Pro-organizational Behavior, Job Stress, Conditional Effects.*



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1. INTRODUCTION

Unethical behavior has plagued organizations for a long time and is frequently motivated by personal gain or a desire to harm the organization (Seuntjens et al., 2019; Thau et al., 2015). However, researchers have recently directed their attention toward a specific form of unethical conduct that is designed to benefit the organization (Dennerlein & Kirkman, 2022; Lee et al., 2022; Wang, Zheng & Zhao, 2022; Yan et al., 2021; Zhang, 2020). This phenomenon is called unethical pro-organizational behavior (UPB) and defined as “actions that are intended to promote the effective functioning of the organization or its members (e.g., leaders) and violate core societal values, mores, laws, or standards of proper conduct” (Umphress & Bingham, 2011). Examples of such behavior include misrepresenting the truth to create a favorable image of the organization, presenting its products and services more positively than warranted, and withholding unfavorable information from the public (Umphress & Bingham, 2011; Umphress et al., 2010). Although UPB is intended to be beneficial for the organization, it may have detrimental effects on the interests of various stakeholders (Umphress & Bingham, 2011). If UPB is revealed or noticed by external stakeholders, the consequences will be devastating. Disclosure of UPB has the potential to cause significant financial and legal issues for an organization, in addition to negatively impacting its image and reputation. While it may seem like harmless support from the employee, UPB can be a significant challenge for businesses. Consequently, it is imperative to take action to prevent this potential threat.

There is a growing body of research on the antecedents and consequences of UPB (Luan et al., 2023; Mishra et al., 2022; Mo et al., 2022). A search of the Web of Science revealed that approximately 250 academic articles with the title "Unethical Pro-organizational Behavior" have been published since 2010. A growing number of studies are exploring why and how employees engage in UPB. To date, various individual, organizational, and contextual factors have been examined as antecedents of UPB (see Mo et al., 2023, for a detailed review and synthesis of the literature on UPB).

In recent years, companies have been physically downsizing and consequently laying off employees because of increasing costs, price instabilities, and intense competitive conditions. Layoffs caused by destructive competition have made job insecurity (JI) a widespread concern among employees. Individuals experiencing JI may face an uncertain work environment. In an environment where the future of employment is uncertain, employees may experience elevated levels of job stress (JS) due to concerns about the potential for job loss (Modrek & Cullen, 2013; Ghani et al., 2022). This may prompt employees into some gray areas in order to keep their positions. By definition, the direct benefit of UPB should not accrue to the employee (Umphress & Bingham, 2011). However, it is probable that the employee who intends to benefit the organization through UPB anticipates an indirect benefit for themselves. From this perspective, it is likely that employees experiencing significant stress due to the risk of job loss will seek to utilize UPB in order to obtain an indirect benefit that will serve to protect their position. Employees who fear losing their jobs may adopt UPB as a coping mechanism.

The dual nature of UPB, which includes both "unethical" and "pro-organizational" behaviors, may explain why employees experiencing JI resort to such behaviors as coping mechanisms (Wang, Weng et al., 2022).

When examining the studies conducted on UPB to date, it is observed that there is an interaction and relationship between UPB and various individual, organizational, and leadership variables such as organizational identification (Effelsberg et al., 2013; Graham et al., 2019; Kong, 2016; Li, 2023; Umphress & Bingham, 2011; Umphress et al., 2010; Vadera & Pratt, 2013), organizational commitment (Ebrahimi & Yurtkoru, 2017; Matherne III & Litchfield, 2012), work engagement (Gigol, 2020; Kong, 2016), ethical leadership (Hsieh et al., 2020; Kim et al., 2023; Miao et al., 2013), empowering leadership (Dennerlein & Kirkman, 2022), transformational leadership (Effelsberg & Solga, 2015; Effelsberg et al., 2013; Graham et al., 2015), charismatic leadership (Zhang et al., 2020), authentic leadership (Gigol, 2020), leader-member exchange (Bryant & Merriitt, 2021; Lee et al., 2019; Vriend et al., 2020), moral disengagement (Chen et al., 2016; Hsieh et al., 2020; Lian et al., 2020; Yan et al., 2021), moral identity (Matherne III & Litchfield, 2012; Zhang et al., 2018), organizational support (Kong, 2016; Wang, Zheng & Zhao, 2022), job satisfaction (Dou et al., 2019; Huang et al., 2022; Zhang, 2020), performance pressure (Chen & Chen, 2021). Furthermore, although there are studies on the relationship and interaction between job insecurity (JI) and UPB (Ghosh, 2016; Lawrence & Kacmar, 2017; Wang, Weng et al., 2022; Xu et al., 2022; Zhang et al., 2023) and job stress (JS) and UPB (Chen et al., 2022; Shaw & Liao, 2018; Xu & Wang, 2020), they are insufficient and limited level. In the literature, no study has been found that addresses the combined effects of JI and JS on UPB. This study aims to consider these three variables together, and it is believed that this study will contribute to literature and fill this gap.

This study is based on the Conservation of Resources theory. COR is predicated on the necessity of acquiring and protecting resources, a natural and instinctive need concomitant with human existence. The theory is a principle that motivates people to protect their own resources or obtain new resources (Hobfoll et al., 2018). According to the COR theory, individuals attempt to avoid the loss of resources (e.g. employment, income, status, sense of control) and seek to retain them (Hobfoll et al., 2018). Job insecurity is the threat of losing one of the individual's most basic resources, their job, and this is a serious source of psychological stress (Cheng & Chan, 2008; Sverke et al., 2002). Job stress may prepare the ground for the individual to use unethical means (e.g., UPOB) to prevent this loss. Because the individual may try to make himself/herself seem more valuable and indispensable by making "extra effort" for the benefit of the organization.

Accordingly, this study aims to explore the independent and joint effects of JI and JS on UPB. To achieve this aim, a survey was conducted among sales and marketing employees in commercial companies, where intense target pressure and high competition are experienced. This study has several contributions. Firstly, an original contribution was made to UPB literature by examining the interactive effects of JI and JS on UPB. As a second contribution, it was suggested that "solely benefiting the

organization" perspective in the UPB definition be expanded to include indirect benefits for the employee. This new perspective posits that UPB can be adopted as a coping strategy by employees. Finally, most of the studies conducted with UPB have examined the relationship or effect of UPB with positive variables (organizational identification, leadership, organizational commitment, work engagement, organizational support, job satisfaction, etc.). It is expected that this study will develop and contribute to literature by addressing negative variables such as job stress and job insecurity.

2. CONCEPTUAL BACKGROUND AND HYPOTHESES

2.1. Unethical Pro-organizational Behavior, Job Insecurity, and Job Stress Relations

Studies in organizational behavior, organizational ethics, and organizational psychology have generally focused on the damage caused by employees' unethical behaviors (such as wasting the organization's time and resources, embezzlement, theft of office supplies, etc.) to the organization (Jones & Kavanagh, 1996; Moore et al., 2012). However, employees may also engage in some unethical activities in the belief that they will benefit their organization (e.g., misrepresenting information to portray the organization in a positive light). These behaviors are known as UPB and differ from other forms of behavior because they are voluntarily performed as extra-role behaviors to provide more benefits than harm to the organization (Kong, 2016). The concept of UPB not only improves the understanding of the antecedents of unethical behavior but also significantly advances research in the field of organizational ethics by expanding the theoretical perspective to understand such behaviors (Chen et al., 2016).

When defining UPB, it refers to actions that violate fundamental values, traditions, laws, or appropriate behavior standards of society while aiming to support the organization or its managers effectively (Umphress & Bingham, 2011). In other words, UPB can be characterized as behaviors that, for the benefit of the organization, simultaneously break ethical norms, potentially causing harm to external stakeholders and the overall interests of society (Effelsberg et al., 2013). UPB does not necessarily involve severe crimes, such as covering up serious offenses. UPBs are performed to help the organization achieve its goals (Graham et al., 2015). As previously stated, UPB is both pro-organization and non-ethical. It is evident that this phenomenon is distinct and cannot be fully explained by existing concepts. Therefore, it can be defined as out-of-duty behavior that disrupts social norms but is done for the benefit of an organization and its members (Kim et al., 2023; Xu et al., 2024; Zhang & Du, 2023). Destroying files containing criminal elements to protect the organization's reputation, failing to refund customers who have been mistakenly overcharged, recommending an incompetent employee to another organization with the thought that she/he will be another organization's problem instead her/his organization (Umphress & Bingham, 2011; Umphress et al., 2010;), destroying important documents that could tarnish the organization's image (Dou et al., 2019), manipulating or making positive changes to organizational accounting records to satisfy stakeholders (Vadera & Pratt, 2013) some notable UPBs from academic studies.

Identifying and expressing behaviors related to UPB is challenging due to the requirement of being both unethical and beneficial to the organization. Umphress and Bingham (2011) have proposed three conditions that are not included in this frame to determine UPB. The first condition pertains to employees' unethical behaviors without seeking any specific benefits. An example of such behavior would be when employees do not inform customers about a significant product flaw due to a lack of knowledge. Because such behaviors do not aim to consciously benefit the organization, they are not considered within the scope of UPB (Liu & Qiu, 2015).

The second condition relates to behaviors when employees attempt to benefit the organization, but the outcome of those actions does not align with the intended purpose. For instance, employees may have disposed of evidence that could implicate their organization in unlawful activities to safeguard it. Nevertheless, the removal of these documents may not have been advantageous for the organization. Moreover, this circumstance may cause external auditors to view the organization as suspicious and may result in long-term harm to the organization (Umphress & Bingham, 2011). Thus, this type of behavior does not qualify as UPB. The final condition refers to unethical behaviors demonstrated by employees for personal gain. These actions are not classified as UPB because they are executed for the employees' benefit rather than the entire organization's benefit (Liu & Qiu, 2015).

Considering the above conditions, a behavior may be deemed UPB if it is performed with conscious intent, provides benefit to the organization, and is designed to safeguard the organization's interests. Employees may experience JI, which manifests as fear and anxiety about losing their jobs and becoming unemployed. Previous studies have indicated that employees dealing with JI may resort to coping mechanisms such as working longer hours, striving for higher performance, and avoiding counterproductive behaviors (Sverke et al., 2002; Armstrong-Stassen, 2006; Probst et al., 2007; Gilboa et al., 2008). This study posits the hypothesis that employees who fear losing their jobs may adopt UPB as a coping mechanism.

Due to economic recessions, advancements in information technology, industrial restructuring, and the relentless acceleration of global competition, working life and the nature of organizations have undergone significant changes in recent years. Numerous organizations have implemented large-scale workforce reductions (such as downsizing, mergers, and acquisitions) to reduce costs and enhance organizational effectiveness and competitiveness. However, for employees, this situation has created an increased sense of JI (Hellgren et al., 1999). JI, as extensively examined by Greenhalgh and Rosenblatt (1984), refers to the perceived powerlessness individuals' experience regarding the continuity of their employment when they feel their job is under threat. Heaney et al. (1994) also discussed perception in their definition of JI, describing it as the perceived potential threat to the continuity of current employment. JI can also be defined as a general concern about the future existence of a job (Rosenblatt & Ruvio, 1996).

JI can be expressed as perceived threats or dangers that employees associate with potential negative impacts on their employment, such as being laid off or dismissed, which can adversely affect their working life. It also encompasses concerns related to the potential loss of a job in the short or long term and the limitation of career and job opportunities. Overall, JI can be described as a combination of these threats and concerns, resulting in a sense of powerlessness that individuals experience in such circumstances (Sverke & Hellgren, 2002). In this context, there is a distinction between JI and actual job loss. Job loss occurs immediately, whereas JI is a long-term experience characterized by uncertainty about the future. Furthermore, the perception of JI can vary among employees, even if they hold the same status or are exposed to similar conditions (Sverke et al., 2002). Therefore, JI represents a phenomenon that includes subjective experiences (Sverke & Hellgren, 2002).

When employees experience the above-mentioned dangers, anxieties, and threats, they may lose self-confidence, feel powerless, and develop a fear of losing something. To avoid losing their positions, these employees may engage in UPB. Employees with a high JI perception may continue to exhibit such behaviors because of the belief that their supervisors or top management will consider them as productive. Indeed, Ghosh (2016) revealed a positive effect of JI on UPB. Furthermore, Ghosh noted that the moderating effect of job embeddedness exists in the relationship between JI and UPB. Lawrence and Kacmar (2017) stated in their study that employees experiencing JI were more likely to experience emotional exhaustion and subsequently engage in UPB. Additionally, in their research, they examined employees' adaptability to changes and found that employees with low levels of adaptability tended to exhibit UPB instead of adjusting and exploring alternative solutions or opportunities in the face of JI. According to Xu et al. (2022), JI has a positive effect on UPB. In addition, the authors stated that employees experiencing JI increase their UPB with their motivation to provide a good impression on their leaders. Wang, Weng et al. (2022) indicated in their study that proactive personality strengthens the positive link between JI and UPB, whereas moral identity weakens it. Additionally, they discovered that individuals with proactive personality and high moral identity exhibit a weaker positive link between JI and UPB than those with high proactive personality but low moral identity. Zhang et al. (2023) demonstrated that JI among subordinates mediates the positive association between supervisor Bottom-Line Mentality (BML) and subordinate UPB. Moreover, they stated that supervisory power has a positive effect on moderating the indirect effect of JI on the link between supervisor BLM and subordinate UPB. The indirect effect is amplified as supervisory power increases. Based on literature and conceptual basis, the following hypothesis is proposed.

H₁: JI has a positive effect on UPB.

JI is considered a significant source of stress. The evaluation of JI as a stressor stems from its uncertainty. Uncertainty, characterized by unpredictability and uncontrollability, leads to stress. Indeed, JI indicates a situation in which the continuity of work cannot be predicted (De Witte, 1999). In other words, facing JI results in the loss of an individual's ability to plan and control their life, increasing

tension. Uncertainty about the future, anxiety, and worry about the possibility of job loss reduce a person's ability to cope with their job and workload and increase JS (Strazdins et al., 2004). Consequently, JI is recognized as a significant work stressor that hinders employees' functionality (Cheng & Chan, 2008; Sverke et al., 2002). Soelton et al. (2020) noted that JI has a significant positive effect on JS. Similarly, Tu et al. (2020) found that quantitative JI is associated with the employee's physical and behavioral stress symptoms. Peng and Potipiroon (2022) indicated that the perception of JI has a positive effect on JS. They also found that psychological capital significantly reduced the perceptions of JI and JS. Based on the literature the following hypothesis is proposed:

H₂: JI has a positive effect on JS.

2.2. Mediating Role of Job Stress

One of the factors that creates tension and increases distress in the workplace is JS. JS is defined as the individual response exhibited by employees toward the characteristics of the work environment that lead to physical and psychological discomfort. (Ganster & Schaubroeck, 1991; Jamal, 2005). The increasing expectations of organizations from employees, excessive workload, and performance pressures are some reasons that contribute to work-related stress experienced by employees. In today's working life, numerous organizations anticipate that their employees will strive to achieve objectives, regardless of any obstacles that may arise. From this perspective, employees who seek long-term relationships with their organizations or want to avoid negative consequences such as unemployment due to their inability to meet organizational needs may engage in ethically questionable behavior and exhibit UPB (Chen & Chen, 2021; Tian & Peterson, 2016; Wang et al., 2019). Additionally, a work environment with the risk of unemployment and the resulting anxiety, uncertainty, and pressure can increase employees' stress levels. As a result, employees may exhibit UPB to protect their current jobs and cope with stress. In line with this, Shaw and Liao (2018) found that JS has a positive effect on UPB, and they also noted that authoritarian leadership can predict employees' UPB through JS and moral disengagement. Similarly, Xu and Wang (2020) found in their study that JS affects UPB. They also indicated that JS exerts a positive effect on UPB with anxiety and anger serving as mediating factors. Chen et al. (2022) found that engagement in UPB is positively associated with stress at work, and they demonstrated that performing tensions moderates the positive relationship between UPB and JS. Based on the literature, the following hypothesis is proposed:

H₃: JS has a positive effect on UPB.

To summarize all the opinions mentioned so far, in today's working life, where competition is felt too much, costs are increased in the markets, and instability is experienced, companies are downsizing and laying off their employees. This scenario leads to JI, which is the anxiety felt by employees about the possibility of losing their jobs and being unemployed. Such an uncertain working environment also creates stress on employees. Critical situations like stress can also lead employees to

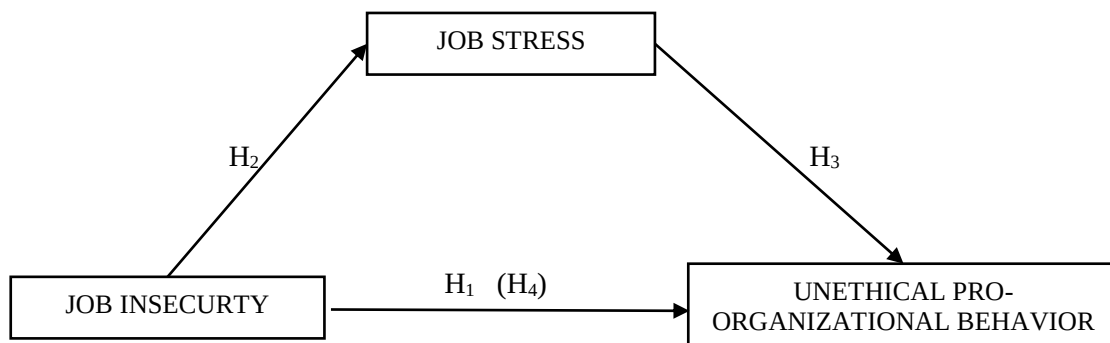
misbehave. As a result, employees who experience both JI and JS may exhibit UPB to maintain their current job. Based on the concern, the following hypothesis is proposed:

H₄: JS mediates the relationship between JI and UPB.

2.3. Research Model

This research model is presented in Figure 1. According to the model, the independent variable of the research is JI, the dependent variable is UPB, and the mediator variable is JS.

Figure 1. Research Model



3. METHODOLOGY

3.1. Sample and Procedure

The sample of this study consists of sales and marketing personnel employed in commercial companies operating in Kocaeli. Sales and marketing departments interact directly with customers and competitors. Especially in a highly industrialized and competitive region like Kocaeli, employees in these departments experience market competition most directly. They are typically subject to numerical and time-pressured performance metrics such as sales quotas, increasing market share, and customer acquisition. For these reasons, they were deemed worthy of examination. This study employed a quantitative research method using a convenience sampling method.

For this research, a Gpower analysis was done a priori to establish a rigorous sample size (Power= .80; effect size= .15; α = .05). The results from Gpower indicated a minimum sample size of 85. Approximately 250 people were reached, and face-to-face questionnaires were administered to the participants. Forms filled incompletely and carelessly were excluded from the data set. When these forms were removed, 202 forms were considered for analyses. The participants in this study were informed about the research purpose, and their consent to participate was obtained.

3.2. Scales

Initially, the participants provided information about their demographic characteristics. Subsequently the participants completed the Job Stress Scale, Job Insecurity Scale, and Unethical Pro-Organizational Behavior Scale. All measurements were analyzed using a 5-point Likert scale (1= Strongly Disagree; 5= Totally Agree).

Job Stress Scale: The participants' JS level was measured using a 7-item, unidimensional scale developed by House and Rizzo (1972) and adapted for the Turkish language by Efeoğlu (2006). A sample item is “I work under a great deal of tension.”

Job Insecurity Scale: The participants' JI level was measured using a 4-item, unidimensional scale developed by De Witte (2000), validated by Vander Elst et al. (2014) and adapted for the Turkish language by Pelenk (2020). A sample item is “I think I might lose my job in the near future.”

Unethical Pro-Organizational Behavior: The participants' tendency to exhibit UPB was measured using a 6-item, unidimensional scale developed by Umphress et al. (2010) and adapted for the Turkish language by Aksoy Kürü (2022). A sample item is “If it would help my organization, I would misrepresent the truth to make my organization look good.”

4. FINDINGS

In this study, the data obtained from the survey method were analyzed using the SPSS 21 package program and structural equation modeling (SEM)-AMOS 24. In this context, descriptive analysis of the demographic characteristics of the participants was performed using SPSS 21. The hypotheses developed within the scope of the research were tested using structural equation modeling (SEM)-AMOS 24.

4.1. Respondent Demographics

In total; 73.3% of the respondents were male ($n=148$), 26.7% were female ($n=54$), 84.1% were under 40 years ($n=170$), 60.9% had a college/university degree ($n=123$), 70.8% were single ($n=143$), 64.3% were in the sector for more than five years ($n=130$) and 52% worked for the organization for more than five years ($n=105$).

Prior to the analysis of the data, the normality of the distribution of the data was checked. The normality of the distribution was confirmed through the assessment of skewness and kurtosis values, which were found to range between +1 and -1. The skewness coefficients in all variables were between -0.21 and 0.81, while the kurtosis coefficients were between -0.07 and -0.75. Consequently, the distribution was accepted as normal (Hair et al., 2017). Table 1 presents the descriptive statistics and correlations between the study variables. When examining the correlations between study variables, it is observed that there is a positive and statistically significant relationship between the independent variable JI and the dependent variable UPB ($r=0.322$), as well as between the mediating variable JS ($r=0.589$). Additionally, there is a positive and statistically significant relationship between JS and UPB ($r=0.543$).

Table 1. Descriptive Statistics and Correlations among the Study Variables

Variables	Mean	Std. Dev.	1	2	3
1) Job Insecurity	2.64	1.336	1		
2) Job Stress	2.88	1.178	0.589**	1	
3) Unethical Pro-organizational Behavior (UPB)	2.44	1.210	0.322**	0.543**	1

**Correlations are significant at the 0.001 level.

4.2. Measurement Model and Confirmatory Factor Analysis (CFA)

To assess the measurement model's validity and reliability, a CFA was conducted that incorporated the constructs of Job Insecurity, Job Stress, and UPB. Scale items were utilized as reflective indicators. Fit statistics demonstrated a good fit to the data: $\chi^2 = 421.734$; $df = 96.000$; $CMIN/DF = 4.393$; $CFI = 0.935$; $SRMR = 0.043$; $RMSEA = 0.130$; $PClose = 0.000$. The scale items exhibited high standardized factor loadings (ranging from 0.883 to 0.961) and reliability statistics (Table 3).

Table 2 illustrates Composite Reliability (CR) to assess the construct reliability of the model, Average Variance Explained (AVE) to evaluate the convergent validity, and maximum shared variance (MSV). Additionally, it presents the correlation matrix of latent variables for discriminant validity. (Henseler et al., 2015). All constructs have CR values that are above acceptable limit of 0.7, thereby indicating their reliability (Hair et al, 2010). The strong standardized factor loadings (ranging between 0.883 and 0.961) of indicators to respective constructs (Table 3) and all AVE values that exceed 0.5 threshold demonstrate that convergent validity has been achieved. The square of all MSV values is lower than AVE values and the square roots of AVE values are greater than the correlations between factors. This shows that discriminant validity is also achieved (Fornell & Larcker, 1981). Upon evaluation of all these results, it can be concluded that the measurement model is valid and reliable (Hair et al., 2010).

Table 2. Validity and Reliability Indicators

	CR	AVE	MSV	MaxR (H)	JI	JS	UPB
JOB INSECURITY	0.968	0.884	0.359	0.971	0.940		
JOB STRESS	0.972	0.834	0.359	0.976	0.599***	0.913	
UPB	0.973	0.856	0.329	0.975	0.333***	0.574***	0.925

JI: Job Insecurity; JS: Job Stress; UPB: Unethical Pro-Organizational Behavior; AVE: Average Variance Extracted; CR: Composite Reliability; MSV: Maximum Shared Variance.

***Correlations are significant at the 0.001 level.

4.3. Structural Model and Hypothesis Tests

Following the determination of the structural model's overall fit as satisfactory, the direct and indirect causal relationships between the structures were subjected to testing. Figure 1 shows the path diagram along with the standardized estimates.

Figure 2. Structural Model

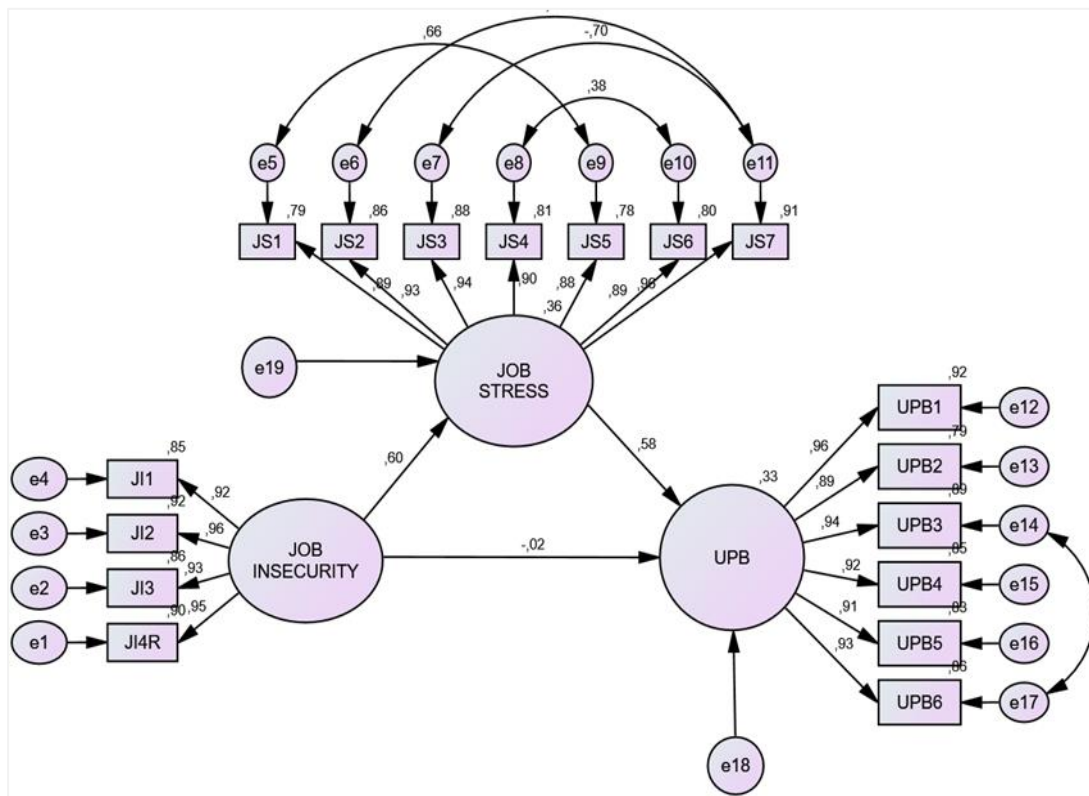


Table 3 presents the path of the coefficients and corresponding level of statistical significance, 95% bias-corrected confidence intervals, and coefficients of determination.

Table 3. Direct, Indirect and Total Effects (Mediated Model)

Regression Path	Unstd. Estimates (t-values)	p	Std. Estimates	95% bias- corrected CI (LL-UL)	Variance Explained (R ²)
JI ---> JS	0.469 (9.434)	< 0.001	0.599 ***	0.510 0.683	0.359
JI ---> UPB (Direct Effect)	-0.016. (-0.223)	0.823	-0.017	-0.157 0.120	
JS ---> UPB	0.714 (7.461)	< 0.001	0.584 ***	0.459 0.697	
JI ---> JS ---> UPB (Indirect Effect)	0.335	< 0.001	0.350***	0.267 0.446	
JI ---> UPB (Total Effect)	0.571	< 0.001	0.333**	0.213 0.436	0.329

A bootstrap test with 5,000 resamples (Preacher et al., 2007) revealed that JI had a significantly positive total effect on UPB ($\beta = 0.333$, $p < 0.001$) and JI also demonstrated a significantly positive effect on JS ($\beta = 0.599$; $p < 0.001$). These findings provide evidence to support H₁ and H₂.

In accordance with H₃; JS demonstrated a significantly positive effect on UPB ($\beta = 0.584$; $p < 0.001$). Additionally, the results indicated that JS acted as a mediator in the relationship between JI and UPB. The results of the path analysis indicated a statistically significant indirect effect of JI and UPB ($\beta = 0.350$; $p < 0.01$) through JS. The 95% bias-corrected and accelerated confidence intervals (lower and upper levels) did not contain zero which provides additional support for this finding. Finally, the direct

effect of JI on UPB was examined, and when the mediating variable of JS was included in the analysis, the effect of JI on UPB became insignificant ($\beta = -0.017$; $p = 0.823$). Based on these findings, JS plays a full mediating role on the effect of JI on UPB. Thus, H_4 was also supported.

5. CONCLUSION, DISCUSSION AND LIMITATIONS

Although UPB has been a subject frequently examined in recent research by organizational behavior researchers, the relationships between JI, JS, and UPB have not been thoroughly examined. JI and JS may lead employees to engage in UPB, but it is necessary to fully understand the boundary conditions. One of the important questions that needs to be answered is who, when, and under what conditions may tend to exceed ethical boundaries to benefit the organization. This study examines the mediating role of JS in the relationship between JI and UPB. Within the scope of the research, data were collected from sales and marketing professionals through a survey. Path analyses using SEM revealed that JI and JS positively influence UPB. In addition, JS exerts a full mediation on the relationship between JI and UPB. Several studies have examined JI (Ghosh, 2016; Lawrence & Kacmar, 2017; Wang, Weng et al., 2022; Xu et al., 2022; Zhang et al., 2023) and JS (Chen et al., 2022; Shaw & Liao, 2018; Xu & Wang, 2020) as important antecedents of UPB, but little is known about the interactive effects of both JI and JS on UPB.

The findings of this research offer a new perspective on coping with JS. Previous studies have found that employees who work harder, perform better, and avoid counterproductive behaviors can more easily cope with JI (Armstrong-Stassen, 2006; Gilboa et al., 2008; Probst et al., 2007; Sverke et al., 2002). However, this study demonstrated that employees who experience both JI and JS engage in UPB to retain their current jobs. In other words, employees display UPB as a coping mechanism for JI and JS. Furthermore, most studies on UPB have focused on its relationship or effect with positive variables (organizational identification, organizational commitment, leadership, job satisfaction, organizational support, etc.). However, this study investigated UPB with negative variables such as JI and JS. In future studies, literature could be expanded to include other negative variables such as performance pressure, risk of exclusion, Machiavellian personality, feelings of anxiety, and organizational cynicism.

According to the results of this study, managers should be aware that employees who suffer from JI may be inclined to exhibit UPB. In addition to this situation, a stressful work environment may affect employees' UPB. Managers should be concerned about employees who are at risk of losing their jobs and experiencing stress. This is because such employees can quickly adopt unethical behaviors that can help them secure their jobs. Therefore, managers should be careful about using language that motivates their employees when dealing with sensitive issues. Even in critical and stressful situations, managers should not demonstrate an approach that encourages unethical behavior. In essence, managers should be mindful of their words, the manner in which they express themselves, and role modeling in the context of their professional relationships with employees. It is of greater importance that managers

foster an environment that emphasizes moral standards. Furthermore, it would be beneficial to incorporate moral issues into training programs, with the aim of enhancing the moral awareness of employees (Ji et al., 2024).

Although such unethical behaviors are for the benefit of the organization, they can harm the organization in long run, and therefore managers should take precautions to discourage such behaviors. If they succeed in creating ethical awareness among their employees by highlighting ethical issues, they can reduce unethical behavior. In addition, clear standards should be established to prevent UPB. Even if it is intended to benefit the organization, unethical behavior should not be left unpunished. These standards should be included in the code of ethics. In this context, an ethics brochure should be prepared, and training on ethics should be organized. Only with such a structure can ethics permeate the entire organization and become permanent.

This study has certain limitations that should be acknowledged. First, the research data were obtained from participants who were employed in a particular industry in a specific cultural environment. There is a need to gather data from diverse sources that employ larger and more representative samples from various industries. In addition, this study examined only JI and JS as antecedents of UPB. For future studies, it is recommended to use different variables such as organizational justice, leadership, organizational identification, job performance, ethical climate, and intention to leave as mediator and/or moderator variables. This may lead to different results, which can be further supported by qualitative research. Finally, research data is cross-sectional and data was collected from a convenient sample of sales and marketing professionals. As data is collected exclusively from accessible individuals, its capacity to represent the universe is limited. Using more representative samples from different industries and respondents holding different organizational roles can enhance the validity of the research findings.

Ethics committee approval for the study was obtained from the Kocaeli University Ethics Committee on April 23, 2022, with decision number E-10017888-100-222313.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

Aksoy Kürü, S. (2022). Örgüt yararına etik olmayan davranışlar: Bir ölçek uyarlama çalışması. *Üçüncü Sektör Sosyal Ekonomi Dergisi*, 57(1), 409-426. <https://doi.org/10.15659/3.sektor-sosyal-ekonomi.22.02.1724>

- Armstrong-Stassen, M. (2006). Determinants of how managers cope with organisational downsizing. *Applied Psychology: An International Review*, 55(1), 1-26. <https://doi.org/10.1111/j.1464-0597.2006.00225.x>
- Bryant, W., & Merritt, S. M. (2021). Unethical pro-organizational behavior and positive leader-employee relationships. *Journal of Business Ethics*, 168(4), 777-793. <https://doi.org/10.1007/s10551-019-04211-x>
- Chen, H., Kwan, H. K., & Xin, J. (2022). Is behaving unethically for organizations a mixed blessing? A dual-pathway model for the work-to-family spillover effects of unethical pro-organizational behavior. *Asia Pacific Journal of Management*, 39(4), 1535-1560. <https://doi.org/10.1007/s10490-021-09776-8>
- Chen, M., & Chen C. C. (2021). The moral dark side of performance pressure: How and when it affects unethical pro-organizational behavior. *The International Journal of Human Resource Management*, 34(7), 1-31. <https://doi.org/10.1080/09585192.2021.1991434>
- Chen, M., Chen, C. C., & Sheldon, O. J. (2016). Relaxing moral reasoning to win: How organizational identification relates to unethical pro-organizational behavior. *Journal of Applied Psychology*, 101(8), 1082-1096. <https://doi.org/10.1037/apl0000111>
- Cheng, H. L. G., & Chan, D. K.-S. (2008). Who suffers more from job insecurity? A meta-analytic review. *Applied Psychology: An International Review*, 57(2), 272-303. <https://doi.org/10.1111/j.1464-0597.2007.00312.x>
- De Witte H., (1999), Job insecurity and psychological well-being: Review of the literature and exploration of some unresolved issues. *European Journal of Work and Organizational Psychology*, 8(2), 155-177. <https://doi.org/10.1080/135943299398302>
- De Witte, H. (2000). Arbeidsethos en jobonzekerheid: Meting enevolgen voor welzijn, tevredenheid en inzet op het werk (Work ethic and job insecurity: Assessment and consequences for wellbeing, satisfaction and performance at work). In R. Bouwen, K. De Witte, H. De Witte, & T. Taillieu (Eds.), *Van groep naar gemeenschap (From group to community)* (pp. 325-350). Garant.
- Dennerlein, T., & Kirkman, B. L. (2022). The hidden dark side of empowering leadership: The moderating role of hindrance stressors in explaining when empowering employees can promote moral disengagement and unethical pro-organizational behavior. *Journal of Applied Psychology*, 107(12), 2220-2242. <https://doi.org/10.1037/apl0001013>
- Dou, K., Chen, Y., Lu, J., Li, J., & Wang, Y. (2019). Why and when does job satisfaction promote unethical pro-organizational behaviours? Testing a moderated mediation model. *International Journal of Psychology*, 54(6), 766-774. <https://doi.org/10.1002/ijop.12528>
- Ebrahimi, N., & Yurtkoru, E. S. (2017). The relationship between affective commitment and unethical pro-organizational behavior: The role of moral disengagement. *Research Journal of Business and Management (RJBM)*, 4(3), 287-295. <http://doi.org/10.17261/Pressacademia.2017.706>
- Efeoğlu, İ. F. (2006). *İş-Aile yaşam çatışmasının iş stresi, iş doyumu ve örgütsel bağlılık üzerindeki etkileri: İlaç sektöründe bir araştırma* [Unpublished master's thesis]. Çukurova University.
- Effelsberg, D., & Solga, M. (2015). Transformational leaders' in-group versus out-group orientation: Testing the link between leaders' organizational identification, their willingness to engage in unethical pro-organizational behavior and follower-perceived transformational leadership. *Journal of Business Ethics*, 126(4), 581-590. <https://doi.org/10.1007/s10551-013-1972-z>
- Effelsberg, D., Solga, M., & Gurt, J. (2013). Transformational leadership and follower's unethical behavior for the benefit of the company: A two-study investigation. *Journal of Business Ethics*, 120(1), 81-93. <https://doi.org/10.1007/s10551-013-1644-z>
- Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.2307/3151312>
- Ganster, D. C., & Schaubroeck, J. (1991). Work stress and employee health. *Journal of Management*, 17(2), 235-271. <https://doi.org/10.1177/0149206313475815>
- Ghani, B., Memon, K. R., Han H, Ariza-Montes, A., & Arjona-Fuentes J. M. (2022). Work stress, technological changes, and job insecurity in the retail organization context. *Frontiers in Psychology*, 13, 1-14. <https://doi.org/10.3389/fpsyg.2022.918065>
- Ghosh, S. K. (2016). The direct and interactive effects of job insecurity and job embeddedness on unethical pro-organizational behavior an empirical examination. *Personnel Review*, 46(1), 1182-1198. <https://doi.org/10.1108/PR-05-2015-0126>

- Gigol, T. (2020). Influence of authentic leadership on unethical pro-organizational behavior: The intermediate role of work engagement. *Sustainability*, 12(3), 1-14. <https://doi.org/10.3390/su12031182>
- Gilboa, S., Shirom, A., Fried Y., & Cooper, C. (2008). A meta-analysis of work demand stressors and job performance: Examining main and moderating effects. *Personnel Psychology*, 61, 227-271.
- Graham, K. A., Ziegert, J. C., & Capitano, J. (2015). The effect of leadership style, framing, and promotion regulatory focus on unethical pro-organizational behavior. *Journal of Business Ethics*, 126(3), 423-436. <https://doi.org/10.1007/s10551-013-1952-3>
- Graham, K., Resick, C. J., Margolis, J. A. Shao, P., Hargis, M. B., & Kiker, J. D. (2019). Egoistic norms, organizational identification, and the perceived ethicality of unethical pro-organizational behavior: A moral maturation perspective. *Human Relations*, 73(9), 1249-1277. <https://doi.org/10.1177/0018726719862851>
- Greenhalgh, L., & Rosenblatt, Z. (1984). Job insecurity: Toward conceptual clarity. *Academy Of Management Review*, 9(3), 438-448. <https://doi.org/10.2307/258284>
- Hair Jr., J. F., Black, W.C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. Pearson.
- Hair Jr., J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage
- Heaney, C. A., Israel, B. A., & House, J. S. (1994). Chronic insecurity among automobile workers: Effect on job satisfaction and health. *Social Science & Medicine*, 38(10), 1431-1437. [https://doi.org/10.1016/0277-9536\(94\)90281-X](https://doi.org/10.1016/0277-9536(94)90281-X)
- Hellgren, J., Sverke, M., & Isaksson, K. (1999). A two-dimensional approach to job insecurity: Consequences for employee attitudes and wellbeing. *European Journal of Work and Organizational Psychology*, 8(2), 179-195. <https://doi.org/10.1080/135943299398311>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of Academy Marketing Science*, 43(1), 115-135. <https://doi.org/10.1007/s11747-014-0403-8>
- Hobfoll, S. E., Halbesleben, J., Neveu, J. P., & Westman, M. (2018). Conservation of resources in the organizational context: The reality of resources and their consequences. *Annual review of organizational psychology and organizational behavior*, 5(1), 103-128. <https://doi.org/10.1146/annurev-orgpsych-032117-104640>
- House, R. J., & Rizzo, J. R. (1972). Role conflict and ambiguity as critical variables in a model of organizational behavior. *Organizational Behavior and Human Performance*, 7(3), 467-505. [https://doi.org/10.1016/0030-5073\(72\)90030-X](https://doi.org/10.1016/0030-5073(72)90030-X)
- Hsieh, H. H., Hsu, H. H., Kao, K. Y., & Wang, C. C. (2020). Ethical leadership and employee unethical pro-organizational behavior: A moderated mediation model of moral disengagement and coworker ethical behavior. *Leadership & Organization Development*, 41(6), 799-812. <https://doi.org/10.1108/LODJ-10-2019-0464>
- Huang, Y., Liu, X., Kim, J., & Na, S. (2022). Effects of idiosyncratic deals, psychological contract, job satisfaction and environmental turbulence on unethical pro-organizational behavior. *Sustainability*, 14(2), 1-14 15995. <https://doi.org/10.3390/su142315995>
- Jamal, M. (2005). Personal and organizational outcomes related to job stress and type-a behavior: A study of Canadian and Chinese employees. *Stress and Health*, 21(2), 129-137. <https://doi.org/10.1002/smi.1047>
- Ji, H., Shenjiang, M., & Su, Y. (2024). How does leader self-sacrifice lead to employees' unethical pro-organizational behavior? A moderated mediation model. *Business Ethics, the Environment & Responsibility*, Early view. <https://doi.org/10.1111/beer.12724>
- Jones, G. E., & Kavanagh, M. J. (1996). An experimental examination of the effects of individual and situational factors on unethical intentions in the workplace. *Journal of Business Ethics*, 15(5), 511-523. <https://doi.org/10.1007/BF00381927>
- Kim, C., Lee, C., & Lee, G. (2023). Impact of superiors' ethical leadership on subordinates' unethical pro-organizational behavior: Mediating effects of followership. *Behavioral Science*, 13(6), 1-18. <https://doi.org/10.3390/bs13060454>

- Kong, D. T. (2016). The pathway to unethical pro-organizational behavior: Organizational identification as a joint function of work passion and trait mindfulness. *Personality and Individual Differences*, 93, 86-91. <https://doi.org/10.1016/j.paid.2015.08.035>
- Lawrence, E. R., & Kacmar, M. K. (2017). Exploring the impact of job insecurity on employees' unethical behavior. *Business Ethics Quarterly*, 27(1), 39-70. <https://doi.org/10.1017/beq.2016.58>
- Lee, A., Schwarz, G., Newman, A., & Legood, A. (2019). Investigating when and why psychological entitlement predicts unethical pro-organizational behavior. *Journal of Business Ethics*, 154(2), 109-126. <https://doi.org/10.1007/s10551-017-3456-z>
- Lee, J., Oh, S-H., & Park, S. (2022). Effects of organizational embeddedness on unethical pro-organizational behavior: Roles of perceived status and ethical leadership. *Journal of Business Ethics*, 176(1), 111-125. <https://doi.org/10.1007/s10551-020-04661-8>
- Li, C. (2023). Organizational identification and unethical pro-organizational behavior: A culture-moderated meta-analysis. *Ethics & Behavior*, 34(5), 360-380. <https://doi.org/10.1080/10508422.2023.2219356>
- Lian, H., Huai, M., Farh, J. L., Huang, J. C., Lee, C., & Chao, M. M. (2020). Leader unethical pro-organizational behavior and employee unethical conduct: Social learning of moral disengagement as a behavioral principle. *Journal of Management*, 48(2), 350-379. <https://doi.org/10.1177/0149206320959699>
- Liu, Y., & Qiu, C. (2015). Unethical pro-organizational behavior: Concept, measurement and empirical research. *Journal of Human Resource and Sustainability Studies*, 3(3), 150-155. <https://doi.org/10.4236/jhrss.2015.33020>
- Luan, Y., Zhao, K., Wang, Z., & Hu, F. (2023). Exploring the antecedents of unethical pro-organizational behavior (UPB): A meta-analysis. *Journal of Business Ethics*, 187, 119-136. <https://doi.org/10.1007/s10551-022-05269-w>
- Matherne III, C. F., & Litchfield, S. R. (2012). Investigating the relationship between affective commitment and unethical pro-organizational behaviors: The role of moral identity. *Journal of Leadership Accountability and Ethics*, 9(5), 35-46.
- Miao, Q., Newman, A. H., Yu, J., & Xu, L. (2013). The relationship between ethical leadership and unethical pro-organizational behavior: Linear or curvilinear effects? *Journal of Business Ethics*, 116(3), 641-653. <https://doi.org/10.1007/s10551-012-1504-2>
- Mishra, M., Ghosh, K., & Sharma, D. (2022). Unethical pro-organizational behavior: A systematic review and future research agenda. *Journal of Business Ethics*, 179, 63-87. <https://doi.org/10.1007/s10551-021-04764-w>
- Mo, S., Lupoli, M. J., Newman, A., & Umphress, E. E. (2022). Good intentions, bad behavior: A review and synthesis of the literature on unethical prosocial behavior (UPB) at work. *Journal of Organizational Behavior*, 44(2), 335-354. <https://doi.org/10.1002/job.2617>
- Modrek, S., & Cullen, M.R. (2013). Job insecurity during recessions: Effects on survivors' work stress. *BMC Public Health*, 13(1), 1-11. <https://doi.org/10.1186/1471-2458-13-929>
- Moore, C., Detert, J. R., Trevino, L. K., Baker, V. L., & Mayer, D. M. (2012). Why employees do bad things: Moral disengagement and unethical organizational behavior. *Personnel Psychology*, 65(1), 1-48. <https://doi.org/10.1111/j.1744-6570.2011.01237.x>
- Pelenk, S. E. (2020). İş güvencesizliğinin görev performansına etkisi: Yenilikçi davranışın düzenleyici rolü. *Bilecik Şeyh Edebalı Üniversitesi Sosyal Bilimler Dergisi*, 5(1), 214-233. <https://doi.org/10.33905/bseusbed.730234>
- Peng, B., & Potipiroon, W. (2022). Fear of losing jobs during COVID-19: Can psychological capital alleviate job insecurity and job stress? *Behavioral Sciences*, 12(6), 1-16. <https://doi.org/10.3390/bs12060168>
- Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, 42(1), 185-227. <https://doi.org/10.1080/00273170701341316>
- Probst, T. M., Stewart, S. M., Gruys, M. L., & Tierney, B. W. (2007). Productivity, counterproductivity and creativity: The ups and downs of job insecurity. *Journal of Occupational and Organizational Psychology*, 80(3), 479-497. <https://doi.org/10.1348/096317906X159103>

- Rosenblatt, Z., & Ruvio, A. (1996). A test of a multidimensional model of job insecurity: The case of Israeli teachers. *Journal of Organizational Behavior*, 17, 587-605. [https://doi.org/10.1002/\(SICI\)1099-1379\(199612\)17:1+<587::AID-JOB825>3.0.CO;2-S](https://doi.org/10.1002/(SICI)1099-1379(199612)17:1+<587::AID-JOB825>3.0.CO;2-S)
- Seuntjens, T. G., Zeelenberg, M., van de Ven, N., & Breugelmans, S. M. (2019). Greedy bastards: Testing the relationship between wanting more and unethical behavior. *Personality and Individual Differences*, 138, 147-156. <https://doi.org/10.1016/j.paid.2018.09.027>
- Shaw, K. H., & Liao, H. Y. (2018). How does authoritarian leadership lead to employee unethical pro-organizational behavior? The mediating effect of work stressor and moral disengagement. *Advances in Economics, Business and Management Research*, 51, 86-94. <https://doi.org/10.2991/icemgd-18.2018.15>
- Soelton, M., Amalia, D., Noermijati, N. & Wahyudiono, B. (2020). Self-esteem: The levels of religiosity in job insecurity and stress in government company. *Advances in Economics, Business and Management Research*, 120, 302-310. <https://doi.org/10.2991/aebmr.k.200205.052>
- Strazdins, L., Rennie, D. M., Lim, L. L. Y., Broom, D. H., & Rodgers, B. (2004). Job strain, job insecurity, and health: Rethinking the relationship. *Journal of Occupational Health Psychology*, 9(4), 296-305. <https://doi.org/10.1037/1076-8998.9.4.296>
- Sverke, M., & Hellgren, J. (2002). The nature of job insecurity: Understanding employment uncertainty on the brink of a new millennium. *Applied Psychology: An International Review*, 51(1), 23-42. <https://doi.org/10.1111/1464-0597.0077z>
- Sverke, M., Hellgren, J., & Näswall, K. (2002). No security: A meta-analysis and review of job insecurity and its consequences. *Journal of Occupational Health Psychology*, 7(3), 242-264. <https://doi.org/10.1037/1076-8998.7.3.242>
- Thau, S., Derfler-Rozin, R., Pitesa, M., Mitchell, M. S., & Pillutla, M. M. (2015). Unethical for the sake of the group: Risk of social exclusion and pro-group unethical behavior. *Journal of Applied Psychology*, 100(1), 98-113. <https://doi.org/10.1037/a0036708>
- Tian, Q., & Peterson, D. K. (2016). The effects of ethical pressure and power distance orientation on unethical pro-organizational behavior: The case of earnings management. *Business Ethics: A European Review*, 25(2), 159-171. <https://doi.org/10.1111/beer.12109>
- Tu, Y., Long, L., Wang, H.-J., & Jiang, L. (2020). To prevent or to promote: How regulatory focus moderates the differentiated effects of quantitative versus qualitative job insecurity on employee stress and motivation. *International Journal of Stress Management*, 27(2), 135-145. <https://doi.org/10.1037/str0000139>
- Umphress, E. E., & Bingham, J. B. (2011). When employees do bad things for good reasons: Examining unethical pro-organizational behaviors. *Organization Science*, 22(3), 621-640. <https://doi.org/10.1287/orsc.1100.0559>
- Umphress, E. E., Bingham, J. B., & Mitchell, M. S. (2010). Unethical behavior in the name of the company: The moderating effect of organizational identification and positive reciprocity beliefs on unethical pro-organizational behavior. *Journal of Applied Psychology*, 95(4), 769-780. <https://doi.org/10.1287/orsc.1100.0559>
- Vadera, A. K., & Pratt, M. G. (2013). Love, hate, ambivalence, or indifference? A conceptual examination of workplace crimes and organizational identification. *Organization Science*, 24(1), 172-188. <https://doi.org/10.1287/orsc.1110.0714>
- Vander Elst, T., De Witte, H., & De Cuyper, N. (2014). The job insecurity scale: A psychometric evaluation across five European countries. *European Journal of Work and Organizational Psychology*, 23(3), 364-380. <https://doi.org/10.1080/1359432X.2012.745989>
- Vriend, T., Said, R., Janssen, O., & Jordan, J. (2020). The dark side of relational leadership: Positive and negative reciprocity as fundamental drivers of follower's intended pro-leader and pro-self unethical behavior. *Frontiers in Psychology*, 11, 1-13. <https://doi.org/10.3389/fpsyg.2020.01473>
- Wang, D., Weng, Q., Kiani, A., & Ali A. (2022). Job insecurity and unethical pro-organizational behavior: The joint moderating effects of moral identity and proactive personality. *Personality and Individual Differences*, 195, 1-7. <https://doi.org/10.1016/j.paid.2022.111685>

- Wang, T., Long, L., Zhang, Y., & He, W. (2019). A social exchange perspective of employee–organization relationships and employee unethical pro-organizational behavior: The moderating role of individual moral identity. *Journal of Business Ethics*, 159, 473-489. <https://doi.org/10.1007/s10551-018-3782-9>
- Wang, X., Zheng, X., & Zhao, S. (2022). Repaying the debt: An examination of the relationship between perceived organizational support and unethical pro-organizational behavior by low performers. *Journal of Business Ethics*, 179, 697-709. <https://doi.org/10.1007/s10551-021-04809-0>
- Xu, L., Wen T., & Wang J. (2022) How does job insecurity cause unethical pro-organizational behavior? The mediating role of impression management motivation and the moderating role of organizational identification. *Frontiers in Psychology*, 13, 1-15. <https://doi.org/10.3389/fpsyg.2022.941650>
- Xu, L., & Wang, J. (2020). Influence of challenge–hindrance stressors on unethical pro-organizational behavior: Mediating role of emotions. *Sustainability*, 12(18), 1-17. <https://doi.org/10.3390/su12187576>
- Xu, S., Yaacob, Z., & Cao, D. (2024). Casting light on the dark side: Unveiling the dual-edged effect of unethical pro-organizational behavior in ethical climate. *Current Psychology*, 43, 14448–14469 <https://doi.org/10.1007/s12144-023-05457-5>
- Yan, H., Hu, X., & Wu, C.-H. (2021). When and how can organizational punishment stop unethical pro-organizational behaviors in hospitality? *International Journal of Hospitality Management*, 94, 1-11. <https://doi.org/10.1016/j.ijhm.2020.102811>
- Zhang, S. (2020). Workplace spirituality and unethical pro-organizational behavior: The mediating effect of job satisfaction. *Journal of Business Ethics*, 161, 687-705. <https://doi.org/10.1007/s10551-018-3966-3>
- Zhang, X, Liang L, Guyang T, & Tian, Y. (2020). Heroes or villains? The dark side of charismatic leadership and unethical pro-organizational behavior. *International Journal of Environmental Research and Public Health*, 17(15), 1-16, <https://doi.org/10.3390/ijerph17155546>
- Zhang, Y, & Du, S. (2023). Moral cleansing or moral licensing? A study of unethical pro-organizational behavior’s differentiating Effects. *Asia Pacific Journal of Management*, (40), 1075–1092 <https://doi.org/10.1007/s10490-022-09807-y>
- Zhang, Y., He, B., & Sun, X. (2018). The contagion of unethical pro-organizational behavior: From leaders to followers. *Frontiers in Psychology*, 9, 1-9. <https://doi.org/10.3389/fpsyg.2018.01102>
- Zhang, Y., Zhang, H., Xie, J., & Yang, X. (2023). Coping with supervisor bottom-line mentality: The mediating role of job insecurity and the moderating role of supervisory power. *Current Psychology*, 42(2), 10556-10565. <https://doi.org/10.1007/s12144-021-02336-9>

Exporter Premia, Self-selection and Learning-by-exporting: Evidence from Listed Firms in Türkiye *

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Abstract

The prevailing view claims that exporter firms (E) have advantages (exporter premia) over non-exporter firms (NE) in many respects. This study examines whether exporter premiums exist for the Turkish manufacturing industry and analyses the relationship between firm's export and productivity. The sample covers the period between 2016:Q3-2023:Q2 and 139 firms listed on Borsa İstanbul. Dataset consists of firm-based (micro) data. In the study, firstly, statistical comparison is made and it is found that exporter firms are mostly composed of larger firms, employ more employees, have higher productivity and profitability than non-exporters. Secondly, industry-level panel data analyses are applied for econometric model. According to the results of the analyses; exports, average wages and profitability are found to increase firm productivity. Lastly, with the method of Granger Bootstrap panel causality analysis revealed that there are causality relationships both from export to productivity and from productivity to export. Thus, it was concluded that both self-selection and learning-by-exporting effects exist in the Turkish manufacturing industry.

Keywords: *Exporter premia, Self-selection, Learning-by-exporting, Firm heterogeneity, New trade theory, Bootstrap panel causality.*

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1. INTRODUCTION

In standard macroeconomic models, output is usually determined by the amount of labour and capital used in the economy. This is based on the microeconomic assumption that producers are homogeneous (Mukoyama, 2022, p. 1). However, depending on the level of analysis, there are considerable differences in many characteristics between industries, firms and even production factors. The fact that firms in the same industry differ in many characteristics is called ‘firm heterogeneity’ (Bernard et al., 2012).

Existing studies consider a large number of factors as sources of heterogeneity. These include productivity, capital intensity, innovation/technology level, firm size, firm age or experience, market power, ownership structure (private-public or domestic-foreign), labour characteristics (education, age, gender, etc.). Within the framework of firm heterogeneity, some studies investigate the sources of heterogeneity and some studies investigate the consequences of heterogeneity. For this reason, some variables representing firm characteristics may be included as dependent variables in some studies and as independent variables in others. Therefore, the direction of causality between variables in heterogeneity studies may vary depending on the research question. For example, while Bleaney and Wakelin (2002) examine the effect of heterogeneity in firms' innovation activities on firm size, Schmitz (2021) analyses the effect of heterogeneity in firm size on innovation.

Empirical studies in the firm heterogeneity literature generally focus on firm productivity and firm export status. In some studies, productivity is considered as a reason for various inter-firm differences. In this context, the effects of different productivity levels on the environment (Kreickemeier & Richter, 2014; Wang & Zhu, 2021), product quality (Antoniades, 2015; Verhoogen, 2008), and propensity to participate in international markets (Engel et al., 2013; Lu et al., 2017; Plouffe, 2017) have been examined. On the other hand, in some studies, productivity differences are evaluated as a result of some other variables such as export status, plant size and capital intensity. Among these variables, the export status of the firm stands out as the dominant variable. In this direction, there is an immense literature suggesting that both exporting firms are more efficient and efficient firms export more. Melitz's (2003) study has been a milestone in the emergence of this literature. Melitz's theoretical framework, based on the heterogeneous firm model and called the New New Trade Theory (NNTT), analytically explains the empirical findings obtained from firm-level data, especially in the 1990s (Ciuriak et al., 2015).

Even in narrowly defined industries, exporters have superior characteristics in many respects compared to non-exporters. Pioneering studies have found that exporters have higher total factor productivity and a more capital-intensive and skilled labour production structure (Bernard et al., 1995; Bernard & Jensen, 1999). Higher labour quality leads exporters to pay higher wages and receive positive feedback in terms of productivity in return. In addition to these, there are some other advantages that exporting provides to firms, such as faster growth in sales and productivity, higher success measurement

indicators, risk allocation, internalisation of innovation and strengthening their capacity to stay in the market. These advantages of exporters are generally known as ‘exporter premia’ or ‘export premium’ (Hallak & Sivadasan, 2013; Schröder & Sørensen, 2012). Similarly, exporters' productivity advantages are referred to as “exporter productivity premia” (Powell & Wagner, 2011; Vogel & Wagner, 2011).

Increasing productivity in an economy is vital for the success of export-led growth strategies and economic development (Demena et al., 2022). Export activities are one of the main sources of productivity gains, especially in the manufacturing industry (Schwarzer, 2017). For this reason, the export-led growth target comes to the fore for developing countries with capital deficits and insufficient productivity levels. Similar to Türkiye, various export strategies have been implemented in developing country groups such as BRICS+ and Asian Tigers in parallel with the development of neoliberalism (Rodrik, 1997). Studies using similar methodology on this issue generally examine the causality of macroeconomic variables such as exports-output. (Bal et. al., 2020; Mamun et. al., 2019). However, one of the main objectives of these policies is to utilise export productivity premiums in the economic development path. This is because these premiums reduce average costs in the economy and create favourable conditions for a high value-added production structure. Therefore, a proper analysis of exporter premiums is a necessary process not only for macro policies but also for effective microeconomic policy making.

The manufacturing industry, which is analysed in the analysis part of this study, is the main industry of export-led growth. Manufacturing is the hotbed of innovations and productivity gains in the economy. Determining exporter premiums in this sector and allocating limited resources correctly basically allows policymakers to pick the winners (Yülek, 2018, pp. 132-224). Supporting firms with high potential to succeed in international markets ensures the success of foreign trade policies. These firms have certain common characteristics and need similar support to compensate for some endowment disadvantages. Governments play a proactive role in identifying similarities and providing optimal support. These can be tangible, such as major infrastructure investments in selected exporters' regions of operation and logistical support to facilitate cheaper market access; or financial, such as loans, investment, R&D and export incentives to facilitate access to capital. The public authority also has an important responsibility in organising the education system to train the labour force to meet the needs of exporters. However, in order to ensure all these, data at firm or facility level need to be analysed.

The main motivation of this study is to determine whether the findings on exporter premiums from other countries are valid for the Turkish manufacturing industry. Accordingly, the aim of the study is to determine the effect of the firm's export status on productivity and the direction of causality between exports and productivity.

The main difference of this study from others is that the company names are openly known. In many databases used by other studies, company information is not shared and company names are

included representatively. Thanks to this advantage, the direction of causality between exports and productivity can be determined for each firm in this study (Appendix 1). Another important issue regarding the originality of the study is that the Granger Bootstrap method is preferred as a causality analysis. Demir (2019), which is the only study that analyses the Turkish manufacturing industry using this method, uses sector-level data similar to other studies. For these reasons, this study is considered to be among the limited number of studies on Türkiye that examine firm heterogeneity using micro data. Moreover, based on this background, it is expected to be the first study to analyse BIST (Borsa Istanbul) firms within the framework of the existing hypotheses.

In the following section of the study, the theoretical dimension of the relationship between exports and productivity is explained. The third section presents a summary of the literature and the fourth section introduces the methodology, dataset and model. The fourth section presents the econometric analyses and the findings obtained from them. In the last section, the conclusions reached in line with the findings of the analyses are interpreted.

2. PRODUCTIVITY AND EXPORT

The main effect arising from the differences in the export status of firms is firm productivity. In the literature, the notion of ‘performance’ is generally used instead of ‘productivity’. This is because productivity is considered as the primary indicator of firm performance. Productivity is usually analysed in terms of labour productivity (LP) or total factor productivity (TFP). There is evidence that exporters are superior in terms of both TFP (Alvarez & Lopez, 2005; Delgado et al., 2002; Lopez, 2009; Pavcnik, 2002;) and LP (Davies & Jeppesen, 2015; Camino-Mogro et al., 2020; Powell & Wagner, 2011; Trefler, 2004). Dalgıç, Fazlıoğlu and Karaoglan (2015) show that the effect of foreign trade on LP is larger than that of TFP. Similarly, Irarrazabal et al. (2013) conclude that LP is the main source of the positive exporter TFP premium. In this respect, it is important to investigate the impact of exports on LP rather than TFP.

It is argued that the productivity advantage of exporters is mainly due to three reasons. First, competition in international markets is stronger than in domestic markets. As shown in Melitz's (2003) model, this competitive situation allows only the most efficient firms to remain in the export market. The second reason is that costs (transport, processing, etc.) are higher in export markets. Exporters have to be more efficient in order to cover these costs. The third reason is that exporters benefit from the positive externalities created by foreign markets in terms of their ability to access know-how, R&D and technological innovations (Delgado et al., 2002; Johansson, 2009, p. 6).

There is a general consensus in the literature that there are productivity differences between exporter and non-exporter firms. The most widespread debate on the superiority of exporters is whether the superiority arises before exporting or after export participation. This debate is related to the direction of causality and this relationship can also result from a two-way causality (Wagner, 2002). Assuming

that there is a causality from productivity to exports, the approach reaches the finding that export participation is the result of a conscious ‘self-selection’ (Yang & Mallick, 2010, p. 1219). In most of the studies in the literature, the source of the relationship between exports and productivity is the selection effect. Self-selection arises from the fact that exporting requires high costs. These consist of fixed exporting costs and variable iceberg costs (Schröder & Sørensen, 2012, p. 1314). Higher competition and higher costs make it inevitable for exporting firms to be composed of the most efficient firms. As a result, the most efficient firms choose to participate in the export market. The first two of the three arguments behind productivity differences are based on the self-selection effect. Wagner (2007) analysed a total of 45 studies from 37 different countries and concluded that the evidence for the self-selection effect is quite high, but the evidence for learning-by-exporting is limited.

The approach that assumes causality direction from exports to productivity aligns with the ‘learning-by-exporting’ effect (Maggioni, 2012, p. 1). The third argument underpins this learning effect. Accordingly, exporter firms learn productivity-enhancing capabilities from their foreign partners and competitors in the market as well as from market operating conditions. This learning process is continuous. According to Yasar et al. (2006, p. 277), although the learning effect is essentially reminiscent of Arrow's (1962) ‘learning-by-doing’ process, in Arrow's approach the learning process slows down after a certain period of time. However, the learning-by-exporting hypothesis involves a continuous learning process. In this respect, the learning-by-exporting hypothesis is closer to Rosenberg's (1982) ‘learning-by-using’ process, which emphasises the continuity of learning. Firms continuously learn the best methods of production, distribution and management from the actors they interact with in export markets; there is a diffusion of knowledge in the market towards exporters. Moreover, exporter firms increase their productivity by taking advantage of economies of scale arising from the structural conditions of international markets. In the meta-analysis of Mebratie and Van Bergeijk (2013), 44 per cent of the reviewed studies support the learning-by-exporting effect.

Apart from these views, a third alternative explanation for the relationship between exports and productivity is the so-called ‘BEJK’ approach proposed by Bernard et al. (2003). In this approach, Bertrand competition is assumed to be valid. Export costs arise from geographical barriers such as transport, language and tariffs and vary depending on the firm. There are no fixed costs of exporting. However, while exporting firms have geographical barriers, domestic firms do not. Because of this disadvantage, the success of exporter firms depends on being more efficient than domestic firms to compensate for the extra costs they have to incur. As a result, exporter firms are more efficient than domestic firms. However, there is not a large empirical literature supporting this approach.

Within this theoretical framework, exporters are expected to be more efficient than non-exporters before or after trade. In the introduction, evidence on exporter premiums from several countries was mentioned. Table 1 below compares the average values of various indicators of 139 firms in the Turkish manufacturing industry listed on the BIST. The table is constructed in terms of arithmetic

averages over the relevant period (2016:Q3-2023:Q2). The number of employees represents the quarterly average. Obtained through monetary values; average wage (short-term payables related to employee benefits/number of employees), productivity (net sales revenue/number of employees), profit (quarterly net operating profit or loss/net sales revenue), capital intensity (tangible fixed assets/number of employees) and firm size (total assets) are calculated in Turkish Lira ('TL') and based on realised values.

Table 1. Comparison of Exporter (E) and Non-exporter (NE) Firms

	Manufacturing Industry (139 firms)	
	Exporter (102 firms)	Non-exporter (37 firms)
Number of employees	2,111	538
Average wage (TL)	9,065	13,714
Productivity (TL)	520,191	353,933
Profit (%)	0.11	0.03
Capital intensity (TL)	2,607,755	8,226,002
Firm size (TL)	4,520,000,000	578,000,000

Source: Created by author by using Public Disclosure Platform (*Public Disclosure Platform [PDP]*) reports.

Note: In Table 1, based on the World Bank's regular entrepreneurship reports (World Bank, 2017; 2024), firms with an arithmetic average of 10 per cent or more of their export intensity in the examined periods (2016:Q3-2023:Q2) are defined as exporters. Firms with export intensity below this threshold are categorised as non-exporters.

The employment of exporters is on average about 3 times higher than that of non-exporters are reported in the Table 1. Moreover, the productivity of exporters is about 0.43 times higher than that of non-exporters, while their profitability is 3.66 times higher. The firm size of exporters, calculated in terms of total assets, is about 8 times that of non-exporters. These findings are consistent with the general findings mentioned in the literature section. On the other hand, in terms of average wages and capital intensity, exporters in the Turkish manufacturing industry do not have an advantage over non-exporters. This result, which is contrary to the theoretical expectation for wages, suggests that skill intensity is low in the analysed industry and other qualitative differences such as ownership structure among firms have a stronger determinant on wages. This may also be a consequence of more competitive international markets and hence lower-cost labour costs for exporters. On the other hand, the most likely reason for the contradictory results in the capital intensity premium is that exporters can utilise their capital stock more efficiently by taking advantage of their scale advantage. Thus, more output can be achieved with less input. In other words, there may be more efficient capital utilisation in exporter firms. In addition, according to NNTT, exporter firms face higher competitive pressure as a result of operating in international markets. This requires optimisation of production processes on the one hand and minimisation of capital expenditure on the other. One of the main methods of minimising capital expenditures is the internalisation of technology by the firm. Considering both the theory and the innovation literature, exporters are likely to use more advanced technologies, while non-exporter firms are likely to have older capital stocks. Therefore, non-exporter firms may have a more capital-intensive structure. Another reason for this is related to the nature of the products that firms trade. As is known, exporter firms generally produce differentiated products that meet the specific demand of consumers. The capacity of firms to differentiate their products is important especially in products for niche markets.

This requires an increase in labour intensity while limiting capital intensity in the production of these products. As a result, non-exporter firms producing more standardised products may lead to higher capital intensity. In terms of Türkiye's foreign trade composition, the fact that national exports are mostly composed of low value-added products leads to high labour intensity. Therefore, this situation may justify the lower capital intensity of exporter firms in Türkiye.

3. LITERATURE REVIEW

Firm-level evidence of the existence of exporter premiums has been obtained from many different countries, such as the USA (Bernard et al., 1995; Bernard & Jensen, 1999; Bernard et al., 2007), Germany (Bernard & Wagner, 1997; Powell & Wagner, 2011; Wagner, 2002), Taiwan (Aw et al., 2000; Aw & Hwang, 1995; Liu et al., 1999), South Korea (Aw et al., 2000), China (Kraay, 1999; Yang & Mallick, 2010), Italy (Castellani, 2002; Razzolini & Vannoni, 2011), Spain (Delgado et al., 2002), United Kingdom (Girma et al., 2004; Greenaway & Yu, 2004), Sweden (Hansson & Lundin, 2004), Australia (Palangkaraya & Yong, 2007), Ethiopia (Bigsten & Gebreeyesus, 2009), Norway (Irrarazabal et al., 2013), Japan (Kaoru et al., 2015), Portugal (Machado, 2019) and Ecuador (Camino-Mogro et al., 2020). These studies summarise that exporters are more efficient, larger and more profitable firms. It is also found that exporters employ more employees and engage in more capital-intensive production. Apart from these, Greenaway et al. (2005) for Sweden, Vogel and Wagner (2011) for Germany, Verardi and Wagner (2012) for the Euro Area, Rivers (2013) for Colombia, and Lei and Zongsen (2017) for China did not find any exporter premium in their analyses. On the other hand, studies investigating exporters' premium in Türkiye have been limited due to insufficient firm-level data (Aldan & Günay, 2008; Yasar & Morrison-Paul, 2008).

Some studies on the export-productivity relationship in Türkiye adopt a traditional approach. For example, Arvas and Uyar (2014) analysed the Turkish manufacturing industry using industry-level data, while Gungor (2017) and Koluman (2022) used sector-level data. However, empirical studies within the NNTT framework are conducted using micro (firm or plant-based) data. The number of studies analysing the relationship between exports and productivity in Türkiye using micro data is limited. In one of them, Taymaz and Yılmaz (2007) examined the effect of trade liberalisation on productivity. However, this does not show the effect of foreign trade or exports on productivity, but the results of the reduction of protectionism. Similarly, Yasar and Morrison-Paul (2008) show that exporters are superior to non-exporters in many respects, but the focus of this study is not on the effect of exports. The study analyses the effect of technology transfers provided by firms through foreign direct investment, exports or imports on productivity.

Apart from these, there are also studies that examine the direction of causality between exports and productivity in the Turkish manufacturing industry using micro data. For instance, Yasar et al. (2006; 2007), Dalgıç, Fazlıoğlu and Gasiorek (2015b) and Dalgıç, Fazlıoğlu and Karaoğlu (2015)

provide evidence for the validity of the learning-by-exporting effect, while Kılıcaslan and Erdogan (2012) conclude that there is no evidence that exports increase firm productivity, hence there is no learning-by-exporting effect. On the other hand, Dalgıç, Fazlıoğlu and Gasiorek (2015a) provide evidence for a self-selection effect. In addition, Aldan and Günay (2008), Maggioni (2012), and Ozarslan and Dogan (2021) find evidence for the existence of both self-selection and learning-by-exporting effects in the manufacturing industry.

4. DATA AND METHODOLOGY

This study aims to determine the effect of exports on productivity and the direction of causality between these two variables. For this purpose, the data of 139 firms operating in the manufacturing industry and listed in BIST for the period 2016:Q3-2023:Q2 are used in the analysis. During the data collection process, the data of all firms included in the manufacturing industry in the classification of the Public Disclosure Platform (PDP) were examined; as a result of the examination, firms that started to be listed within the analysis period and firms with incorrectly defined various indicators were excluded from the data set. Finally, 139 firms whose data were determined to be correct and started to be listed on the stock exchange before the analysis period were included in the analysis. The data set consists of a comprehensive heterogeneous panel with 28 quarters, 4 different variables and 15,568 observations. The data source is the PDP. The balance sheet and income statements published here include both quarterly and cumulative variables. Therefore, cumulative variables are converted to quarterly by taking their differences. Python (PyCharm 2023.2.3) coding language was used for data collection. The number of employees was obtained by analysing approximately 4,000 company reports (financial report and operational report) in the PDP. Table 2 shows the stock exchange codes of the firms included in the analysis.

Table 2. Firms Included in the Analysis

No	Code	No	Code	No	Code	No	Code	No	Code	No	Code	No	Code
1	ADEL	21	FMIZP	41	CEMAS	61	AFYON	81	BRKSN	101	SKTAS	121	TATGD
2	VESTL	22	EMKEL	42	CELHA	62	TUPRS	82	BAGFS	102	ROYAL	122	SELGD
3	VESBE	23	EGEEN	43	BURVA	63	TMPOL	83	AYGAZ	103	MNDRS	123	PNSUT
4	ULUSE	24	DITAS	44	BURCE	64	SEKUR	84	ALKIM	104	LUKSK	124	PINSU
5	TTRAK	25	BFREN	45	BRSAN	65	SASA	85	AKSA	105	KORDS	125	PETUN
6	PRKAB	26	BNTAS	46	USAK	66	SANFM	86	ACSEL	106	KRTEK	126	PENGD
7	TMSN	27	ARCLK	47	NUHCM	67	RTALB	87	VKING	107	HATEK	127	OYLUM
8	TOASO	28	ASUZU	48	NIBAS	68	PETKM	88	SAMAT	108	DESA	128	KRSTL
9	SILVR	29	ALCAR	49	KUTPO	69	MRSHL	89	PRZMA	109	DERIM	129	KNFRT
10	SAYAS	30	TUCLK	50	KONYA	70	HEKTS	90	MNDTR	110	DAGI	130	KERVIT
11	PARSN	31	SARKY	51	GOLTS	71	GUBRF	91	KARTN	111	BOSSA	131	KENT
12	OTKAR	32	KRDMA	52	EGSER	72	GOODY	92	KAPLM	112	BRMEN	132	FRIGO
13	MAKTK	33	IZMDC	53	DOGUB	73	GEDZA	93	DURDO	113	BRKO	133	ERSU
14	KLMSN	34	ISDMR	54	CIMSA	74	EMNIS	94	BAKAB	114	BLCYT	134	EKIZ
15	KATMR	35	EREGL	55	CMENT	75	EPLAS	95	ALKA	115	ARSAN	135	DARDL
16	KARSN	36	ERBOS	56	CMBTN	76	EGPRO	96	GENTS	116	ATEKS	136	CCOLA
17	JANTS	37	DOKTA	57	BUCIM	77	EGGUB	97	DGNMO	117	ULKER	137	BANVT
18	IHEVA	38	DMSAS	58	BSOKE	78	DYOBY	98	YUNSA	118	ULUUN	138	AVOD
19	GEREL	39	CUSAN	59	BTCIM	79	DEVA	99	YATAS	119	TBORG	139	AEFES
20	FROTO	40	CEMTS	60	AKCNS	80	BRISA	100	SNPAM	120	TUKAS		

Source: Created by the author by using PDP reports.

Labour productivity, export intensity, average wage and profitability variables were derived from the data obtained. The methods used in the calculation of these variables are presented in Table 3.

Table 3. Description of Variables

Variables	Description	Calculation	Source
LP	Labour productivity	Natural logarithm of (Net sales revenues/number of employees)	(Public Disclosure Platform [PDP], (2023)
EI	Export intensity	Net foreign sales revenues/net total sales revenues	(PDP, 2023)
AW	Average wage	Natural logarithm of (Short-term payables related to employee benefits/number of employees)	(PDP, 2023)
PR	Profitability	Quarterly net operating profit or loss/net sales revenue	(PDP, 2023)

Source: Created by the author.

In many studies in the literature, it is seen that productivity is taken with two methods as TFP and LP. However, in studies where firm-level data are used, as in this study, only LP is preferred since plant-level data are not available. Therefore, LP represents the productivity variable in this study. In microeconomic theory, the average productivity of labour is measured by the amount of output per labour. However, the quantity of output is usually not clearly stated in financial statements. Such operational data and performance measures are usually provided through internal reports or management reports. In order to access operational data such as production quantity, it is necessary to obtain the company's internal operational reports or management reports. For this reason, in analyses based on micro data, variables such as sales revenue or value added, which indirectly represent output, are generally used. In our study, following many studies in the literature, revenue per employee (Net sales revenues/number of employee) was preferred (Alvarez & Gonzalez, 2023; Atabek-Demirhan, 2016; Batrakova & Davies, 2012; Camino-Mogro et al., 2020; Davies & Jeppesen, 2015; Girma et al., 2008; Lei & Zongsen, 2017; Lemonakis et al., 2013; Powell & Wagner, 2011; Wagner, 2002).

In the NNTT literature focusing on inter-firm heterogeneity, the export variable is usually included in the analyses as a dummy variable for export participation status or export intensity. In most studies, exports are treated only as a binary variable (1,0 dummy) to denote a firm's export status. (Alvarez & Gonzalez, 2023; Alvarez & Lopez, 2005; Atabek-Demirhan, 2016; Batrakova & Davies, 2012; Bernard & Jensen, 1999; Camino-Mogro et al., 2020; Cassiman & Martinez-Ros 2007; Cassiman et al., 2010; Cui et al., 2016; Fabling & Sanderson, 2013; Greenaway & Yu, 2004; Greenaway et al., 2005; Hagemejer & Kolasa, 2011; Javalgi et al., 1998; Johansson, 2009; Kaoru et al., 2015; Lemonakis et al., 2013; Lopez, 2009; Lukason & Laitinen, 2018; Machado, 2019; Poschl et al., 2009; Serrano & Myro, 2019; Sharma & Mishra, 2012). In some studies, only the export intensity variable was preferred. (Bekteshi, 2020; Brooks, 2006; Cavusgil, 1984; Majocchi et al., 2005; Sun & Hong, 2011; Tomiura, 2007). There are also studies that use both variables together (Abor, 2011; Bleaney & Wakelin, 2002; Girma et al., 2008; Schank et al., 2007; Verhoogen, 2008). In a different methodology, it is also common to group firms according to their export status and analyse them separately (Alcala & Hernandez, 2010;

Damijan et al., 2010; Davies & Jeppesen, 2015; Delgado et al., 2002; Lei & Zongsun, 2017; Powell & Wagner, 2011; Samadi et al., 2023; Wagner, 2002; Wickramasekera & Bianchi, 2013; Yang & Mallick, 2010; Yasar & Rejesus, 2005). However, in addition to the export status of companies, how much they participate in exports (export intensity) is also very important (Fryges & Wagner, 2008). This is because many studies have concluded that export participation has no effect on firm productivity. It can be thought that this is mainly due to the selection of the export variable as a dummy. In economic terms, it is inevitable that there are important linkage channels and cause-and-effect relationships between exports and productivity. Therefore, ‘export intensity’ variable is preferred to represent exports in our study. Export intensity is considered to be more useful for two reasons. The first one is that export intensity is the most widely used variable regarding the export status of the firm. In this way, it can be compared with other studies. Secondly, since export and sales information is clearly stated in the income statements of firms, the resistance of managers, especially in SMEs, to confidentiality is not encountered. Since export intensity is obtained through open information, it is more reliable (Majocchi et al., 2005, pp. 721-722).

In the literature, studies based on firm heterogeneity generally use annual, monthly, weekly or hourly wage averages as wage variables. In a few studies based on employee-employer data, wage variables containing more detailed information such as blue-white collar distinction or education level are used (Frias et al., 2009; Schank et al., 2007; Tanaka, 2015). Yet, this information is only available at the facility level through special reports, surveys or mutual legal protocols. Alternatively, it is possible to use the personnel expenses item in the accounting statements as a wage variable; but it is not possible to access the accounting statements on company basis for similar reasons. In addition, the personnel expenses item is not included in the balance sheets and income statements used in our study. Another possible expense item that can be used to represent the wage variable is the cost of sales; however, in our study, this item was not deemed appropriate to represent the wage variable due to its content. Due to these reasons, it is quite difficult to access the wage information of active firms in Türkiye. In our study, an alternative method is preferred to represent the wage variable and the data of the ‘short-term payables related to employee benefits’ account in the balance sheets of the firms are used. The content of this account is described by the Public Oversight Accounting and Auditing Standards Authority as follows; ‘*wages, salaries and social security benefits, paid annual leave and paid sick leave, profit sharing and bonuses (payable within twelve months from the end of the period) and non-monetary benefits provided to existing employees (health benefits, lodging, vehicles and food and other services provided free of charge or at a discount)*’ (Public Oversight Accounting and Auditing Standards Authority, 2018, p. 6).

The profitability variable represents the percentage profit/loss ratio achieved by the firm in the relevant period. In the analysis, this variable is calculated as ‘quarterly net operating profit or loss/quarterly net sales revenue’ for each quarter following Atabek-Demirhan (2016). This study mainly

focuses on the effects of exports on production-related indicators such as productivity, wages and capital intensity. For this reason, it is deemed appropriate to use only the firm's operating profitability indicator.

A model, was constructed with the variables given in Table 3. The model of the study is shown in Equation (1).

$$LP_{it} = \beta_0 + \beta_1 EI_{it} + \beta_2 AW_{it} + \beta_3 PR_{it} + u_{it} \quad (1)$$

In the equation i , denotes the horizontal cross-sectional units (firms) of the study; t , denotes the time dimension; β_0 , denotes the constant term and u_{it} , denotes the error term.

5. EMPIRICAL RESULTS

In this section of the study, the model in equation 1 is estimated to analyse the effect of exports on productivity. Since both the time and unit dimension of the data set are larger than one, the panel data analysis method was followed for model estimation. Stata 15 and Eviews 12 programmes were used for this purpose. In addition, (Granger Bootstrap) causality test was applied to determine the direction of the export-productivity relationship in the industry. Gauss 21 programme was used for this test. In the first subsection, panel data analysis is reported and in the following subsection, causality analysis results are presented.

5.1. Panel Data Analysis Results

The model in Equation 1 includes four different variables: productivity, average wages, exports and profitability. Descriptive statistics of these variables are presented in Table 4. The number of observations for each variable in the table is 3892.

Table 4. Descriptive Statistics

Variables	Mean value	Standart deviation	Minimum	Maximum
LP	481,916	867,720	7,027	13,800,000
AW	10,135	15,547	338	339,112
EI	0.320	0.265	0	1
PR	0.099	0.444	-20.057	4.284

Source: Created by the author.

In table 4, the summary statistics for the variables are reported. Higher mean values indicate a positive indicator for all variables. In the case of the total sample, the mean value of LP is 481,916, AW is 10,135 and PR is 0.09. The difference between the minimum and maximum values of these variables is high. The first reason for this is that firms have quite heterogeneous characteristics. The second reason is that the data set is constructed from quarterly firm reports. In some periods, extreme values may appear in firm reports due to cyclical reasons. On the other hand, EI, which expresses the share of export revenue in total sales revenue, takes a value between 0 and 1. A total of 5 firms in the dataset did not participate in any export activity in the period analysed. Therefore, the minimum value is 0. For some

firms, all of their income in a quarter period is derived from export activities. Such firms are called pure exporters (Mahakitsiri & Suwanprasert, 2023) and there are a small number of such firms in the dataset.

Another important indicator for the variables is the correlation relationship between them. The results of the Pearson correlation test are reported in Table 5.

Table 5. Correlation Between Labour Productivity, Average Wage, Export Intensity and Profitability

Variables	LP	AW	EI
AW	0.469*** (0.000)		
EI	-0.007 (0.657)	-0.089*** (0.000)	
PR	0.111*** (0.000)	-0.045*** (0.004)	0.044*** (0.005)

Note: p-values are reported between brackets. *** indicate significance at 1% level.

The NNTT and Melitz (2003) model suggests that, on the one hand, efficient firms are more likely to engage in exporting and, on the other hand, exporters are generally more efficient. However, the coefficient -0.007 in the correlation matrix representing the correlation between LP and EI is not statistically significant. This result implies that there is no direct relationship between export intensity and labour productivity or that the relationship is not linear. Therefore, the theoretical relationships between the two variables are more likely to be realised through non-linear channels. On the other hand, the correlation of labour productivity with average wages (0.469) and profitability (0.111) has a positive coefficient. This result is consistent with the neo-classical microeconomic theory. There is a negative, albeit weak, correlation (-0.089) between average wages and exports. The small coefficient indicates that the direct relationship between the two variables is limited. In fact, although exports are expected to lead to higher wages in the NNTT, the catalyst for this relationship is that exporters demand higher quality labour inputs. Therefore, in theory, this relationship is realised indirectly. As it is known, the correlation matrix reflects only direct relationships between variables. Finally, profitability is weakly positively correlated with exports (0.044) and negatively correlated with average wages (-0.045). The negative result indicates the existence of a trade-off relationship between the two variables due to firms' labour and capital preferences. The positive result, on the other hand, indicates that firms' export success can increase their profitability in line with the theoretical expectation.

Before the model estimation, the correlation between the units should be determined. Accordingly, Pesaran's (2021) cross-sectional dependence (CD) test was applied to the variables. The findings obtained as a result of this test are presented in Table 6.

As a result of Pesaran CD test, all probability values are found to be 0.000. Thus, the null hypothesis of the test as 'there is no horizontal cross-section dependence' is rejected. Therefore, it is concluded that there is horizontal cross-section dependence for all variables.

Table 6. Cross-Section Dependence Test Results

Variables	CD Test Value
LP	389.927***
AW	351.85***
EI	21.216***
PR	45.236***

Note: *** indicate significance at 1% level.

Finally, the heterogeneity of the variables should be determined especially for the selection of the appropriate causality analysis. For this reason, the heterogeneity test was applied to the series (Blomquist & Westerlund, 2013). The results of this test are presented in Table 7.

Table 7. Heterogeneity Test Results

Variables	Δ^{HAC}	$\Delta^{HAC}_{adj.}$
LP	-5.627***	-5.982***
AW	-1.945*	-2.068 **
EI	-3.138***	-3.337***
PR	-4.422***	-4.701***

Note: ***, ** and * indicate significance at 1%, 5% and 10% level.

According to the heterogeneity test results, the null hypothesis ‘slope coefficients are homogenous’ is rejected for all variables. Therefore, it is concluded that variables are heterogeneous.

The model to be used in the analysis was determined through Hausman test. In addition, various tests were applied to test the cross-sectional dependence, heteroscedasticity and autocorrelation problems that reduce the reliability of the model estimation. The results of these tests are presented in Table 8.

Table 8. Hausman Test Statistic, Cross-sectional Dependence, Heteroscedasticity and Auto-Correlation Results

Tests	Hypotheses	Results
Hausman Test Statistic	H ₀ : There is no correlation between explanatory variables and unit effect (random effects model is appropriate). H ₁ : There is correlation between explanatory variables and unit effect (fixed effects model is appropriate).	2.29 (0.5151)
Cross-sectional Dependence (Pesaran’s CD Test)	H ₀ : There is no cross-section dependence H ₁ : There is cross-section dependence	Pesaran CD= 264.351 (0.000)
Heteroscedasticity (Levene, Brown & Forsythe’s Test)	H ₀ : There is no heteroscedasticity H ₁ : There is heteroscedasticity	W0= 6.8309235 df(138, 3753) Pr>F= (0.000)***
Auto-Correlation (Durbin-Watson & Baltagi-Wu’s LBI Test)	H ₀ : There is no autocorrelation H ₁ : There is autocorrelation	Durbin-Watson 1.2659108 Baltagi-Wu 1.3598957

Note: *** indicate significance at 1% level.

The probability value of the Hausman test statistic is 0.5151. This value is greater than 0.05; therefore, the hypothesis H_0 cannot be rejected. As a result, it is appropriate to use the random effects (RE) model. According to the results of Pesaran CD Test ($p < 0.05$), Levene, Brown and Forsythe Test ($p < 0.05$) and Durbin-Watson and Baltagi-Wu's LBI Test (since the test results are less than the critical value of 2), H_0 hypotheses are rejected in all of the tests and it is concluded that cross-section dependence, heteroscedasticity and autocorrelation problems exist, respectively.

In line with these results, the Driscoll-Kraay estimator, which provides consistent and robust results under the presence of these three problems, was used (Driscoll & Kraay, 1998). The results of the model are reported in Table 9.

Table 9. Driscoll-Kraay Model Estimation

Dependent Variable: LP				
Independent Variables	Coefficient	Standard Error	t	P> t
EI	0.275*	[0.147]	1.87	0.072
AW	0.566***	[0.063]	8.86	0.000
PR	0.252***	[0.034]	7.40	0.000
Constant	7.375***	[0.782]	9.43	0.000
Wald chi2 (3)	284.82			
Prob>chi2	0.000			
R ²	0.237			

Note: *** and * indicate significance at 1% and 10% level.

The probability value (0.000) in Table 9 indicates that the model is statistically significant at $p < 0.01$ level. The coefficient of determination (0.237) shows that the independent variables used in the model explain approximately 23.7% of the total change in the dependent variable. The rate is relatively low. However, this is usual in panel data analysis, especially due to the heterogeneity of the units. According to the RE estimation results, all independent variables have a statistically significant effect on the dependent variable. Accordingly, increases in export intensity, average wages and profits increase productivity in line with the theoretical expectation. The effect of exports on productivity supports the learning-by-exporting effect. This result obtained for the Turkish manufacturing industry is consistent with the findings of Yasar et al. (2006; 2007), Yasar and Rejesus (2005), Dalgıç, Fazlıoğlu and Gasiorek (2015b) and Dalgıç, Fazlıoğlu and Karaoglan (2015), while it does not support the findings of Kılıçaslan and Erdogan (2012).

In the previous literature, there are studies that conclude that there is no exporter premium or that there is an exporter premium only stemming from the self-selection effect (Aw & Hwang, 1995; Bernard & Jensen, 1999; Delgado et al., 2002; Lei & Zongsun, 2017; Liu et al., 1999; Wagner & Van Biesebroeck, 2008; Wagner, 2002; Vu, 2012;). The findings of this paper do not support the results of these studies in general. Nevertheless, the number of studies finding learning-by-exporting effect for different countries is quite high (Baldwin & Gu, 2004; Bigsten & Gebreeyesus, 2009; Blalock & Gertler, 2004; Damijan et al., 2010; De Loecker, 2007; Kaoru et al., 2015; Kraay, 1999; Palangkaraya & Yong,

2007; Razzolini & Vannoni, 2011; Sharma & Mishra, 2011; Van Biesebroeck, 2005a, 2005b; Yang & Mallick, 2010). However, it would be appropriate to elaborate here only on the studies that measure the export variable as export intensity. For instance, the findings on exports and average wages are quite consistent with the findings of Abor (2011) using a fixed effect model. Moreover, in this analysis, where a similar model is used, the coefficient of average wage is larger than the coefficient of exports. Moreover, the result for exports is also consistent with the findings of Sun and Hong (2011) using three different methods (Pooled OLS, FE and RE). Similar results are reported by Hashim and Banga (2009) for unskilled labour only and Castellani (2002) for growth in firm productivity (value added/employee). Fryges and Wagner (2008) examine the effect of exports on labour productivity (sales/employee) growth in terms of different deciles of export intensity using the GPS method and find evidence of a learning effect in a sub-range of export intensity.

In the literature, it is observed that the findings on the learning-by-exporting effect are mostly obtained from studies on developing countries. In this paper, this effect is supported by the case of Türkiye. These findings point to the importance of exports for productivity growth in developing countries.

5.2. Granger Bootstrap Causality Test Results

In the Granger (2003) approach, the causality relationship is based on the fact that the past values of one variable improve the predictions of another variable. There are three different causality tests widely used in the literature. The first one is the GMM estimator. In this method, cross-section dependence in the panel is not controlled and the heterogeneity of the parameters is ignored (Pesaran et al., 1999). In the second method developed by Hurlin (2008), although heterogeneity is controlled, cross-sectional dependence cannot be explained. The third method is Granger causality developed by Konya (2006). Granger causality has two important advantages over other tests: controlling the cross-sectional dependence in the panel (not requiring unit root test) and taking into account the heterogeneity of the parameters. Since our study focuses on the differences between firms on the basis of NNTT, the heterogeneity between the units in the panel should be taken into account. Therefore, following similar studies (Kar et al., 2011; Menyah et al., 2014), Granger-Bootstrap causality analysis, which is appropriate for the heterogeneous structure of the panel, was used to examine causality. The procedure of Emirmahmutoglu and Kose (2011) was followed in the analysis conducted through Gauss 21 software.

There are some studies that are similar to our study in terms of method or sample. For example, Demir (2019) examined the Turkish manufacturing industry with the same method. However, this study used sector-level data. Albayrak and Agazade (2017), using Granger causality test, concluded that there is a unidirectional long-run relationship from two different labour productivity indicators to exports. Ozdemir (2019) conducted a Granger causality test using aggregated macro data and found a

unidirectional causality relationship between exports and total factor productivity in the Turkish manufacturing industry.

In this study, micro-scale quarterly firm data are used. In the analysis, export variable is represented by export intensity (EI) and productivity variable is represented by labour productivity (LP). In addition, the causality relationship result can be known for each firm in the sample. In this respect, this paper differs from the previous literature. The causality test result for the industry is presented in Table 10. Firm-based results are presented in Appendix 1.

Table 10. Causality from Productivity to Exports and from Exports to Productivity: Granger Causality Test

Productivity→ Export	Export→ Productivity
Panel Fisher= 599.009	Panel Fisher= 612.234
Asymptotic p-value=0.000	Asymptotic p-value= 0.000
Bootstrap p-value= 0.000	Bootstrap p-value= 0.000

Source: Created by the author.

According to the results in Table 10, there is a bi-directional causality relationship for the industry in general. When the probability values in the causality test are considered, the null hypothesis of ‘There is no Granger causality between the variables’ is rejected for both directions of causality. In this respect, there is a causality relationship both from productivity to export and from export to productivity. In other words, both variables are important determinants of each other. Similar to these findings, there are studies reporting bidirectional causality for different countries such as the United Kingdom (Girma et al., 2004), Sweden (Hansson & Lundin, 2004), 9 different African countries (Van Biesebroeck, 2005b), Australia (Palangkaraya & Yong, 2007), Ethiopia (Bigsten & Gebreeyesus, 2009), China (Yang & Mallick, 2010) and Italy (Razzolini & Vannoni, 2011). Further, these results are consistent with many studies cited in the literature section that find both learning-by-exporting and self-selection effects in the Turkish manufacturing industry (Aldan & Günay, 2008; Maggioni, 2012; Ozarslan & Dogan, 2021). Unlike these studies, the analysis also presents the results of this causality on a firm-by-firm basis. As a result, for the group of firms analysed, exporting is a result of firms' own choices; on the other hand, exports are the determinant of productivity changes in exporting firms - theoretically, usually in the direction of increase.

6. CONCLUSION

Export activities are considered as a vital factor for developing countries. Because there is generally a productivity gap in these countries. Exports are an important determinant of productivity increases that support growth. Especially labour productivity, which is the main source of total productivity, is affected by export activities. Similar to many studies in the literature, this study reports the positive effect of exports on labour productivity for the Turkish manufacturing industry. Our significant findings on the productivity-export relationship underlying the Melitz (2003) model

encouraged the determination of the direction of causality between the two variables. As a result of the causality analysis, a bi-directional causality relationship was identified, where both productivity is an important determinant of exports and exports are an important determinant of productivity. These results indicate that the self-selection and learning-by-exporting hypotheses are valid in the Turkish manufacturing industry. In this respect, the results of the analyses are consistent with the findings of many similar studies, which are detailed in the literature section and find the existence of both effects. Unlike the literature, the results of the causality relationship on a firm-by-firm basis are also presented in the appendix section of the study. Thus, this study has shown that the existing analyses can be deepened by presenting the direction of the causality relationship on a more micro scale, and it has shown that selective incentive policies that can be applied on a firm basis can be implemented. Therefore, it has provided outputs not only at the sector level but also at the firm level for policies to select winners.

In line with the results obtained, this study provides important policy implications for the Turkish economy. It points out that exports are important and should be encouraged in terms of both foreign trade and fiscal policies. Because for the firms analysed, export activity is a determinant factor that has direct or indirect effects on many parameters. For example, the implementation of policies that will reduce the export intensity of firms will lead to a decreasing effect on labour productivity. Labour productivity is the main determinant of total factor productivity, which is considered as the source of healthy economic growth. The choice of policies that will restrict exports has the potential to restrict the average productivity of the economy and thus growth. As a result, a larger share of firms' sales revenues from exports will have positive effects both on the firm level and on the national macroeconomic scale. Therefore, it is necessary to implement economic policies that will support more inclusion of exports by firms. In terms of the causality relationship reported in this study, policies that will support both learning and selection effects are expected to provide positive economic outcomes. The results indicate the existence of a virtuous cycle between exports and productivity.

Another important policy recommendation derived from our analyses is that policies that would lead to a decline in average wages and firm profitability should be avoided. This is because a decline in average wages and profitability reduces labour productivity. This can be expected to restrain growth at the macro scale similar to the relationship in export intensity. Based on these results, it can be argued that the current policy preferences in the Turkish economy involve some dichotomies. Because the contractionary policies implemented or expected to be implemented against the current inflation carry some risks. For instance, the fight against inflation based on regulations that reduce firm profitability and policies that reduce wages in real terms may have negative effects on firm productivity. For this reason, it is necessary to conduct effective SWOT analyses that take into account the dichotomies and trade off relationships between economic factors in the selection of current policy choices. Making

policy choices by considering these complex relationships will make it more likely that the policies to be determined will be successful.

In the light of this study, some suggestions can be made for future studies. For example, the analyses that we have only considered manufacturing industry firms can be applied for different industries in future studies. In addition, the scope of foreign trade in the analyses can be expanded to include import activities. Another important research issue is whether the findings are valid for different types of markets. The characteristics of the manufacturing industry analysed are in line with the monopolistic competition market assumed in heterogeneous firm theories. Instead, it is worth investigating, for example, exporter premiums and the export-productivity relationship in oligopolistic markets.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Abor, J. (2011). Do export status and export intensity increase firm performance?. *Thunderbird International Business Review*, 53(1), 9-18. <https://doi.org/10.1002/tie.20386>
- Albayrak, N. C., & Agazade, S. (2017). Emek verimliliği ve ihracat ilişkisi: Türk imalat sanayi örneği. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, 53, 11-25.
- Alcala, F., & Hernandez, P. J. (2010). *Firms' main market, human capital, and wages*. *SERIEs*, 1, 433-458. <https://doi.org/10.1007/s13209-009-0007-6>
- Aldan, A., & Günay, M. (2008). *Entry to export markets and productivity: Analysis of matched firms in Turkey*. TCMB. <https://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Publications/Research/Working+Papers/2008/08-05>
- Alvarez, R., & Gonzalez, M. A. (2023). *Are innovation barriers different for Chilean exporters and non-exporters?*. Universidad de Chile, Departamento de Economía.
- Alvarez, R., & Lopez, R. A. (2005). Exporting and performance: Evidence from Chilean plants. *Canadian Journal of Economics/Revue Canadienne D'économie*, 38(4), 1384-1400. <https://doi.org/10.1111/j.0008-4085.2005.00329.x>
- Antoniades, A. (2015). Heterogeneous firms, quality, and trade. *Journal of International Economics*, 95(2), 263-273. <https://doi.org/10.1016/j.jinteco.2014.10.002>
- Arrow, K. (1962). The Economic implications of learning by doing. *Review of Economic Studies*, 29(80), 155-173. <https://doi.org/10.2307/2295952>

- Arvas, M. A., & Uyar, B. (2014). Exports and firm productivity in Turkish manufacturing: An Olley-Pakes estimation. *International Journal of Economics and Financial Issues*, 4(2), 243-257.
- Atabek-Demirhan, A. (2016). To be exporter or not to be exporter? Entry–exit dynamics of Turkish manufacturing firms. *Empirical Economics*, 51(1), 181-200. <https://doi.org/10.1007/s00181-015-1005-0>
- Aw, B. Y., & Hwang, A. R. M. (1995). Productivity and the export market: A firm-level analysis. *Journal of Development Economics*, 47(2), 313-332. [https://doi.org/10.1016/0304-3878\(94\)00062-H](https://doi.org/10.1016/0304-3878(94)00062-H)
- Aw, B. Y., Chung, S., & Roberts, M. J. (2000). Productivity and turnover in the export market: Micro-level evidence from the Republic of Korea and Taiwan (China). *The World Bank Economic Review*, 14(1), 65-90. <https://doi.org/10.1093/wber/14.1.65>
- Bal, H., Akça, E. E., Mamun, A. H., & Bayraktar, M. (2020). Revisiting export-output growth nexus: Findings from Granger causality and leveraged bootstrap approach for Japan. *Dogus Universitesi Dergisi*, 21(2), 37-51.
- Baldwin, J. R., & Gu, W. (2004). Trade liberalization: Export-market participation, productivity growth, and innovation. *Oxford Review of Economic Policy*, 20(3), 372-392. <https://doi.org/10.1093/oxrep/grh022>
- Batrakova, S., & Davies, R. B. (2012). Is there an environmental benefit to being an exporter? Evidence from firm-level data. *Review of World Economics*, 148, 449-474. <https://doi.org/10.1007/s10290-012-0125-2>
- Bekteshi, S. A. (2020). Firm size related to export performance. *International Journal of Economics and Business Administration*, 8(1), 51-61. <https://www.um.edu.mt/library/oar/handle/123456789/53838>
- Bernard, A. B., & Jensen, J. B. (1999). Exceptional exporter performance: Cause, effect, or both?. *Journal of International Economics*, 47(1), 1-25. [https://doi.org/10.1016/S0022-1996\(98\)00027-0](https://doi.org/10.1016/S0022-1996(98)00027-0)
- Bernard, A. B., Eaton, J., Jensen, J. B., & Kortum, S. (2003). Plants and productivity in international trade. *American Economic Review*, 93(4), 1268-1290. <https://doi.org/10.1257/000282803769206296>
- Bernard, A. B., Jensen, J. B., & Lawrence, R. Z. (1995). Exporters, jobs, and wages in US manufacturing: 1976-1987. *Brookings Papers on Economic Activity Microeconomics*, 1995, 67-119. <https://doi.org/10.2307/2534772>
- Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007). Firms in international trade. *Journal of Economic Perspectives*, 21(3), 105-130. <https://doi.org/10.1257/jep.21.3.105>
- Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2012). The empirics of firm heterogeneity and international trade. *Annual Review of Economics*, 4(1), 283-313. <https://doi.org/10.1146/annurev-economics-080511-110928>
- Bernard, A.B., & Wagner, J. (1997). Exports and success in German manufacturing. *Review of World Economics*, 133, 134–157. <https://doi.org/10.1007/BF02707680>
- Bigsten, A., & Gebreeyesus, M. (2009). Firm productivity and exports: Evidence from Ethiopian manufacturing. *The Journal of Development Studies*, 45(10), 1594-1614. <https://doi.org/10.1080/00220380902953058>
- Blalock, G., & Gertler, P. J. (2004). Learning from exporting revisited in a less developed setting. *Journal of Development Economics*, 75(2), 397-416. <https://doi.org/10.1016/j.jdeveco.2004.06.004>
- Bleaney, M., & Wakelin, K. (2002). Efficiency, innovation and exports. *Oxford Bulletin of Economics and Statistics*, 64(1), 3-15. <https://doi.org/10.1111/1468-0084.00001>
- Blomquist, J., & Westerlund, J. (2013). Testing slope homogeneity in large panels with serial correlation. *Economics Letters*, 121(3), 374-378. <https://doi.org/10.1016/j.econlet.2013.09.012>
- Brooks, E. L. (2006). Why don't firms export more? Product quality and Colombian plants. *Journal of Development Economics*, 80(1), 160-178. <https://doi.org/10.1016/j.jdeveco.2005.10.001>
- Camino-Mogro, S., Vera-Gilces, P., & Ordeñana-Rodríguez, X. (2020). *Microeconomic evidence between exporters and non-exporters: Differences in economic and productivity performance*. EPEL. <http://economiclab.org/microeconomic-evidence-between-exporters-and-non-exporters-differences-in-economic-and-productivity-performance.html>
- Cassiman, B., & Martinez-Ros, E. (2007). *Product innovation and exports. Evidence from Spanish manufacturing*. IESE Business School.

- Cassiman, B., Golovko, E., & Martínez-Ros, E. (2010). Innovation, exports and productivity. *International Journal of Industrial Organization*, 28(4), 372-376. <https://doi.org/10.1016/j.ijindorg.2010.03.005>
- Castellani, D. (2002). Export behavior and productivity growth: Evidence from Italian manufacturing firms. *Weltwirtschaftliches Archiv*, 138(4), 605-628. <https://doi.org/10.1007/BF02707654>
- Cavusgil, S. T. (1984). Differences among exporting firms based on their degree of internationalization. *Journal of Business Research*, 12(2), 195-208. [https://doi.org/10.1016/0148-2963\(84\)90006-7](https://doi.org/10.1016/0148-2963(84)90006-7)
- Ciuriak, D., Lapham, B., Wolfe, R., Collins-Williams, T., & Curtis, J. (2015). Firms in international trade: Trade policy implications of the new new trade theory. *Global Policy*, 6(2), 130-140. <https://doi.org/10.1111/1758-5899.12183>
- Cui, J., Lapan, H., & Moschini, G. (2016). Productivity, export, and environmental performance: Air pollutants in the United States. *American Journal of Agricultural Economics*, 98(2), 447-467. <https://doi.org/10.1093/ajae/aav066>
- Dalgıç, B., Fazlıoğlu, B., & Gasiorek, M. (2015a). Costs of trade and self-selection into exporting and importing: The case of Turkish manufacturing firms. *Economics*, 9(1), 1-29. <https://doi.org/10.5018/economics-ejournal.ja.2015-15>
- Dalgıç, B., Fazlıoğlu, B., & Gasiorek, M. (2015b). *Does it matter where you export and does real productivity really rise with exporting?* Munich Personal RePEc Archive, MPRA Paper No. 69956. <https://mpra.ub.uni-muenchen.de/id/eprint/69956>
- Dalgıç, B., Fazlıoğlu, B., & Karaoglan, D. (2015). Entry to foreign markets and productivity: Evidence from a matched sample of Turkish manufacturing firms. *The Journal of International Trade & Economic Development*, 24(5), 638-659. <https://doi.org/10.1080/09638199.2014.948904>
- Damijan, J. P., Kostevc, C., & Polanec, S. (2010). From innovation to exporting or vice versa?. *World Economy*, 33(3), 374-398. <https://doi.org/10.1111/j.1467-9701.2010.01260.x>
- Davies, R. B., & Jeppesen, T. (2015). Export mode, firm heterogeneity, and source country characteristics. *Review of World Economics*, 151, 169-195. <https://doi.org/10.1007/s10290-014-0207-4>
- De Loecker, J. (2007). Do exports generate higher productivity? Evidence from Slovenia. *Journal of International Economics*, 73(1), 69-98. <https://doi.org/10.1016/j.jinteco.2007.03.003>
- Delgado, M. A., Farinas, J. C., & Ruano, S. (2002). Firm productivity and export markets: A non-parametric approach. *Journal of International Economics*, 57(2), 397-422. [https://doi.org/10.1016/S0022-1996\(01\)00154-4](https://doi.org/10.1016/S0022-1996(01)00154-4)
- Demena, B. A., Msami, J., Mmari, D., & Van Bergeijk, P. A. (2022). Productivity premia and firm heterogeneity in Eastern Africa. In B. A. Demena & P.A.G. Van Bergeijk (Eds.), *Trade and investment in East Africa: Prospects, challenges and pathways to sustainability* (pp. 131-161). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-4211-2_7
- Demir, I. (2019). *Türkiye imalat sanayi alt sektörlerinde ihracat ile emek verimliliği arasındaki nedensellik ilişkisi*. [Unpublished master's thesis], Pamukkale University.
- Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, 80(4), 549-560. <https://doi.org/10.1162/003465398557825>
- Emirmahmutoglu, F., & Kose, N. (2011). Testing for Granger causality in heterogeneous mixed panels. *Economic Modelling*, 28, 870-876. <https://doi.org/10.1016/j.econmod.2010.10.018>
- Engel, D., Procher, V., & Schmidt, C. M. (2013). Does firm heterogeneity affect foreign market entry and exit symmetrically? Empirical evidence for French firms. *Journal of Economic Behavior & Organization*, (85), 35-47. <https://doi.org/10.1016/j.jebo.2012.10.016>
- Fabling, R., & Sanderson, L. (2013). Exporting and firm performance: Market entry, investment and expansion. *Journal of International Economics*, 89(2), 422-431. <https://doi.org/10.1016/j.jinteco.2012.08.008>
- Frias, J. A., Kaplan, D. S., Verhoogen, E. A., & Alfaro-Serrano, D. (2009). Exports and wage premia: Evidence from Mexican employer-employee data. *Unpub. paper, Columbia University*. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=4dbeb709e9b56d30dca6c6a414d7688281d55607>

- Fryges, H., & Wagner, J. (2008). Exports and productivity growth: First evidence from a continuous treatment approach. *Review of World Economics*, 144, 695-722. <https://doi.org/10.1007/s10290-008-0166-8>
- Girma, S., Görg, H., & Hanley, A. (2008). R&D and exporting: A comparison of British and Irish firms. *Review of World Economics*, 144, 750-773. <https://doi.org/10.1007/s10290-008-0168-6>
- Girma, S., Greenaway, A., & Kneller, R. (2004). Does exporting increase productivity? A microeconomic analysis of matched firms. *Review of International Economics*, 12(5), 855-866. <https://doi.org/10.1111/j.1467-9396.2004.00486.x>
- Granger, C. W. (2003). Some aspects of causal relationships. *Journal of Econometrics*, 112(1), 69-69.
- Greenaway, D., & Yu, Z. (2004). Firm-level interactions between exporting and productivity: Industry-specific evidence. *Review of World Economics*, 140, 376-392. <https://doi.org/10.1007/BF02665981>
- Greenaway, D., Gullstrand, J., & Kneller, R. (2005). Exporting may not always boost firm productivity. *Review of World Economics*, 141, 561-582. <https://doi.org/10.1007/s10290-005-0045-5>
- Gungor, A. G. (2017 September, 7-8). *Küresel kriz sürecinde imalat sanayi alt sektörlerinde verimlilik değişimleri ve rekabet gücü ilişkisi* [Conference presentation]. IV. International Caucasus-Central Asia Foreign Trade and Logistics Congress. Aydın/Türkiye. https://ulk.ist/media/kitap/IV-UKODTLK/kuresel-kriz-surecinde-imalat-sanayi-alt-sektorlerinde-verimlilik-degis_XW8GLZr.pdf
- Hagemeyer, J., & Kolasa, M. (2011). Internationalisation and economic performance of enterprises: Evidence from Polish firm-level Data. *The World Economy*, 34(1), 74-100. <https://doi.org/10.1111/j.1467-9701.2010.01294.x>
- Hallak, J. C., & Sivadasan, J. (2013). Product and process productivity: Implications for quality choice and conditional exporter premia. *Journal of International Economics*, 91(1), 53-67. <https://doi.org/10.1016/j.jinteco.2013.05.001>
- Hansson, P., & Lundin, L. L. (2004). Exports as an indicator on or promoter of successful Swedish manufacturing firms in the 1990s. *Review of World Economics*, 140, 415-445. <https://doi.org/10.1007/BF02665983>
- Hashim, D., & Banga, R. (2009). *Impact of trade on labour productivity and wage inequality in India*. Munich Personal RePEc Archive, MPRA Paper No. 35200. <https://mpa.ub.uni-muenchen.de/35200/>
- Hurlin, C. (2008). *Testing for Granger non causality in heterogeneous panels*. Department of Economics: University of Orleans Working Paper.
- Irrazabal, A., Moxnes, A., & Ulltveit-Moe, K. H. (2013). Heterogeneous firms or heterogeneous workers? Implications for exporter premiums and the gains from trade. *Review of Economics and Statistics*, 95(3), 839-849. https://doi.org/10.1162/REST_a_00285
- Javalgi, R. G., Lawson, D., Gross, A. C., & White, D. S. (1998). Firm characteristics and export propensity: A comparison of manufacturers and manufacturing-based service providers. *International Business Review*, 7(5), 521-534. [https://doi.org/10.1016/S0969-5931\(98\)00027-4](https://doi.org/10.1016/S0969-5931(98)00027-4)
- Johansson, S. (2009). *Market experiences and export decisions in heterogeneous firms*. Centre of Excellence for Science and Innovation Studies (CESIS), (196). <https://static.sys.kth.se/itm/wp/cesis/cesiswp196.pdf>
- Kaoru, H., Daisuke, M., & Miho, T. (2015). *Learning by export: Does the presence of foreign affiliate companies matter?* (No. 15053). RIETI. <https://www.rieti.go.jp/jp/publications/dp/15e053.pdf>
- Kar, M., Nazlıoğlu, S., & Ağır, H. (2011). Financial development and economic growth nexus in the MENA countries: Bootstrap panel Granger causality analysis. *Economic Modelling*, 28(1-2), 685-693. <https://doi.org/10.1016/j.econmod.2010.05.015>
- Kılıçaslan, Y., & Erdoğan, L. (2012). Industry orientation, exporting and productivity. *Modern Economy*, 3(1), 81-90. <https://doi.org/10.4236/me.2012.31012>
- Koluman, A. (2022). *Türkiye imalat sanayinde firma bazlı ihracatı etkileyen faktörler*. [Unpublished master's thesis], Tarsus University.
- Konya, L. (2006). Exports and growth: Granger causality analysis on OECD countries with a panel data approach. *Economic Modelling*, 23(6), 978-992. <https://doi.org/10.1016/j.econmod.2006.04.008>
- Kraay, A. (1999). Exports and economic performance: Evidence from a panel of Chinese enterprises. *Revue d'Economie du Développement*, 1(2), 183-207.

- Kreickemeier, U., & Richter, P. M. (2014). Trade and the environment: The role of firm heterogeneity. *Review of International Economics*, 22(2), 209-225. <https://doi.org/10.1111/roie.12092>
- Lei, Y., & Zongsun, Z. (2017). Do exports firms outperform non-export ones? An empirical study on different classification of manufacturing industries in China. *China Finance and Economic Review*, 6(4), 78-98. <https://doi.org/10.1515/cfer-2017-060405>
- Lemonakis, C., Voulgaris, F., Christakis, S., & Vassakis, K. (2013). *Profit performance of exporting and non-exporting agricultural manufacturing firms: The case of Greece* [Conference presentation]. 8th NHIBE International Conference New Horizons in Industry and Education, Chania/Greece. <https://doi.org/10.13140/RG.2.1.4330.0007>
- Liu, J. T., Tsou, M. W., & Hammitt, J. K. (1999). Export activity and productivity: Evidence from the Taiwan electronics industry. *Weltwirtschaftliches Archiv*, 135(4), 675-691. <https://doi.org/10.1007/BF02707390>
- Lopez, R. A. (2009). Do firms increase productivity in order to become exporters?. *Oxford Bulletin of Economics and Statistics*, 71(5), 621-642. <https://doi.org/10.1111/j.1468-0084.2009.00558.x>
- Lu, J., Lu, Y., Sun, Y., & Tao, Z. (2017). Intermediaries, firm heterogeneity and exporting behaviour. *The World Economy*, 40(7), 1381-1404. <https://doi.org/10.1111/twec.12423>
- Lukason, O., & Laitinen, E. K. (2018). Failure of exporting and non-exporting firms: Do the financial predictors vary?. *Review of International Business and Strategy*, 28(3/4), 317-330.
- Machado, L. P. M. (2019). *Exporter firms behaviour, evidence from Portuguese firms using microdata* (No. 0136). Gabinete de Estratégia e Estudos, Ministério da Economia. https://www.gee.gov.pt/RePEc/WorkingPapers/GEE_PAPERS_136.pdf
- Maggioni, D. (2012). Learning by exporting in Turkey: An investigation for existence and channels. *Global Economy Journal*, 12(2), 1-15. <https://doi.org/10.1515/1524-5861.1865>
- Mahakitsiri, D., & Suwanprasert, W. (2023). Who are pure exporters?. *The World Economy*, 46(6), 1759-1781. <https://doi.org/10.1111/twec.13351>
- Majocchi, A., Bacchiocchi, E., & Mayrhofer, U. (2005). Firm size, business experience and export intensity in SMEs: A longitudinal approach to complex relationships. *International Business Review*, 14(6), 719-738. <https://doi.org/10.1016/j.ibusrev.2005.07.004>
- Mamun, A., Bal, H., & Akca, E. E. (2019). The export-output growth nexus in Bangladesh: A leveraged bootstrap approach. *Journal of Asia Business Studies*, 13(2), 196-213. <https://doi.org/10.1108/JABS-09-2017-0159>
- Mebratie, A. D., & Van Bergeijk, P. A. (2013). Firm heterogeneity and development: A meta-analysis of FDI productivity spillovers. *The Journal of International Trade & Economic Development*, 22(1), 53-74. <https://doi.org/10.1080/09638199.2013.745281>
- Melitz, J. M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-725. <https://doi.org/10.1111/1468-0262.00467>
- Menyah, K., Nazlioglu, S., & Wolde-Rufael, Y. (2014). Financial development, trade openness and economic growth in African countries: New insights from a panel causality approach. *Economic Modelling*, 37, 386-394. <https://doi.org/10.1016/j.econmod.2013.11.044>
- Mukoyama, T. (2022). *Heterogeneous firms*. [Draft Book]. https://phdmacrobook.org/wp-content/uploads/2023/12/draft2023_02_09.pdf
- Ozarslan, D., & Dogan, M. (2021). İhracat piyasasına giriş yapmanın verimlilik ve diğer firma göstergeleri üzerindeki etkisi: Türkiye imalat sanayii örneği. *Izmir İktisat Dergisi*, 36(3), 567-588. <https://doi.org/10.24988/ije.202136305>
- Ozdemir, O. (2019). Türkiye’de toplam faktör verimliliği, ekonomik büyüme ve ihracat arasındaki ilişkinin nedensellik analizi. *Finans Politik & Ekonomik Yorumlar*, 56(647), 23-63.
- Palangkaraya, A., & Yong, J. (2007). *Exporter and Non-Exporter Productivity Differentials: Evidence from Australian Manufacturing Establishments* (No. wp2007n04). Melbourne Institute of Applied Economic and Social Research. http://melbourneinstitute.unimelb.edu.au/downloads/working_paper_series/wp2007n04.pdf

- Pavcnik, N. (2002). Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *The Review of Economic Studies*, 69(1), 245-276. <https://doi.org/10.1111/1467-937X.00205>
- Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, 60(1), 13-50. <https://doi.org/10.1007/s00181-020-01875-7>
- Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634. <https://doi.org/10.1080/01621459.1999.10474156>
- Plouffe, M. (2017). Firm heterogeneity and trade-policy stances evidence from a survey of Japanese producers. *Business and Politics*, 19(1), 1-40. <https://doi.org/10.1017/bap.2016.6>
- Poschl, J., Stehrer, R., & Stollinger, R. (2009). *Characteristics of exporting and non-exporting firms in Austria* (No. 2009/10-01). FIW-Research Reports. https://www.econstor.eu/bitstream/10419/121207/1/fiw-rp_2009-10-01.pdf
- Powell, D., & J. Wagner (2011), *The exporter productivity premium along the productivity distribution: First evidence from a quantile regression approach for fixed effects panel data models*. IZA Discussion Paper No. 5112.
- Public Disclosure Platform. (2023). BIST Sirketleri [Data set]. <https://www.kap.org.tr/tr/bist-sirketler>
- Public Oversight Accounting and Auditing Standards Authority. (2018). Çalışanlara Sağlanan Faydalar (Türkiye Muhasebe Standardı No. 19). Kamu Gözetimi Kurumu, https://www.kgk.gov.tr/Portalv2Uploads/files/DynamicContentFiles/T%C3%BCrkiye%20Muhasebe%20Standartlar%C4%B1/TMSTFRS2018Seti/TMS/TMS_19_2018.pdf
- Razzolini, T., & Vannoni, D. (2011). Export premia and subcontracting discount: Passive strategies and performance in domestic and foreign markets. *The World Economy*, 34(6), 984-1013. <https://doi.org/10.1111/j.1467-9701.2011.01329.x>
- Rivers, D. A. (2013). *Are exporters more productive than non-exporters?* (No. 2013-2). CIBC Working Paper. <https://hdl.handle.net/10419/121973>
- Rodrik, D. (1997). Trade strategy, investment and exports: Another look at East Asia. *Pacific Economic Review*, 2(1), 1-24. <https://doi.org/10.1111/1468-0106.t01-1-00020>
- Rosenberg, N. (1982). *Inside the black box: Technology and economics*. Cambridge University Press.
- Samadi, M., Mirnezami, S. R., Khayyatian, M. S., & Torabi Khargh, M. (2023). The difference between exporter and non-exporter knowledge-based firms: The case of Iranian firms in the chemical industry. *Review of International Business and Strategy*, 33(5), 830-854.
- Schank, T., Schnabel, C., & Wagner, J. (2007). Do exporters really pay higher wages? First evidence from German linked employer–employee data. *Journal of International Economics*, 72(1), 52-74. <https://doi.org/10.1016/j.jinteco.2006.08.004>
- Schmitz, T. (2021). Endogenous growth, firm heterogeneity and the long-run impact of financial crises. *European Economic Review*, 132(103637), 1-21. <https://doi.org/10.1016/j.euroecorev.2020.103637>
- Schröder, P. J., & Sørensen, A. (2012). Second thoughts on the exporter productivity premium. *Canadian Journal of Economics/Revue canadienne d'économique*, 45(4), 1310-1331. <https://doi.org/10.1111/j.1540-5982.2012.01742.x>
- Schwarzer, J. (2017). *The effects of exporting on labour productivity: Evidence from German firms*. CEP Working Paper, 2017/2. <https://www.cepweb.org/wp-content/uploads/CEP-WP-2017-2-The-Effects-of-Exporting-on-Labour-Productivity.pdf>
- Serrano, J., & Myro, R. (2019). From domestic to exporter, what happens? Evidence for Spanish manufacturing firms. *Structural Change and Economic Dynamics*, 51, 380-392. <https://doi.org/10.1016/j.strueco.2019.01.005>
- Sharma, C., & Mishra, R. K. (2011). Does export and productivity growth linkage exist? Evidence from the Indian manufacturing industry. *International Review of Applied Economics*, 25(6), 633-652. <https://doi.org/10.1080/02692171.2011.557046>
- Sharma, C., & Mishra, R. K. (2012). Export participation and productivity performance of firms in the Indian transport manufacturing. *Journal of Manufacturing Technology Management*, 23(3), 351-369.

- Sun, X., & Hong, J. (2011). Exports, ownership and firm productivity: Evidence from China. *The World Economy*, 34(7), 1199-1215. <https://doi.org/10.1111/j.1467-9701.2011.01373.x>
- Tanaka, A. (2015). *Wage premiums for exporters and multinational enterprises: Evidence from Japanese linked employer-employee data*. RIETI. <https://www.rieti.go.jp/jp/publications/dp/15e106.pdf>
- Taymaz, E., & Yılmaz, K. (2007). Productivity and trade orientation: Turkish manufacturing industry before and after the customs union. *The Journal of International Trade and Diplomacy*, 1(1), 127-154.
- Tomiura, E. (2007). Effects of R&D and networking on the export decision of Japanese firms. *Research Policy*, 36(5), 758-767. <https://doi.org/10.1016/j.respol.2007.02.020>
- Trefler, D. (2004). The long and short of the Canada-US free trade agreement. *American Economic Review*, 94(4), 870-895. <https://doi.org/10.1257/0002828042002633>
- Van Biesebroeck, J. (2005a). Exporting raises productivity in sub-Saharan African manufacturing firms. *Journal of International Economics*, 67(2), 373-391. <https://doi.org/10.1016/j.jinteco.2004.12.002>
- Van Biesebroeck, J. (2005b). Firm size matters: Growth and productivity growth in African manufacturing. *Economic Development and Cultural Change*, 53(3), 545-583.
- Verardi, V., & Wagner, J. (2012). Productivity premia for German manufacturing firms exporting to the Euro-area and beyond: First evidence from robust fixed effects estimations. *The World Economy*, 35(6), 694-712. <https://doi.org/10.1111/j.1467-9701.2011.01414.x>
- Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the Mexican manufacturing sector. *The Quarterly Journal of Economics*, 123(2), 489-530. <https://doi.org/10.1162/qjec.2008.123.2.489>
- Vogel, A., & Wagner, J. (2011). Robust estimates of exporter productivity premia in German business services enterprises. *Economic and Business Review*, 13(1). <https://doi.org/10.15458/2335-4216.1217>
- Vu, V. H. (2012). *Higher productivity in exporters: Self-selection, learning by exporting or both? Evidence from Vietnamese Manufacturing SMEs*. Munich Personal RePEc Archive, MPRA Paper No. 40708. https://mpra.ub.uni-muenchen.de/40708/1/MPRA_paper_40708.pdf
- Wagner, J. (2002). The causal effects of exports on firm size and labor productivity: First evidence from a matching approach. *Economics Letters*, 77(2), 287-292. [https://doi.org/10.1016/S0165-1765\(02\)00131-3](https://doi.org/10.1016/S0165-1765(02)00131-3)
- Wagner, J. (2007). Exports and productivity: A survey of the evidence from firm-level data. *World Economy*, 30(1), 60-82. <https://doi.org/10.1111/j.1467-9701.2007.00872.x>
- Wagner, J., & Van Biesebroeck, J. (2008). Understanding cross-country differences in export premia-comparable evidence for 14 countries. *Review of World Economics*, 144(4), 596-635. <https://doi.org/10.5167/uzh-9823>
- Wang, Q., & Zhu, L. (2021). Environmental regulation, firm heterogeneity, and intra-industry reallocation. *China Economic Review*, 68(101648), 1-17. <https://doi.org/10.1016/j.chieco.2021.101648>
- Wickramasekera, R., & Bianchi, C. C. (2013). Management characteristics and the decision to internationalize: Exploration of exporters vs. non-exporters within the Chilean wine industry. *Journal of Wine Research*, 24(3), 195-209. <https://doi.org/10.1080/09571264.2013.795484>
- World Bank. (2017). *Enterprise surveys: Indicator descriptions*. WB. <https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/Indicator-Description.pdf>
- World Bank. (2024). *Enterprise surveys: Indicator descriptions*. WB. <https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/Indicator-Description.pdf>
- Yang, Y., & Mallick, S. (2010). Export premium, self-selection and learning-by-exporting: Evidence from Chinese matched firms. *The World Economy*, 33(10), 1218-1240. <https://doi.org/10.1111/j.1467-9701.2010.01277.x>
- Yasar, M., & Morrison-Paul, C. J. (2008). Foreign technology transfer and productivity: Evidence from a matched sample. *Journal of Business & Economic Statistics*, 26(1), 105-112. <https://doi.org/10.1198/073500107000000197>

- Yasar, M., & Rejesus, R. M. (2005). Exporting status and firm performance: Evidence from a matched sample. *Economics Letters*, 88(3), 397-402. <https://doi.org/10.1016/j.econlet.2005.05.001>
- Yasar, M., Garcia, P., Nelson, C. H., & Rejesus, R. M. (2007). Is there evidence of learning-by-exporting in Turkish manufacturing industries?. *International Review of Applied Economics*, 21(2), 293-305. <https://doi.org/10.1080/02692170701189193>
- Yasar, M., Nelson, C. H., & Rejesus, R. (2006). Productivity and exporting status of manufacturing firms: Evidence from quantile regressions. *Review of World Economics*, 142, 675-694. <https://doi.org/10.1007/s10290-006-0088-2>
- Yülek, M. A. (2018). *How nations succeed*. Palgrave Macmillan.

APPENDIX

Appendix 1. Causality Relationship from Productivity to Export and from Export to Productivity Based on Units: Granger Causality Test

No	Firm Code	Productivity → Export			Export → Productivity		
		Lag	Wald Statics	P-value	Lag	Wald Statics	P-value
1	ADEL	5	9.979	0.076	5	4.274	0.511
2	VESTL	5	8.159	0.148	5	4.929	0.425
3	VESBE	5	7.891	0.162	5	10.405	0.065
4	ULUSE	5	10.823	0.055	5	4.194	0.522
5	TTRAK	5	13.826	0.017	5	2.543	0.770
6	PRKAB	5	15.571	0.008	5	2.570	0.766
7	TMSN	5	13.511	0.019	5	8.978	0.110
8	TOASO	3	1.958	0.581	3	4.366	0.225
9	SILVR	5	7.891	0.162	5	14.927	0.011
10	SAYAS	4	4.873	0.301	4	11.494	0.022
11	PARSN	3	0.205	0.977	3	3.415	0.332
12	OTKAR	1	0.344	0.558	1	0.502	0.479
13	MAKTK	3	0.830	0.842	3	8.696	0.034
14	KLMSN	5	5.277	0.383	5	2.223	0.818
15	KATMR	1	0.511	0.475	1	0.464	0.496
16	KARSN	1	1.160	0.281	1	1.982	0.159
17	JANTS	1	0.397	0.529	1	0.682	0.409
18	IHEVA	1	1.267	0.260	1	0.431	0.511
19	GEREL	3	4.813	0.186	3	9.081	0.028
20	FROTO	1	2.310	0.129	1	0.060	0.806
21	FMIZP	5	17.335	0.004	5	5.550	0.352
22	EMKEL	3	4.097	0.251	3	15.232	0.002
23	EGEEN	3	6.928	0.074	3	10.544	0.014
24	DITAS	1	0.035	0.851	1	0.442	0.506
25	BFREN	1	0.228	0.633	1	0.964	0.326
26	BNTAS	1	0.315	0.574	1	1.970	0.160
27	ARCLK	2	6.882	0.032	2	1.266	0.531
28	ASUZU	2	4.675	0.097	2	0.841	0.657
29	ALCAR	1	0.068	0.795	1	1.453	0.228
30	TUCLK	1	0.049	0.825	1	0.184	0.668
31	SARKY	1	0.322	0.571	1	0.012	0.914
32	KRDMA	1	0.026	0.872	1	0.825	0.364
33	IZMDC	1	0.310	0.578	1	0.645	0.422
34	ISDMR	1	0.816	0.366	1	3.578	0.059
35	EREGL	1	0.586	0.444	1	12.085	0.001
36	ERBOS	1	0.353	0.552	1	6.155	0.013
37	DOKTA	1	0.360	0.548	1	10.849	0.001
38	DMSAS	1	0.019	0.890	1	7.126	0.008
39	CUSAN	3	5.668	0.129	3	6.282	0.099
40	CEMTS	4	6.437	0.169	4	9.546	0.049
41	CEMAS	5	9.736	0.083	5	14.257	0.014
42	CELHA	4	6.331	0.176	4	12.770	0.012
43	BURVA	5	12.708	0.026	5	10.185	0.070
44	BURCE	5	18.114	0.003	5	12.273	0.031
45	BRSAN	5	11.368	0.045	5	28.334	0.000
46	USAK	5	2.669	0.751	5	16.704	0.005
47	NUHCM	3	5.268	0.153	3	6.083	0.108
48	NIBAS	1	0.000	0.994	1	1.172	0.279
49	KUTPO	1	0.056	0.813	1	3.581	0.058
50	KONYA	2	3.464	0.177	2	3.723	0.155
51	GOLTS	1	0.425	0.514	1	0.525	0.469
52	EGSER	1	0.187	0.665	1	0.186	0.667
53	DOGUB	1	0.861	0.353	1	0.882	0.348
54	CIMSA	1	0.078	0.781	1	0.040	0.842
55	CMENT	1	1.129	0.288	1	1.156	0.282
56	CMBTN	1	0.837	0.360	1	0.921	0.337
57	BUCIM	2	4.787	0.091	2	3.019	0.221
58	BSOKE	3	7.440	0.059	3	5.086	0.166
59	BTCIM	5	14.340	0.014	5	6.072	0.299
60	AKCNS	4	18.260	0.001	4	1.026	0.906

61	AFYON	5	11.033	0.051	5	3.353	0.646
62	TUPRS	1	0.429	0.513	1	1.205	0.272
63	TMPOL	3	9.128	0.028	3	1.179	0.758
64	SEKUR	5	13.325	0.021	5	17.202	0.004
65	SASA	5	3.471	0.628	5	19.138	0.002
66	SANFM	2	0.639	0.727	2	5.933	0.051
67	RTALB	1	0.054	0.817	1	0.185	0.667
68	PETKM	1	0.009	0.926	1	0.188	0.664
69	MRSHL	1	0.010	0.919	1	0.087	0.768
70	HEKTS	1	0.078	0.780	1	0.030	0.862
71	GUBRF	1	0.009	0.923	1	0.158	0.691
72	GOODY	1	0.0302	0.858	1	0.651	0.420
73	GEDZA	1	0.869	0.351	1	0.700	0.403
74	EMNIS	1	0.087	0.768	1	0.141	0.707
75	EPLAS	1	0.059	0.808	1	0.007	0.935
76	EGPRO	1	0.206	0.650	1	0.767	0.381
77	EGGUB	1	0.765	0.382	1	0.324	0.569
78	DYOBY	1	0.217	0.641	1	0.005	0.944
79	DEVA	2	1.707	0.426	2	0.537	0.765
80	BRISA	1	0.623	0.430	1	0.029	0.865
81	BRKSN	1	0.027	0.868	1	0.308	0.579
82	BAGFS	1	0.333	0.564	1	0.114	0.735
83	AYGAZ	1	0.778	0.378	1	0.043	0.835
84	ALKIM	1	1.055	0.304	1	0.729	0.393
85	AKSA	1	0.904	0.342	1	2.090	0.148
86	ACSEL	1	2.151	0.143	1	0.566	0.452
87	VKING	1	0.715	0.398	1	0.986	0.321
88	SAMAT	1	0.763	0.382	1	2.157	0.142
89	PRZMA	1	0.788	0.375	1	10.212	0.001
90	MNDTR	2	6.745	0.034	2	5.088	0.079
91	KARTN	1	2.854	0.091	1	2.566	0.109
92	KAPLM	5	10.207	0.070	5	16.060	0.007
93	DURDO	1	7.886	0.005	1	2.095	0.148
94	BAKAB	1	7.860	0.005	1	3.404	0.065
95	ALKA	3	8.049	0.045	3	7.891	0.048
96	GENTS	2	4.219	0.121	2	6.963	0.031
97	DGNMO	2	5.236	0.073	2	7.586	0.023
98	YUNSA	4	4.582	0.333	4	15.404	0.004
99	YATAS	3	8.978	0.030	3	6.571	0.087
100	SNPAM	1	2.202	0.138	1	0.845	0.358
101	SKTAS	1	2.171	0.141	1	3.277	0.070
102	ROYAL	4	6.987	0.137	4	15.259	0.004
103	MNDRS	1	0.424	0.515	1	1.131	0.287
104	LUKSK	1	0.142	0.706	1	3.459	0.063
105	KORDS	1	0.380	0.538	1	4.792	0.029
106	KRTEK	1	0.039	0.844	1	2.280	0.131
107	HATEK	1	0.033	0.856	1	3.088	0.079
108	DESA	1	0.239	0.625	1	0.662	0.416
109	DERIM	1	0.015	0.903	1	3.298	0.069
110	DAGI	4	13.496	0.009	4	2.733	0.604
111	BOSSA	5	25.179	0.000	5	5.609	0.346
112	BRMEN	4	13.905	0.008	4	4.801	0.308
113	BRKO	4	21.370	0.000	4	8.534	0.074
114	BLCYT	5	39.880	0.000	5	3.874	0.568
115	ARSAN	5	45.788	0.000	5	10.137	0.071
116	ATEKS	5	9.417	0.094	5	8.740	0.120
117	ULKER	4	13.382	0.010	4	8.088	0.088
118	ULUUN	5	30.802	0.000	5	4.119	0.532
119	TBORG	3	13.026	0.005	3	6.666	0.083
120	TUKAS	3	6.542	0.088	3	4.609	0.203
121	TATGD	2	10.360	0.006	2	6.039	0.049
122	SELGD	4	4.934	0.294	4	8.260	0.083
123	PNSUT	1	0.005	0.941	1	0.102	0.750
124	PINSU	2	8.057	0.018	2	0.304	0.859
125	PETUN	4	8.983	0.062	4	10.943	0.027
126	PENGD	1	0.143	0.706	1	6.151	0.013
127	OYLUM	1	1.244	0.265	1	0.444	0.505
128	KRSTL	1	2.675	0.102	1	0.326	0.568
129	KNFRT	2	10.111	0.006	2	1.539	0.463
130	KERVIT	4	7.833	0.098	4	7.658	0.105
131	KENT	4	2.822	0.588	4	11.748	0.019
132	FRIGO	4	8.645	0.071	4	9.545	0.049
133	ERSU	4	18.581	0.001	4	19.298	0.001
134	EKIZ	5	4.372	0.497	5	38.170	0.000
135	DARDL	5	14.529	0.013	5	15.588	0.008
136	CCOLA	5	2.391	0.793	5	11.809	0.037
137	BANVT	4	1.684	0.794	4	9.442	0.051
138	AVOD	4	0.431	0.980	4	12.353	0.015
139	AEFES	1	4.499	0.034	1	0.138	0.710

Panel Fisher= 599.009
Asymptotic p-value=0.000
Bootstrap p-value= 0.000

Panel Fisher= 612.234
Asymptotic p-value= 0.000
Bootstrap p-value= 0.000

Redefining Financial Manipulation Detection: A New Model's Performance Against the M-Score *

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Abstract

Financial manipulation negatively affects market participants. Therefore, various techniques are developed to detect manipulation. One of the most widely used techniques in the literature is the M-score. The study investigates whether the M-score is an effective model across different periods and aims to provide perspective to researchers and market players. In this study, we developed a model to detect financial manipulation. We compared our model results with the M-score results. In the study, we first scanned the US Securities and Exchange Commission's "Accounting and Auditing Practice Bulletins" and identified fifty-one companies (red flags) from the reports. Then, we calculated some ratios from the financial reports of these companies (red flags) and companies with control variables and created the prediction model. The results show that the success of the created manipulation prediction model is eighty-three per cent. The M-score results are lower. The model in the study is the most up-to-date model with many explanatory variables to detect financial manipulation. The study showed that established manipulation detection models may lose effectiveness over time, and the effects of the variables in the model may change. Therefore, the study offers a novel perspective to the literature. In future studies, researchers could investigate how imbalances in the proportion of "1" versus "0" observations affect the detection model.

Keywords: *Financial statements, Financial fraud, USA, Logistic regression analysis, M-score.*

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Research Article	December 24, 2024	March 25, 2025

1. INTRODUCTION

Financial statements are prepared to fairly present a company's financial position, operational performance, and cash flows. These reports play a critical role in the financial decision-making process. Shareholders, investors, creditors, and government agencies base their financial decisions on the information in these statements. Therefore, ensuring the reliability of financial reporting standards is of great importance.

Accounting fraud involves intentionally misrepresenting financial statements or illegal acts that directly affect financial disclosures. It is usually committed by corporate executives who fraudulently present financial information (Guy & Pany, 1997). Beasley et al. (2010) define accounting fraud as intentionally misrepresenting financial statements or disclosures. These fraudulent activities may have different motivations but always lead to significant negative consequences (Brennan & Hennessey, 2001).

According to the Association of Certified Fraud Examiners (ACFE), financial statement fraud is the least common globally, accounting for only 10% of detected cases. However, it is the costliest form of fraud when it does occur. Financial fraud is often complex and challenging to detect in advance. Notable examples include fraudulent financial reporting by companies such as Enron, WorldCom, Xerox, Qwest, Tyco, HealthSouth, and Cendant (Kedia & Philippon, 2009).

Since the late 20th century, various methods have been developed to detect such fraudulent activities. Pioneering studies in this area include Healy's (1985) study of manipulations used by corporate executives to obtain incentive bonuses, DeAngelo's (1986) examination of financial manipulations through discretionary accruals during stock buybacks, and Jones's (1991) analysis of profit manipulations by companies seeking to benefit from import discounts. Additionally, Barton and Simko (2002) analyzed changes in net operating items to detect balance sheet manipulations, while Beneish (1997, 1999) used accruals and financial ratios (known collectively as the M-score) to detect fraudulent reporting.

Many studies have developed financial fraud detection models (Beasley, 1996; Persons, 1995; Spathis, 2002; Küçükkocaoğlu & Küçüksözen, 2005; Aprillia, 2011; Dechow et al., 2011; Perols & Lougee, 2011; Ujal et al. 2012; Amara et al., 2013; Kanapickiene & Grundiene, 2015; Lin et al., 2015; Zainuddin & Hashim, 2016; Hajek & Henriques, 2017; Hung et al., 2017; Ravenda et al., 2018; Song et al., 2018; Tran et al., 2018; Situngkir & Triyanto, 2020; Çağlak & Çakır, 2024). However, the model results in these studies have not been compared with the M-score results. Some studies in the literature aim to detect firms that engage in manipulation by using the M-score equation rather than developing a new detection model (Matsumura & Tucker, 1992; Küçükkocaoğlu et al., 2007; Bekçi & Avğarlıgil 2011, Aris et al., 2013; Kara et al., 2015; Mahama, 2015; Hasan et al., 2017; Herawati & Tarjo, 2017; Erdoğan & Erdoğan, 2020; Halilbegovic et al., 2020; Lehenchuk et al., 2020; Demetriades & Owusu-

Agyei, 2022). This study developed a financial fraud detection model using financial statement data of companies traded on the US stock exchanges. The estimation results of this model were compared with the M-score results to fill a gap in the literature. The findings provide insights to investors, creditors, and researchers in detecting financial statement fraud.

The contribution of this study to the literature is that it includes more financial variables than existing models and compares the model results with the M-score results. Therefore, this research brings a new perspective to the field. Future studies can be conducted with an alternative dataset that includes the financial ratios of bankrupt companies withdrawn from the stock exchange or traded in the OTC market. In this way, it will contribute to the literature by eliminating the limitations stated in the dataset.

2. METHODOLOGY

2.1. Econometric Model

Classical regression techniques are not appropriate when the dependent variable is categorical (e.g., 0 or 1). Instead, the Logistic regression method should be used. The logistic regression method is a decision-making tool in many fields, such as medicine, engineering and social sciences. This technique is a regression method that allows for the separation and assigning of sample groups. The fact that it is an analysis that does not require normal distribution and continuity assumptions increases the ease of application of this technique. The accumulated model reveals which class the data groups should belong to according to specific probabilities. The coefficient obtained by the model is classified using the threshold value. If the company's coefficient accumulated with the help of the model is greater than the threshold value, that company is considered a company that has been manipulated. If the coefficient is less than the threshold value, it is concluded that the company does not manipulate.

In the logistic regression equation, the odds ratio is calculated as follows:

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} = e^{\beta_1+\beta_2X_i} \quad (1)$$

In logistic regression, the probability of an event not occurring (0) and the probability of it occurring (1) must be calculated. In order to obtain a linear equation, its logarithm must be taken. (that is why it is called the logit model) The final form of the equation is created as follows:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i \rightarrow \beta_1 + \beta_2X_i \quad (2)$$

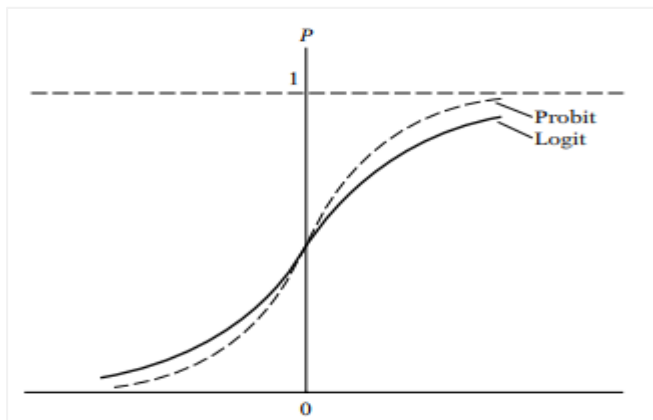
The log of the odds ratio, L , is linear in X and (in terms of prediction) linear in the parameters. L is called logit. Therefore, models such as L_i are called the logit models (Gujarati & Porter, 2009).

As P goes from 0 to 1 (Z changes from $-\infty$ to $+\infty$), the logit L goes from $-\infty$ to $+\infty$. Although the probabilities are (necessarily) between 0 and 1, logits are not that limited. Although L is linear in X , the probabilities themselves are nonlinear. This contrasts with the Linear Probability Model (LPM) model as probabilities move linearly with X . However, we only included a single X variable or regressor

in the previous model as many regressors as required by the underlying theory can be added. Let us assume that L (logit) is optimistic. In this case, this means that the probability of the regressor being equal to 1 (meaning a relevant event has occurred) increases as the value of the regressor/regressor increases. If L is negative, the probability of the regressor equaling one decreases as the value of X increases. In other words, as the odds ratio decreases from 1 to 0, the logit becomes negative and gradually increases. As the odds ratio increases from 1 to infinity, the logit becomes increasingly significant and positive (Hosmer & Lemeshow, 1989). For the logit model in $L_i: \beta_2$, the slope measures the change in L for one unit change in X . While LPM is linearly related to P_i and X_i , in the logit model, it is assumed that the log of the odds ratio is linearly related to X_i (Gujarati & Porter, 2009).

Logit and probit are similar for most practical applications. The main difference is that P_i approaches zero or one more slowly in the logit model than in the probit model, as seen in Figure 1. That is, the logistic distribution has slightly thicker tails. Many researchers choose the logit model in practice due to its mathematical simplicity.

Figure 1. Logit and Probit Cumulative Distributions



Source: Authors' own creation.

In this study, the Binary Logistic Regression method was used to test the presence (coded as "1") or absence (coded as "0") of financial manipulation.

2.2. Sample Selection and Data Processing

Bulletins of companies on the US stock exchanges published between 2009 and 2019 were scanned to select the companies. Subsequently, errors, frauds and irregularities in previous financial reports were identified through detailed examination.

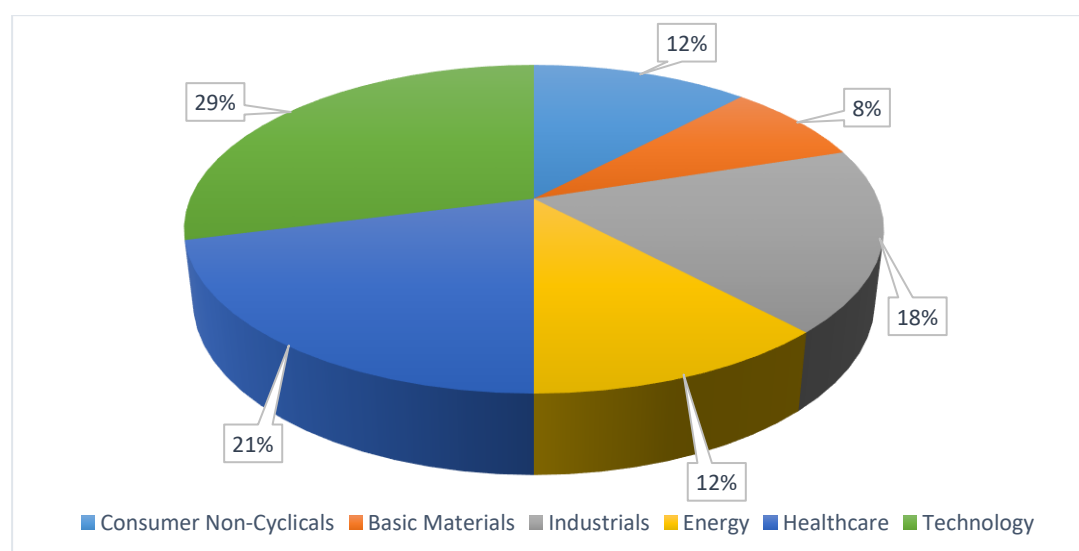
The bulletins (from AAER_3094 to AAER_4200) of companies subject to accounting enforcement actions by the Securities and Exchange Commission (SEC) using Accounting and Auditing Enforcement Releases (AAERs) published between 2009 and 2019 were scanned in the USA. Subsequently, errors, frauds and irregularities in previous financial reports were tried to be detected through detailed examination. 180 bulletins containing manipulation were identified. 159 of the releases

included manipulations regarding financial reports. Among the companies that engage in financial manipulation, 51 companies whose financial statements can be accessed and are not included in Over the Counter Markets (OTC) were included in the sample. Financial reports of 51 companies in the same sector and with similar asset sizes were used as a control group for these companies.

In the analysis, companies that manipulate the dependent variable will be included as "1" (red flag), and companies selected as control variables will be included as "0" (green flag). Companies that should have been included in the sample but whose financial statements needed to be improved (bankruptcy, delisting, being placed in the custody market, etc.) were excluded from the analysis. In addition, although there are studies on the financial manipulations of banks (Fratrič et al., 2022; Li et al., 2022), banks, insurance companies, and intermediary institutions were excluded from the sample due to different financial reporting techniques. Financial reports of the companies in the sample were obtained from ROIC.ai. (n.d.) and Securities and Exchange Commission (2009) 10-K reports. Independent variable ratios were calculated from these reports.

Of the companies that engage in financial manipulation (red flag), 29% are technology companies, and 21% are healthcare sector companies. Some examples in AAER bulletins are as follows: He committed irregularities by paying bribes to the authorities of the countries in question while obtaining operating permits for health sector companies and recording these bribes as education expenses. Companies such as technology and energy make fictitious sales through subsidiaries in different countries or make manipulations through bribes in tender purchases, which frequently encounter manipulations. Supervisory authorities took penal actions for these manipulations.

Figure 2. Sectoral Distribution of Manipulating Companies (Red Flag)



Source: Authors' own creation.

3. EMPIRICAL RESULTS AND DISCUSSION

Eight of the ratios in the analysis (DSRI, GMI, AQI, DEPI, SGAI, ACR, SGI, LVGI) are the variables used by Beneish (1999). In addition, twenty-one different ratios are independent variables with the ratios added from the literature.

For analysis, the data set consists of the ratios calculated from the companies' financial reports using the formulas in Table 1. This data set is divided into "training data" and "test data".

Table 1. Ratios and Formulas to Be Used in the Analysis

Days' sales in receivables index (DSRI)	$\frac{\text{Account Receivable}_t / \text{Sales}_t}{\text{Account Receivable}_{t-1} / \text{Sales}_{t-1}}$
Gross margin index (GMI)	$\frac{\text{Sales} - \text{Cost of goods sold}_{t-1} / \text{Sales}_{t-1}}{\text{Sales} - \text{Cost of goods sold}_t / \text{Sales}_t}$
Asset quality index (AQI)	$\frac{(1 - \text{Current assets.} + \text{PPandE})_t / \text{Total assets}_t}{(1 - \text{Current assets.} + \text{PP\&E})_{t-1} / \text{Total assets}_{t-1}}$
Depreciation index (DEPI)	$\frac{\text{Depreciation}_{t-1} / (\text{Depreciation} + \text{PP\&E})_{t-1}}{\text{Depreciation}_t / (\text{Depreciation} + \text{PP\&E})_t}$
Sales, general, and administrative expenses index (SGAI)	$\frac{(\text{Sales, general, and administrative expense})_{t-1} / \text{Sales}_{t-1}}{(\text{Sales, general, and administrative expense})_t / \text{Sales}_t}$
Total accruals to total asset (TATA)	$\frac{\text{Operation income} - \text{Cash Provided by Operating Activities}}{\text{Total assets}}$
Sales growth index (SGI)	$\frac{\text{Sales}_t}{\text{Sales}_{t-1}}$
Leverage index (LVGI)	$\frac{\text{Current Liabilities} + \text{non} - \text{Current Liabilities}_t / \text{Total assets}_t}{\text{Current Liabilities} + \text{non} - \text{Current Liabilities}_{t-1} / \text{Total assets}_{t-1}}$
Financial Expenses/ Operating Expenses	$\frac{\text{Financial Expense}}{\text{Total operation expense}}$
EBIDTA/Financial Expenses	$\frac{\text{EBIDTA}}{\text{Financial expenses}}$
Current Ratio	$\frac{\text{Total current assets}}{\text{Total current liabilities}}$
Acid-Test ratio	$\frac{\text{Total current assets} - \text{Inventory}}{\text{Total current liabilities}}$
Leverage ratio	$\frac{\text{Current Liabilities} + \text{non} - \text{Current Liabilities}}{\text{Total assets}}$

Table 1 (cont.)

Equity to Dept (E/D)	$\frac{\text{Total Shareholders Equity}}{\text{Total Dept}}$
ROA	$\frac{\text{Net Profit}}{\text{Total Assets}}$
ROE	$\frac{\text{Net Profit}}{\text{Equity}}$
Commercial receivable/net sales	$\frac{\text{Commercial receivable}}{\text{Net Sales}}$
Gross Profit/ Net Sales Ratio	$\frac{\text{Gross Profit}}{\text{Net Sales}}$
Other Assets/Total Assets	$\frac{\text{Other Assets}}{\text{Total Assets}}$
Accumulated Depreciation ratio (ADR)	$\frac{\text{Depreciation}}{(\text{Depreciation} + \text{PP\&E})}$
Operating Expenses/Revenue	$\frac{\text{Operating Expenses}}{\text{Revenue}}$

Source: Authors' own creation.

For analysis, it is necessary to look at the data structure and whether there is a correlation between the data. In this respect, firstly, the descriptive statistics of the independent variables were calculated for the companies that manipulated the data set and the control variables. In this context, the descriptive statistics of the data set are in Table 2.

Table 2. Descriptive Statistics

		Mean	Median	Std Dev.	Min.	Max.	Total	Number
<i>DSRI</i>	1	1.19	1.03	0.71	0.34	4.37	60.46	51
	0	3.81	1.02	19.32	139.03	0.12	194.31	51
<i>GMI</i>	1	1.07	1.01	0.42	-0.26	3.40	54.32	51
	0	1.18	1.01	0.75	5.89	0.50	60.20	51
<i>AQI</i>	1	1.33	1.00	1.55	0.14	11.38	68.05	51
	0	1.04	1.01	0.41	2.49	-0.72	52.98	51
<i>SGI</i>	1	1.13	1.07	0.41	0.49	3.22	57.46	51
	0	1.08	1.05	0.42	3.07	0.02	54.96	51
<i>DEPI</i>	1	1.06	0.99	0.49	0.29	3.63	54.22	51
	0	1.95	1.02	5.14	37.11	0.61	99.40	51
<i>SGAI</i>	1	0.95	1.01	1.03	-5.63	2.57	48.51	51
	0	1.28	1.02	1.84	13.87	0.06	65.48	51
<i>LVGI</i>	1	1.12	1.01	0.61	0.12	5.04	56.93	51
	0	1.10	0.98	0.48	4.00	0.73	56.33	51
<i>ACR(TATA)</i>	1	-0.03	0.00	0.18	-1.19	0.23	-1.50	51
	0	-0.02	-0.01	0.09	0.17	-0.48	-0.89	51

Table 2 (cont.)

		Mean	Median	Std Dev.	Min.	Max.	Total	Number
Current Ratio	1	2.48	2.12	1.42	0.30	6.27	126.53	51
	0	2.63	2.38	1.55	6.67	0.76	133.99	51
Acid-Test Ratio	1	1.85	1.48	1.30	0.28	6.24	94.24	51
	0	2.07	1.78	1.34	6.04	0.07	105.42	51
Leverage Ratio	1	0.57	0.53	0.35	0.14	2.44	28.83	51
	0	0.49	0.48	0.25	1.17	0.08	24.99	51
Equity to Dept (E/D)	1	1.29	0.90	1.37	-0.59	6.16	65.92	51
	0	1.96	1.07	2.50	11.04	-0.19	99.73	51
EBITDA/Financial Expenses	1	453577.74	15.31	3230043	-246.58	23068387	23132465	51
	0	16.28	13.34	250.20	632.01	-1381.00	830.05	51
Financial Expense Ratio	1	0.16	0.04	0.46	-1.25	1.98	8.12	51
	0	0.14	0.08	0.16	0.56	-0.10	7.39	51
ROA	1	-0.02	0.06	0.41	-2.80	0.28	-1.02	51
	0	0.06	0.07	0.12	0.33	-0.49	3.04	51
ROE	1	0.15	0.12	0.36	-0.70	1.94	7.73	51
	0	0.23	0.13	0.66	3.48	-1.77	11.48	51
Account Receivable/Revenue	1	0.69	0.19	3.52	0.01	25.33	35.33	51
	0	0.45	0.15	2.16	15.58	0.00	22.91	51
Gross profit/net income	1	1.02	0.12	6.78	-1.93	48.47	52.25	51
	0	0.18	0.19	0.22	0.73	-0.81	9.43	51
Other assets/total assets	1	0.29	0.26	0.18	0.01	0.61	14.62	51
	0	0.28	0.21	0.21	0.80	0.02	14.24	51
Accumulated Depreciation ratio (ADR)	1	0.18	0.14	0.19	0.00	1.00	9.40	51
	0	0.22	0.18	0.22	0.99	0.00	11.14	51
Operation expense/Revenue	1	0.18	0.18	0.38	-2.18	1.03	9.01	51
	0	0.44	0.17	1.56	11.23	0.01	22.60	51

Source: Authors' own creation.

Table 2 shows that there are extreme values in the interest-earning variable. This situation is because the ratio is calculated as EBITDA/financing expenses. The interest earned reaches high values in companies with very low or no financing expenses.

In addition to descriptive statistics, the correlation relationship between variables before building the model is in the correlation table in Table 3.

Table 3. Correlation Matrix

	DSRI	GMI	AQI	SGI	DEPI	SGAI	LVGI	ACR	CR	ATR	LR	E/D	EBITDA/Fin. Exp.	FER	ROA	ROE	Acc. Rec./Rev.	G. Profit/ Net Inc.	Other Assets/Tot. Assets	ADR	Oper. Exp./ Revenue
DSRI	1																				
GMI	0.79	1																			
AQI	-0.17	-0.16	1																		
SGI	-0.27	-0.19	0.20	1																	
DEPI	0.19	0.12	-0.08	-0.04	1																
SGAI	0.85	0.66	-0.13	-0.21	0.18	1															
LVGI	0.55	0.37	-0.08	-0.32	0.09	0.16	1														
ACR	0.02	-0.10	-0.06	-0.26	0.05	0.02	0.00	1													
Current Ratio(C/R)	0.28	0.21	-0.09	-0.03	0.14	0.31	0.13	0.13	1												
Acid-Test Ratio (ATR)	0.26	0.23	-0.15	-0.03	0.07	0.28	0.16	0.05	0.90	1											
Leverage Ratio (LR)	0.01	0.09	-0.01	0.31	-0.02	-0.03	-0.07	-0.53	-0.47	-0.42	1										
Equity to Debt(E/D)	-0.04	0.00	0.00	-0.10	-0.03	0.00	0.08	0.04	0.54	0.54	-0.64	1									
EBITDA/ Financial Expenses	-0.01	-0.02	-0.02	0.00	-0.03	-0.01	0.03	0.04	0.15	0.16	-0.06	-0.03	1								
Financial Expense Ratio (FER)	-0.04	0.01	0.01	0.24	0.06	0.08	-0.39	0.08	0.07	0.15	0.08	0.05	-0.04	1							
ROA	0.00	-0.09	-0.10	-0.47	0.05	0.04	0.06	0.64	0.11	0.08	-0.66	0.18	0.03	-0.05	1						
ROE	-0.04	-0.10	0.04	0.21	0.01	-0.03	-0.04	-0.39	-0.10	-0.04	0.42	0.00	0.00	0.00	-0.29	1					
Account Receivable/ Revenue	0.53	0.34	-0.13	-0.26	0.10	0.06	0.89	0.00	0.08	0.08	0.01	-0.01	-0.01	-0.36	0.02	-0.02	1				
Gross Profit/ Net Income	0.00	-0.09	-0.04	-0.16	0.00	-0.46	0.72	-0.01	-0.09	-0.08	-0.01	0.00	-0.01	-0.40	0.05	0.00	0.85	1			
Other Assets/ Total Assets	-0.11	0.04	-0.03	-0.04	-0.12	-0.07	-0.09	0.08	-0.16	-0.07	-0.08	0.14	-0.03	-0.07	0.12	-0.04	-0.13	-0.08	1		
ADR	-0.10	0.01	-0.10	-0.01	-0.13	-0.06	-0.01	-0.09	0.09	0.15	0.11	-0.08	-0.07	-0.09	-0.11	0.22	-0.12	-0.08	0.21	1	
Operation Expense/ Revenue	0.96	0.77	-0.18	-0.20	0.17	0.93	0.36	-0.02	0.32	0.30	0.03	-0.04	0.01	0.00	-0.05	0.02	0.32	-0.23	-0.07	-0.03	1

Source: Authors' own creation.

When the correlation table is examined, it is seen that there is a very high positive correlation between operation expense/revenue/revenue/revenue and SGAI and DSRI. In addition, there is a robust positive correlation between operating accounts receivable/revenue and LVGI and gross profit/net income and between operation expense/revenue/revenue and trade receivables index (DSRI) and operating expense index (SGAI). Therefore, while establishing the model, care was taken to ensure that these variables were not included in the model simultaneously.

A total of 51 manipulation companies in the sample and 51 non-manipulation companies were selected as a match for these companies, and they were separated as training and test data. 39 manipulation companies and their equivalent 39 control variable companies, a total of 78 companies (77% of the total data set), were determined as the training set. For the test data set, 24 companies (23% of the total data set) were chosen, including 12 manipulation companies and 12 matched control variable companies.

Table 4. Logistic Regression Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Exp(B)
GMI	-2.233	1.037	2.558	0.031**	0.107
ACR(TATA)	5.347	4.199	3.275	0.203	210.052
Leverage Ratio (LR)	-2.008	1.178	3.907	0.088***	0.134
Equity to Dept(E/D)	-0.675	0.268	3.262	0.012**	0.509
EBITDA/Financial Expenses	0.003	0.001	5.833	0.016**	1.003
ROA	-5.101	2.407	3.159	0.034**	0.006
Account Receivable/Revenue	10.191	3.939	7.647	0.010*	266.090
Other Assets/Total Assets	4.489	1.799	6.231	0.013**	89.068
Constant	1.046	1.529	0.468	0.494	2.846
Prob (LR statistic)	0.0000	Obs with Dep=0 Obs with Dep=1 Total obs	39 39 78		

* Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level. (The “Backward: Conditional” method was used in logistic regression.)

Table 5. Model Fitting Information

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	66.431	0.414	0.552
13	72.016	0.371	0.494

The R² of the model created using the training data set is approximately 50%. As for the model variables, seven variables are significant, except the ratio of total accruals to total assets (ACR). The equation obtained from the analysis is as follows:

$$g(x) = 1.046 - 2.233 \cdot \text{GMI} + 5.347 \cdot \text{ACR} - 2.008 \cdot \text{LR} - 0.675 \cdot (\text{E/D}) + 0.003 \cdot (\text{EBITDA/Financial Expenses}) - 5.101 \cdot \text{ROA} + 10.191 \cdot (\text{Account Receivable/Revenue}) + 4.489 \cdot (\text{Other Assets/Total Assets}) \quad (3)$$

The probability equation to be used to determine the possibility of financial manipulation is formulated as follows:

$$P(x) = 1 / 1 + \text{Exp} (1.046 - 2.233 \cdot \text{GMI} + 5.347 \cdot \text{ACR} - 2.008 \cdot \text{LR} - 0.675 \cdot (\text{E/D}) + 0.003 \cdot (\text{EBITDA/Financial Expenses}) - 5.101 \cdot \text{ROA} + 10.191 \cdot (\text{Account Receivable/Revenue}) + 4.489 \cdot (\text{Other Assets/Total Assets})) \quad (4)$$

P is the probability of fraud in financial statements (ranging from 0 to 1). The P value is interpreted according to a threshold value. Since a matched sample was used in the study, the threshold value is 50%. If $P > 0.5$, the financial statements are fraudulent; If $P < 0.5$, the financial statements are not fraudulent.

The companies were classified by typing the ratios of the companies selected for the probability equation training data. Using this classification, the model has predictive power for companies that engage in manipulation, as reported in Table 6.

Table 6. Strength of Models Used for Training Data

Estimate						Success
New Model	Observation		0	1	Total	%
		0	31	8	39	79.5 %
		1	7	32	39	82.1 %
		Total	38	40	78	79.2%
M-Score	Observation	0	25	14	39	64.1 %
		1	22	17	39	43.5 %
		Total	47	31	78	53.8 %

Source: Authors' own creation.

The model's power to differentiate the training data set companies was tested. The results show that the power to distinguish companies that do or do not manipulate is around 80%. This rate is higher than the discrimination power of the M-score, which is widely used in literature. The model's power to discriminate the companies in the test data set is in Table 7.

Table 7. Strength of Models Used for Test Data

		Estimate			Success	
New Model	Observation	0	1	Total	%	
		0	11	1	12	91.6 %
		1	3	9	12	75 %
		Total	14	10	24	83.3%
M-Score	Observation	0	8	4	12	66.7 %
		1	8	4	12	33.3 %
		Total	16	8	24	50 %

Source: Authors' own creation.

In the test data, 20 out of 24 companies were correctly classified as manipulating or non-manipulating. Only four companies were incorrectly classified. These results show that the model has 83% correct classification power. With the M-score, for the same companies, 66.7% of the companies that did not manipulate were correctly predicted, while 33.3% of the companies that manipulated were correctly predicted. The probability of Type 1 error (i.e., falsely identifying manipulation) is high in the M-score results. Furthermore, the new model's predictive accuracy surpasses that reported in previous logistic regression studies (Beasley, 1996; Persons, 1995; Dechow et al., 2011; Ujal et al., 2012; Kanapickiene & Grundiene, 2015; Lin et al., 2015; Zainuddin & Hashim, 2016; Hajek & Henriques, 2017).

4. CONCLUSION

In the literature on financial manipulation, studies based on accrual and earnings management are concentrated. This study detected manipulation in accrual and earnings management ratios and bankruptcy and efficiency ratios.

In this study, the performance of a new logistic regression model developed to detect manipulation in financial statements was evaluated and compared with the M-score, which is widely used in the literature. The findings show that the model successfully distinguishes between manipulating

and non-manipulating companies in the training and test data sets. The estimation model variables are AGMI, ACR (TATA), Leverage Ratio (LR), Equity/Debt (E/D), EBITDA/Financial Expenses, ROA, Account Receivables/Revenue, Other Assets/Total Assets. The model classified companies that did not manipulate the training data set at 79.5% accuracy and manipulating companies at 82.1%. The overall accuracy rate of the model was calculated as 79.2%. These results show that the model has a high discrimination power when detecting manipulation. Because the model is developed using the training dataset, evaluating its performance on a separate test dataset offers more objective validation. In the test dataset, the model classified non-manipulating companies with 91.6% accuracy and manipulating companies with 75% accuracy. The overall accuracy rate of the model was calculated as 83.3%. These results show that the model has a high generalization ability and performs consistently on different datasets. To understand the consistency of the model, we estimated the same dataset with the M-score. As a result, the training dataset classified non-manipulating companies with 64.1% accuracy and manipulating companies with 43.5% accuracy. The test dataset calculated the M-score accuracy rate as 66.7% for non-manipulating companies and 33.3% for manipulating companies. These results show that the M-score is particularly weak in detecting manipulating companies and that Type 1 errors (false positives) are high.

The new model in this study has a higher success rate than the M-score in detecting companies that do and do not engage in financial manipulation. Indeed, studies by Ramírez-Orellana et al., (2017), Mehta and Bhavani (2017), Lotfi and Chadegani (2017), Halilbegovic et al. (2020), Svabova et al. (2020) and Benligiray and Onay (2021) also show that the M-score is insufficient to detect manipulation in different country samples. In addition to these studies, the new model offers a more comprehensive analysis process instead of focusing only on the threshold value. In addition to providing higher accuracy rates on data sets, the model is more resistant and compatible with changing financial manipulation techniques. Hence, it eliminates the shortcomings of traditional methods and offers a more reliable and effective approach to detect manipulation.

The model could be a reliable tool for investors, creditors, and monetary authorities in assessing the risk of financial manipulation. In particular, the ability to detect manipulation using only two years of financial data (SEC 10-K reports) increases the practical applicability of the model. Limitations of the model include excluding companies from specific sectors, such as banks, insurance companies, and brokerage firms, from the analysis. In addition, the model did not use the financial ratios of bankrupt companies, companies that have exited the stock exchange, and companies in the OTC market. These limitations may affect the general validity of the model.

Future studies can be conducted with an alternative dataset that includes the financial ratios of bankrupt companies that have withdrawn from the stock exchange or are traded in the OTC market. It is also recommended that the model be tested on companies from different sectors and with other financial structures.

In conclusion, this study has significantly contributed to the literature on financial manipulation detection. The developed logistic regression model can be an effective tool in economic analysis and auditing processes with its high accuracy rate and practical applicability. However, future research should test and address the model's limitations using a more comprehensive dataset.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

REFERENCES

- Amara, I., Amar, A. B., & Jarboui, A. (2013). Detection of fraud in financial statements: French companies as a case study. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 3(3), 0-51. <https://doi.org/10.6007/IJARAFMS/v3-i3/34>
- Aris, N. A., Othman, R., Arif, S. M. M., Malek, M. A. A., & Omar, N. (2013). Fraud detection: Benford's law vs Beneish model. *In IEEE Symposium on Humanities, Science and Engineering Research*, (June), 726-731.
- Barton, J., & Simko, P. J. (2002). The balance sheet as an earnings management constraint. *The accounting review*, 77(1), 1-27. <https://doi.org/10.2308/accr.2002.77.s-1.1>
- Beasley, M.S., (1996). An empirical analysis of the relation between board of director composition and financial statement fraud, *Accounting Review*, 71(4), 443-65.
- Beasley, M. S., Hermanson, D. R., Carcello, J. V., & Neal, T. L. (2010). *Fraudulent financial reporting: 1998-2007: An analysis of US public companies*. American Institute of Certified Public Accountants. https://egrove.olemiss.edu/cgi/viewcontent.cgi?article=1534&context=aicpa_assoc
- Bekçi, İ., & Avşarlıgil, N. (2011). Finansal bilgi manipülasyonu yöntemlerinden yaratıcı muhasebe ve bir uygulama. *World of Accounting Science*, 13(2), 133-162.
- Benligiray, S., & Onay, A. (2021). Kazanç manipülasyonu tespit modellerinin Borsa İstanbul şirketlerinde test edilmesi. *Muhasebe ve Denetim Bakış*, 21(64), 179-204.
- Beneish, M. D., (1997). Detecting GAAP violation: Implications for assessing earnings management among firms with extreme financial performance. *Journal of Accounting and Public Policy*, 16(3), 271-309. [https://doi.org/10.1016/S0278-4254\(97\)00023-9](https://doi.org/10.1016/S0278-4254(97)00023-9)
- Beneish, M. D., (1999). The detection of earnings manipulation. *Financial Analysts Journal*, 55(5), 24-36. <https://doi.org/10.2469/faj.v55.n5.2296>
- Brennan, N., & Hennessy J. (2001). *Forensic accounting*. Round Hall Sweet & Maxwell.
- Çağlak, E., & Çakır, H. M. (2024). Türkiye’de finansal bilgi manipülasyonun tespit ve tahmini ile ilgili ampirik çalışma. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 17(1), 130-157. <https://doi.org/10.25287/ohuibf.1325130>
- DeAngelo, L. (1986). Accounting numbers as market valuation substitutes: A study of management buyouts of public stockholders. *The Accounting Review*, 6(1), 400-420.

- Dechow, P. M., Ge, W., Larson, C. R., & Sloan, R. G. (2011). Predicting material accounting misstatements. *Contemporary Accounting Research*, 28(1), 17–82. <https://doi.org/10.1111/j.1911-3846.2010.01041.x>
- Demetriades, P., & Owusu-Agyei, S. (2022). Fraudulent financial reporting: An application of fraud diamond to Toshiba's accounting scandal. *Journal of Financial Crime*, 29(2), 729-763. <https://doi.org/10.1108/JFC-05-2021-0108>
- Erdoğan, M., & Erdoğan, E. O. (2020). Financial statement manipulation: A Beneish model application. In *Contemporary Issues in Audit Management and Forensic Accounting* (pp. 173-188). Emerald Publishing Limited. <https://doi.org/10.1108/S1569-375920200000102014>
- Fratrič, P., Sileno, G., Klous, S., & van Engers, T. (2022). Manipulation of the Bitcoin market: An agent-based study. *Financial Innovation*, 8(1), 60. <https://doi.org/10.1186/s40854-022-00364-3>
- Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics*. McGraw-Hill/Irwin.
- Guy, D. M., & Pany, K. (1997). *Fraud in a financial statement audit* Online unter. <https://www.aicpa-cima.com/home>.
- Hajek, P., & Henriques, R. (2017). Mining corporate annual reports for intelligent detection of financial statement fraud—A comparative study of machine learning methods. *Knowledge-Based Systems*, 128, 139-152. <https://dx.doi.org/10.1016/j.knosys.2017.05.001>
- Halilbegovic, S., Celebic, N., Cero, E., Buljubasic, E., & Mekic, A. (2020). Application of Beneish M-score model on small and medium enterprises in Federation of Bosnia and Herzegovina. *Eastern Journal of European Studies*, 11(1), 146-163.
- Hasan, M. S., Omar, N., Barnes, P., & Handley-Schachler, M. (2017). A cross-country study on manipulations in financial statements of listed companies: Evidence from Asia. *Journal of Financial Crime*, 24(4), 656-677. <https://doi.org/10.1108/JFC-07-2016-0047>
- Healy, P. M. (1985). The effect of bonus schemes on accounting decisions. *Journal of Accounting and Economics*, 7(1-3), 85-107. [https://doi.org/10.1016/0165-4101\(85\)90029-1](https://doi.org/10.1016/0165-4101(85)90029-1)
- Herawati, N., & Tarjo (2017). The comparison of two data mining method to detect financial fraud in Indonesia. *Accounting and Finance Review*, 2(1), 1-8 [https://doi.org/10.35609/af.2017.2.1\(1\)](https://doi.org/10.35609/af.2017.2.1(1))
- Hosmer, D. W., & S. Lemeshow, (1989). *Applied Logistic Regression*. John Wiley & Sons.
- Hung, D. N., Ha, H. T. V., & Binh, D. T. (2017). Application of F-score in predicting fraud, errors: Experimental research in Vietnam. *International Journal of Accounting and Financial Reporting*. 7(2), 303-322. <https://doi.org/10.5296/ijaf.v7i2.12174>
- Jones, J. (1991). Earnings management during import relief investigations. *Journal of Accounting Research*, 29, 193-228. <https://doi.org/10.2307/2491047>
- Kanapickiene, R., & Grundiene, Ž. (2015). The model of fraud detection in financial statements by means of financial ratios. *Procedia-Social and Behavioral Sciences*, 213(2), 321–327. <https://doi.org/10.1016/j.sbspro.2015.11.545>
- Kara, E., Ugurlu, M., & Korpi, M. (2015). Using Beneish model in identifying accounting manipulation: An empirical study in BIST manufacturing industry sector. *Journal of Accounting, Finance and Auditing Studies*, 1(1), 21-39. <https://doi.org/10.56578/jafas010102>
- Kedia, S., & Philippon, T. (2009). The economics of fraudulent accounting. *The Review of Financial Studies*, 22(6), 2169-2199. <https://doi.org/10.1093/rfs/hhm016>
- Küçükkocaoğlu, G., & Küçüksözen, C. (2005). Gerçeğe aykırı finansal tabloların ortaya çıkarılması: IMKB şirketleri üzerine amprik bir çalışma. *Muhasebe ve Finansman Dergisi*, 28, 160-171.
- Küçükkocaoğlu, G., Benli Keskin, B., & Küçüksözen, C. (2007). Finansal bilgi manipülasyonunun tespitinde yapay sinir ağı modelinin kullanımı. *IMKB Dergisi*, 9(36), 1-30.
- Lehenchuk, S., Mostenska, T., Tarasiuk, H., Polishchuk, I., & Gorodysky, M. (2020, November). Financial statement fraud detection of Ukrainian corporations on the basis of beneish model. In *International Conference on Business and Technology* (pp. 1341-1356). Springer International Publishing. https://doi.org/10.1007/978-3-030-69221-6_100

- Li, S., Wang, G., & Luo, Y. (2022). Tone of language, financial disclosure, and earnings management: A textual analysis of form 20-F. *Financial Innovation*, 8(1), 43. <https://doi.org/10.1186/s40854-022-00346-5>
- Lin, C. C., Chiu, A. A., Huang, S. Y., & Yen, D. C. (2015). Detecting the financial statement fraud: The analysis of the differences between data mining techniques and experts' judgments. *Knowledge-Based Systems*, 89, 459–470. <https://doi.org/10.1016/j.knosys.2015.08.011>
- Lotfi, N., & Aghaei Chadegani, A. (2018). Detecting corporate financial fraud using Beneish M-Score Model. *International Journal of Finance & Managerial Accounting*, 2(8), 29-34.
- Mahama, M. (2015). Detecting corporate fraud and financial distress using the Altman and Beneish models. *International Journal of Economics, Commerce and Management*, 3(1), 1-18.
- Matsumura, E. M., & Tucker, R. R. (1992). Fraud detection: A theoretical foundation. *Accounting Review*, 67(4) 753-782.
- Mehta, A., & Bhavani, G. (2017). Application of forensic tools to detect fraud: The case of Toshiba. *Journal of Forensic and Investigative Accounting*, 9(1), 692-710
- Persons, O. S. (1995). Using financial statement data to identify factors associated with fraudulent financial reporting. *Journal of Applied Business Research*, 11, 38–38. <https://doi.org/10.19030/jabr.v11i3.5858>
- Perols, J. L., & Lougee, B. A. (2011). The relation between earnings management and financial statement fraud. *Advances in Accounting*. 27(1), 39-53. <https://doi.org/10.1016/j.adiac.2010.10.004>
- Ramírez-Orellana, A., Martínez-Romero, M. J. & Mariño-Garrido, T. (2017). Measuring fraud and earnings management by a case of study: Evidence from an international family business. *European Journal of Family Business*, 7(1-2), 41-53. <https://doi.org/10.1016/j.ejfb.2017.10.001>
- Ravenda, D., Valencia-Silva, M. M., Argiles-Bosch, J. M., & Garcia-Blandon, J. (2018). Accrual management as an indication of money laundering through legally registered Mafia firms in Italy. *Accounting, Auditing & Accountability Journal*, 31(1), 286-317. <https://doi.org/10.1108/AAAJ-12-2015-2329>
- ROIC.ai. (n.d.). ROIC.ai. <https://www.roic.ai/>
- Securities and Exchange Commission (2009). Accounting and Auditing Enforcement. <https://www.sec.gov/divisions/enforce/friactions?aId=edit-year&year=2009&month=All>
- Situngkir, N. C., & Triyanto, D. N. (2020). Detecting fraudulent financial reporting using fraud score model and fraud pentagon theory: Empirical study of companies listed in the LQ 45 Index. *The Indonesian Journal of Accounting Research*, 23(3), 373-410.
- Song, Y., Wang, H., & Zhu, M. (2018). Sustainable strategy for corporate governance based on the sentiment analysis of financial reports with CSR. *Financial Innovation*, 4, 1-14. <https://doi.org/10.1186/s40854-018-0086-0>
- Spathis C. T. (2002). Detecting false financial statements using published data: Some evidence from Greece. *Managerial Auditing Journal*, 17(4), 179-191. <https://doi.org/10.1108/02686900210424321>
- Svabova, L., Kramarova, K., Chutka, J., & Strakova, L. (2020). Detecting earnings manipulation and fraudulent financial reporting in Slovakia. *Oeconomia Copernicana*, 11(3), 485–508. <https://doi.org/10.24136/oc.2020.020>
- Tran, M. D., Dang, N. H., & Hoang, T. V. H. (2018) Research on misstatements in financial statements: The case of listed firms on Ho Chi Minh City stock exchange. *International Journal of Applied Business and Economic Research*, 15(23), 499-518.
- Ujal, M., Amit, P., Hiral, P., & Rajen, P. (2012). Detection of fraudulent financial statement in India: An exploratory study. *Global Science Research Journals*, 4, 1-19.
- Zainuddin, E. F., & Hashim, H. A. (2016). Detecting fraudulent financial reporting using financial ratio. *Journal of Financial Reporting and Accounting*, 15, 266–278. <https://doi.org/10.1108/JFRA-05-2015-0053>

The Role of Digital Health Technologies in the Healthcare Marketing Process *

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Abstract

Digital health technologies have the potential to significantly transform the way health data is structured and visualized effectively. The research was conducted between April and July 2024. It was conducted with 15 managers from healthcare institutions who are knowledgeable about the role of digital health technologies in the healthcare marketing process. Maximum diversity sampling, one of the purposeful sampling methods, was used to determine the study group. The research was conducted in a qualitative, phenomenological design. Data were collected through in-depth interview method. The data obtained were analyzed using the NVivo 15 program. According to the findings of the research, the four main themes are ‘Digital Applications that Distinguish Institution’, ‘Healthcare Services Marketing’, ‘Advantages of Digitalization in Healthcare Services’, ‘The Disadvantages of Digitalization in Healthcare’. In the healthcare marketing process, digital technologies increase the competitiveness of hospitals, visibility and patient satisfaction, while also playing a critical role in creating effective marketing strategies with digital media and strategic planning. In this context, investments should be made to strengthen the technological infrastructure of health institutions and increase the reliability of digital systems. Regular monitoring of the effectiveness of digital tools and performance evaluations will ensure the rational use of technology. This study contributes to the field by analyzing the effect of digital health technologies on the marketing process.

Keywords: *Digital Health Technologies, Healthcare Marketing, Healthcare Marketing Strategies.*

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1. INTRODUCTION

The privatization of the healthcare sector in many countries has led to an increase in marketing activities (Proctor, 2010). The spread of new information and communication technologies necessitates marketing practices in the health sector, which opens the sector to different stakeholders and, most importantly, to patients and customers. Healthcare marketing refers to the application of marketing principles to the broad, heterogeneous, and complex field of healthcare (Crie & Chebat, 2013). The importance of marketing in health institutions can be observed with many examples. One of them is that when a health manager thinks about adding a new service to the institution, they first conduct market research to measure the size of the need in the society. Through this research, they will discover the services offered by existing competitors. It will also enable a detailed evaluation of the organization, delivery, pricing, and profitability of the new service (Kotler et al., 2008). The health sector has entered a transformation process with its dimensions such as active personnel structure, places where health services are provided, and more intensive use of technology (Uysal, 2019). The inclusion of technological innovations in health services aims to increase patient awareness and make patients feel they need these services (Purcarea, 2016). Digital technologies are creating significant changes in healthcare delivery and patient outcomes. The integration of electronic medical records and mobile health applications strengthens patient participation by increasing accessibility and efficiency in health services (Adler-Milstein & Jha, 2017).

The effect of digital systems on preventive and therapeutic health services is accelerating daily and can reduce inefficient aspects of health services (World Health Organization [WHO], 2021). By increasing access equality, healthcare professionals can easily access the information necessary to provide quality care. This provides an opportunity to improve health outcomes for all citizens (Braithwaite et al., 2020). According to the results of the household information technology usage survey of the Turkish Statistical Institute (TURKSTAT), the rate of households with access to the internet from home increased by 1.4 points to 95.5% in 2023 (Turkish Statistical Institute, 2023). Likewise, the widespread use of mobile phones worldwide is expected to increase their role in digital health technologies (Howitt et al., 2012). Recently, it has been seen that the use of digital healthcare marketing applications in the delivery of healthcare has become widespread.

In this context, determining the effects of digital health technologies on the health services marketing process is becoming increasingly important. In this research, the positive and negative aspects of digital health services will be examined, and opportunities of health institutions towards improving health services marketing strategies and competitiveness will be discussed. The aim of this study is to determine the role of digital health technologies in the marketing of health services. Accordingly, first, the literature information and the opinions of health managers with experience in the field of health service marketing will be included.

2. CONCEPTUAL FRAMEWORK

2.1. Digital Health Technologies

Digital health is a concept that covers all the benefits obtained by adapting the developing technologies in the healthcare field (Fahy & Williams, 2021). However, the lack of an agreed definition of digital health arises from an approach based on academic, institutional, industrial, and individual perspectives (Fatehi et al., 2020). According to the World Health Organization, digital health technologies can be defined as “the field of knowledge and application related to the development and use of digital technologies to improve health.” Digital health expands the concept of e-health to encompass a wider range of smart and connected devices and digital consumers. The internet of Things (IoT) also includes the use of other digital technologies such as advanced computing, big data analytics, machine learning, and artificial intelligence (WHO, 2021).

Mobile Apps: More than 90% of people under the age of 65 and 65% of people over the age of 65 have smartphones. These devices offer important opportunities for health services as personal communication tools that can actively or passively collect health data (Butcher & Hussain, 2022). Sensors on the phones enable early detection of the disease and remote patient-centered intervention. There are more than 100,000 applications in Apple and Google app stores, and they cover a wide range of conditions, from Parkinson’s disease to cardiovascular care (Butcher & Hussain, 2022).

An Electronic Health Record (EHR) is a digital version of a patient's documents and involves comprehensive information such as medical history, diagnoses, and treatment plans (Bender et al., 2013). Remote monitoring of chronic diseases has been associated with better management and reduced readmissions to the hospital (Ash & Bates, 2005). EHRs transform healthcare delivery by increasing the accuracy and accessibility of patient information (Blumenthal & Tavenner, 2010).

Artificial Intelligence and Data Analytics refer to datasets that can be analyzed using big data, data science, and machine learning (Hulsen et al., 2019). Artificial Intelligence simulates human intelligence processes by analyzing such data to identify patterns and make predictions (O’Leary, 2013). While this technology allows researchers to draw conclusions from large datasets, it also plays an important role in improving medicine (Hulsen et al., 2023).

Tele-Health: Telehealth refers to the offer of health services through telecommunication and digital communication technologies (McBain & Morgan, 2005). After the COVID-19 pandemic, there has been a significant increase in the transition to telehealth solutions. This includes the development of virtual services as well as traditional phone clinics (Honarbakhsh et al., 2021). Applications like remote monitoring provide an opportunity to safely detect clinical problems early (Raatikainen et al., 2008).

Wearable Devices: Wearable technology applications are increasingly in demand by healthcare users. Devices such as watches, gloves, and rings passively collect physiological data, which can be later transferred to smartphone applications (Piwek et al., 2016). These devices are designed to identify

diseases early, make it easier to follow up, and provide clinicians to interact with more data (Butcher & Hussain, 2022). For example, it was found that 0.52% of more than 400,000 participants in the Apple Heart Study have an irregular heartbeat (Perez et al., 2019).

It is seen that digital health technologies have lead to significant differences for individuals to follow and manage their health as well as the delivery of healthcare. Digital health technologies have changed the delivery and management of healthcare services radically and led to important developments in patient care. It positively affects patient participation in the delivery of health services by strengthening physician-patient communication. It can also be put forward as an advantage for health institutions to have digital health technology in promoting themselves.

2.2. Healthcare Marketing

In 1969, Kotler and Levy showed that the marketing concept is not limited to for-profit organizations. Therefore, institutions thought to serve primarily for social purposes have also begun to adopt marketing processes in their activities. The studies reveal that before the 1970s, hospitals did not have a marketing department or employed marketing-oriented staff. During this period, hospitals thought that only those in need would come to their institutions, considering their primary aim was to provide preventive and therapeutic care. Similarly, studying healthcare marketing has also taken a long time; the first journal to publish articles on healthcare marketing appeared in 1980 (Balogun & Ogunnaike, 2017).

Nowadays, the healthcare sector, technological developments, the rise in health institutions, and the differentiation of consumers' health-seeking behaviors have led healthcare providers to think and plan professionally (Tengilimoğlu, 2016). The use of the 7p model (product, price, place, promotion, people, physical evidence, process), which is a combination of improving healthcare services, increasing health literacy, and healthcare marketing, provides the improvement of financial resources by creating important strategies (Zade et al., 2024).

The primary purpose of marketing in healthcare is to increase patient satisfaction, provide high-quality medical care, and improve living standards. However, there are limitations in the available data about the effects of different service providers and care services on health (Raji, 2019). It is stated that the use of a marketing mix by healthcare institutions may increase the number of patients (customers). In healthcare services where competition is at the highest level, almost all hospitals provide fully equipped technological and comfortable services (Gümüş, 2018).

2.3. Positive and Negative Aspects of Digital Health Technologies

Interoperability difficulties, such as data security and privacy issues, are among the most important obstacles to the widespread adoption of healthcare technologies (Adler-Milstein & Jha., 2017). Institutional challenges such as resistance to change and inadequate education make the integration of these technologies into existing workflow more complicated (Jiang et al., 2017).

Healthcare providers must operate in a complex regulatory environment to secure patient privacy and ensure data security; thus, regulatory and legal challenges make the process more complicated (Koonin et al., 2020).

To fully exploit the benefits of digital healthcare technologies, interoperability among different systems must be improved. Developing standardized protocols and encouraging the use of open-source solutions can ease data exchange and enhance care coordination (Adler-Milstein & Jha, 2017). In addition, ensuring data security and privacy in digital health services is extremely important. Cybersecurity measures, such as encryption and multi-factor authentication can be effective in protecting patient's data. In terms of encouraging the adaption of digital tools, educating the patients about data security and obtaining informed consent for data sharing are important (Koonin et al., 2020).

Efforts to improve the interoperability of EHRs, telemedicine platforms, and m-health applications are critical for maximizing the benefits of digital healthcare technologies. Interoperability provides a comprehensive view of the patient's health history by ensuring a smooth exchange of information between different systems. This continuous flow of information is necessary for effective care coordination, especially for patients with complex health needs (Campanella et al., 2016).

2.4. Future Trends in Digital Health Technologies

The future of digital healthcare services is promising, and continuous technological developments have the potential to further transform healthcare delivery and patient outcomes. Developing technologies such as artificial intelligence (AI), machine learning, and blockchain offer important opportunities for improving diagnosis, treatment, and data security (Kvedar et al., 2014).

Artificial intelligence (AI) and machine learning (ML) technologies have the potential to reorganize healthcare by providing predictive analytics, personalized medicine, and auto diagnosis. AI-driven tools can identify patterns by analyzing large datasets and improve clinical decision-making processes by providing actionable insights, thereby improving patient outcomes (Matiang'i, et al., 2022). As for blockchain technology, it offers a secure and transparent way to manage health data. By providing a decentralized and tamper-proof register, data security can be improved, administrative processes can be eased, and interoperability among different systems can be enhanced. Blockchain adoption in healthcare has the potential to address many challenges related to data privacy and security (Smedlund et al., 2018). Developments in telecommunication technologies and changes in patient preferences enable the widespread use of telehealth services. The integration of telehealth with other digital tools such as remote monitoring devices and m-Health applications offers the opportunity to create a comprehensive digital health ecosystem that improves patient outcomes by increasing accessibility (Taylor-Phillips et al., 2014).

3. METHOD

The study was conducted using a qualitative, phenomenological design. Phenomenological design focuses on phenomena that we are aware of but do not have a deep and detailed understanding (Yıldırım & Şimşek, 2021). In phenomenological research, data sources refer to individuals or groups that experience the phenomenon the study focuses on or can express or reflect this phenomenon.

3.1. Study Group

The study population consists of healthcare managers responsible for implementing digital health technologies in healthcare marketing processes. The maximum variation sampling method, which is one of the purposeful sampling methods, was used to determine the study group. To determine the study group, the managers who provide digital healthcare technologies in their institutions were first investigated, reached, and given information about the purpose and process of the study. The reason for selecting the maximum variation sampling was to identify the types of association or similarities (and differences to the same extent) that exist among the varied situations. Considering the role of digital health technologies in the marketing of health services, private and public hospitals are discussed as dimensions that will form the basis for ensuring this diversity. The data were collected using an in-depth interview method. It has been stated in the literature that the number of items to create the sample may vary between 5 and 25 items (Rubin & Babbie, 2016). As a result of the study pursued by the researcher, data acquisition is completed as soon as data saturation is reached. The study was conducted with 15 health managers.

3.2. Data Collection Tools

The data were collected through personal information forms and in-depth interviews related to sociodemographic characteristics. Personal Information Form: The questionnaire created by examining the relevant literature consists of questions on gender, age, marital status, educational status, professional experience year, duty, and sector information of health managers. In-depth Interview: The data were collected by recording audio in in-depth, individual, semi-structured, face-to-face interviews of 25-30 minutes. The interview questions consist of 9 open-ended questions. In-depth interviewing is a data collection technique based on verbal communication between the research and the subject regarding the topic examined (Uslu & Demir, 2023).

3.3. Procedure

For the in-depth interviews, each health manager was contacted beforehand, and face-to-face interviews were conducted when available. Before starting the interview, the purpose of the research was explained, and later, written consent from the health managers was obtained. After consent, the sociodemographic information of the health managers was obtained. Health managers were informed that voice recordings would be recorded during the interview, and research questions were asked. Based on the semi-structured interview method, the participants were encouraged to express their thoughts on

the research questions, and their opinions were appreciated. In this process, the researcher exhibited an objective attitude. At the end of the interview, audio recordings were obtained. The in-depth interviewer has experience and training in qualitative research methods.

3.4. Pre-Application

Pre-application was made with 3 health managers to evaluate if the questions were clear. According to the feedback from the health managers, the questions were put into final form. Participants in the prestudy could not be included in the study group.

3.5. Data Analysis

The obtained data were analyzed using the NVIVO 15 software. The data were arranged according to common themes using descriptive analysis. Voice recordings obtained from the interviews were transcribed and then coded based on the topics most frequently mentioned by the participants in order to separate them meaningfully. Then, similar codes were grouped together to form themes. The coding process involves dividing the data into sections, analyzing, comparing, conceptualizing, and establishing relationships (Straus & Corbin, 1990). Codes are tags, names or a descriptors; therefore, coding is the process of tagging, naming, or describing the data sets (Punch, 2005).

3.6. Validity and Reliability

In order to maintain the internal validity of the study, personal information forms and questionnaires were evaluated by an academic member who has experience in different courses and studies, and according to feedback, the form was rearranged and put into the final form. To ensure external validity, detailed explanations regarding the steps and results of the research were provided. Both researchers who code the research data have experience and training in qualitative methods. To enhance the reliability of the coding process, after the data were initially coded by the researcher, a part of the interview documents with health managers was independently coded a second time by an academic member who had expertise and studies in qualitative research, and the results were compared.

3.7. Research Ethics

For the research, permission numbered 2024/341 was obtained from the Selçuk University Faculty of Health Sciences Non-Interventional Clinical Research Ethics Committee.

4. FINDINGS

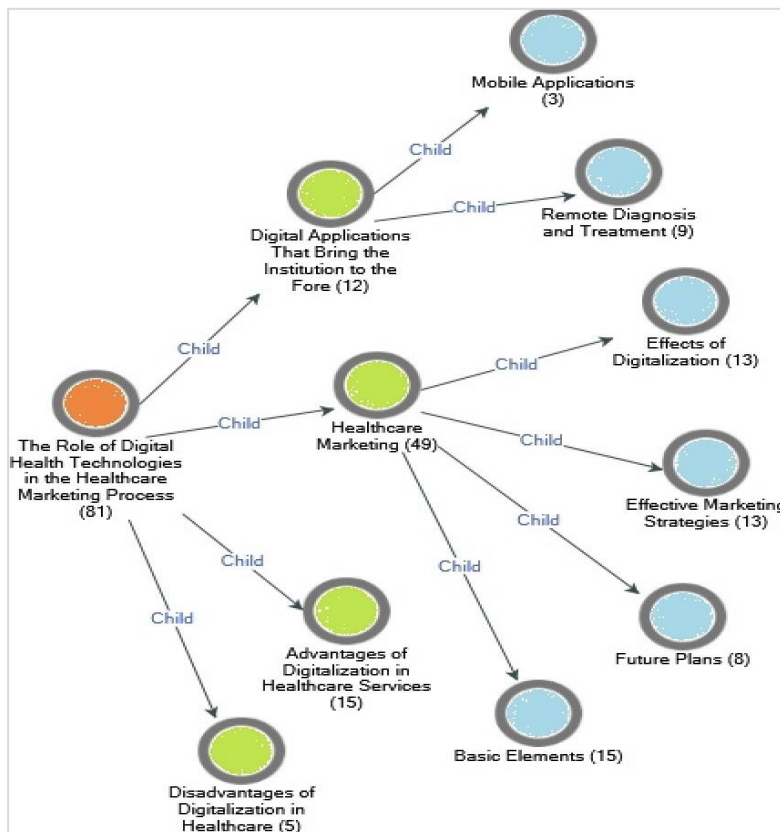
This section presents the research findings. First, descriptive information about the study participants is included.

Table 1. Descriptive Information about Participants

Participants	Gender	Age	Marital Status	Educational Level	Professional Experience	Role	Sector
Participant 1	Male	47	Married	Bachelor's degree	20 years	Hospital Manager	State
Participant 2	Male	31	Single	Bachelor's degree	1 year	Assistant Hospital Manager	State
Participant 3	Female	52	Single	Postgraduate degree	32 years	Hospital Manager	State
Participant 4	Male	45	Married	Bachelor's degree	21 years	Quality Manager	State
Participant 5	Male	48	Married	Bachelor's degree	20 years	Assistant Hospital Manager	State
Participant 6	Male	49	Married	Bachelor's degree	29 years	Hospital Manager	State
Participant 7	Female	42	Married	Postgraduate degree	20 years	Quality Unit Representative	State
Participant 8	Female	33	Married	Postgraduate degree	9 years	Psychologist	Private
Participant 9	Male	31	Single	Postgraduate degree	5 years	Civil servant	State
Participant 10	Male	27	Single	Bachelor's degree	2 years	Medical Advisor	State
Participant 11	Female	25	Single	Bachelor's degree	1.5 years	Domestic Sales Opr. Assistant Specialist	Private
Participant 12	Male	29	Single	High school	12 years	Nurse	Private
Participant 13	Female	33	Single	Bachelor's degree	6 years	Responsible for Domestic Patients Coordinator (Doctor)	Private
Participant 14	Female	35	Single	Bachelor's degree	13 years	Business Development Experts	Private
Participant 15	Male	31	Married	Bachelor's degree	3 years	Business Development Experts	Private

When the gender distribution of the participants is examined, it is seen that 9 of the 15 people are male (60%) and 6 were female (40%). The age ranges from 25 to 52 years. Considering their marital status, 7 participants were married (46%), and 8 were single (54%). According to educational status, 10 people had a bachelor's degree (67%), 5 people had a postgraduate degree (33%), and 1 person was a high school graduate (7%). The participants' professional experience varies from 1 to 32 years. While 9 (53%) participants worked in state hospitals, 6 (47%) worked in the private sector. Current positions include hospital manager, assistant hospital manager, quality manager, psychologist, medical advisor, business development expert, and domestic sales operations specialist assistant.

As a result of the analysis of the research data, a total of 81 codings were generated. With the combination of similar codes, 4 main themes and 6 sub-themes were obtained.

Figure 1. Role of Digital Health Technologies in Healthcare Marketing Process (NVIVO Project Map)

The main themes are "Digital applications that distinguish the institution", "Health services marketing", "Advantages of digitalization in health services" and "Disadvantages of digitalization in health services". This theme and the subthemes related to these themes are discussed under the following headings.

4.1. Digital Applications that Distinguish the Institution

The main theme of "digital applications that distinguish the institution" is divided into 2 sub-themes; "Mobile applications" and "Remote diagnosis and treatment".

4.1.1. Mobile Applications

Three participants provided their opinions on the mobile applications sub-theme. Participants stated that making an appointment through mobile applications and accessing laboratory results and electronic medical records distinguish the health institution. Sample participant statements related to this theme are as follows: "Getting an appointment and examination with the mobile health application..." (P3). "Laboratory results and e-appointment in mobile application..." (P15). "Mobile health applications, electronic health records, electronic medical records..." (P10).

4.1.2. Remote Diagnosis and Treatment

Nine participants provided opinions on the sub-theme of remote diagnosis and treatment. According to the participants' statements, performing examination, diagnosis, and treatment procedures

remotely through digital applications brings health institutions to the forefront compared with other institutions. In addition, robotic surgery is important for health institutions. On the other hand, it is stated that the use of surgical operations through videoconferencing is an application that distinguishes health institutions from other institutions. Participants' statements related to this theme are presented below.

“Currently, we prioritize telemedicine health services and think that we stand out as an institution...” (P5). “I can say that telemedicine applications are features that we have successfully presented. We put this into practice within the framework of the pilot scheme, and we want to further develop this area. Another advantage of our technological infrastructure is that we are at the top in terms of medical equipment” (P6). “Although we are not very active as an institution in this respect, our interviews (psychotherapy and counseling) can also be held online in terms of accessibility. This makes a difference when compared to other institutions. Especially for patients reaching from upstate...” (P8). “Surgical operations through videoconferencing are used very effectively in educational presentations...” (P7). “Examination with a Tytcare remote examination device” (P13).

4.2. Healthcare Services Marketing

The main theme of "health service marketing" is discussed under 4 sub-themes: "effects of digitalization", "effective marketing strategies", "future plans" and "key elements".

4.2.1. Effects of Digitalization

Thirteen participants presented their opinions on the sub-theme of the effects of digitalization. The majority of participants stated that the use of digital applications in healthcare delivery positively affects the institutional preference of patients. Accordingly, it has been stated that digitalization increases patient density in institutions. Participants also stated that digitalization in healthcare institutions is a necessity of the moment. It has been noted that digitalization in healthcare institutions is also important and necessary for health service marketing. Some of the original statements of the participants regarding this sub-theme are as follows:

“Health institutions are trying to adapt to this pace with the development of medical technology. A hospital can stand out in a certain field. For example, a marketing strategy can be implemented using this technology by focusing on neurosurgery. Another hospital may have the capacity to attract patients with its superior imaging techniques. Therefore, a hospital or health facility can serve more patients with more digital marketing opportunities. Accordingly, there is an increase” (P5). “...organizations that use digital technologies are much more successful in terms of preference” (P9). “...It is directly the subject of marketing strategies. The institution must adapt by following developments to stay up-to-date and relevant” (P11). “With the development of digital technologies, there is an increase in the preference for institutions where changing expectations can be met” (P13). “Keeping up with the technological developments in a changing and developing world can be used as a marketing strategy for an institution. This contributes positively to preferability” (P14).

4.2.2. Effective Marketing Strategies

Thirteen participants expressed their opinions on the sub-theme of effective marketing strategies. Most participants stated that word-of-mouth marketing was the most effective strategy. Participants stated that obtaining successful results in the health services offered and prioritizing patient satisfaction were factors affecting word-of-mouth marketing. On the other hand, it has been stated that institutions' patient communication activities, rapid diagnosis and treatment opportunities, and the publication of information about the health institution and its employees on the website are effective in health service marketing. The original statements of some participants regarding this sub-theme are as follows:

"Satisfied patient recommendation..." (P1). "Conscious patients and intermediary institutions to examine the resumes of the physicians whom they will receive services in the relevant field, patient recommendations, their publication on the web..." (P3). "You know that there is no advertising in health institutions, but the type of marketing we use and adopt the most is word-of-mouth marketing. As an institution, we prioritize a high level of friendly service and patient satisfaction. Since we have a high level of technology, doctors, and medical personnel, we adopt word-of-mouth marketing" (P5). "...one of the most important things we care about is that when we discharge the patients with full recovery by satisfying them, that patient leading the others to come to our hospital by recommending us" (P6).

"...This situation provides more client/patient returns since the trust (effectiveness of the treatment) revealed by the experience is related" (K8). "Healthcare technologies provided by the institution are often preferred because of the introduction of advantages in and outside the institution, and awareness in the neighborhood beside the visit of marketing sales team to the institution" (P11). "Often, patient advice and sales team, customer visits, direct patient communication studies (SMS, satisfaction stage), physician staff, rapid diagnosis and treatment" (P14).

4.2.3. Future Plans

Eight participants provided their opinions on the sub-theme of future plans. The majority of participants stated that digitalization was among the future plans of the institution. As understood from the participants' statements, the future plans of the institutions include developing remote examination systems, providing services to patients through mobile applications, switching to a smart hospital system, and increasing digital service delivery and service quality. The original statements of some participants regarding this sub-theme are presented below.

"Our primary goal is to become an accredited hospital in 2025. Digitalization is a must in order to become an accredited hospital, so we have an effort to digitalize throughout the hospital, especially the Hospital information management system..." (P4). "First, we make plans for at least the next 3 years by drawing a perspective according to the estimation methods along with structural equation modeling. There is a commission we have established for this. We have this strategic plan in written form and are

working on it. We have a hospital automation system in terms of digital health services, and we are improving its integration with E-nabız day by day. We have projects to incorporate our hospital into a smart hospital. Our primary goal is to achieve this. In addition, we will soon complete the mobile application called m-Health, which we will develop along with our automation systems, and put into service for our patients” (P5). “There is a medium- and long-term strategy plan in place at our hospital. Within the framework of this plan, we focus on digital health services and aim to increase the diversity of digital marketing and to provide patients with better quality, faster, and more effective services. We want to focus mostly on the mobile application, and we are working on it...” (P6). “If needed, to ensure that our patient’s examinations and tests are evaluated online by a physician in a different part of Türkiye, within the legal framework, ...” (P7). “...In the field of digital health, we aim to be one of the leading companies in Türkiye” (P10).

4.2.4. Key Elements

All participants expressed their opinions on the key elements subtheme. The majority of the participants stated that accessibility, technology, price, treatment effectiveness, experienced physicians, and service quality are key elements in health service marketing. The original statements of some participants regarding this sub-theme are as follows:

“...Technology, price, and quality. In the future, technology will dominate more and affect prices and quality” (P2). “Since our hospital is a tertiary healthcare institution, we focus on technology and treatment effectiveness. Tertiary health institutions see more cases than other hospitals and are the most efficient training centers for assistant physicians and medical faculty students. Since our hospital is in the center of Central Anatolia, it is accessible from anywhere, and our biggest goal is to discharge our patients with full recovery using our high-tech devices and experienced physicians” (P5). “We mainly focus on technology in our hospital. Because there is a certain responsibility and obligation to the university hospital. Treatment effectiveness and technology are areas in which we are leading. The reason why I get this main idea is that we are a university hospital, and we can primely deal with more contradictory cases than usual” (P6). “...In general, technology stands out. Because there are many good machines in our institution” (P9). “While providing healthcare, our priority is to apply the necessary intervention and treatment methods with quality and accurate diagnosis as soon as possible. After the patient trusts the institution without any question in their mind, our quality, treatment plan, and technologies are at the highest level...” (P10).

4.3. Advantages of Digitalization in Healthcare Services

All participants expressed their opinions on the main theme. Most participants stated that digitalization in health service delivery is advantageous in terms of facilitating access to the service, accelerating service delivery, providing financial savings, saving time, and personnel, facilitating the

data recording system, and increasing patient safety. The original statements of some participants on the main theme are as follows:

“... saving personnel, speed, avoiding mistakes, financial savings, easier transportation... Tracking has become easier. The registration system has become easier. People did not deal with institutions, and their direct access to the digital system became easier” (P2). “Customer satisfaction. Once again, I will mention e-nabız and imaging systems, but for example, the patient is examined in a private hospital, and imaging procedures such as MRI in private hospitals are expensive. Thus, they get it done and even have blood tests in public hospitals, and they show the results in private hospitals, so it benefits the patient in terms of cost. Digitalization processes for hospitals save costs and energy by increasing data quality and data completeness. For example, samples such as the drug maturity stock tracking system warn about critical stock or expired drugs and keep both employee and patient safety at the maximum level.” (P4). “We live in a modern time. Time is indeed the most important phenomenon at present. We implement many alternatives in digital healthcare services. If we mention the advantages for patients, currently, a patient's examination and analysis procedures can be concluded within a day, the patient can get treatment, and they can view the results on e-nabız and show them instantly to the doctor they want. Or, when a radiograph is taken, even a physician from another part of Türkiye can view it. In early diagnosis and treatment, this speed and immediate results can eliminate life-threatening situations and are an advantage for patients and employees. As patients receive services from a health institution using these technologies, they strengthen their bond with the hospital. I can say that there is currently no hospital without PACS, or we can see the direct results because PACS was integrated into the e-nabız system in a short time after analysis. If good technology equipment exists in a health institution and there is no medical personnel supporting it, I think digitalization will benefit to some extent. I think these support each other” (P5). “The functioning of the hospital has been completely carried out digitally. In fact, everything is carried out through our electronics, automation, and software systems. I can say that the use of any type of stationery is out of the question. With rapid analysis and examinations, we aim to minimize the time spent in the hospital by patients. These are advantages for patients. Because patients usually want to see the result immediately after an imaging technique is used or want to consult other physicians, a revised application in e-nabız has been implemented. Since we are an integrated facility with the state, we are completely focused on this with our software and applications, and we act within the framework of the idea of constantly improving ourselves” (P6). “Applications like Telemedicine provide an advantage by individualizing medical science, applying personalized methods, and providing one-to-one health services. Such technologies have brought significant positive changes to health care, especially because they minimize human-induced errors and make life easier, as in most systems. The spread of such technologies also provides evidence for treatments that can turn into judicial cases caused by errors” (P8). “...The digitalization of hospitals has led to significant changes in patient requests and expectations. Thanks to digitalization, patients can now

access health services faster and effectively, access their medical records easily, and follow their treatment processes better” (P10). “Advantageous aspects are that the patient does not waste time due to transportation, both financially and morally. The physician can examine the patient who will be absent remotely as if they are physically with him/her thanks to our technologies. Patients can easily perform their procedures, such as blood drawing and appointment making, thanks to medical home and mobile applications. The fact that it is accessible and planned by considering even the needs in the hospital of the patient they could not think of will make the patient feel more special and show that all the work done in the institution is done with the same care” (P11). “Decrease in inflation indicators and decline in facility usage frequency, low labor force...” (P12). “It saves time for patients and provides services regardless of the location. It provides ease and speed for patients to get healthy” (P13). “It makes a positive contribution to patients in terms of time and distance (transportation cost). The reason why it is preferred for employees/institutions is that it ensures effective use of time. The digitalization of hospitals has also affected patient expectations. The desire to reach the results online and through online interviews with physicians, etc.” (P14). “Remote Parkinson’s disease follow-up, chronic patient blood sequence, and blood pressure treatment... Rather than the source of access to classical medical data, more accessible data are important for both domestic and foreign patients” (P15).

4.4. The Disadvantages of Digitalization in Healthcare

Five participants expressed their opinions on the main theme. Some participants stated that with the increase in digitalization of health service delivery, the number of patients demanding services increased, which is disadvantageous in terms of an increase in the workload of medical personnel. Some participants considered digital service delivery a disadvantage owing to its low success rate compared to face-to-face service delivery. In addition, one participant emphasized a negative aspect of digitalization in healthcare service delivery because elderly patients struggle to use some digital health applications. Participants’ statements related to this theme are presented below.

“When we think of it as a disadvantage, I observe that medical personnel get more workload because, with the development of these technologies, a system that focuses more on treatment is formed. But since all kinds of technologies bring convenience, I can say that the advantages outweigh the disadvantages” (P5). “As a disadvantage, medical personnel create a density because they have to serve a more intense patient group...” (P6). “...However, adapting the elderly who need healthcare services more to such technologies and obtaining healthy data is a major problem faced in this field” (P8). “...the disadvantage is that the treatment success rate is relatively lower considering face-to-face interviews” (P10). “As a disadvantage; the patient finds it more reliable to be physically in the hospital and with the physician due to the usual situation” (P11).

5. CONCLUSION

According to the results obtained in this study, digital technologies increase the competitiveness and visibility of hospitals in both private and public hospitals in the healthcare services marketing process. Digital media and strategic planning play critical roles in forming effective marketing strategies. Healthcare managers have stated that digital health technologies bring institutions to the forefront. Mobile applications and remote diagnosis and treatment services are important applications that distinguish institutions.

The effects of digital health technologies in the healthcare service marketing process include positive aspects, such as facilitating communication between patients and health institutions, enabling patients to ask questions, receiving feedback, providing personalized care, remote monitoring, improving service quality, increasing preferability, cost savings, accessibility, and gaining superiority in competition. However, the disadvantages include problems such as increased patient expectations and difficulties in adapting to digital health technologies. It has been observed that word-of-mouth marketing is the most effective marketing strategy for health services. Rapid diagnosis and treatment have a positive effect on patient-healthcare institution communication. In addition, the majority of healthcare managers stated that digitalization will be included in future plans. As can be seen, the field of health is not independent of developing technology all over the world. Digital health technologies have brought health to another dimension than the traditional one. Digital health technologies have benefits in developing both individual and social health. In addition, it has become a tool whereby the institutions can put themselves forward and get a competitive edge. On the other hand, ethical attention must be paid to the privacy and safety of the data obtained by the institution.

In a study conducted by Şantaş and Şantaş (2020), positive technologies were found to manage patient habits and strengthen patients' ability to manage their health. Bostan and Tehci (2020), on the other hand, revealed that service quality and friendliness are among the main stresses in general marketing within healthcare services, but non-operative treatment, technology, and transportation-price factors are also important for some institutions. Kapoor et al. (2020) stated that digital health applications were quite beneficial during the pandemic. Rojas et al. (2019) emphasized that using internet-based applications in depression treatment is effective. Henkenjohann (2021) revealed that using patients' digital records increases the effectiveness of healthcare services. Wilson et al. (2021) found in their study that elderly people need information support for using e-health applications. However, Györfy et al. (2023) draw attention that even though elderly people nowadays face obstacles using digital health technologies, this issue will decrease in the future with them using it easily. In their study, Poon et al. (2006) indicated that barcode technology used in pharmacies reduced distribution errors by 93-96%. During the COVID-19 pandemic, QR codes were used and benefited by many digital contact tracing applications (Yeung et al., 2023). The research findings support the literature in this regard. However, in a study conducted by Gentili et al. (2022), a systematic review was conducted on

the cost-effectiveness studies of digital health technologies; it was revealed that 2 of the 17 studies on video conferencing systems were deficient in terms of cost-effectiveness, which could be attributed to reasons such as pre-training cost and resource, intensive intervention.

Although the effects of digital health technologies have been generally examined from a patient's perspective in the literature, studies on the advantages and disadvantages of digital health technologies for health institutions are limited. It is clear that digital health technologies positively affect the brand image of healthcare institutions; however, their use may also affect the professional integrity of healthcare professionals because they can rely on technology instead of professional knowledge to make decisions. Therefore, healthcare professionals should receive the necessary training on the use of digital health technologies and be reminded of their responsibilities and obligations when providing healthcare services. It is important that the training is carried out in a practical way so that healthcare professionals will be active. On the other hand, it is thought that following the developments in the field of digital health technologies and carrying them out periodically will increase the efficiency of the training. In addition, the fact that digital health technologies are offered by many incompatible competitor companies requires health institutions to conduct research and develop appropriate applications because the data cannot be easily changed or transferred (Yeung et al., 2023).

Many digital health technologies require significant preliminary investments. Therefore, these technologies cannot be easily defrayed by poor countries or communities and become impractical on a global scale (Kabore et al., 2022). In this context, health institutions must strengthen their technological infrastructure and make investments to increase the reliability of digital systems. However, although the costs of these investments are high, it is thought that the costs will decrease in the long run as the market expands and interest in these technologies increases. Thus, monitoring the effectiveness of the digital tools regularly and evaluating performances would ensure wise use of technology. In addition, it is recommended that elderly patients make improvements to adapt to digital health technologies.

Digital marketing in healthcare services ensures the necessary precautions without patients attending hospitals. Thereby, cost and time have been saved and personalized treatment methods become easier. When creating public health strategies for health policymakers, health data obtained from digital environments allow for a better definition of the current patient profile. It is thought that digital health technologies will play a more important role in the upcoming years in the diagnosis and treatment of patients. For future studies, it is suggested to conduct studies on topics such as the effect of digitalization on the decision process, and financial burden of digital infrastructure.

Ethics committee approval for the study was obtained from the Selçuk University Ethics Committee on March 27, 2024, with decision number 2024/341.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors declare that they equally contributed to all processes at the research.

REFERENCES

- Adler-Milstein, J., & Jha, A. K. (2017). HITECH Act drove large gains in hospital electronic health record adoption. *Health Affairs*, 36(8), 1416-1422.
- Ash, J. S. & Bates, D. W. (2005). Factors and forces affecting EHR system adoption: Report of a 2004 ACMI discussion. *Journal of the American Medical Informatics Association*, 12(1), 8-12. <https://doi.org/10.1197/jamia.M1684>
- Balogun, B. A., & Ogunnaike, O. O. (2017). Healthcare organizations in a global marketplace: A systematic review of the literature on healthcare marketing. *Journal of Marketing Management and Consumer Behavior*, 1(5), 36-52.
- Bender, B. G., Grana, R., Sharma, S., & Kallem, S. (2013). A pilot randomized clinical trial to explore the impact of mobile health on adherence and outcomes in asthma patients. *Journal of Asthma*, 50(5), 490-496. <https://doi.org/10.3109/02770903.2013.790417>
- Blumenthal, D., & Tavenner, M. (2010). The 'meaningful use' regulation for electronic health records. *New England Journal of Medicine*, 363(6), 501-504. <https://doi.org/10.1056/NEJMp1006114>
- Bostan, S., & Tehci, A. (2020). Sağlık hizmetleri pazarlama stratejileri: Bir nitel araştırma. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, 26, 181-194. <https://doi.org/10.18092/ulikidince.590734>
- Braithwaite, J., Glasziou P. & Westbrook, J. (2020). The three numbers you need to know about healthcare: The 60-30-10 Challenge. *BMJ Medicine*, 18(102), 1-8. <https://doi.org/10.1186/512916-020-01563-4>
- Butcher, C., J. T., & Hussain, W. (2022). Digital healthcare: The future. *Future Healthcare Journal*, 9(2), 113-117.
- Campanella, P., Lovato, E., Marone, C., Fallacara, L., Mancuso, A., Ricciardi, W., & Specchia, M., L. (2016). The impact of electronic health records on healthcare quality: A systematic review and meta-analysis. *European Journal of Public Health*, (26), 60-64. <https://doi.org/10.1093/eurpub/ckv122>
- Crie, D., & Chebat, J. C. (2013). Health marketing from an integrative perspective. *Journal of Business Research*, 66(1), 123-126. <https://doi.org/10.1016/j.jbusres.2012.09.002>
- Fahy, N., & Williams, G. A. (2021). *Digital health tools in Europe*. World Health Organization. <https://apps.who.int/iris/handle/10665/345091>
- Fatehi, F., Samadbeik, M. & Kazemi, A. (2020). What is digital health? Review of definitions. *Studies in Health Technology and Informatics*. 24(1), e33081.
- Gentili, A., Failla, G., Melnyk, A., Puleo, V., & Tanna, G. L. D. (2022). Cost-effectiveness of digital health interventions: A systematic review of the literature. *Front Public Health*, 10, 787135. <https://doi.org/10.3389/fpubh.2022.787135>
- Gümüş, R. (2018). Pazarlama faaliyetlerinin sağlık sektörüne uygulanması: Bir literatür incelemesi. *Bulletin of Economic Theory and Analysis*, 3(4), 217-235.
- Györfy, Z., Boros, J., Döbrösy, B., & Girasek, E. (2023). Older adults in the digital health era: Insights on the digital health related knowledge, habits and attitudes of the 65 year and older population. *BMC Geriatrics*, (23), 779. <https://doi.org/10.1186/s12877-023-04437-5>

- Henkenjohann, R. (2021). Role of individual motivations and privacy concerns in the adoption of German electronic patient record apps: A mixed methods study. *International Journal of Environmental Research and Public Health*, 18(18), 9553. <https://doi.org/10.3390/ijerph18189553>
- Honarbakshsh, S., Sporton, S., Monkhouse, C., Lowe, M., Earley, M. J. & Hunter, R. J. (2021). Remote clinics and investigations in arrhythmia services: What we have learned during coronavirus disease 2019? *Arrhythm Electrophysiol Rev*, 10(2), 120-124.
- Howitt, P., Darzi, A., Yang, G-Z., Ashrafian, H., Atun, R., & Barlow, J. (2012). Technologies for global health. *Lancet*, (380), 507-535. [https://doi.org/10.1016/S0140-6736\(12\)61127-1](https://doi.org/10.1016/S0140-6736(12)61127-1)
- Hulsen, T., Friedecky, D., Renz, H., Melis, E., Vermeersch, P., & Fernandez-Calle, P. (2023). From big data to better patient outcomes. *Clinical Chemistry and Laboratory Medicine*, 61(4), 580–586. <https://doi.org/10.1515/ccm-2022-1096>
- Hulsen, T., Jamuar, S. S., Moody, A. R., Karnes, J. H., Varga, O., Hedensted, S., Spreafico, R., Hafler, D. A., & McKinney, E. F. (2019). From big data to precision medicine. *Frontiers in Medicine*, 6, 34. <https://doi.org/10.3389/fmed.2019.00034>
- Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S. & Wang, Y. (2017). Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology*, (2), 230-243. <https://doi.org/10.1136/svn-2017-000101>
- Kabore, S. S. P., Ngangue, D., Soubeiga, A., Pilabre, A., H., & Bationo, N. (2022). Barriers to and facilitators of sustainable digital health interventions in low- and middle-income countries: A systematic review. *Front. Digit. Health*, 4, 245. <https://doi.org/10.3389/fdgth.2022.1014375>
- Kapoor, A., Guha, S., Kanti Das, M., Goswami, K. C., & Yadav, R. (2020). Digital healthcare: The only solution for better healthcare during COVID-19 pandemic? *Indian Heart Journal*, 72(1), 61–64. <https://doi.org/10.1016/j.ihj.2020.04.005>
- Koonin, L. M., Hoots, B., Tsang, C., A., Leroy, Z., Farris, K., Jolly, B. & McCabe, B. (2020). Trends in the use of telehealth during the emergence of the COVID-19 pandemic-United States, January-March 2020. *Morbidity and Mortality Weekly Report*, (69), 1595-1599. <https://doi.org/10.15585/mmwr.mm6943a3>
- Kotler, P., Shalowitz, J., & Stevens, R. J. (2008). *Strategic marketing for healthcare organizations*. Bass. <http://ndl.ethernet.edu.et>
- Kotler, P., & Levy, S. J. (1969). Broadening the concept of marketing. *Journal of Marketing*, 33(1), 10–15.
- Kvedar, J., Coye M, & Everett W. (2014). Connected health: A review of technologies and strategies to improve patient care through telemedicine and telehealth. *Health Affairs*, (33), 194-199. <https://doi.org/10.1377/hlthaff.2013.0992>
- Matiang’i, M., Ngunju, P., Heteyey, A., Odek, L., Smet, E., Arnoldus, M., Opanga, Y., & Kiilu, C. (2022). Opportunities to integrate primary health care digital innovations in maternal and child health care services in Kenya. *Open Journal of Clinical Diagnostics*, 12(3), 39–54. <https://doi.org/10.4236/ojcd.2022.123005>
- McBain, L., & Morgan, D. (2005). Telehealth, geography, and jurisdiction: Issues of health care delivery in Northern Saskatchewan. *Canadian Woman Studies*, (24), 123-129.
- O’Leary, D. E. (2013). Artificial intelligence and big data. *IEEE Intelligent Systems*, 28, 96-99.
- Perez, M. V., Mahaffey, K. W., & Hedlin, H. (2019). Large-scale assessment of a smartwatch to identify atrial fibrillation. *The New England Journal of Medicine*, 381(20), 1909–1917. <https://doi.org/10.1056/NEJMoa1901183>
- Piwek, L., Ellis, D., Andrews, S., & Joinson, A. (2016). The rise of consumer health wearables promises and barriers. *PLoS Med*, (13), e1001953.
- Poon, E. G., Cina, J. L., Churchill, W., Patel, N., Featherstone, E., & Rothschild, J. M. (2006). Medication dispensing errors and potential adverse drug events before and after implementing barcode technology in the pharmacy. *Annals of Internal Medicine*, 145(6), 426–434. <https://doi.org/10.7326/0003-4819-145-6-200609190-00006>
- Proctor, T. (2010). Internal marketing and its basis for sound customer relationship management. *Journal of Management & Marketing in Healthcare*, 3(4), 256-263. <https://doi.org/10.1179/175330310x12918040319658>

- Purcarea, T. U. (2016). Creating the ideal patient experience. *Journal of Medicine and Life*, 9(4), 380–385. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5141398/>
- Punch, K. F. (2005). *Introduction to social research: Quantitative and qualitative approaches* (2nd ed.). Sage.
- Raatikainen, M. J., Uusimaa, P., van Ginneken, M. M., Janssen, J. P., & Linnauto, M. (2008). Remote monitoring of implantable cardioverter defibrillator patients: A safe, time-saving, and cost-effective means for follow-up. *Europace*, (10), 1145-1151.
- Rojas, G., Martinez, V., Martinez, P., Franco, P., & Jimenez-Molina, A. (2019). Improving mental health care in developing countries through digital technologies: A mini narrative review of the chilean case. *Front Public Health*, (7), 391. <https://doi.org/10.3389/pubh.2019.00391>
- Raji, S. (2019). Introducing 5P's methodology as a healthcare marketing plan: Using 5P's healthcare marketing plan in Diabetic foot care management. *Indian Journal of Public Health Research & Development*, 10(6), 1235-1239. <https://doi.org/10.5958/0976-5506.2019.01462.1>
- Rubin, A., & Babbie, E. R. (2016). *Empowerment series: Research methods for social work*. Cengage Learning.
- Smedlund, A., Turkama, P., & Ikavalko, H. (2018). Digital health platform complements strategies and effectual reasoning. *Journal of Service Science and Management*, 11(4), 360–373. <https://doi.org/10.4236/jssm.2018.114025>
- Straus, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. SAGE Publications.
- Şantaş, G., & Şantaş, F. (2020). Pozitif teknolojilerin sağlık hizmetlerinde ve hasta katılımında rolü. *Düzce Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi*, 10(1), 131-137.
- Taylor-Phillips, S., Grove, A., Hoffmeister, S., Wheaton, M., Coult, S., Essex, J., Hackney, J., Cioccio, S., & Clarke, A. (2014). Going 'paperless' in an English national health service (NHS) breast cancer screening service: The introduction of fully digital mammography. *Health*, 6(5), 468–474. <https://doi.org/10.4236/health.2014.65065>
- Tengilimoğlu, D. (2016). *Health services marketing* (4th ed.). Siyasal Kitabevi.
- Turkish Statistical Institute. (2023). *Household information technology usage survey 2023*. [https://data.tuik.gov.tr/Bulten/Index?p=Hanehalki-Bilisim-Teknolojileri-\(BT\)-Kullanim-Arastirmasi-2023-49407](https://data.tuik.gov.tr/Bulten/Index?p=Hanehalki-Bilisim-Teknolojileri-(BT)-Kullanim-Arastirmasi-2023-49407)
- Uslu, F., & Demir, E. (2023). Nitel bir veri toplama tekniği: Derinlemesine görüşme. *Hacettepe Üniversitesi Edebiyat Fakültesi Dergisi*, 40(1), 289-299. <https://doi.org/10.32600/huefd.1184085>
- Uysal, Y. (2019). Kamu-Özel iş birliği (Yap-Kirala-Devret) modeli ve şehir hastanelerinin sağlık hizmetlerindeki değişim ve dönüşüm üzerine etkileri. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 14(3), 877-898.
- World Health Organization (2021). *Global strategy on digital health 2020-2025*. WHO. <https://apps.who.int/iris/bitstream/handle/10665/344249/9789240020924-eng>
- Wilson, J., Heinsch, M., Betts, D., Booth, D., & Kay-Lambkin, F. (2021). Barriers and facilitators to the use of e-health by older adults: A scoping review. *BMC Public Health*, 21, 1556. <https://doi.org/10.1186/s12889-021-11623-w>
- Yeung, A. W. K., Torkamani, A., Buttle, A. J., Glicksberg, B. S., Schuller, B., Rodriguez, B., Ting, D. S. W., Bates, D., Schaden, E., Peng, H., Willschke, H., van der Leek, J., Car, J., Rahimi, K., Celi, L. A., Banach, M., Kletecka-Pulker, M., Kimberger, O., Elis, R., ... Atanasov, A. G. (2023). The promise of digital healthcare technologies. *Frontiers in Public Health*, 11, 1196596. <https://doi.org/10.3389/fpubh.2023.1196596>
- Yıldırım, A., & Şimşek, H. (2021). *Nitel araştırma yöntemleri* (12th ed.). Seçkin Yay.
- Zade, M. B., Tiwade, Y. R., Shahu, S. G., & Surkar, S. (2024). Marketing technology in healthcare services: A narrative review. *National Journal of Community Medicine*, 15(6), 496-502. <https://doi.org/10.55489/njcm.150620243671>

Volatility Modelling of Cryptocurrencies According to Different Investment Horizons: The Case of Bitcoin *

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Abstract

In this study, the fractal structure, efficiency, and long memory features of Bitcoin are investigated according to different investment horizons. The study utilized daily returns from 01.01.2017 to 22.11.2023, applying the maximum overlap discrete wavelet transform, Rescaled Range (R/S) analysis, and volatility models. The analysis results revealed a deviation of Bitcoin returns from the average and a negative correlation, indicating a lack of permanent behaviour in the series. The analysis demonstrates the rejection of the efficient market hypothesis and reveals a chaotic structure in the Bitcoin market. Furthermore, we observed a hyperbolic rate of decrease in returns at long-term investment horizons due to information shocks. This indicates that past returns can predict future returns. This suggests that instead of the efficient market hypothesis, the fractal market hypothesis is valid due to the existence of recurring trends. Finally, we determined the most appropriate volatility models for Bitcoin. The analysis shows that information shocks in Bitcoin returns at medium- and long-term investment horizons decrease over time, and past returns can predict future returns. However, volatility and information shocks are transitory at short- and medium-term investment horizons but can vary. All analysis methods yield consistent and compatible results, suggesting their potential extension to other cryptocurrency markets beyond the Bitcoin market.

Keywords: *Cryptocurrency, Investment Horizon, Wavelet Analysis, Efficient Market Hypothesis, Fractal Market Hypothesis, Volatility, Bitcoin.*

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1. INTRODUCTION

Accelerated advancements in information technologies have profoundly influenced economic systems, particularly the progression of currencies. Historically, there has been a progression from barter systems to precious metals, representational currencies, and paper money, culminating in a notable transformation with the advent of digital currencies in the 21st century. Nakamoto introduced Bitcoin in 2008, and subsequently, over 22,000 cryptocurrencies have arisen, collectively valued at more than \$1 trillion (CoinMarketCap, 2023). Cryptocurrencies like Ethereum, Ripple, and Binance utilize blockchain and cryptographic technologies to facilitate decentralized peer-to-peer transactions without intermediaries like banking institutions. Their digital characteristics, autonomy from centralized entities, and divisibility differentiate these currencies from conventional financial assets, enabling them to obtain value from secure algorithms and transaction records rather than physical assets. The reduction of transaction costs and the principle of decentralization have facilitated the extensive acceptance of cryptocurrencies, culminating in significant price volatility and heightened transaction volumes. Initially utilized in online gaming, cryptocurrencies garner considerable attention from investors, regulators, and the media. With daily trade volumes over \$3 billion, these assets have gained significant prominence in global financial markets. Nonetheless, the considerable volatility of cryptocurrencies and the absence of complete regulatory frameworks indicate that they remain in a developmental stage as financial instruments. Consequently, cryptocurrencies have emerged as a significant subject of scholarly inquiry, underscoring the necessity for additional examination to comprehend their potential as a modern asset class and their ramifications for countries and investors. This field contains substantial information that can be enhanced through analysis utilizing the Efficient Market Hypothesis (EMH), the Fractal Market Hypothesis (FMH), and volatility models.

Louis Bachelier's work, published in 1900, has opened the debate on whether price movements in financial markets are random for many years. In this context, the Random Walk Hypothesis argues that there is no discernible trend in price movements, that past price data cannot predict future prices, and that it is impossible to beat the market. In other words, this hypothesis suggests that it is unlikely to achieve a consistent advantage in the market. The Random Walk Hypothesis has been tested for many years and largely parallels the EMH. The EMH posits that prices move randomly and that financial asset prices fully reflect all available information. In line with this assumption, it is accepted that asset prices exhibit a normal distribution. Additionally, The EPH argues that prices move randomly, and financial asset prices reflect all available information. Therefore, according to the EPH, asset prices are assumed to follow a normal distribution. Thus, the EPH can be characterised by linearity, continuity and stationarity. However, research and observations have revealed that financial asset prices often exhibit sharp and heavy-tailed distributions and significant anomalies in price movements. These findings indicate that financial asset prices have a nonlinear, discontinuous, and complex structure. Therefore, it has been understood that new hypotheses need to be developed to explain these price movements. In

this context, the FMH developed by Peters (1994) argues that financial asset prices exhibit Fractional Brownian Motion (FBM), and returns have a fractal distribution characterised by self-similarity and extended memory (Liu et al., 2022). FPH aims to explain the dynamics of financial markets more realistically by considering the irregular, volatile, and nonlinear nature of market movements. The fundamental assumptions of EPH fall short of explaining the crises, imbalances, chaos, distinct trends, speculative bubbles, and other anomalies in financial markets. In contrast, FPH provides a framework that can address such phenomena. While EPH generally focuses on a single investment horizon, FPH presents a broader perspective by acknowledging that investors may have different investment horizons. Thanks to these features, FPH allows for a more comprehensive analysis of market dynamics. As a result, FPH offers a more flexible and realistic approach to explaining crises, irregularities, distinct trends, and speculative bubbles in financial markets as an alternative to the unrealistic rigid assumptions of EPH. This different perspective has led to a growing interest in FPH. The FMH argues that financial instruments exhibit fractal characteristics over time and that financial time series display a self-similar structure when analyzed across different time scales. FPH also suggests that long-term memory and recurring structures at different investment horizons are present in price movements.

In this context, the Hurst exponent is the most commonly used method in long-term memory analysis. According to Hurst exponent coefficients, three different states of financial time series can be explained: a series having a long memory, meaning a trend; the series returning to its old average value; or the series exhibiting a completely random walk. Many methods are used to analyze different investment horizons in financial time series. Among these, the Maximum Overlapping Discrete Wavelet Transform (MODWT) is often preferred due to its lack of requirement for dyadic (powers of 2) properties and its more flexible structure (Gençay et al., 2002). The combined use of the Hurst exponent and wavelet analysis are effective methods in examining financial time series. These two analysis methods are of great importance in understanding behaviours in financial markets and developing investment strategies. The Hurst exponent is used to determine long-term trends in the price movements of financial assets and the tendency of the series to revert to its old mean. This information can help investors develop risk management strategies and make investment decisions focused on trend following or mean reversion. Wavelet analysis, on the other hand, can detect short-, medium-, and long-term cycles, volatility changes, and market anomalies in financial time series. This method allows for predicting market cycles and potential financial developments or crises in advance. Additionally, it contributes to adjusting risk levels according to market conditions. These two methods help investors and portfolio managers create balanced, risk-optimized portfolios, adapt to market dynamics, and make informed investment decisions. Hurst exponent and wavelet analysis have become fundamental tools of modern portfolio management. These methods can contribute significantly to understanding the cryptocurrency markets characterized by high volatility and complex structures. These methods are indispensable for developing a risk management and portfolio optimization strategy sensitive to the

cryptocurrency markets' rapid changes and unexpected price movements. The study aims to determine appropriate volatility models for cryptocurrencies according to different investment horizons and examine them within the EMH and the FMH framework. The study focuses on Bitcoin, the cryptocurrency with the highest market value (CoinMarketCap, 2023). The analysis of Bitcoin contributes to the consistency and significance of the findings, allowing for generalizable results for the cryptocurrency market. Additionally, the results of the analysis allowed the findings related to Bitcoin to be evaluated within the scope of EPH and FPH.

A review of the existing literature reveals that studies on the price movements of cryptocurrencies do not comprehensively address the fractal dynamics of prices, the existence of extended memory, wavelet analysis and volatility models. Moreover, existing studies generally focus on a single time scale and ignore market dynamics and investor behaviour over different investment horizons. This study performs a filtering process for different investment horizons using multiscaling analysis. The EPH argues that there is no link between past and future market prices and that earning above the market return is impossible. However, long memory in financial markets suggests that past price data can be used to predict future prices. While this situation questions the validity of the EPH, it allows investors to earn returns above the market average. In this framework, there is a contrast between EPH and FPH. FPH provides an important framework for understanding the complex structure of the markets to explain the dynamics of financial markets more comprehensively and realistically. The primary motivation of this study is that studies on the cryptocurrency market generally ignore different investment horizons. In this context, the study is expected to contribute to the literature. The research findings are expected to contribute significantly to a better understanding of the cryptocurrency market dynamics, developing effective investment strategies, optimal portfolio diversification and improving risk management practices. It is also expected to provide a more in-depth perspective on the fractal structure of the cryptocurrency market and the effects of extended memory. The structure of the study is as follows: The "Literature Review" section provides a general evaluation of relevant studies. The "Methodology" section defines the data used and summarizes the methods applied in the analysis. The "Findings" section presents the empirical results, while the "Conclusion" part summarizes the key insights and discusses policy recommendations.

2. LITERATURE REVIEW

The financial literature has frequently analyzed cryptocurrency markets under both the Efficient market hypothesis and the Fractal market hypothesis, with numerous studies examining the level of market efficiency and price dynamics in these markets. Studies conducted within the context of the Efficient market hypothesis suggest that cryptocurrency markets are generally not efficient in a weak form but may exhibit efficiency during specific periods. For instance, Urquhart (2016) analyzed Bitcoin's market efficiency using the BDS and R/S Hurst Exponent tests. The findings suggested that Bitcoin does not operate as an efficient market; however, the division of data into sub-periods revealed

periods of increased efficiency, indicating the potential for Bitcoin to achieve market efficiency in the future. Similarly, Nadarajah and Chu (2017), through BDS and Variance Ratio tests, observed that Bitcoin's market aligns with the efficient market hypothesis over time, asserting that no information loss accompanies this evolution. In a comparable analysis, Açıkalin and Sakınç (2022) employed Run Test and Variance Ratio Test analyses, concluding that the broader cryptocurrency market does not exhibit weak efficiency. Several studies focused on the persistence and long-memory properties of cryptocurrency markets. Bariviera (2017), using R/S and DFA analyses, determined that Bitcoin returns do not exhibit long memory, though its volatility does. Al-Yahyaee et al. (2018) employed MF-DFA methods to demonstrate multifractality and long memory traits across Bitcoin, gold, and other indices. They highlighted Bitcoin's more pronounced multifractality, implying lower market efficiency. Celeste et al. (2020) validated the fractal market hypothesis for Bitcoin, Ethereum, and Ripple, revealing that Bitcoin shows long memory and progresses toward maturity, while Ethereum and Ripple display speculative tendencies. Çelik (2020) indicated that the fractal market hypothesis was valid in the Bitcoin market in 2013-2019 and that financial bubbles and regime changes strengthen the long-memory structure of the market. Similarly, Sağlam Bezgin (2023), through R/S Analysis, confirmed the Fractal Market Hypothesis across various indices, with Bitcoin showing the highest persistence among cryptocurrencies and indices studied. A subset of research incorporated advanced econometric models to explore volatility and structural dynamics. Dyhrberg (2016) utilized GARCH and EGARCH models, revealing Bitcoin's high volatility persistence and symmetric market responses, emphasizing its value in financial markets. Mensi, Al-Yahyaee & Kang (2019) using FIGARCH, FIAPARCH, and HYGARCH models, found long memory and structural breaks in Bitcoin and Ethereum returns and volatility. Also, Mensi, Lee et. al. (2019) found that Bitcoin is less efficient than Ethereum and that market efficiency varies by time scale and sub-periods. Their findings were consistent with Eteman and Işığçok (2022), who applied FIGARCH to Bitcoin, Ethereum, and Cardano, affirming long memory through statistically significant parameters. The impact of external shocks on cryptocurrency market dynamics was another theme in the literature. Mnif and Jarboui (2021) observed that Bitcoin's fractal structure diminished post-pandemic, indicating improved efficiency. Similarly, Assaf et al. (2022) noted shifts in long-term memory during and after COVID-19, with DASH exhibiting persistent traits, while Ethereum, Litecoin, and Ripple showed reduced market efficiency. These results are similar to those found by Özdemir Yazgan (2022), who used ARFIMA-LSTM hybrid models to see Bitcoin's extended memory. This shows how advanced forecasting techniques can be helpful in changing market conditions. The comparative analysis of cryptocurrencies with traditional assets has also enriched the understanding of market efficiency. Morali and Uyar (2018), through R/S Analysis, validated the fractal market hypothesis across precious metals such as gold and platinum. Their findings resonate with those of Fakhfekh and Jeribi (2020), who used advanced GARCH models to highlight asymmetry in cryptocurrency responses to market information, drawing parallels to other asset classes. Similarly, Caporale et al. (2018) noted persistence in Bitcoin, Litecoin, Ripple, and DASH markets, emphasizing

the variability of persistence across periods. In conclusion, the reviewed studies collectively highlight the evolving nature of cryptocurrency markets, characterized by long memory, multifractality, and structural breaks. These traits challenge the weak form of the Efficient Market Hypothesis, offering a nuanced perspective on cryptocurrencies as an emerging asset class.

3. METHODOLOGY

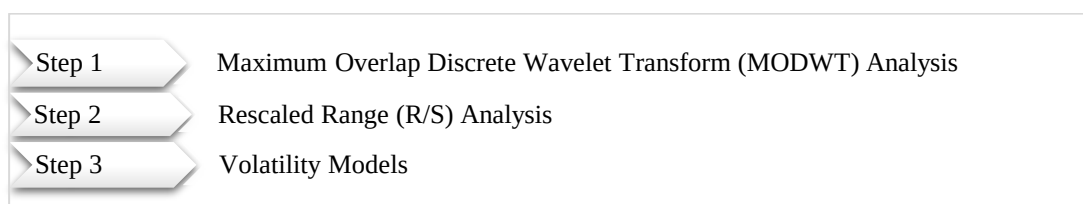
3.1. Aim of the Study and Data Set

This research aims to model the volatility of cryptocurrencies across different investment horizons. To achieve this, wavelet coefficients were calculated for the returns of Bitcoin cryptocurrency based on the Maximum overlap discrete wavelet transform. Following this, the return series were filtered into seven different time scales (investment horizons): D1 (2-4 days), D2 (4-8 days), D3 (8-16 days), D4 (16-32 days), D5 (32-64 days), D6 (64-128 days), and D7 (128-256 days), along with S7. Furthermore, we computed the Hurst exponent, representing the fractal structure, for each horizon by analyzing the returns generated from filtering the Bitcoin cryptocurrency across different investment horizons. Additionally, we utilized short-term and long-term memory models to capture the dynamics of time-varying volatility and the persistence of shocks affecting it. The study used daily closing prices of Bitcoin cryptocurrency sourced from the Bitstamp platform, calculated based on a global volume-weighted average of selected cryptocurrency exchanges worldwide and processed using the Python programming language. Data from January 1, 2017, to November 22, 2023 (totaling 2,517 days) were analyzed. The focus on Bitcoin's daily closing prices starting in 2017 stems from the substantial surge in interest from individual and institutional investors during this period, accompanied by increased liquidity and heightened volatility. In addition, focusing on Bitcoin, the cryptocurrency with the highest market capitalization, in the research and analysis is anticipated to improve the reliability and relevance of the findings, thus aiding in the broader application of the results to the overall cryptocurrency market. Bitcoin returns are calculated with the help of $r_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$ formula. $r_{i,t}$, price returns of the i 'th variable at time t and $P_{i,t}$ and $P_{i,t-1}$ denote the closing prices of the variables at time t and $t-1$, respectively.

3.2. Research Methodology

The analysis steps are depicted in Figure 1.

Figure 1. Steps of Analysis



3.2.1. Maximum Overlap Discrete Wavelet Transform (MODWT)

The Maximum Overlap Discrete Wavelet Transform (MODWT) is often used in economic and financial forecasting because it is flexible and can work around the problems with the Discrete Wavelet Transform (DWT). Like DWT, MODWT uses wavelet filters to decompose data into various scales and calculate wavelet coefficients. MODWT, on the other hand, has some significant benefits, like working with data sets of any size and having very accurate timing, which keeps the sample size and makes scale-specific wavelet coefficients. This enhances the ability to capture the underlying features of time series more effectively. The zero-phase property of MODWT makes it easier to understand wavelet details in the context of the original time series. This makes it a more asymptotically helpful tool for estimating wavelet variance. Unlike DWT, MODWT is non-orthogonal and does not require filtered output sampling but supports multi-scale analysis (In & Kim, 2012, p. 24). The pyramid algorithm (Mallat, 1989) is used to compute detail and approximation coefficients for efficient decomposition. These MODWT coefficients are represented as indicated in equation (1) (Gençay et al., 2002, p. 135):

$$\tilde{\mathbf{w}} = \tilde{\mathbf{W}}_x \quad (1)$$

In this equation (1), $\mathbf{x}$ represents the $N \times 1$ observation vector. $\tilde{\mathbf{W}}$, represents the $(J + 1) \times N \times N(J + 1) \times N \times N$ matrix that defines the MODWT in this equation. For $N > 2^J$, the discrete wavelet coefficients are expressed as follows:

$$\tilde{\mathbf{w}} = [\tilde{w}_1, \tilde{w}_2, \dots \dots \dots \tilde{w}_J, \tilde{v}_J]^T \quad (2)$$

Here, as in the DWT, $\tilde{\mathbf{w}}_i = N/2^i$ is expressed as dimension of a vector of wavelet coefficients and is associated with changes in the $\lambda_i = 2^{i-1}$ dimension of the scale. In addition, $\tilde{\mathbf{v}}_J, N/2^J$ is a vector of scaling coefficients and is related to changes in the $2^J = 2\lambda_J$ signal scale (Gençay et al., 2002, p. 136).

The pyramid algorithm used by the Maximum overlap discrete wavelet transform is similar to that of DWT. However, MODWT applies scaled versions of wavelet and scaling filters. Here $\mathbf{x}$ represents a vector of observations with NN dimensions, while $\tilde{h}_l = \tilde{h}_l/2^l, l = 0, 1, 2, \dots \dots \dots, L - 1$, denotes the rescaled wavelet filter (high-pass filter), and represents the rescaled scaling filter (low-pass filter). $\tilde{g}_l = \tilde{g}_l/2^l, l = 0, 1, 2, \dots \dots \dots, L - 1$ represents the rescaled scaling filter (low-pass filter) (Gençay et al., 2002, p. 136). The pyramid algorithm of MODWT is as follows: The MODWT pyramid algorithm requires three key components for each iteration: $\mathbf{x}$ data vector, h_l wavelet filter, and g_l scaling filter. Using wavelet and scaling filters, the observation vector $\mathbf{x}_t \quad \forall t = 0, 1, 2, \dots \dots \dots, N - 1$ is filtered. The first iteration begins by applying each filter to obtain the following wavelet and scaling coefficients (Gençay et al., 2002, p. 136):

$$\tilde{w}_{1,t} = \sum_{l=0}^{L-1} \tilde{h}_l \tilde{x}_{t-l \bmod N} \quad (3)$$

and

$$\tilde{v}_{1,t} = \sum_{l=0}^{L-1} \tilde{g}_l \tilde{x}_{t-l \bmod N} \quad (4)$$

Here, the obtained $\tilde{v}_{1,t}$ values are assigned as a new observation vector. Subsequently, $\tilde{v}_{1,t}$ is filtered using wavelet and scaling filters to derive the second level for $x_t \quad \forall t = 0, 1, 2, \dots, N-1$.

$$\tilde{w}_{2,t} = \sum_{l=0}^{L-1} \tilde{h}_l \tilde{x}_{1,t-l \bmod N} \quad (5)$$

and

$$\tilde{v}_{2,t} = \sum_{l=0}^{L-1} \tilde{g}_l \tilde{v}_{1,t-l \bmod N} \quad (6)$$

After obtaining the second level, the wavelet coefficient vector is designated as $\tilde{w} = [\tilde{w}_1, \tilde{w}_2, \tilde{v}_2]^T$ (Gençay et al., 2002, p. 137). The $v_{2,t}$ values obtained at the second level are set as the new observation vector. Then, $v_{2,t}$ is filtered for $\forall t = 0, 1, 2, \dots, N-1$ using wavelet and scaling filters. Here, the wavelet coefficient vector is assigned as $\tilde{w} = [\tilde{w}_1, \tilde{w}_2, \tilde{w}_3, \tilde{v}_3]^T$. This procedure can be repeated up to $J = \log_2(N)$ iterations, and the final wavelet coefficient vector is given as $\tilde{w} = [\tilde{w}_1, \tilde{w}_2, \dots, \tilde{w}_J, \tilde{v}_J]^T$ (Gençay et al., 2002, p. 137). The $\tilde{w}_J, \tilde{v}_J$ series obtained above are filtered using wavelet and scaling filter coefficients for $\forall t = 0, 1, \dots, N-1$ resulting in the $J-1$ dimensioned $\tilde{v}_{J-1}$ vector as shown below:

$$\tilde{v}_{J-1,t} = \sum_{l=0}^{L-1} \tilde{h}_{l,t+l \bmod N} + \sum_{l=0}^{L-1} \tilde{g}_l \tilde{v}_{J,t+l \bmod N} \quad (7)$$

The $J-2$ dimensioned $\tilde{v}_{J-2}$ vector is obtained as shown below (Gençay et al., 2002, p. 137):

$$\tilde{v}_{J-2,t} = \sum_{l=0}^{L-1} \tilde{h}_l \tilde{w}_{J-1,t+l \bmod N} + \sum_{l=0}^{L-1} \tilde{g}_l \tilde{v}_{J-1,t+l \bmod N} \quad (8)$$

This procedure can be repeated until the first wavelet level and scaling coefficients are combined to produce the original observation vector. The procedure continues until the first wavelet level, and the initial observation vector is obtained for $\forall t = 0, 1, 2, 3, \dots, N-1$ as shown in the following Equation (9) (Gençay et al., 2002, p. 137):

$$x_t = \sum_{l=0}^{L-1} \tilde{h}_l \tilde{w}_{1,t+l \bmod N} + \sum_{l=0}^{L-1} \tilde{g}_l \tilde{v}_{1,t+l \bmod N} \quad (9)$$

Wavelet analysis is a robust tool for analyzing time series data's time and frequency components, offering insights into short- and long-term trends, abrupt changes, and irregular patterns (Uyar, 2019, p. 141). It is particularly effective for non-stationary and complex time series, revealing how relationships between variables evolve across scales. In financial applications, wavelet analysis decomposes asset returns into various components, enabling an in-depth examination of volatility and risk transformation over time (Uyar & Kangallı Uyar, 2021, p. 316). This method is highly valuable in economics and finance due to its multiscaling capability, which is crucial in markets where participants operate on diverse investment horizons. Investors and portfolio managers often make decisions at different time scales, adding complexity to variable dynamics. By addressing these multi-scale dynamics, wavelet analysis provides critical insights into the temporal evolution of market behaviour (In & Kim, 2012, p. 5). Key techniques in wavelet analysis include General Wavelet Transform, stationary process-long memory analysis, denoising, and multiscaling. Multiscaling is particularly effective in understanding the time-varying nature of investments. Table 1 categorizes the cycle times corresponding to different horizons across annual, monthly, and daily scales.

Table 1. Wavelet Analysis Time Horizons by Multiscale Method

Scales (2^j)		Annual Frequency	Monthly Frequency	Daily Frequency
1	2^1	2-4	2-4	2-4
2	2^2	4-8	4-8	4-8
3	2^3	8-16	8-16 (8 months-1 year 4 months)	8-16
4	2^4	16-32	16-32 (1 year 4 months-2 years 8 months)	16-32(3 weeks 1 days-6 weeks 2 days)
5	2^5	32-64	32-64 (2 years 8 months-5 years 4 months)	32-64(6 weeks 2 days-12 weeks 4 days)
6	2^6	64-128	64-128 (5 years 4 months-10 years 8 months)	64-128 (12 weeks 4 days-25 weeks 3 days)
7	2^7	128-256	128-256 (10 years 8 months-21 years 4 months)	128-256 (25 weeks 3 days - 51 weeks 1 days)
8	2^8	256-512		

Source: Crowley (2007, p. 214). The theoretical maximum number of scales is expressed as 9. When the number of scales is denoted by j ($j=9$), frequencies are calculated using 2^j notation.

After conducting a wavelet analysis on the scale frequencies in Table 1, we will predict the specified number of scales and estimate coefficients for different investment horizons. In Table 1, we categorize the time scales as follows: The grouping is as follows: short-term, medium-term, and long-term. This categorization examines how investors' movements with short-, medium-, and long-term investment horizons evolve across different time scales. Short-term investment horizons represent short-term changes caused by shocks occurring in the 2–16-day time scales and encompass daily and weekly variations. Medium-term investment horizons represent medium-term changes occurring in the 32–128-

day time scales and encompass monthly and quarterly variations. Long-term investment horizons represent long-term changes in time scales of 256 days or more and correspond to periods that encompass annual variations (Uyar & Kangalli Uyar, 2021, p. 319).

3.2.2. Rescaled Range (R/S) Analysis

This method was developed by Hurst (1951) in a study on the Nile River flow rate, and the ‘Rescaled Range (R/S)’ test was proposed by Mandelbrot (1972, 1975) for use as a range or R/S statistic on the standard deviation. This method is the best-known non-parametric method for analysing long-term memory. The R/S statistic is an interval obtained by rescaling a time series using its standard deviation and partial sums of deviations from its mean. Taking $X_1, X_2, \dots, X_n$ as the return series of the sample and $\bar{X}_n = \frac{1}{n} \sum_j X_j$ as the mean, the classical R/S statistic is calculated using the following formula:

$$\tilde{Q}_n \equiv \frac{1}{S_n} \left[\max_{1 \leq k \leq n} \sum_{j=1}^k (X_j - \bar{X}_n) - \min_{1 \leq k \leq n} \sum_{j=1}^k (X_j - \bar{X}_n) \right] \quad (10)$$

where S_n denotes the usual (maximum likelihood). The standard deviation estimator is formulated as follows:

$$S_n \equiv \left[\frac{1}{n} \sum_j (X_j - \bar{X}_n)^2 \right]^{1/2} \quad (11)$$

It is formulated as follows. The first term in brackets in equation (10) represents the maximum value of the first k deviations of the absolute values of the deviations of the X_j values from the sample mean (over k). Since the deviations of X_1 from the mean are 0 (zero), this maximum value does not always take a negative value. On the other hand, the second term in brackets represents the minimum value (over k) of the same set of partial sums of X_j . However, this minimum value is always positive. Therefore, the difference between these two terms, called the range, takes a value greater than or equal to zero. In short, the difference between the two terms never takes a negative value ($Q_n \geq 0$) (Lillo & Farmer, 2004, p. 6; Lo, 1991, pp. 1286-1287). Although the usability of this method depends on the highest and lowest values in the dataset, the effect of outliers should be taken into account. Due to this effect, the technique can only be applied to stable and trend-free time series (Cao et al., 2018, p. 2). If a time series is stationary and does not have the long memory property, the R/S statistic tends to approach a random variable at a rate of $T^{1/2}$. If a stationary time series y_t has the long memory property, Mandelbrot (1975) showed that the R/S statistic converges to a random variable at the rate H^T (where H is the Hurst parameter). Based on this result, if a time series exhibits short memory, depending on the sample size, the log-log plot of the R/S statistic should be distributed around a straight line with a slope of $1/2$. However, in the case of a time series with long memory, if the sample size is large enough, the

log-log plot should be distributed around a straight line with slope $H > 1/2$ (Zivot & Wang, 2006, p. 280). Mandelbrot and Wallis (1969), addressed issues such as autocorrelations, variance ratios and spectral decompositions to demonstrate the superiority of R/S analysis over conventional methods for detecting long-run dependence. For example, Mandelbrot and Wallis (1969) showed through Monte Carlo simulations that the R/S statistic can detect long-run dependence in non-Gaussian time series with skewness and kurtosis. Mandelbrot (1972, 1975) also emphasised that for stochastic processes with infinite variance, the R/S statistic converges almost surely and provides a distinct advantage over autocorrelations and variance ratios in such processes (Lo, 1991, p. 12867). In their 1969 study, Mandelbrot and Wallis defined metrics called ‘Hurst Exponent’ to determine the long memory feature. They also developed a graphical technique to assess these metrics by utilising R/S analysis.

3.2.3. Short and Long Memory Volatility Models

3.2.3.1. Generalized Autoregressive Conditional Variance (GARCH) Model

ARCH models serve as the basis for volatility modelling but lack a definitive method for selecting lag order, leading to potentially complex models and parameter estimation issues. These limitations prompted Bollerslev (1986) to extend Engle’s ARCH model by incorporating ARMA processes, resulting in the Generalized Autoregressive Conditional Heteroskedasticity (GARCH, p, q) model. Unlike ARCH, GARCH models account for both past errors and previous conditional variances, providing a more comprehensive framework for modelling volatility (Rachev et al., 2007, p. 284). This extension addresses the shortcomings of ARCH models, offering greater flexibility in capturing the dynamics of conditional variance in financial time series (Rachev et al., 2007, p. 284). Bollerslev’s (1986) simplest GARCH model is:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 + \beta_1 h_{t-1}^2 + \dots + \beta_q h_{t-q}^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j h_{t-j}^2 \quad (12)$$

In this equation, the coefficient α_1 indicates the short-term effect and the coefficient β_1 indicates the long memory effect, i.e. the memory of the shocks to the series (Engle, 2002, p. 342). GARCH(p,q) condition; If $\omega > 0$, $\alpha_1 \geq 0$, $\beta_1 \geq 0$, $\alpha_1 + \beta_1 < 1$, the effect of shocks on the conditional variance is not permanent (terminated) (Davidson & Mackinnon, 2004, p. 579; Tsay, 2010, p. 133). If $\alpha_1 + \beta_1 < 1$, the effect of shocks is permanent, and if $\alpha_1 + \beta_1 > 1$, shocks have a long memory feature (Brooks, 2008, p. 423).

3.2.3.2. GARCH-M Model (GARCH-MEAN)

The return of a financial asset may depend on its volatility in the financial market. In order to model such a phenomenon, the GARCH-M model, where M (Mean) is GARCH on average, can be used (Tsay, 2010, p. 142). GARCH models are arguably more popular than ARCH models. A GARCH-M model takes the following form (Brooks, 2019, pp. 525-526):

$$y_t = \mu + \delta\sigma_{t-1} + \mu_t, \quad \mu_t \sim N(0, \sigma_t^2) \quad (13)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1\mu_t^2 + \beta\sigma_{t-1}^2 \quad (14)$$

In equation (13), y_t indicates that the return series is serially correlated. When δ is positive and statistically significant, the average return rises as a result of the increase in conditional variance. Therefore, it may be possible to interpret δ as a risk premium (Brooks, 2019, pp. 525-526).

3.2.3.3.C-GARCH Model (Component GARCH)

$$\sigma_t^2 = q_1 + \alpha_1(\varepsilon_{t-1}^2 - q_{t-1}) + b_1(\sigma_{t-1}^2 - q_{t-1}) \quad (15)$$

$$q_t = \alpha_0 + pq_{t-1} + \theta(\varepsilon_{t-1}^2 - \sigma_{t-1}^2) \quad (16)$$

q_t : is the long memory volatility, whereas the first equation is the non-permanent component (short-term volatility movements) that approaches 0 with the power of $(\alpha + \beta)$ and the second equation is the long-run component that approaches q_t with the power of p (Ding & Granger, 1996).

3.2.3.4. FIGARCH Model

In the context of financial market volatility, the Fractionally Integrated Generalized Autoregressive Conditional Heteroscedastic (FIGARCH) model, developed by Baillie et al. (1996), has the potential to provide more accurate and suitable results for conditional variance processes. Compared to the GARCH model, FIGARCH can reflect long-range dependencies more precisely and flexibly. The key difference between the two models is that while older shocks in the time series tend to decay rapidly, the impact of recent shocks persists hyperbolically for an extended period (Kasman & Torun, 2007, p. 17). The FIGARCH(p, d, q) model can be formulated using the following equation:

$$[1 - \alpha(L) - \beta(L)](1 - L)^d \varepsilon_t^2 = \omega + [1 - \beta(L)]v_t \quad (17)$$

Here ω represents the constant value, α represents the coefficient of the ARCH model, β represents the coefficient of the GARCH model, and d represents the fractional differencing parameter, which indicates the degree of long memory. In this context, d is a value within the range $0 < d < 1$. Such a model exhibits a much more flexible structure compared to GARCH-type models used to explain the transient dependencies observed in financial market volatility (Davidson, 2004, p. 20). The FIGARCH model can be briefly explained as follows:

$$\phi(L) (1 - L)^d \varepsilon_t^2 = \omega + [1 - \beta(L)]v_t \quad (18)$$

ε_t^2 , represents the squared errors of the GARCH process. It is assumed that all roots of $\phi(L)$ and $[1 - \beta(L)]$ lie outside the unit circle to ensure the stationarity of the process.

When $d = 0$ FIGARCH (p, d, q) process becomes GARCH (p, q).

When $d = 1$ FIGARCH (p, d, q) process becomes IGARCH (p, q). This situation implies that shocks have an infinite impact on future volatility.

If $0 < d < 1$ FIGARCH (p, d, q) process indicates that the impact of shocks on variance decreases hyperbolically.

3.2.3.5. HYGARCH Model

The Hyperbolic GARCH (HYGARCH) model was developed by Davidson in 2004 to test whether the Fractionally Integrated GARCH (FIGARCH) model exhibits a stationary structure. This model is used to detect long-term memory in conditional variance. Proposing the inclusion of weights in the difference operator to expand the conditional variance of the FIGARCH model, Davidson (2004) states that the HYGARCH model should be as follows:

$$h_t^2 = \omega[1 - \beta(L)]^{-1} + [1 - (1 - \beta(L))^{-1}\rho(L)\{1 + \alpha(1 - L)^d\}]\varepsilon_t^2 \quad (19)$$

In equation (17) the Hyperbolic GARCH model is obtained by replacing $(1 - L)^d$ with $\{1 + \alpha[(1 - L)^d]\}$ in the FIGARCH model. The coefficient α represents the weight factor's coefficient. Generally, in model estimation, the coefficient α is used as $\ln(\alpha)$ or $\log(\alpha)$. When $\alpha = 1$ or $\ln(\alpha) = 0$ the model reduces to the FIGARCH model, and this process becomes stationary when $\ln(\alpha) < 0$ (Davidson, 2004). While FIGARCH and HYGARCH models effectively capture volatility clustering and long memory in financial time series, they fail to detect asymmetry in return volatility (Eyüboğlu & Eyüboğlu, 2022, p. 25).

4. FINDINGS

Table 2. Descriptive Statistics of Bitcoin Return Series

	Mean	Maximum	Minimum	Standard Deviation	Skewness	kurtosis	Jarque-Bera	P. Value	Number of Observations
Bitcoin	0.0014	0.2383	-0.4939	0.0398	-0.7788	15.194	15850.9	[0.0000]	2517

Note: ***, ** and * represent statistical significance at the 1%, 5%, and 10% confidence intervals, respectively.

Table 2 presents the descriptive statistics for the Bitcoin return series. Examining Table 2, it can be stated that while the average return shows a positive trend with 0.14%, the maximum return of 23.83% and the minimum return of -49.39% indicate a wide fluctuation range and high volatility (3.98%). The skewness value is expected to be 0 (zero) in a normal distribution. However, the negative skewness value (-0.7788) indicates that the distribution is left-skewed, and the kurtosis value (15.194) is observed to be positive and greater than 3. This shows a more peaked (leptokurtic) structure than a normal distribution. Finally, the Jarque-Bera statistic rejects the hypothesis “H0: the series is consistent with a normal distribution. Due to the very high value of the Bitcoin return series, it is observed that the series does not exhibit a normal distribution. The statistical results for the ARCH-LM and Ljung-Box test statistics for the Bitcoin return series are presented in Table 3.

Table 3. ARCH-LM and Ljung-Box Test Statistics for Bitcoin Return Series

	ARCH (2)	ARCH (5)	ARCH (10)	Q (5)	Q (10)	Q (20)	Q ² (5)	Q ² (10)	Q ² (20)
Bitcoin	13.817***	8.299***	5.116***	14.224**	19.929**	26.561	48.419***	63.996***	79.793***

Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% confidence levels. [] indicates p-values, and Q and Q² represent the Ljung-Box test for independence of return and squared return series, respectively. ARCH(2,5,10) refers to the ARCH-LM test for order (2, 5, and 10).

Examining the ARCH-LM and Ljung-Box (Q and Qsquare) statistics in Table 3, variance issues in the residuals of the included Bitcoin return series are evident up to lag 2, 5, and 10. Ljung-Box (Q and Qsquare) test statistics for different lag orders were used to assess the independence of the return error and squared return error series for the variables. Analysis of the statistical results reveals an autocorrelation problem in Bitcoin's logarithmic return series. In other words, the analysis relates the logarithmic return series of the Bitcoin cryptocurrency to its past values.

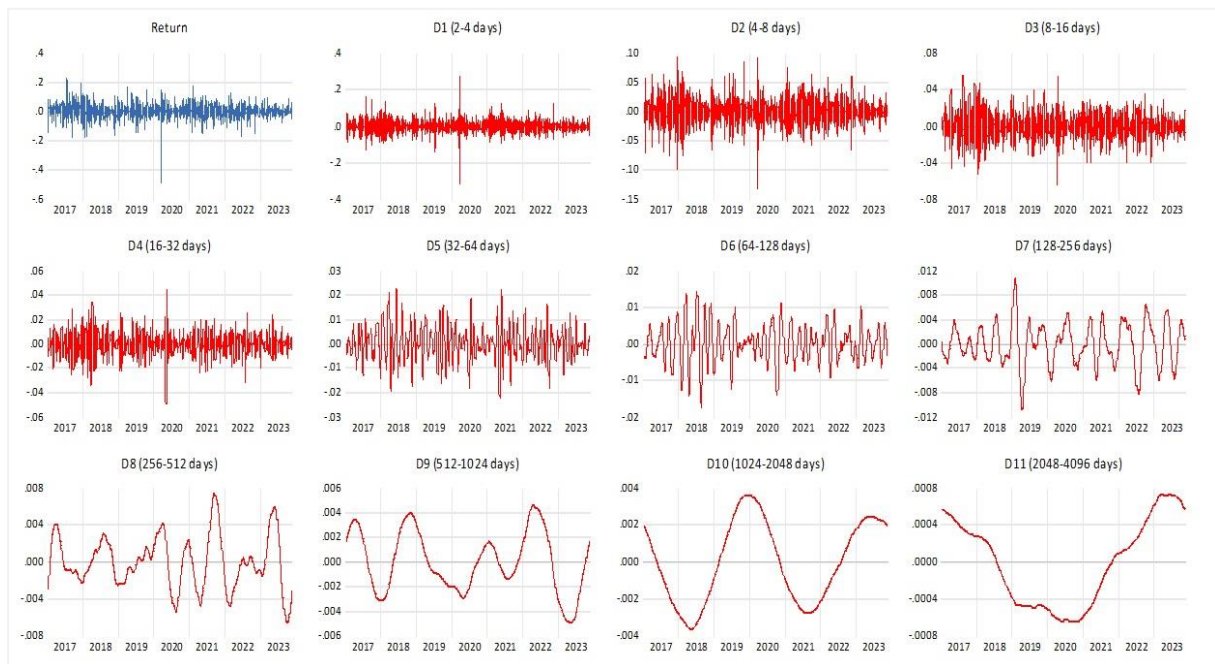
Table 4. Unit Root Test Results for Bitcoin

	Model	Level			Return		
		ADF	PP	KPSS	ADF	PP	KPSS
Bitcoin	With constant	-1.4024	-1.4124	3.4584	52.8097***	-52.7415***	0.2168
	With constant and Trend	-1.9326	-1.9350	0.4477	52.8317***	-52.7613***	0.0822

Note: In the ADF test, the maximum lag was set to 26, and the optimal lag was determined using the Schwarz Information Criterion. For the PP and KPSS tests, the long-run variance was obtained using the Bartlett kernel estimator, and the bandwidth was determined using the Newey-West method. For the ADF and PP tests, the critical values are -3.433122 (1%), -2.862651 (5%), and -2.567407 (10%) for the model with a constant; and -3.962212 (1%), -3.411849 (5%), and -3.127817 (10%) for the model with a constant and a trend. For the KPSS test, the critical values are 0.739000 (1%), 0.463000 (5%), and 0.347000 (10%) for the model with a constant, and 0.216000 (1%), 0.146000 (5%), and 0.119000 (10%) for the model with a constant and a trend. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Analyzing how a variable's previous values influence its current state provides insight into a time series' long-term characteristics. Regression analysis across periods helps reveal the series' evolution. To check for stationarity, unit root tests like the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are very important (Tari, 2014, p. 387). Table 4 presents the results of these tests for the Bitcoin price and return series analyzed in this study. For the ADF and PP tests, the null hypothesis (H₀) assumes non-stationarity (I(1)), while the KPSS test assumes stationarity (I(0)). All tests found the Bitcoin price series to be non-stationary. However, the return series produced significantly negative ADF and PP test statistics, thereby rejecting the null hypothesis of non-stationarity. Conversely, the KPSS test confirmed stationarity, failing to reject its null hypothesis. These results indicate that the Bitcoin return series exhibits a stationary structure. The MODWT was used to break down Bitcoin returns, as shown in Figure 2. The scale was set to the seventh level to balance information richness and detail preservation. Scaling could theoretically go up to the 11th level ($\log_2(2517) = 11.3$), but keeping it at the 7th level ensures the best insights without filtering too much. The wavelet-based decomposition highlights the underlying structure and dynamics of Bitcoin returns at different scales.

Figure 2. Graphs of Returns and Different Time Scale Return Series for Bitcoin



Note: This figure presents the multiresolution analysis of BTC's daily series using the Maximum overlap discrete wavelet transform data from 01/01/2017-22/11/2023. The Y-axis shows the multiscale movement of returns. The series is decomposed using a Daubechies wavelet filter of length seven (7) at the scale level $J = 1$ to 7 (or 2-128 days). The periodic boundary condition is applied to solve the extreme wavelet coefficients.

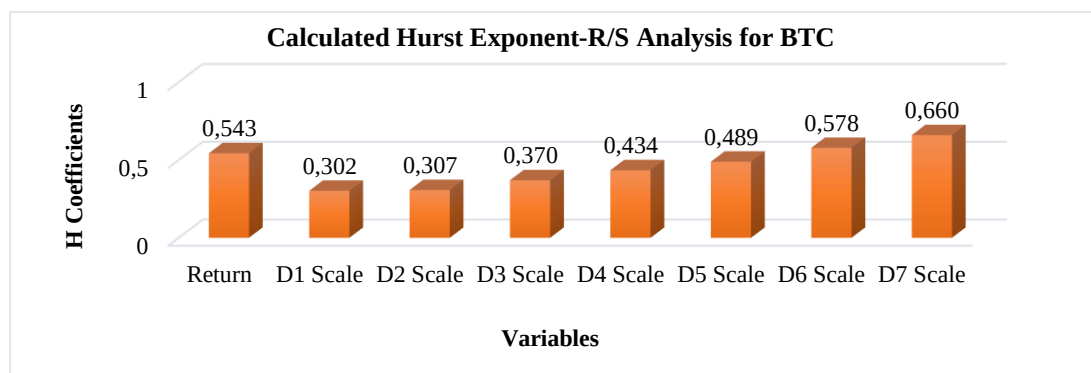
This study applied the Hurst exponent and R/S analysis, which Hurst (1951) developed to identify long-term memory properties in time series data. Detailed analyses of Bitcoin were conducted, calculating Hurst exponent (H) coefficients for return series across various investment horizons. This method was employed to understand better the complexity and dynamics of the Bitcoin cryptocurrency market. The results obtained provide both quantitative and qualitative insights. Table 5 presents the calculated Hurst exponent for Bitcoin in detail, while Figure 3 further clarifies it graphically.

Table 5. Hurst Exponent - R/S Analysis Results Calculated for Bitcoin

	Calculated Hurst Exponent (H) R/S Analysis	Confidence Intervals
Bitcoin Return	0.543	0.3979-0.5966 ^b
D1 Scale	0.302 ^{***}	0.3684-0.6262 ^a
D2 Scale	0.307 ^{***}	0.3684-0.6262 ^a
D3 Scale	0.370	0.3979-0.5966 ^b
D4 Scale	0.434	0.3979-0.5966 ^b
D5 Scale	0.489	0.3979-0.5966 ^b
D6 Scale	0.578	0.3979-0.5966 ^b
D7 Scale	0.660 ^{***}	0.3979-0.5966 ^a

Note: The returns to scale obtained according to different investment horizons in the table are categorized as (D1 = 2-4 days, D2 = 4-8 days, D3 = 8-16 days, D4 = 16-32 days, D5 = 32-64 days, D6 = 64-128 days, D7, 128-256 days). The symbols ^{***}, ^{**}, and ^{*} indicate statistical significance at the 1% (0.3684-0.6262)^a, 5% (0.3979-0.5966)^b, and 10% (0.4137-0.5811)^c confidence levels, respectively. The Hurst exponent confidence interval values at the 1%, 5%, and 10% levels were obtained from Weron (2002).

Figure 3. Hurst Exponent Graph Calculated for Bitcoin



When examining the results presented in Table 5 and Figure 3, the Hurst exponent coefficients calculated for the returns of the Bitcoin cryptocurrency according to short-, medium-, and long-term investment horizons have been determined. It has been determined that the lowest Hurst exponent coefficient, 0.302, is found in the 2–4-day data of the D1 short-term investment horizon. The highest Hurst exponent value was observed at 0.660 in the D7 long-term investment horizon with 128–256-day data. Theoretically, when the Hurst exponent approaches the value of 1, the level of noise in the series decreases, and the expected values deviate from the Random Walk Hypothesis (Mulligan, 2004). In line with this information, when evaluating the findings for the Bitcoin cryptocurrency, it is observed that the calculated Hurst exponent for Bitcoin returns is 0.543. Therefore, this finding differs from the $H = 0.50$ value assumed by the efficient market hypothesis. According to the fractal market hypothesis, a Hurst exponent coefficient of less than 0.50 indicates that the series lacks continuity, deviates from the mean, possesses negative autocorrelation, and exhibits a mean-reversion process. In this case, it is stated that increases/decreases are likely to be followed by movements in the opposite direction. On the other hand, the Hurst exponent greater than 0.50 indicates that the series exhibits persistent and trend-reinforcing behaviour, meaning the presence of long memory and the validity of the fractal market hypothesis. The Hurst exponent calculated for Bitcoin returns being 0.543, which is greater than the value of $H = 0.50$, indicates that Bitcoin returns do not conform to the assumptions of the efficient market hypothesis and do not exhibit a random walk; instead, they show a discrete Brownian motion as specified by the fractal market hypothesis. Additionally, this finding supports that Bitcoin returns exhibit a continuous, trend-reinforcing persistent behaviour and the presence of long memory. When looking at the long-term investment horizons D6 and D7, it is observed that the Hurst exponents are 0.578 and 0.660, respectively. These values are more significant than 0.50, indicating that information shocks reaching the market are eliminated at a hyperbolic rate on long-term investment horizons, and future returns can be predicted based on past returns. This situation indicates that the efficient market hypothesis is invalid in long-term investment horizons and that the market creates repeating trends. Thus, the fractal market hypothesis is valid. The fact that the Hurst coefficients in long-term investment horizons take similar values across the entire sample provides evidence of self-similarity, that is, fractality. On the other hand, when the short-term investment horizons (D1, D2, and D3) were examined,

the Hurst exponent values were calculated as 0.302, 0.307, and 0.370, respectively. Since these values are below 0.50, it has been concluded that there is no behaviour consistent with the assumptions of the efficient market hypothesis in Bitcoin returns and that the series does not exhibit a random walk. Similarly, for medium-term investment horizons (D4 and D5), the Hurst exponent values are 0.434 and 0.489, respectively. Since these values are also below 0.50, it has been determined that the assumptions of the efficient market hypothesis do not hold for Bitcoin returns and that the series does not exhibit a random walk. These findings, obtained in both short- and medium-term investment horizons, indicate that Bitcoin returns exhibit a chaotic structure and that investors may react to incoming market information more than they would in an efficient market, causing sharp and high volatility.

Short and long-memory models play a critical role in examining the effects of volatility and shocks that change over time in the cryptocurrency market. Short-memory models are successful in understanding the short-term effects of volatility dynamics. For example, the GARCH model is frequently preferred to model the current period's volatility based on the volatility of past periods. On the other hand, long-memory models are used to analyze long-term dependencies and trends in financial time series. The FIGARCH model is widely used to examine the long-memory characteristics of cryptocurrency price movements. In analyzing cryptocurrency markets, combining short and long-term models allows for a better understanding of the market's volatility structure, the effects of shocks, and how market behaviours change over time. It should be noted that cryptocurrency markets have different dynamics compared to traditional financial markets. Therefore, the development of risk management and investment strategies specific to cryptocurrency markets is of great importance. The volatility modelling results for Bitcoin according to different investment horizons are provided in Table 6. To determine the most suitable model for Bitcoin, both short-memory and long-memory presence and the validity of the EMH and the FMH were tested. ARCH, GARCH, EGARCH, T-GARCH, GJR-GARCH, C-GARCH, APARCH, GARCH-M, HYGARCH, FIGARCH, FIAPARCH, and FIEGARCH models ($p, q = 0, 1, 2$) were estimated in the p and q ranges. These models were evaluated based on the log-likelihood value and AIC, SIC, and HQ information criteria, and the most suitable volatility models were selected. The α and β parameters in Table 6 represent the coefficients of the ARCH and GARCH terms, respectively. Here, α represents the ARCH effect, which predicts the response to any shock or news in the cryptocurrency market. β , on the other hand, represents the GARCH effect that defines the persistence of volatility. A high α coefficient indicates that the volatility is more sensitive to incoming news; a high β coefficient, on the other hand, suggests that the volatility is more persistent and that this effect dissipates more slowly. In the GARCH model, the sum of α and β is expected to be less than 1. The Component GARCH (1,1) model, on the other hand, is a method used to model the volatility of financial time series and separates volatility into two components: persistent (long-term) and transitory (short-term) components. The parameters theta (θ) and rho (ρ) represent the components of the C-GARCH (Component GARCH) model, while " d " denotes the long memory parameter. The long

memory parameter " d " has been interpreted according to the value ranges presented in the studies by Hosking (1981) and Tkacz (2001, p. 23). This parameter is used to measure the presence of long-term dependencies in the series. Table 6 presents the findings obtained from the analyses for Bitcoin.

Table 6. Volatility Modeling Results for Bitcoin According to Different Investment Horizons

BTC- Return		D1	D2	D3	D4	D5	D6	D7
Optimal Volatility Model	HYGARCH (1,d,1)	AR(1) MA(1) C-GARCH (1,1)	C-GARCH (1,1)	AR(1) GARCH-M (1,1)	AR(1) MA(1) GARCH (1,1)	AR(1) MA(1) GARCH (1,1)	AR(1) FIGARCH (1,d,1)	AR (1) MA (1) FIGARCH (1,d,1)
Mean Equation								
Constant (c)	0.001162 (0.00045224)**	9.06e-09 (2.07e-07)	1.52e-05 (0.000220)	-0.020387 (0.002012)***	7.96e-05 (0.000651)	-0.000888 (0.001043)	0.118386 (0.74723)	0.113983 (0.007925)***
AR	-	-0.493505 (0.0119438)***	-	0.826489 (0.010019)***	0.927651 (0.007298)***	0.986310 (0.001890)***	0.999069 (0.0060204)***	0.9996008 (0.9478e-00)***
MA	-	-0.998978 (0.000476)***	-	-	0.999275 (0.000443)***	0.988898 (0.000299)***	-	0.967708 (0.003214)***
Variance Equation								
Constant (ω)	-0.060869 (0.18434)	0.011282 (0.023788)	0.036116 (0.026355)**	5.94e-06 (5.01e-07)***	7.10e-08 (1.28e-08)***	2.81e-08 (2.37e-09)***	0.085982 (0.049328)*	0.347665 (0.139680)**
d-Figarch	0.614177 (0.13830)***	-	-	-	-	-	0.733670 (0.050443)***	0.832334 (0.025514)***
ARCH (α)	0.344742 (0.085068)***	0.113867 (0.023601)***	0.112865 (0.042401)***	0.648055 (0.037057)***	0.248612 (0.020794)***	0.593614 (0.036564)***	0.533356 (0.12439)***	0.102953 (0.017328)***
GARCH(β)	0.826760 (0.066608)***	0.552241 (0.071324)***	0.646333 (0.046807)***	0.379450 (0.018769)***	0.739983 (0.017795)***	0.309394 (0.025707)***	0.277347 (0.16687)*	0.040838 (0.021817)*
C-GARCH(ρ)	-	0.999847 (0.000329)***	0.999950 (5.10e-15)***	-	-	-	-	-
C-GARCH(θ)	-	0.225272 (0.034579)***	0.267109 (0.041138)***	-	-	-	-	-
GARCH-M	-	-	-	-1.172661 (0.025294)***	-	-	-	-
Log (α)	0.126340 (0.070794)*	-	-	-	-	-	-	-
AIC	-3.978168	-5.967514	-5.466327	-7.255935	-10.25342	-12.65830	-13.602058	-17.289134
SIC	-3.961952	-5.946658	-5.450111	-7.239714	-10.23720	-12.64208	-13.585842	-17.268284
HQ	-3.972283	-5.959945	-5.460442	-7.250048	-10.24753	-12.65241	-13.596172	-17.281567
Log-Likelihood	5013.525	7516.133	7886.373	9134.966	12905.80	15931.140	17125.189	21767.375

Note: The symbols ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively, while () indicates the standard errors.

The analysis identifies the HYGARCH (1, d ,1) model as the most suitable for Bitcoin returns, with the parameter " d " representing long memory, valued at 0.614177 and statistically significant at the 1% level. This indicates that Bitcoin returns exhibit a substantial long-memory property, where past trends influence current price movements. Long memory implies that volatility arises from the long-term effects of prior informational shocks, decaying at a hyperbolic rate. Consequently, forecasting Bitcoin returns using historical data is viable. The α coefficient of 0.344742 indicates that approximately 34% of the informational shocks are derived from past periods, while the β coefficient of 0.826760 suggests that shocks persist across consecutive periods. These findings reveal Bitcoin's volatile structure, where periods of high or low volatility tend to follow similar periods. The $\text{Log}(\alpha)$ value of $0.126340 < 1$ implies that short-term volatility effects are limited and diminish over time, while long-memory effects dominate. The analysis supports the fractal market hypothesis over the efficient market hypothesis, highlighting Bitcoin's chaotic and non-stationary market dynamics. For short-term investment horizons, models such as AR(1), MA(1), and C-GARCH(1,1) are most suitable, particularly for 2-4 day and 4-8 day periods. The θ coefficients of 0.225272 and 0.267109 suggest a permanent but moderate volatility component, where short-term market disruptions amplify long-term volatility. This heightens sensitivity to short-term fluctuations, requiring market participants to account for cumulative risk impacts in their strategies. Additionally, the negative θ coefficient of the GARCH-M model for the 8-16 day horizon suggests that higher risk (volatility) negatively impacts average returns, contradicting the conventional risk-return tradeoff. This implies investors anticipate lower returns during heightened volatility, diverging from traditional market expectations. For medium-term investment horizons, AR(1), MA(1), and GARCH(1,1) models demonstrate strong predictive capacity for 16-32 day and 32-64 day periods. The α and β coefficients, statistically significant at the 1% level, indicate that informational shocks are carried over from previous periods, with cumulative sums of these coefficients close to 1, signifying persistent but eventually diminishing volatility effects. These results show that Bitcoin doesn't behave like itself in the short and medium term. This suggests that the market is more sensitive to new information and doesn't behave as the efficient market hypothesis says it should. For long-term investment horizons of 64-128 days and 128-256 days, the most appropriate models are AR(1) FIGARCH(1, d ,1) and AR(1) MA(1) FIGARCH(1, d ,1). The d coefficients, 0.733670 and 0.832334, respectively, confirm the strong long-memory properties of Bitcoin returns. This indicates that historical trends significantly influence current price movements, with the long-term effects of prior informational shocks fading gradually. The α coefficients of 0.533356 and 0.102953 show that 53% and 10% of informational shocks for these periods come from past volatility, respectively. The β coefficients of 0.277347 and 0.040838 show that shocks from the past are still affecting volatility today. Findings validate the fractal market hypothesis, indicating that Bitcoin's volatility exhibits short- and long-term memory components. For adequate portfolio diversification, risk-seeking investors should focus on short- and medium-term horizons (2-4 days to 32-64 days), where market volatility is more pronounced. On the other hand, we advise risk-averse or neutral investors to concentrate on long-term horizons (64-

256 days), where volatility effects diminish over time, thereby enabling more stable returns. Incorporating Bitcoin into portfolios, particularly within these identified horizons, can enhance diversification benefits and mitigate the risks associated with its volatile nature. In conclusion, understanding Bitcoin's volatility dynamics and employing appropriate models for different investment horizons provide valuable insights for portfolio managers, researchers, and investors. Strategies tailored to Bitcoin's unique market behaviour can improve decision-making, manage risks effectively, and optimize diversification in the cryptocurrency market.

5. CONCLUSION

The cryptocurrency market, originating with Bitcoin and proliferating with several cryptocurrencies, has emerged as a significant alternative asset class. It provides investors with chances for portfolio diversification and enhanced risk-return tradeoffs. The expanding market, characterized by rising value and volume, needs comprehensive comprehension from investors, scholars, and regulators to traverse its distinct dynamics adeptly. This study aims to model the volatility of cryptocurrencies across different investment horizons. We calculated the Hurst exponent, which quantifies the fractal characteristics of the series, using the filtered returns across these time scales. Lastly, we applied short- and long-memory models to capture the dynamics of time-varying volatility and the persistence of shocks affecting it.

The MODWT analysis reveals that overall returns and those across various investment horizons are volatile. Moreover, similar periods of low volatility typically follow low-volatility phases, while high-volatility phases tend to precede subsequent high-volatility periods. Additionally, the cryptocurrency exhibits fractal properties, including self-similarity and self-affinity. We also find that Bitcoin returns exhibit fractal dynamics across various investment horizons. In the short term, entering positive or negative information into the Bitcoin market significantly influences BTC returns and intensifies volatility. However, we observe that the impact of these information shocks is transient. In medium-term investment horizons, information shocks affecting the Bitcoin market have shown a certain level of persistence, with transitions between market regimes potentially lasting. The persistence of these shocks appears to grow within each regime. In long-term investment horizons, the impact of information shocks gradually weakens, with annual cycles becoming more apparent over time. These cycles reflect low-frequency trends and long-memory traits in Bitcoin returns. As a result, the MODWT analysis has shown that BTC returns across different investment horizons exhibit enduring fluctuations under varying market conditions and display fractal volatility characteristics.

The Hurst exponent coefficients reveal that both Bitcoin and long-term investment horizon returns have a Hurst exponent greater than 0.50. This finding suggests that BTC returns and returns in long-term investment horizons violate the efficient market hypothesis, as the return series exhibit persistent, trend-reinforcing, and continuous behaviour. This implies the existence of a long-term

memory. Therefore, the fractal market hypothesis may be relevant to the Bitcoin market. According to observations, information shocks impacting the BTC cryptocurrency market tend to dissipate gradually over long-term investment horizons. Therefore, we can forecast future returns based on past returns. In addition, the fact that the Hurst exponent (the exponent) stays the same across the whole sample over long-term investment horizons shows that the data is self-similar and has fractal properties. Conversely, the Hurst exponents for returns in short- and medium-term investment horizons fall below 0.50. This result indicates a deviation from the assumption of the efficient market hypothesis, which posits $H = 0.50$. These findings suggest that short- and medium-term investment horizons may entirely reject the EMH, and the returns do not display a random walk behaviour. According to the fractal market hypothesis, a Hurst exponent (H) lower than 0.50 signifies that the series lacks persistence, tends to deviate from the mean, and exhibits negative autocorrelation. This implies that the series displays non-persistent behaviour and undergoes a mean reversion process. It also suggests that decreases will likely follow increases and vice versa. As a result, BTC returns in short- and medium-term investment horizons display a chaotic pattern. This suggests that investors react more strongly to new information than they would in an efficient market, leading to sharp fluctuations and heightened volatility.

Our research shows that the HYGARCH (1, d , 1) model best fits Bitcoin's return series. The statistical significance of the long-memory parameter d at the 1% level supports strong long-memory dynamics. The predicted $\log(\alpha)$ value is less than 1, indicating that short-term volatility responses are limited, with market shocks having a substantial short-term impact that diminishes over time. The AR(1) FIGARCH(1, d , 1) and AR(1) MA(1) FIGARCH(1, d , 1) models are best for long-term investments because they have strong long-memory properties, as shown by the statistical significance of dd . These findings challenge the efficient market hypothesis and suggest the applicability of the fractal market hypothesis. For short- and medium-term investment horizons, different models are suitable. The AR(1) MA(1) C-GARCH(1, 1) model is most appropriate for D1, while the C-GARCH(1, 1) hypothesis fits D2. These models highlight the persistence of volatility in the short term, though its impact on total volatility is moderate. The positive θ coefficient suggests that an increase in short-term volatility contributes to long-term volatility. The AR(1) GARCH-M(1,1) model for the D3 horizon reveals a positive relationship between daily returns and a negative relationship between high volatility and average returns. This is different from the usual high-risk, high-return relationship. In medium-term horizons (D4 and D5), the AR(1) MA(1) GARCH(1,1) model is the most suitable. Here, 24% to 59% of volatility shocks stem from previous periods, and the sum of the α and β coefficients, while less than 1, suggests that shocks to conditional variance are temporary yet resilient. This indicates that volatility is predictable, with the impact of information shocks fading more gradually over medium- and long-term horizons.

During the periods covered by the study, the Bitcoin cryptocurrency market exhibited a chaotic structure, showing that the EMH is not valid, as the returns on short and medium-term investment

horizons had a high degree of information asymmetry and formed a new average without reverting to the old average. On the other hand, the returns on long-term investment horizons show that the FPH may be valid because they create repeating trends and exhibit similar structures. This situation highlights the increasing importance of these cryptocurrencies as "a store of value" and "a long-term" asset, similar to gold and other precious metals. These research findings highlight the importance of different investment horizons and strategic approaches for portfolio managers, analysts, and investors when investing in cryptocurrency. For portfolio managers and investors who prefer to take risks, it may be advisable to focus on short-term investment horizons of 2-4 days, 4-8 days, and 8-16 days to evaluate the market's short-term fluctuations. This approach offers the potential for high returns from short-term market movements while also providing the opportunity to reassess and adjust their portfolios frequently. On the other hand, for risk-averse or risk-neutral portfolio managers, researchers, and investors, focusing on long-term investment horizons of 64-128 days and 128-256 days may be more appropriate. This strategy can minimize the risk of being affected by cryptocurrency markets' high volatility while offering more stable growth potential in their portfolios. Long-term investment strategies can contribute to portfolio balance by protecting capital, especially during market corrections and fluctuations. However, investors should consider different cryptocurrencies besides Bitcoin when diversifying their portfolios. This diversification can reduce the portfolio's overall risk profile by balancing each cryptocurrency's response to market conditions and news. Additionally, investors can adopt strategies suitable for their investment horizons to provide more effective protection against the volatility of cryptocurrency markets, thereby creating a portfolio better suited to market fluctuations. Diversification, a principle generally accepted in financial markets, applies to cryptocurrency markets. In this context, investors should diversify their portfolios with cryptocurrencies and traditional asset classes in a balanced manner. For example, traditional asset classes such as stocks, bonds, and commodities can balance the volatile nature of cryptocurrencies and serve as a stabilizer under general market conditions. Regarding risk management strategies, portfolio managers and investors may consider using tools such as stop-loss orders and risk-limiting techniques to counter sudden price movements in the cryptocurrency markets. Such measures help limit potential losses in portfolio value during unexpected market movements.

Additionally, continuously obtaining up-to-date information about cryptocurrency markets and closely monitoring market trends is critical for effective portfolio management and risk minimization. This can allow investors to make quick and informed decisions suitable for market conditions. These approaches allow for the development of a more suitable portfolio management strategy against the fluctuations in the cryptocurrency market. As a result, in the cryptocurrency markets, it is observed that information shocks occurring in the short and medium-term investment horizons quickly dissipate. In contrast, information shocks in the medium and long-term investment horizons are gradually eliminated. This situation indicates that past return data can be utilized to predict future returns. The analyzed

findings reveal that the cryptocurrency market presents risks and profitable opportunities for investors. Investors can predict future price changes using technical analysis methods and thus minimize the risks in these markets. In this context, including cryptocurrencies in investors' portfolios is an approach suitable for long-term investment strategies and is thought to contribute to risk management and the diversification of portfolios. At the same time, considering the volatile nature of cryptocurrency markets, it may be beneficial for investors, portfolio managers, and analysts to focus on long-term investment horizons and the fundamental values of cryptocurrency projects rather than short-term market fluctuations to develop safer and more sustainable investment strategies.

The paper's findings have significant strategic and policy implications, especially for individual and institutional investors and regulatory authorities. Indeed, at long-term investment horizons, the long memory properties of investment returns and the hyperbolic decay of information shocks make it possible to shape investment decisions based on forecasts derived from historical data. In this context, individual and institutional investors are advised to be cautious about short-term market volatility and reduce risk through portfolio diversification. Moreover, regulatory authorities should develop transparency policies to reduce information asymmetry in cryptocurrency markets where market efficiency is weak, implement risk warning systems to protect investors, and establish differentiated capital adequacy criteria based on time horizon to ensure financial stability. Moreover, since traditional risk analysis methods may be insufficient in cryptocurrency markets where fractal structures and long memory effects are prominent, wavelet-based analyses and time-frequency decompositions should be used more effectively in macro-financial regulations. In this context, it is emphasized that the findings obtained for Bitcoin are not limited to this cryptocurrency but can be generalized to other cryptocurrency markets with similar structural characteristics; therefore, a new paradigm is needed in guiding investor behaviour and formulating regulatory policy sets.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that Artificial Intelligence tools were employed solely to enhance the clarity and fluency of the language. Following the use of these tools, the authors thoroughly reviewed and edited the content as needed and assume full responsibility for the final version of the published article.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all processes of the research.

REFERENCES

Açıkalin, S., & Sakınç, İ. (2022). Zayıf form etkinlik ve kripto para piyasası. *Maliye ve Finans Yazıları*, (117), 177–196. <https://doi.org/10.33203/mfy.1084658>

- Al-Yahyaee, K. H., Mensi, W., & Yoon, S. M. (2018). Efficiency, multifractality, and the long-memory property of the Bitcoin market: A comparative analysis with stock, currency, and gold markets. *Finance Research Letters*, 27, 228–234. <https://doi.org/10.1016/j.frl.2018.03.017>
- Assaf, A., Bhandari, A., Charif, H., & Demir, E. (2022). Multivariate long memory structure in the cryptocurrency market: The impact of COVID-19. *International Review of Financial Analysis*, 82, 102132. <https://doi.org/10.1016/j.irfa.2022.102132>
- Baillie, R. T., Bollerslev, T., & Mikkelsen, H. O. (1996). Fractionally integrated generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 74(1), 3–30. [https://doi.org/10.1016/S0304-4076\(95\)01749-6](https://doi.org/10.1016/S0304-4076(95)01749-6)
- Bariviera, A. F. (2017). The inefficiency of Bitcoin revisited: A dynamic approach. *Economics Letters*, 161, 1–4. <https://doi.org/10.1016/j.econlet.2017.09.013>
- Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31(3), 307–327. [https://doi.org/10.1016/0304-4076\(86\)90063-1](https://doi.org/10.1016/0304-4076(86)90063-1)
- Brooks, C. (2008). *Introductory econometrics for finance*. Cambridge University Press.
- Brooks, C. (2019). *Introductory econometrics for finance* (4th ed.). Cambridge University Press.
- Cao, G., He, L. Y., & Cao, J. (2018). *Multifractal detrended analysis method and its application in financial markets*. Springer.
- Caporale, G. M., Gil-Alana, L., & Plastun, A. (2018). Persistence in the cryptocurrency market. *Research in International Business and Finance*, 46, 141–148. <https://doi.org/10.1016/j.ribaf.2018.01.002>
- Celeste, V., Corbet, S., & Gurdgiev, C. (2020). Fractal dynamics and wavelet analysis: Deep volatility and return properties of Bitcoin, Ethereum, and Ripple. *The Quarterly Review of Economics and Finance*, 76, 310–324. <https://doi.org/10.1016/j.qref.2019.09.011>
- Çelik, İ. (2020). Can Bitcoin be a stable investment? *Financial Studies*, 24(2 (88)), 19–36. <https://hdl.handle.net/10419/231697>
- CoinMarketCap. (2023, December 25). *Homepage*. CoinMarketCap. <https://coinmarketcap.com/>
- Crowley, P. M. (2007). A guide to wavelets for economists. *Journal of Economic Surveys*, 21(2), 207–267.
- Davidson, J. (2004). Moment and memory properties of linear conditional heteroscedasticity models, and a new model. *Journal of Business & Economic Statistics*, 22(1), 16–29. <https://doi.org/10.1198/073500103288619359>
- Davidson, R., & MacKinnon, J. G. (2004). *Econometric theory and methods*. Oxford University Press.
- Ding, Z., & Granger, C. W. (1996). Modeling volatility persistence of speculative returns: A new approach. *Journal of Econometrics*, 73(1), 185–215. [https://doi.org/10.1016/0304-4076\(95\)01737-2](https://doi.org/10.1016/0304-4076(95)01737-2)
- Dyhrberg, A. H. (2016). Bitcoin, gold and the dollar—A GARCH volatility analysis. *Finance Research Letters*, 16, 85–92. <https://doi.org/10.1016/j.frl.2015.10.008>
- Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of business & economic statistics*, 20(3), 339–350. <https://doi.org/10.1198/073500102288618487>
- Etaman, V., & Işığçık, E. (2022). Yüksek frekanslı kripto varlık oynaklığının uzun hafıza ve stokastik özelliklerinin FIGARCH modeli ile incelenmesi. *Dicle Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 12(24), 284–310. <https://doi.org/10.53092/duibfd.1124966>
- Eyüboğlu, K., & Eyüboğlu, S. (2022). Bist ana sektör endekslerinde zayıf formda etkinliğin yapısal kırılmalı uzun hafıza modelleri ile analizi. *Abant Sosyal Bilimler Dergisi*, 22(2), 702–720. <https://doi.org/10.11616/asbi.1097446>
- Fakhfekh, M., & Jeribi, A. (2020). Volatility dynamics of cryptocurrencies' returns: Evidence from asymmetric and long memory GARCH models. *Research in International Business and Finance*, 51, 101075. <https://doi.org/10.1016/j.ribaf.2019.101075>
- Gençay, R., Selçuk, F., & Whitcher, B. (2002). *An introduction to wavelets and other filtering methods in finance and economics*. Academic Press.

- Hosking, J. R. M. (1981). Fractional differencing. *Biometrika*, 68(1), 165–176.
<https://doi.org/10.1093/biomet/68.1.165>
- Hurst, H. E. (1951). The long-term storage capacity of reservoirs. *Transactions of the American Society of Civil Engineers*, 116, 770–799. <https://doi.org/10.1061/TACEAT.0006518>.
- In, F., & Kim, S. (2012). *An introduction to wavelet theory in finance: A wavelet multiscale approach*. World Scientific.
- Kasman, A., & Torun, E. (2007). Long memory in the Turkish stock market return and volatility. *Central Bank Review*, 7(2), 13–27.
- Lillo, F., & Farmer, J. D. (2004). The long memory of the efficient market. *Studies in Nonlinear Dynamics & Econometrics*, 8(3), 1–33. <https://doi.org/10.2202/1558-3708.1226>
- Liu, G., Yu, C. P., Shiu, S. N., & Shih, I. T. (2022). The efficient market hypothesis and the fractal market hypothesis: Interflaves, fusions, and evolutions. *SAGE Open*, 12(1), 1–8.
<https://doi.org/10.1177/21582440221082137>
- Lo, A. W. (1991). Long-term memory in stock market prices. *Econometrica: Journal of the Econometric Society*, 59(5), 1279–1313. <https://doi.org/10.2307/2938368>
- Mallat, S. (1989). *A wavelet tour of signal processing*. Academic Press.
- Mandelbrot, B. (1972). Statistical methodology for nonperiodic cycles: From the covariance to R/S analysis. In *Annals of Economic and Social Measurement, Volume 1, Number 3* (pp. 259–290). NBER.
- Mandelbrot, B. B. (1975). Limit theorems on the self-normalized range for weakly and strongly dependent processes. *Zeitschrift für Wahrscheinlichkeitstheorie und Verwandte Gebiete*, 31, 271–285.
<https://doi.org/10.1007/BF00532867>
- Mandelbrot, B. B., & Wallis, J. R. (1969). Computer experiments with fractional Gaussian noises: Averages and variances. *Water Resources Research*, 5(1), 228–241. <https://doi.org/10.1029/WR005i001p00228>
- Mensi, W., Al-Yahyaee, K. H., & Kang, S. H. (2019). Structural breaks and double long memory of cryptocurrency prices: A comparative analysis from Bitcoin and Ethereum. *Finance Research Letters*, 29, 222–230. <https://doi.org/10.1016/j.frl.2018.07.011>
- Mensi, W., Lee, Y. J., Al-Yahyaee, K. H., Sensoy, A., & Yoon, S. M. (2019). Intraday downward/upward multifractality and long memory in Bitcoin and Ethereum markets: An asymmetric multifractal detrended fluctuation analysis. *Finance Research Letters*, 31, 19–25.
<https://doi.org/10.1016/j.frl.2019.03.029>
- Mnif, E., & Jarboui, A. (2021). COVID-19, Bitcoin market efficiency, and herd behaviour. *Review of Behavioral Finance*, 13(1), 69–84. <https://doi.org/10.1108/RBF-09-2020-0233>
- Moralı, T., & Uyar, U. (2018). Kıymetli metaller piyasasının fraktal analizi. *Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 11(3), 2203–2218. <https://doi.org/10.17218/hititsosbil.441151>
- Mulligan, R. F. (2004). Fractal analysis of highly volatile markets: An application to technology equities. *The Quarterly Review of Economics And Finance*, 44(1), 155–179, [https://doi.org/10.1016/S1062-9769\(03\)00028-0](https://doi.org/10.1016/S1062-9769(03)00028-0)
- Nadarajah, S., & Chu, J. (2017). On the inefficiency of Bitcoin. *Economics Letters*, 150, 6–9.
<https://doi.org/10.1016/j.econlet.2016.10.033>
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Manubot*.
- Özdemir Yazgan, S. D. (2022). Kripto para piyasasında uzun hafıza ve fraktal dinamikler: Hibrit model yaklaşımı. In T. Ünkarcılar (Ed.), *Finans, muhasebe ve iktisat alanlarında güncel araştırmalar-1* (pp. 1–19). Art Revisited.
- Peters, E. E. (1994). *Fractal market analysis: Applying chaos theory to investment and economics*. Wiley.
- Rachev, S. T., Mittnik, S., Fabozzi, F. J., Focardi, S. M., & Jasic, T. (2007). *Financial econometrics: From basics to advanced modeling techniques*. Wiley.
- Sağlam Bezgin, M. (2023). Gelişmiş ve gelişmekte olan borsalar ile kripto varlık piyasasında Fraktal Piyasa Hipotezi'nin testi. *Doğuş Üniversitesi Dergisi*, 24(1), 81–91.
<https://doi.org/10.31671/doujournal.1101057>

- Tarı, R. (2014). *Ekonometri*. Umuttepe Yayınları. Kocaeli.
- Tkacz, G. (2001). Estimating the fractional order of integration of interest rates using a wavelet OLS estimator. *Studies in Nonlinear Dynamics & Econometrics*, 5(1), 1–16. <https://doi.org/10.2202/1558-3708.1068>
- Tsay, R. S. (2010). *Analysis of financial time series* (3rd ed.). John Wiley & Sons.
- Urquhart, A. (2016). The inefficiency of Bitcoin. *Economics Letters*, 148, 80–82. <https://doi.org/10.1016/j.econlet.2016.09.019>
- Uyar, U. (2019). Sistematik risk davranışında yatırım döngüsü: Wavelet analizi. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 37(1), 135–168. <https://doi.org/10.17065/huniibf.347775>
- Uyar, U., & Kangallı Uyar, S. (2021). Sermaye ve altın piyasaları arasındaki yayılım etkisi: Wavelet’e dayalı dinamik koşullu korelasyon yaklaşımı. In M. Ural & Ü. Aydın (Eds.), *Finansal ekonometri uygulamaları: Kavram-teori-uygulama* (pp. 309–335). Seçkin Yayıncılık.
- Zivot, E., & Wang, J. (2006). *Modeling financial time series with S-Plus* (2nd ed.). Springer.
- Weron, R. (2002). Estimating long-range dependence: Finite sample properties and confidence intervals, *Physica A*, 312, 285-299.

Evaluating the Logistics Performance of One Belt One Road Project Countries with Multi Criteria Decision Making Methods

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Abstract

Logistics is significant for national governments to evaluate the activities, functions and elements of the existing country-level logistics system to develop competitive advantage. The Logistics Performance Index (LPI) is one of the most reliable reports used to evaluate logistics performance at the country level. In this study, a new hybrid model using the SIWEC, CRITIC, LOPCOW and MACONT methods from the Multi-Criteria Decision Making (MCDM) methods is proposed to measure the logistics performance of the countries located in the northern, southern and central corridors of the One Belt, One Road Project (OBORP) connecting Asia to Europe. SIWEC, CRITIC, and LOPCOW methods were used to calculate the objective weights of the criteria for each corridor. The MACONT method was employed to rank the countries based on their logistics performance for each corridor. According to the combined criteria weights, the most important criterion in the northern corridor was international shipping, while the least crucial criterion was customs. The most crucial criterion in the southern corridor was customs, while the least crucial criterion was tracking and tracing. In the middle corridor, the most crucial criterion was tracking and tracing, while the least crucial criterion was logistics quality and competence. Owing to the analysis made with the MACONT method, Germany was the country that showed the best logistics performance in all three corridors. The results obtained for each corridor using the decision-making approach offered in the study were compared with other alternative assessment methods such as MARA, ARAS, COPRAS, GIA, EDAS and OCRA to ensure the validity and robustness of the findings. Based on the comparison, it was observed that the results obtained for each corridor were quite similar, and the proposed approach gave consistent results.

Keywords: *Logistics Performance Index (LPI), Multi Criteria Decision Making (MCDM), SIWEC, CRITIC, LOPCOW, MACONT*



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1. INTRODUCTION

Globalization and increasing global economic integrations have increased the trade volumes of countries and businesses (Gürler et al., 2024). Before the globalization phenomenon, countries generally contended with countries in their regions. With globalization, the scope of competition has expanded to encompass the entire world. This has made logistics a fundamental element of international trade and a cornerstone of economic growth and development (Martí et al., 2014; Rezaei et al., 2018).

Logistics has multiple activities, functions and elements. Thus, being competitive in the global market and increasing the number of persistent customers by ensuring customer satisfaction is a challenge (Mešić et al., 2022). To develop logistics competitive advantage, it is crucial for national governments to appraise the activities, functions and elements of the existing country-level logistics system. Due to the assessment outcomes, it is obligatory to decide which infrastructures should be most appropriately utilized, developed, created, or completely removed through policies and initiatives (Beysenbaev & Dus, 2020; Jhavar et al., 2017).

The logistics sector plays a significant role in a country's achievement of its sustainable development aims. Hence, it is of high priority for country governments and industry leaders to understand how their logistics performance compares to other countries. This is notably true for global logistics suppliers. This essential comparison of national logistics performances not only lets countries to identify their competitive position relative to international logistics service providers but also eases benchmarking with market leaders to advance and cultivate national logistics performance (Rashidi & Cullinane, 2019).

There are not many tools for assessing logistics efficiency at the country level. This is because research is generally conducted at the micro-logistics level rather than at the global logistics level (Beysenbaev & Dus, 2020). One of the most reliable reports used to analyze the efficiency of logistics systems at the country level is the Logistics Performance Index (LPI), composed by the World Bank in 2007 and brought out every two years. The World Bank evaluates the logistics competitiveness of countries by utilizing the LPI. The LPI is a benchmarking tool utilized by directors and decision makers in the logistics industry to identify potential challenges and opportunities that countries may face in their trade logistics performance (Rezaei et al., 2018). LPI is estimated by considering six main criteria of logistics performance for each country (Arvis et al., 2010; Rashidi & Cullinane, 2019):

- Customs and border management: It covers the efficiency of customs clearance procedures, such as speed, ease and predictability of procedures and laws.
- Infrastructure: The qualification of infrastructure related to trade and transportation such as railways, information technology, ports and roads.
- Shipping arrangements: The ease of arranging shipments to markets at competitive prices.

- Quality of logistics services: All levels of competence and qualification of key logistics service providers, such as freight forwarders, transport operators, customs and border agents, distributors, and shippers.
- Track and trace: The ability to track shipments during transportation to market.
- Timeliness: Shipments arrive at their destination on time within the planned or expected delivery time.

Since One Belt, One Road Project (OBORP) creates an uninterrupted supply chain network from Asia to Europe, the logistics performance of the countries where the project is implemented is of great importance. This situation increases interest in this huge project with high geographical and commercial importance. Recently, decision-making in complex environments has become a global focus. The objective of this study is to analyze the logistics performance of the countries located in the Northern, Southern and Central corridors of the OBORP railway line connecting Asia and Europe using MCDM methods. The data in the study were compiled from the LPI documentation presented by the World Bank (2023). The weights of the evaluation factors were determined by applying three multi criteria decision making (MCDM) methods (SIWEC, CRITIC and LOPCOW). The MACONT method was utilized to rank the alternatives using the criteria weights. There is no study in the literature that integrates the four methods used in the study in terms of both weighting and ranking. In addition, the SIWEC method is a relatively new method in the literature. The number of studies applying this method (Puška et al., 2024) is quite low. The study aims to fill these gaps in the literature in terms of methods.

The study is composed of five chapters. In the next chapter, LPI studies using MCDM methods in the literature will be reviewed. In the third chapter, the MCDM methods utilized in the study will be detailed. In the fourth chapter, the logistics performances of the countries in the North, South and Central corridors of the OBORP in line with the data extracted from the LPI report announced by the World Bank in 2023 will be analyzed by integrating the identified MCDM methods. In the fifth chapter, which is the last section, a discussion section will be included in line with the analysis results.

2. LITERATURE REVIEW

In this chapter, LPI studies using MCDM approaches in the literature are reviewed. Some of the logistics performance index studies conducted in the literature by utilizing MCDM methods are given in Table 1. Google Scholar database was utilized during the literature review. The keywords "Logistics Performance Index" and "MCDM" were used as keywords.

Table 1. LPI Studies Using MCDM Methods

Author(s)	Aim	Method(s)	Findings
Mercangoz et al. (2020)	Analyzing the logistics performance of 28 EU countries and 5 candidate countries.	COPRAS-G	The ranking of the F-AHP method criteria weights is as follows: infrastructure>timeliness>customs=logistics quality and competence>international shipping>tracking and tracing. Consequently, according to the SAW method, the country with the highest LPI score was “Germany”, while “Albania” was in the last place.
Işık et al. (2020)	Evaluation of LPI of 11 CEECs using 2018 LPI data.	SV and MABAC	The ranking of the F-AHP method criteria weights is as follows: timeliness>international shipping>customs>logistics quality and competence>tracking and tracing>infrastructure. Consequently, according to the MABAC approach, the country with the highest LPI score was “Czechia”, while “Latvia” was in the last place.
Yıldırım and Mercangoz (2020)	Evaluation of LPI of OECD countries in the period 2010-2018	Fuzzy AHP and Grey ARAS	The ranking of the F-AHP method criteria weights is as follows: infrastructure> timeliness> customs> logistics quality and competence> international shipping > tracking and tracing. Consequently, according to the Grey ARAS technique, the country with the highest LPI score was “Germany”, while “Latvia” was in the last place.
Senir (2021)	Comparison of domestic logistics performance of Türkiye and EU countries using 2018 LPI data.	CRITIC and COPRAS	Using the CRITIC approach, the most significance criteria was defined as the customs clearance period sub-criterion "without physical examination". According to the COPRAS method results, the country with the best domestic logistics performance was "Netherlands", while "Latvia" was in the last place.
Stojanović and Puška (2021)	Measuring the logistics performance of the Gulf Cooperation Council countries.	CRITIC and MABAC	The ranking of the CRITIC method criteria weights is as follows: logistics quality and competence>tracking and tracing>international shipping>infrastructure>customs> timeliness. As a result of the MABAC approach, the country with the most LPI score was “United Arab Emirates”, while “Kuwait” was in the last place.
Özdağoğlu et al. (2022)	They evaluated all 160 countries included in the LPI report together.	MAUT, TOPSIS, MOORA, MAIRCA, MABAC, WSM, WPM, Borda Method	Consequently, the ranking of the top 10 countries is as follows: Germany > Sweden > Belgium > Japan > Austria > Netherlands > Singapore > Denmark > United Kingdom > Finland.
Stević et al. (2022)	Evaluation of logistics performance of Balkan countries in the period 2007-2018.	CRITIC and MARCOS	The ranking of the CRITIC method criteria weights is as follows: timeliness>international shipping>tracking and tracing>infrastructure>logistics quality and competence>customs. As a result of the MARCOS, the country with the highest LPI score was “Slovenia”, while “Albania” was in the last place.

(Table 1 cont.)

Author(s)	Aim	Method(s)	Findings
Oğuz (2023)	2023 evaluation of LPI of the top 10 countries in the LPI report	EDAS and TOPSIS	The ranking of the criteria weights is as follows: logistics quality and competence> tracking and tracing= infrastructure> customs> timeliness>international shipping. Consequently, the TOPSIS, the country with the most LPI score was “Finland”, while “Canada” was in the last place. Consequently, the EDAS, the country with the most LPI was “Singapore”, while “Austria” was in the last place.
Kara et al. (2024)	Evaluating 78 countries' supply chain performance and logistics performance.	MPSI and ARLON	The ranking of the MPSI method criteria weights is as follows: mean delivery time for postal activities> maritime connectivity> aviation connectivity> postal connectivity>mean consolidated import dwell time> mean turnaround time at ports> mean consolidated export dwell time> mean port export dwell time>mean port import dwell time> mean aviation import dwell time. As a result of the ARLON, the country with the most LPI score was “Netherlands”, while “Sudan” was in the last place.
Pehlivan et al. (2024)	Evaluation of logistics performance of G20 countries.	TOPSIS and Cluster Analysis	All criteria weights were taken as equal (0.167). Consequently, the TOPSIS, the country with the most LPI score was “Germany”, while “Russia” was in the last place.
Ju et al. (2024)	Evaluating the logistics performance of European countries.	CRITIC, MEREC, ENTROPY and Fuzzy ROV	According to CRITIC, MEREC, ENTROPY and Fuzzy ROV integrated model results, Finland was the country with the highest LPI, while Cyprus was in the last place.
Akbulut et al. (2024)	Evaluation of logistics performance of G20 countries.	SD, PSI, MEREC and MARA	According to SD, PSI, MEREC and MARA integrated model results, Germany was the country with the highest LPI, while Russia was in the last place.

2.1. Research Gap Analysis

Literature reviews show that there are many studies examining the logistics performance of different countries or economic integrations. However, the logistics performance indices of the countries located in the three corridors (north, south and central) of the OBORP railway route connecting Asia to Europe have not been evaluated comprehensively with MCDM methods before. The study contributes to literature in this respect.

In this study, various criteria weighting methods were applied. Therefore, the criterion weights obtained in this study are considered to be more precise and robust.

The second gap is the absence of studies in the literature that combine the SIWEC, CRITIC, LOPCOW, and MACONT methods to assess the logistics performance of countries. Therefore, it is targeted to complete this research gap in the literature by designing a performance measurement basis that combines the beneficial aspects of these four methods and provides more comprehensive and practical evaluations of countries. In addition, the SIWEC method is a relatively new method in the

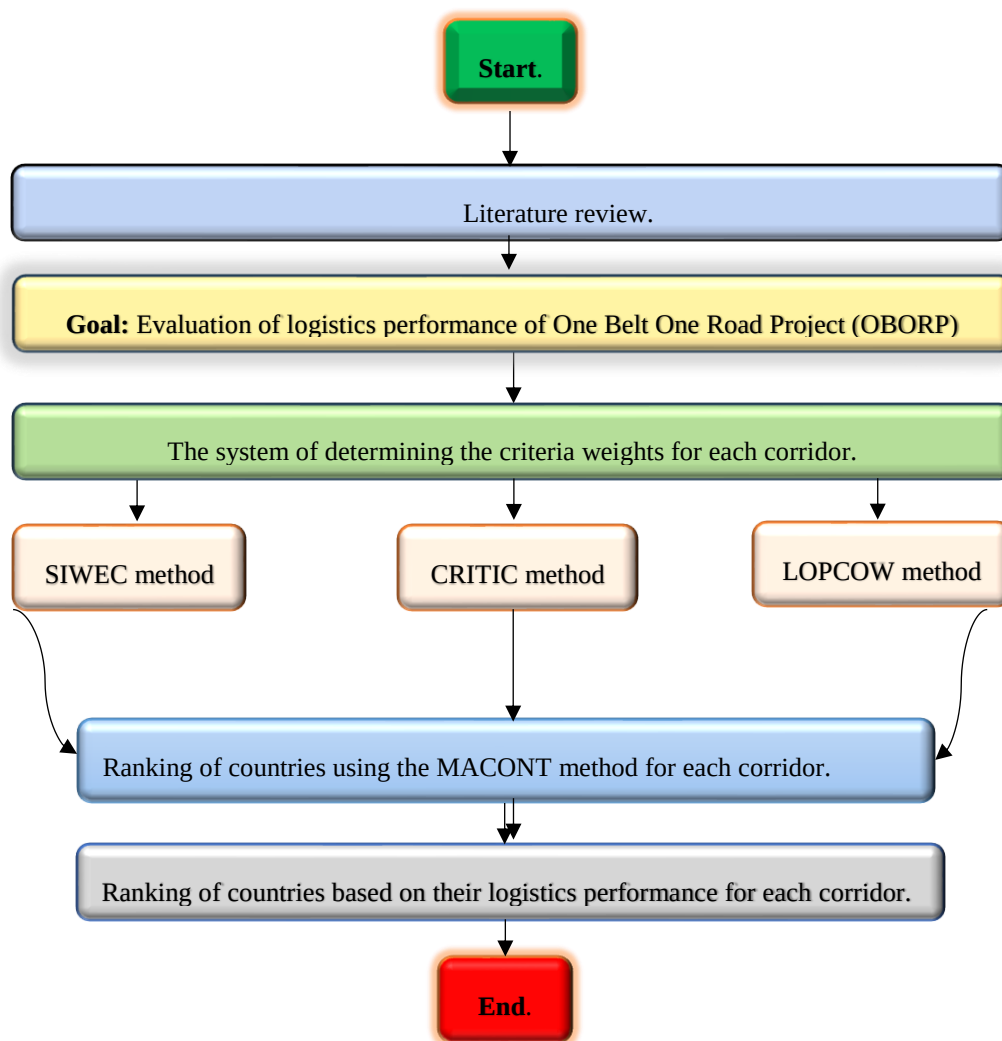
literature. The number of studies applying this method (Puška et al., 2024) is quite low, and there is a void in the literature in this branch.

Hence, in order to fill all these gaps detected in the literature, the effectiveness of the proposed integrated method in evaluating the LPIs of countries located in the north, south and center corridors of the OBORP railway route was tested.

3. METHODOLOGY

This section introduces the SIWEC, CRITIC, LOPCOW and MACONT methods employed to assess the logistics performance of countries located in the northern, southern and central corridors of the OBORP railway route. The weights of the evaluation factors for each corridor are determined by applying SIWEC, CRITIC and LOPCOW. The MACONT method was employed to rank the countries based on their logistics performance for each corridor. Figure 1 illustrates the flow diagram of the research methodology.

Figure 1. Flow Diagram of Research Methodology



Source: Created by the authors.

3.1. SIWEC Method

The SIWEC technique is a simple and novel technique developed by Puška et al. (2024) to calculate the weights of the criteria. The most important advantage of the SIWEC method is that it reduces the complexity in determining the criteria weights in the decision-making process and simplifies the steps, thus providing an approach that a wider audience can understand (Puška et al., 2024). In this study, the SIWEC method was preferred because it simplifies the process of calculating the criteria weights using simple procedures and steps (Puška et al., 2024). Some studies using the SIWEC method: Puška et al. (2024) in determining sales channels, El-Jaberi (2024) in selecting projects based on renewable energy sources, Cao et al. (2025) in determining innovative approaches for smart cities, Gao and Qian (2025) on risk assessment, and Kaya (2025) in designing routes. The SIWEC method determines the importance levels of the criteria through six stages. These stages are (Puška et al., 2024):

Stage 1. The decision matrix is organized based on the data and is represented in Eq. (1).

$$D = [d_{ij}]_{m \times n} \quad (1)$$

The d_{ij} value presented in Eq. 1 describes the performance of alternative i on criteria j .

Stage 2. The decision matrix is normalized applying Eq. (2). Unlike other MCDM methods, in the SIWEC approach, each criterion is split by the maximum value across all criteria.

$$n_{ij} = \frac{d_{ij}}{d_{ij}mak} \quad (2)$$

$d_{ij}mak$ in Eq. (2) shows the highest value of all criteria.

Stage 3. Standard deviation values of normalized values are figured for each alternative.

Stage 4. The v_{ij} value is obtained by multiplying the normalized values of the alternatives by their respective standard deviation values.

$$v_{ij} = n_{ij} \times st.dev.j \quad (3)$$

Stage 5. The sum of the criteria weights is figured with the aid from Eq. (4).

$$s_{ij} = \sum_{j=1}^n v_j \quad (4)$$

Stage 6. The final crucial levels of the criteria are figured with Eq. (5).

$$w_{SIWEC} = \frac{s_{ij}}{\sum_{j=1}^n s_{ij}} \quad (5)$$

3.2. CRITIC Method

In 1995, it was introduced by Diakoulaki et al. for the calculation of the objective weights of indicators (Diakoulaki et al., 1995). The advantages of the CRITIC method are outlined below:

- CRITIC is a method that takes a correlation-based approach using analytical tests to extract important data from the decision matrix (Zafar et al., 2021).
- This method determines the relative weights of different criteria precisely and consistently by using the decision matrix directly (Amari et al., 2023).
- When determining the criteria weights, the standard deviation of each criterion and the correlation coefficient between it and other criteria are taken into account. With this method, the variability of the criteria, the direction and degree of the relationships between the criteria are effective in determining the criteria weights (Ecer & Güneş, 2024).
- Furthermore, MCDM methods like CCSD, which consider the correlations among criteria, it can be effortlessly implemented without requiring any specialized software (Yürüyen et al., 2023).

Some of the studies conducted employing the CRITIC technique in the literature can be condensed as follows: Wu et al. (2020) used the CRITIC approach in the analysis of security in railway transportation, Zafar et al. (2021) used the CRITIC method in evaluating blockchain systems, Amari et al. (2023) used the CRITIC method in parking lot selection, Sarıgül et al. (2023) used the CRITIC approach in the assessing of financial performance of airline firms, Brodny and Tutak (2023) used the CRITIC method in assessing energy security, Işık et al. (2024) used the CRITIC method to assess urban competitiveness and Maruf and Özdemir (2024) used the CRITIC method in the evaluation of service performance of tourism websites. Using the CRITIC approach, the weights of the criteria are founded by appealing to the following Eq.s (Madić & Radovanović, 2015);

Stage 1. The decision matrix is organized based on the data and is represented in Eq. (1).

Stage 2. The matrix in Eq. (1) is normalized applying Eq. (6) and Eq. (7). For this process, Eq. (6) is applied for the normalization of beneficial criteria, and Eq. (7) is applied for the normalization of cost (for the non-beneficial criteria) criteria.

$$v_{ij} = \frac{d_{ij} - d_j^{\min}}{d_j^{\max} - d_j^{\min}} \quad (6)$$

$$v_{ij} = \frac{d_j^{\max} - d_{ij}}{d_j^{\max} - d_j^{\min}} \quad (7)$$

Stage 3. Criteria weights ($w_{jCRITIC}$) are calculated by applying Eq. (8), considering the standard deviation of the criteria and the correlations of each criterion with respect to the other criteria.

$$w_{jCRITIC} = \frac{s_j}{\sum_{k=1}^n s_k} \quad j = 1, 2, 3, 4, 5, \dots, n \quad (8)$$

The value s_j in Eq. (8) indicates the quantity of information included in criteria j . This value is calculated by applying Eq. (9):

$$s_j = \sigma_j \sum_{k=1}^n (1 - y_{jk}) \quad j = 1, 2, 3, 4, 5, \dots, n \quad (9)$$

In Eq. (9) σ_j , is the standard deviation of criteria j . In the same Eq., the correlation coefficient of each criterion j and k with respect to the other criteria is denoted by y_{jk} .

3.3. LOPCOW Method

In 2022, it was developed by Ecer and Pamucar to find the objective weights of the criteria. The advantages of the LOPCOW method are outlined below:

The LOPCOW method ensures more balanced and acceptable outcomes by minimizing the weight difference between the most noteworthy and the least noteworthy criteria.

- Its ability to directly include criteria with negative values enhances the flexibility of the approach.
- It eliminates variability within a dataset by incorporating the percentage of the standard deviation of the mean square of measurements.
- The LOPCOW method proves its efficiency even when handling extensive datasets.
- Additionally, the method can be applied with any number of criteria, which ensures its adaptability to problems at different scales.

These characteristics establish the LOPCOW method as a practical and effective tool for multi-criteria decision-making processes. When some studies conducted with the LOPCOW method are examined, Ecer and Pamucar (2022) used it in the analysis of sustainability performance in the banking sector, Ulutaş et al. (2023) in the selection of natural fibers from insulation materials, Işık et al. (2023) in determining the causal relationship between financial performance and premium production, Yalman et al. (2023) in evaluating macroeconomic performance, Gülcemal and İzci (2024), in the performance evaluation of banks, Bakır and İnce (2024), in the evaluation of passenger satisfaction in airline companies, Bağcı (2024), measuring the efficiency of public debt and stock exchange traded government domestic debt securities indicators, Ayçin and Bektaş (2024), in financial performance analysis, Öztaş and Öztaş (2024), in the evaluation of innovation performance of G20 countries, Korucuk et al. (2024), in the selection of storage location, Özekenci (2024), in financial performance analysis, Kahreman (2025), in his analysis of Türkiye's productive capacity performance, Yürüyen and Ulutaş (2024), in assessing urban competitiveness, Deveci et al. (2025), in the analysis of green energy in transportation, Ünal (2025), Performance evaluation of insurance companies. There are four basic steps in the method (Ecer & Pamucar, 2022);

Stage 1. The decision matrix is organized in line with the data obtained. The decision matrix is expressed in Eq. (1).

Stage 2. The matrix in Eq. (1) is normalized applying Eq. (10) and Eq. (11). It is calculated by applying Eq. (10) for beneficial criteria and Eq. (11) for cost (for the non-beneficial criteria) criteria.

$$p_{ij} = \frac{d_{ij} - \min(d_{ij})}{\max(d_{ij}) - \min(d_{ij})} \quad (10)$$

$$p_{ij} = \frac{\max(d_{ij}) - d_{ij}}{\max(d_{ij}) - \min(d_{ij})} \quad (11)$$

Stage 3. The % values of the criteria (PVI_{ij}) are calculated by applying Eq. (12).

$$PVI_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^m p_{ij}^2}{m}}}{\sigma} \right) \cdot 100 \right| \quad (12)$$

In Eq. (12), σ is the standard deviation.

Stage 4. The weights of the criteria are defined by applying Eq. (13).

$$w_{jLOPCOW} = \frac{PV_{ij}}{\sum_{i=1}^n PV_{ij}} \quad (13)$$

The weights of the criteria calculated according to the 3 methods are merged with the arithmetic mean. Eq. (14) shows this process.

$$w_{jUF} = \frac{w_{jSIWEC} + w_{jCRITIC} + w_{jLOPCOW}}{3} \quad (14)$$

w_{jUF} Eq. (14) represents the unified weight of the j . criterion.

3.4. MACONT Method

The MACONT approach was employed to rank the countries based on their logistics performance for each corridor. The advantages of the MACONT method are outlined below (Wen et al., 2020).

- By combining three different linear normalization techniques based on criteria types, it reduces the deviations that occur in the normalization process.
- For each criterion, a virtual reference alternative is created that represents the average performance of the alternatives. Thus, both the advantages and disadvantages of an alternative compared to other alternatives are evaluated simultaneously.
- In order to collect the distance values between each alternative and the reference alternative under each criterion, two mixed aggregation operators based on the compensability and non-compensability perspectives between the criteria are applied. Thanks to this approach, versatile and reliable alternative ranking results are obtained.

Some of the studies conducted using the MACONT method in the literature can be condensed as follows: Wen et al. (2020) used the MACONT method in the option of a sustainable third-party

reverse logistics company, Wen and Liao (2021) in the selection of a retirement service organization, Ecer and Torkayesh (2022) in the selection of sustainable circular suppliers, Aksakal et al. (2022) in the selection of insulation materials, Yürüyen et al. (2023) in the performance analysis of logistics enterprises, Ulutaş et al. (2024) in the selection of 3PL for automobile manufacturing enterprises, Taşcı (2024) in the evaluation of the Turkish non-life insurance industry, Aydın Ünal (2024), in the evaluation of the Turkish health insurance sector, and Amiri et al. (2025) in their assessment of countries' Covid 19 performance. The stages of the approach are as follows (Aksakal et al., 2022; Wen et al., 2020).

Stage 1. The decision matrix is organized according to the data obtained. The decision matrix is expressed in Eq. (1).

Stage 2. The data in the decision matrix are normalized applying three normalization techniques by employing Eq. (15), Eq. (16) and Eq. (17) respectively. The first normalization approach is the normalization technique based on linear summation, as stated in Eq. (15) and the normalized data is suggested by $\hat{d}_{ij}^1$. The second normalization approach is the linear ratio-based normalization approach as specified in Eq. (16) and the normalized data is suggested by $\hat{d}_{ij}^2$. The third normalization approach is the linear max-min normalization approach, as specified in Eq. (17) and the normalized data is suggested by $\hat{d}_{ij}^3$. After the three-normalization approach, Eq. (18) is used to combine the normalized values.

$$\hat{d}_{ij}^1 = \begin{cases} d_{ij} / \sum_{i=1}^m d_{ij} & \text{if } j \in BN \\ \frac{1}{d_{ij}} / \sum_{i=1}^m \frac{1}{d_{ij}} & \text{if } j \in CS \end{cases} \quad (15)$$

$$\hat{d}_{ij}^2 = \begin{cases} d_{ij} / \max_i d_{ij} & \text{if } j \in BN \\ \min_i d_{ij} / d_{ij} & \text{if } j \in CS \end{cases} \quad (16)$$

$$\hat{d}_{ij}^3 = \begin{cases} (d_{ij} - \min_i d_{ij}) / (\max_i d_{ij} - \min_i d_{ij}) & \text{if } j \in BN \\ (d_{ij} - \max_i d_{ij}) / (\min_i d_{ij} - \max_i d_{ij}) & \text{if } j \in CS \end{cases} \quad (17)$$

$$\hat{d}_{ij} = \theta \hat{d}_{ij}^1 + \mu \hat{d}_{ij}^2 + (1 - \theta - \mu) \hat{d}_{ij}^3 \quad (18)$$

The values of θ and μ in Eq. (18) will be taken as 0.200 in this study.

Stage 3. The two mixed adders (U_{1i} ve U_{2i}) are determined by the following Eq.s:

$$U_{1i} = \delta \frac{\pi_i}{\sqrt{\sum_{i=1}^m (\pi_i)^2}} + (1 - \delta) \frac{Q_i}{\sqrt{\sum_{i=1}^m (Q_i)^2}} \quad (19)$$

$$U_{2i} = \beta \max_j (w_{jBR} (\hat{d}_{ij} - \bar{d}_j)) + (1 - \beta) \min_j (w_{jBR} (\hat{d}_{ij} - \bar{d}_j)) \quad (20)$$

$\pi_i = \sum_{j=1}^n w_{jBR} (\hat{d}_{ij} - \bar{d}_j)$ and $Q_i = \prod_{j=1}^n (\bar{d}_j - \hat{d}_{ij})^{w_{jBR}} / \prod_{\omega=1}^n (\hat{d}_{ij} - \bar{d}_j)^{w_{jBR}}$ and γ denotes the part of the criteria that satisfies the condition $\hat{d}_{ij} < \bar{d}_j$ and ω denotes the part of the criteria that

satisfies the condition $\hat{d}_{ij} \geq \bar{d}_j$. While performing these operations, the total of the criteria weights must be equivalent to "1". In this study, δ and β values equal 0.5.

Stage 4. U_i (final comprehensive score) is determined for each alternative by employing Eq. (21):

$$U_i = \frac{1}{2} \left(U_{1i} + \frac{U_{2i}}{\sqrt{\sum_{l=1}^m (U_{2l})^2}} \right) \quad (21)$$

The alternative with the highest U_i score is selected as the best.

4. RESEARCH APPLICATION

In this study, the logistics performances of the countries located in the northern, southern and central corridors of the railway route connecting Asia to Europe of the OBORP analyzed separately (corridor by corridor) with the help of MCDM techniques. The data utilized in the study is received the LPI report declared by the World Bank (2023). The criteria employed in the study for the analysis are the six main criteria that the World Bank takes into account when calculating the LPI values of countries. These criteria are customs (C1), infrastructure (C2), international shipping (C3), logistics quality and competence (C4), tracking and tracing (C5) and timeliness (C6). All six criteria used are useful criteria. In the study, the countries located in the northern, southern and central corridors of the railway route connecting Asia to Europe of the OBORP are listed below (Tümenbatur, 2021). According to Tümenbatur (2021), there are 8 countries in the northern corridor, 12 countries in the southern corridor, and 15 countries in the central corridor. However, the logistics performance indices of Turkmenistan, which is in both the southern corridor and the central corridor, and Azerbaijan, which is located in the central corridor, for the year 2023 were not included in the published report and were therefore excluded from the analysis. Thus, 8 countries in the northern corridor, 11 countries in the southern corridor and 13 countries in the central corridor were analyzed as alternatives. The weights of the assessment criteria were identified by applying SIWEC, CRITIC and LOPCOW methods. Utilizing the weights of the assessed criteria, MACONT approach was employed to rank the countries. Table 2 for the northern corridor, Table 3 for the southern corridor and Table 4 for the central corridor are given in the decision matrices created in line with the data received from the LPI report declared by the World Bank in 2023.

Table 2. Northern Corridor Decision Matrix

	C1	C2	C3	C4	C5	C6
China	3.3	4	3.6	3.8	3.7	3.8
Mongolia	2.5	2.3	2.5	2.3	2.7	2.4
Russia	2.4	2.7	2.3	2.6	2.9	2.5
Belarus	2.6	2.7	2.6	2.6	3.1	2.6
Poland	3.4	3.5	3.3	3.6	3.9	3.8
Germany	3.9	4.3	3.7	4.2	4.1	4.2
Belgium	3.9	4.1	3.8	4.2	4.2	4
France	3.7	3.8	3.7	3.8	4.1	4

Table 3. Southern Corridor Decision Matrix

	C1	C2	C3	C4	C5	C6
China	3.3	4	3.6	3.8	3.7	3.8
Kazakhstan	2.6	2.5	2.6	2.7	2.9	2.8
Uzbekistan	2.6	2.4	2.6	2.6	2.8	2.4
Iran	2.2	2.4	2.4	2.1	2.7	2.4
Türkiye	3	3.4	3.4	3.5	3.6	3.5
Bulgaria	3.1	3.1	3	3.3	3.5	3.3
Romania	2.7	2.9	3.4	3.3	3.6	3.5
Hungry	2.7	3.1	3.4	3.1	3.6	3.4
Austria	3.7	3.9	3.8	4	4.3	4.2
Germany	3.9	4.3	3.7	4.2	4.1	4.2
France	3.7	3.8	3.7	3.8	4.1	4

Table 4. Central Corridor Decision Matrix

	C1	C2	C3	C4	C5	C6
China	3.3	4	3.6	3.8	3.7	3.8
Kazakhstan	2.6	2.5	2.6	2.7	2.9	2.8
Kyrgyzstan	2.2	2.4	2.4	2.2	2.4	2.3
Tajikistan	2.2	2.5	2.5	2.8	2.9	2
Uzbekistan	2.6	2.4	2.6	2.6	2.8	2.4
Georgia	2.6	2.3	2.7	2.6	3.1	2.8
Türkiye	3	3.4	3.4	3.5	3.6	3.5
Bulgaria	3.1	3.1	3	3.3	3.5	3.3
Romania	2.7	2.9	3.4	3.3	3.6	3.5
Hungary	2.7	3.1	3.4	3.1	3.6	3.4
Austria	3.7	3.9	3.8	4	4.3	4.2
Germany	3.9	4.3	3.7	4.2	4.1	4.2
France	3.7	3.8	3.7	3.8	4.1	4

4.1. Criteria Weights' Calculation

Once the decision matrix was assembled, the criteria weights were figured out employing the SIWEC, CRITIC, and LOPCOW approaches. The criteria weights derived from SIWEC, CRITIC and LOPCOW methods are unified using Eq. (14). Table 5 includes the unified criteria weights of the northern corridor countries according to SIWEC, CRITIC and LOPCOW methods, Table 6 includes the unified criteria weights of the southern corridor countries according to SIWEC, CRITIC and LOPCOW methods and Table 7 includes the unified criteria weights of the central corridor countries according to SIWEC, CRITIC and LOPCOW methods.

Table 5. Unified Criteria Weights of Northern Corridor Countries

	C1	C2	C3	C4	C5	C6
w_{jsiwec}	0.1583	0.1702	0.1572	0.1680	0.1772	0.1691
$w_{jcritic}$	0.1762	0.2006	0.1877	0.1213	0.1806	0.1336
$w_{jlopcow}$	0.1493	0.1757	0.1662	0.1644	0.1717	0.1727
w_{juf}	0.1613	0.1822	0.1704	0.1512	0.1765	0.1585

The ranking of the unified weights of the criteria in Table 5 is as follows: $C2 > C5 > C3 > C1 > C6 > C4$. In view of the result of the unified criteria weights, the most significant criterion for the northern corridor is C2 (infrastructure), while the least important criterion is C4 (logistics quality and competence). The results of the unified criteria weights are transferred to the MACONT method for ranking the countries.

Table 6. Unified Criteria Weights of Southern Corridor Countries

	C1	C2	C3	C4	C5	C6
w_{jsiwec}	0.1518	0.1641	0.1647	0.1672	0.1791	0.1732
$w_{jcritic}$	0.2396	0.1806	0.1985	0.1520	0.1013	0.1280
$w_{jlopcow}$	0.1571	0.1396	0.1768	0.1921	0.1717	0.1628
w_{juf}	0.1828	0.1614	0.1800	0.1704	0.1507	0.1547

The ranking of the unified weights of the criteria in Table 6 is as follows: $C1 > C3 > C4 > C2 > C6 > C5$. In view of the result of the unified criteria weights, the most crucial criterion for the southern corridor is C1 (Customs), while the least crucial criterion is C5 (tracking and tracing). The results of the unified criteria weights are transferred to the MACONT method for the ranking of the countries.

Table 7. Unified Criteria Weights of Central Corridor Countries

	C1	C2	C3	C4	C5	C6
w_{jsiwec}	0.1521	0.1628	0.1652	0.1694	0.1808	0.1697
$w_{jcritic}$	0.2096	0.1916	0.1818	0.1255	0.1406	0.1508
$w_{jlopcow}$	0.1419	0.1413	0.1611	0.1799	0.1954	0.1804
w_{juf}	0.1679	0.1652	0.1694	0.1583	0.1723	0.1670

The ranking of the unified weights of the criteria in Table 7 is as follows: $C5 > C3 > C1 > C6 > C2 > C4$. In view of the result of the unified criteria weights, the most crucial criterion for the central corridor is C5 (tracking and tracing), while the least crucial criterion is C4 (logistics quality and competence). The results of the unified criteria weights are transferred to the MACONT method for ranking the countries.

4.2. Countries Ranking

In this section, the MACONT method used to rank the countries in the North, South and Central corridors of the railway route connecting Asia to Europe of the OBORP. The results are calculated according to the MACONT method by applying Eq.s (15)-(21) to the decision matrices. Table 8 includes the ranking of π_i , Q_i , U_{1i} , U_{2i} , U_i and countries for each alternative in the northern corridor, Table 9 includes the ranking of π_i , Q_i , U_{1i} , U_{2i} , U_i and countries for each alternative in the southern corridor and Table 10 includes the ranking of π_i , Q_i , U_{1i} , U_{2i} , U_i and countries for each alternative in the central corridor.

Table 8. MACONT Method Results of Northern Corridor Countries

	π_i	Q_i	U_{1i}	U_{2i}	U_i	Rankings	Intra-group 2023 LPI Rankings	Change
China	0.1319	9.0307	0.3450	0.0218	0.2612	5	4	Increase
Mongolia	-0.3737	0.3717	-0.2429	-0.0626	-0.3762	8	8	No
Russia	-0.3320	0.3278	-0.2158	-0.0569	-0.3394	7	7	No
Belarus	-0.2715	0.2698	-0.1765	-0.0446	-0.2697	6	6	No
Poland	0.0884	13.3352	0.4374	0.0150	0.2797	3	5	Decrease
Germany	0.2827	3.5682	0.2927	0.0483	0.3429	1	1	No
Belgium	0.2733	3.6837	0.2896	0.0435	0.3218	2	2	No
France	0.2009	5.1079	0.2808	0.0321	0.2710	4	3	Increase

According to the MACONT method results in Table 8, the northern corridor countries are ranked as follows: Germany>Belgium> Poland> France> China> Belarus> Russia> Mongolia. Based on the ranking, the country with the best logistics performance among the northern corridor countries is Germany and the country with the lowest logistics performance is Mongolia. According to the proposed model, the correlation between the ranking obtained for the northern corridor and the LPI ranking for 2023 was tested with Pearson correlation. The Pearson correlation coefficient was calculated as 0.929. According to this result, there is a high correlation between the two rankings. This indicates that the proposed method gives accurate results.

Table 9. MACONT Method Results of Southern Corridor Countries

	π_i	Q_i	U_{1i}	U_{2i}	U_i	Rankings	Intra-group 2023 LPI Rankings	Change
China	0.1574	6.9095	0.4159	0.0274	0.3202	4	4	No
Kazakhstan	-0.2465	0.2423	-0.1592	-0.0446	0.2623	9	9	No
Uzbekistan	-0.2885	0.2804	-0.1865	-0.0469	0.2854	10	10	No
Iran	-0.3713	0.3697	-0.2396	-0.0620	0.3738	11	11	No
Türkiye	0.0401	5.6362	0.2783	0.0055	0.1617	5	5	No
Bulgaria	-0.0352	0.1045	-0.0196	-0.0083	0.0438	8	6	Increase
Romania	-0.0237	0.8584	0.0218	-0.0058	0.0129	6	8	Decrease
Hungary	-0.0293	0.3178	-0.0061	-0.0058	0.0268	7	7	No
Austria	0.2730	3.6881	0.3523	0.0439	0.3560	2	2	No
Germany	0.3017	3.3740	0.3581	0.0502	0.3847	1	1	No
France	0.2220	4.5564	0.3557	0.0387	0.3364	3	3	No

According to the results of the MACONT method in Table 9, the southern corridor countries are ranked as follows: Germany> Austria> France> China> Türkiye> Romania> Hungary> Bulgaria> Kazakhstan> Uzbekistan> Iran. Based on the determined ranking, the country with the best logistics performance among the southern corridor countries is Germany and the country with the lowest logistics performance is Iran. According to the proposed model, the correlation between the ranking obtained for the southern corridor and the LPI ranking for 2023 was tested with Pearson correlation. The Pearson correlation coefficient was calculated as 0.964. According to this result, there is a high correlation between the two rankings. This indicates that the proposed method gives accurate results.

Table 10. MACONT Method Results of Central Corridor Countries

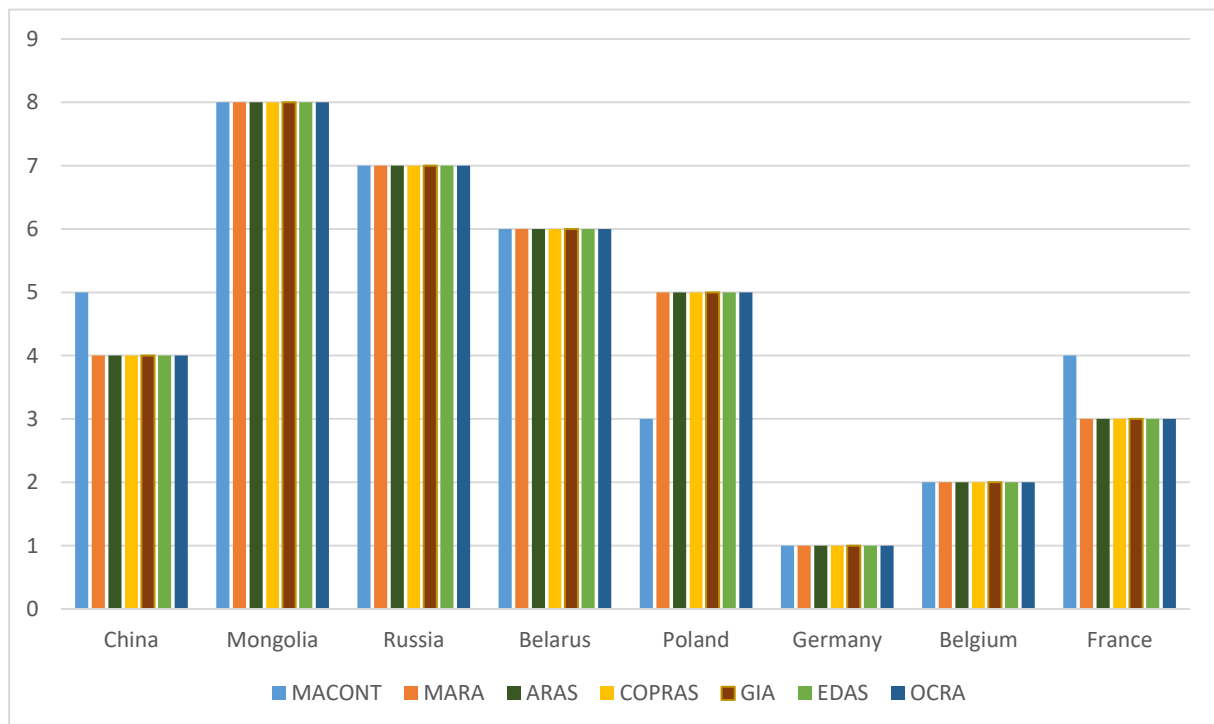
	π_i	Q_i	U_{1i}	U_{2i}	U_i	Rankings	Intra-group 2023 LPI Rankings	Change
China	0.1925	5.5252	0.2884	0.0340	0.2743	5	4	Increase
Kazakhstan	-0.1912	0.1867	-0.1169	-0.0341	-0.1890	10	10	No
Kyrgyzstan	-0.3277	0.3247	-0.2001	-0.0536	-0.3052	13	13	No
Tajikistan	-0.2648	0.2510	-0.1621	-0.0456	-0.2556	12	12	No
Uzbekistan	-0.2307	0.2256	-0.1410	-0.0349	-0.2041	11	11	No
Georgia	-0.1876	0.1789	-0.1148	-0.0343	-0.1887	9	9	No
Türkiye	0.0812	13.9885	0.4700	0.0126	0.2832	4	5	Decrease
Bulgaria	0.0094	2.9775	0.0950	-0.0004	0.0460	7	6	Increase
Romania	0.0204	2.7463	0.0951	0.0023	0.0564	6	8	Decrease
Hungary	0.0155	0.7052	0.0310	0.0023	0.0243	8	7	Increase
Austria	0.3015	3.3253	0.2924	0.0491	0.3341	2	2	No
Germany	0.3287	3.0958	0.3030	0.0553	0.3631	1	1	No
France	0.2528	3.9890	0.2811	0.0420	0.3013	3	3	No

According to the results of the MACONT method in Table 10, the central corridor countries are ranked as follows: Germany> Austria> France> Türkiye> China> Romania> Bulgaria> Hungary> Georgia> Kazakhstan> Uzbekistan> Tajikistan> Kyrgyzstan. Based on the determined ranking, the country with the best logistics performance among the central corridor countries is Germany and the country with the lowest logistics performance is Kyrgyzstan. According to the proposed model, the correlation between the ranking obtained for the central corridor and the LPI ranking for 2023 was tested with Spearman Rho correlation. Spearman's Rho correlation coefficient was calculated as 0.978. According to this result, there is a high correlation between the two rankings. This indicates that the proposed method gives accurate results.

4.3. Comparison with Other MCDM Approaches

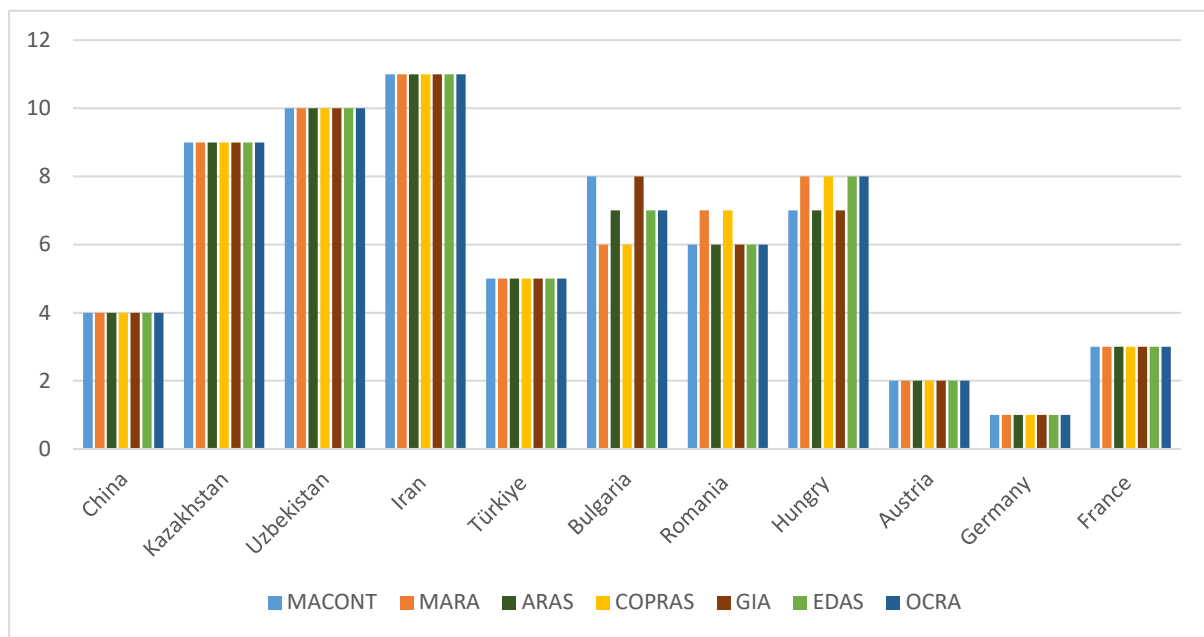
The results obtained for each corridor with the proposed decision-making approach in the study were compared with other alternative assessment approaches such as MARA, ARAS, COPRAS, GIA, EDAS and OCRA. The comparison for the northern corridor is given in Figure 2, the comparison for the south corridor is given in Figure 3 and the comparison for the central corridor is given in Figure 4.

Figure 2. Comparison of Northern Corridor Countries' Results with Other MCDM Approaches



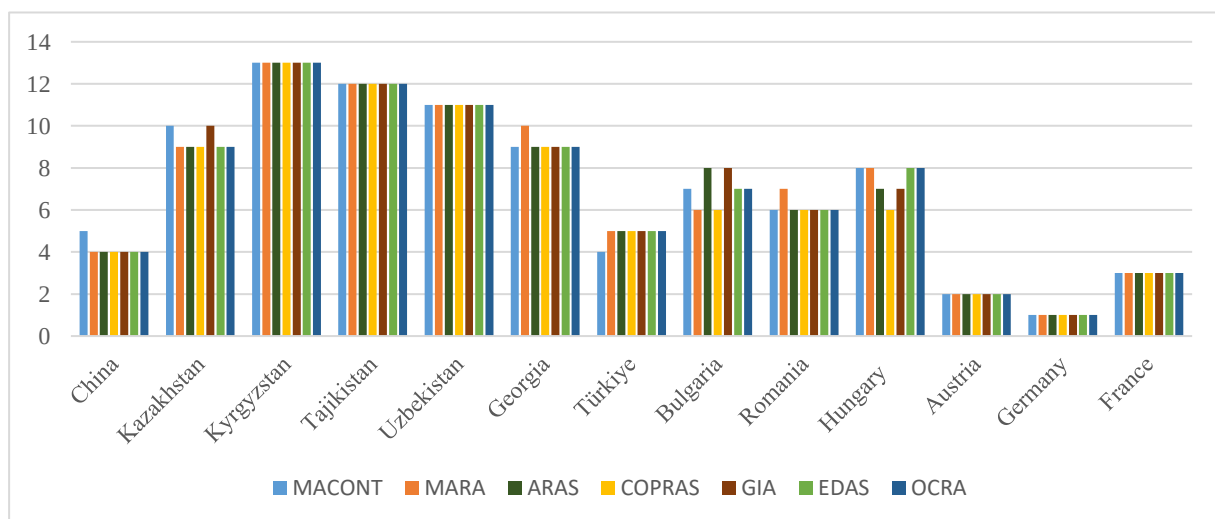
When analyzing the Northern Corridor countries, the results obtained from the MACONT method and other approaches used to make decisions were tested using Pearson's correlation coefficient. The calculated Pearson correlation coefficient of 0.929 confirms that the proposed method provides valid and reliable outputs.

Figure 3. Comparison of Southern Corridor Countries' Results with Other MCDM Approaches



When analyzing the Southern Corridor countries, the results obtained from the MACONT method and other approaches used to make decisions were compared with the Pearson correlation analysis. The correlation coefficients obtained were 0.973 with the MARA and COPRAS methods, 0.996 with the ARAS method, 1 with the GIA method, and 0.991 with the EDAS and OCRA methods. These high correlation values reveal that the proposed method produces valid, reliable and largely compatible results with other established methods.

Figure 4. Comparison of Central Corridor Countries' Results with Other MCDM Approaches



When analyzing the Middle Corridor countries, the results obtained from the MACONT method and other approaches used to make decisions were compared with Spearman's correlation analysis. The correlation coefficients obtained were 0.984 with the MARA method, 0.988 with the ARAS and COPRAS methods, 0.989 with the GIA method, and 0.993 with the EDAS and OCRA methods. These

high correlation values reveal that the proposed method produces valid, reliable and largely compatible results with other established methods.

5. PRACTICAL AND MANAGERIAL IMPLICATIONS

For countries, logistics performance assessment is not only limited to trade and economy but also has critical importance in areas such as infrastructure development, sustainability, crisis management and international cooperation. Optimizing logistics processes allows a country to achieve its development goals and gain a stronger position in the global system. Some practical implications of the current article, which evaluates the multi-dimensional logistics performance of countries, are as follows:

- The first practical contribution of the research is to provide a new, holistic and hybrid decision-making approach to assess the multi-dimensional logistics performance of countries.
- The proposed decision-making approach has a simple but effective mathematical model that does not require advanced mathematics.
- The model, which combines SIWEC, CRITIC and LOPCOW methods in determining the criteria weights, helps to achieve more ideal and optimized results.
- It has been proven through comparative analysis that the proposed decision-making model produces consistent and reliable results.

The managerial implications conclusions reached in the research can be revealed as follows:

- The results of this research, which examines the multi-dimensional logistics performances of countries, provide important implications in terms of managerial strategies such as sustainable growth of national economies, increasing competitiveness in international trade, and policy regulations.
- Regular analyses of logistics performance by countries to improve their positions in global competition provide important information to policymakers and the success of strategies implemented in global integrations.
- The proposed decision-making approach allows policymakers to improve the country's logistics performance and achieve sustainable competitive advantage through these improvements, resulting in long-term benefits in terms of economic growth and development.

6. DISCUSSION AND CONCLUSION

OBORP includes sustainability and integration issues both locally and internationally. The economic and political components of the project are evaluated together. In this context, the corridors are geo-politically and geo-economically different from each other. Considering this difference, connections and connection elements and the risks that may be encountered are taken into consideration. For example, technical risks such as gauges can be mentioned in railways. In addition, the existence of

collaborations such as TRACECA, Trans-Asia Railway Project, Marmaray Project, Baku-Tbilisi-Kars Railway Project, etc., which connect Europe and Asia on designated corridors, has increased the trade volume between European and Asian countries. With the increasing trade volume, countries have become obliged to develop the necessary trade logistics capabilities to increase their logistics competitiveness by identifying the possible opportunities and challenges they may be exposed to in trade logistics. At the same time, it is predicted that OBORP will significantly change the direction of trade in the world. All these situations reveal the importance and currency of OBORP railway networks.

In the study, the 2023 LPIs of the countries located in the northern, southern and central corridors of the OBORP were evaluated with an MCDM model in which different methods were integrated. The weights of the assessment criteria were identified by applying SIWEC, CRITIC and LOPCOW methods. Utilizing the weights of the assessed criteria, MACONT method was utilized to rank the countries. After calculating the criteria weights according to the three methods, the unified weights were calculated by taking the arithmetic mean of the obtained criteria weights. According to the result of the unified criteria weights, the ranking of the criteria for the northern corridor countries: $C3 > C2 > C6 > C5 > C4 > C1$, the ranking of criteria for the southern corridor countries: $C1 > C3 > C4 > C2 > C6 > C5$ and the ranking of criteria for the central corridor countries: $C5 > C3 > C1 > C6 > C2 > C4$.

Countries were ranked by transferring the calculated criteria weights to the MACONT method. According to the result of MACONT method; the ranking of the northern corridor countries: Germany>Belgium> Poland> France> China> Belarus> Russia> Mongolia, ranking of the southern corridor countries: Germany> Austria> France> China> Türkiye> Romania> Hungary> Bulgaria> Kazakhstan> Uzbekistan> Iran, and the ranking of the central corridor countries: Germany> Austria> France> Türkiye> China> Romania> Bulgaria> Hungary> Georgia> Kazakhstan> Uzbekistan> Tajikistan> Kyrgyzstan. According to the proposed model, the correlation between the ranking obtained for the northern and southern corridors and the LPI ranking in 2023 was tested with Spearman Rho correlation, and the central corridor was tested with Pearson correlation. The Spearman Rho correlation coefficient is calculated as 0.929 for the northern corridor and 0.964 for the southern corridor. The Pearson correlation coefficient for the central corridor calculated as 0.978. According to this result, there is a high correlation between the two rankings. However, the results of the proposed integrated model for each corridor were compared with the MARA, ARAS, COPRAS, GIA, EDAS and OCRA methods. As a result of the comparison, it was seen that the results of the proposed model and the results of the determined methods were quite similar in the three corridors. This shows that the proposed method gives consistent and reliable results.

Policymakers should prioritize infrastructure investments to improve the LPI. Strengthening road, rail, sea and air connections will accelerate transportation processes and reduce logistics costs. Harmonizing logistics processes of countries involved in regional and global economic integration

processes can accelerate trade flows and reduce costs. In addition, digitalization of customs procedures and reduction of bureaucracy will contribute to facilitating trade. Vocational training programs should be encouraged to increase service quality in the logistics sector, and the digital transformation processes of companies should be supported. In addition, the dissemination of smart logistics systems and big data analytics will increase operational efficiency and provide an advantage in global competition.

In order to increase the LPI, it is of great importance to bring the regulatory framework in line with international standards. This will encourage foreign investments and facilitate integration into global supply chains. Adopting sustainable logistics practices, supporting low-emission transportation methods, and investing in alternative energy sources will reduce environmental impacts and encourage green logistics. In addition, cooperation with international logistics networks should be increased and regional trade agreements should be prioritized. Strategies to be developed through public and private sector cooperation will contribute to economic growth by making logistics systems more effective.

The analysis results showed that high-income countries showed the best logistics performance scores, while low- and medium-income countries showed worse logistics performance scores. This result shows that the logistics performance of countries is significantly driven by income and geographical area.

Despite the comprehensiveness, originality and up-to-datedness of the study, there are also some limitations. The first limitation of the study is that it uses only objective data and does not include subjective expert judgments and does not use subjective weighting methods such as AHP, SWARA and FUCOM. The evaluation of only the criteria included in the LPI report is another limitation of the study. Recommendations for future studies: These corridors can be studied differently, taking into account geopolitical and geoeconomic differences. Objective and subjective data can be combined by obtaining expert opinions in the LPI assessment. They can choose fuzzy or gray methods in LPI evaluation. They can use the proposed model in different decision-making problems.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors declare that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

REFERENCES

- Akbulut, E. A., Ulutaş, A., Yürüyen, A. A., & Balalan, S. (2024). Hibrit bir ÇKKV modeli ile G20 ülkelerinin lojistik performansının ölçülmesi. *Business & Management Studies: An International Journal*, 12(1), 1-21. <https://doi.org/10.15295/bmij.v12i1.2300>

- Aksakal, B., Ulutaş, A., Balo, F., & Karabasevic, D. (2022). A new hybrid MCDM model for insulation material evaluation for healthier environment. *Buildings*, 12(5), 655. <https://doi.org/10.3390/buildings12050655>
- Amari, A., Moussaid, L., & Tallal, S. (2023). New parking lot selection approach based on the multi-criteria decision making (MCDM) methods: Health criteria. *Sustainability*, 15(2), 938. <https://doi.org/10.3390/su15020938>
- Amiri, A. S., Babaei, A., & Khedmati, M. (2025). Country-level assessment of COVID-19 performance: A cluster-based MACONT-CRITIC analysis. *Applied Soft Computing*, 112762. <https://doi.org/10.1016/j.asoc.2025.112762>
- Arvis, J. F., Alina Mustra, M., Ojala, L., Shepherd, B., & Saslavsky, D. (2010). Connecting to compete 2010: Trade logistics in the global economy--the logistics performance index and its indicators. *World Bank*.
- Ayçin, E., & Bektaş, S. (2024). BIST Kocaeli şehir endeksinde yer alan şirketlerin LOPCOW ve OPARA yöntemleriyle finansal performanslarının değerlendirilmesi. *Sinop Üniversitesi Sosyal Bilimler Dergisi*, 8 (Eğitim Bilimleri ve Sosyal Bilimler Özel Sayısı), 1-24. <https://doi.org/10.30561/sinopusd.1551020>
- Aydın Ünal, E. (2024). PSI-MEREC-MACONT hibrit modeli ile TÜRKİYE sağlık sigorta branşının yıllara göre performans sıralaması. *Karamanoglu Mehmetbey University Journal of Social & Economic Research/Karamanoğlu Mehmetbey Üniversitesi Sosyal ve Ekonomik Araştırmalar Dergisi*, 26(47). <https://doi.org/10.18493/kmusekad.1448284>
- Bağcı, S. A. (2024). Kamu borçlanması ve borsada işlem gören devlet iç borçlanma senetleri göstergelerinin etkinliğinin LOPCOW yöntemi ile belirlenmesi. *Third Sector Social Economic Review*, 59(4), 2556-2575. <https://doi.org/10.15659/3.sektor-sosyal-ekonomi.24.11.2281>
- Bakır, M., & İnce, F. (2024). Havayolu işletmelerinde yolcu memnuniyetinin LOPCOW-AROMAN modeliyle analizi: Star alliance stratejik ortaklığı uygulaması. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, (81), 168-189. <https://doi.org/10.51290/dpusbe.1432572>
- Beysenbaev, R., & Dus, Y. (2020). Proposals for improving the logistics performance index. *The Asian Journal of Shipping and Logistics*, 36(1), 34-42. <https://doi.org/10.1016/j.ajsl.2019.10.001>
- Brodny, J., & Tutak, M. (2023). Assessing the energy security of European Union countries from two perspectives—A new integrated approach based on MCDM methods. *Applied Energy*, (347), 121443. <https://doi.org/10.1016/j.apenergy.2023.121443>
- Cao, J., Spulbar, C., Eti, S., Horobet, A., Yüksel, S., & Dinçer, H. (2025). Innovative approaches to green digital twin technologies of sustainable smart cities using a novel hybrid decision-making system. *Journal of Innovation & Knowledge*, 10(1), 100651. <https://doi.org/10.1016/j.jik.2025.100651>
- Deveci, M., Gokasar, I., Chen, Y., Wang, W., Karaismailoğlu, A. E., & Antucheviciene, J. (2025). Analysis of green energy in sustainable transportation in developing nations through a decision support model. *Renewable Energy*, 122643. <https://doi.org/10.1016/j.renene.2025.122643>
- Diakoulaki, D., Mavrotas, G., & Papayannakis, L. (1995). Determining objective weights in multiple criteria problems. [https://doi.org/10.1016/0305-0548\(94\)00059-H](https://doi.org/10.1016/0305-0548(94)00059-H)
- Ecer, F., & Güneş, E. (2024). G7 ülkelerinin bilgi iletişim teknoloji düzeylerini belirleme: MEREC-CRITIC entegre ağırlıklı CoCoSo metodolojisi. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 11(1), 219-242. <https://doi.org/10.30798/makuiibf.1281607>
- Ecer, F., & Pamucar, D. (2022). A novel LOPCOW-DOBI multi-criteria sustainability performance assessment methodology: An application in developing country banking sector. *Omega*, 112, 102690. <https://doi.org/10.1016/j.omega.2022.102690>
- Ecer, F., & Torkayesh, A. E. (2022). A stratified fuzzy decision-making approach for sustainable circular supplier selection. *IEEE Transactions on Engineering Management*, 71, 1130-1144. <https://doi.org/10.1109/TEM.2022.3151491>
- El-Jaberi, I. K. A., Stojanović, I., Puška, A., Ljepava, N., & Prodanović, R. (2024). Selection of renewable energy projects from the investor's point of view based on the fuzzy-rough approach and the bonferroni mean operator. *Sustainability*, 16(22), 9929. <https://doi.org/10.3390/su16229929>
- Gao, H., & Qian, K. (2025). Risk assessment of municipal water supply and drainage project costs using neutrosophic numbers. *Neutrosophic Sets and Systems*, 81, 712-728.

- Gülcemal, T., & İzci, A. Ç. (2024). TÜRK katılım bankacılığı sektörünün performansının LOPCOW-MOOSRA modeliyle analizi. *Dogus University Journal/Doğuş Üniversitesi Dergisi*, 25(1).
<https://doi.org/10.31671/doujournal.1287120>
- Gürler, H. E., Özçalıcı, M., & Pamucar, D. (2024). Determining criteria weights with genetic algorithms for multi-criteria decision-making methods: The case of logistics performance index rankings of European Union countries. *Socio-Economic Planning Sciences*, 91, 101758.
<https://doi.org/10.1016/j.seps.2023.101758>
- Işık, Ö., Aydın, Y., & Kosaroglu, S. M. (2020). The assessment of the logistics performance index of CEE countries with the new combination of SV and MABAC methods. *LogForum*, 16(4), 549-559.
<https://doi.org/10.17270/J.LOG.2020.504>
- Işık, Ö., Shabir, M., & Belke, M. (2023). Is there a causal relationship between financial performance and premium production? Evidence from Turkish insurance industry. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 10(2), 1388-1412.
<https://doi.org/10.30798/makuiibf.1220299>
- Işık, Ö., Shabir, M., & Moslem, S. (2024). A hybrid MCDM framework for assessing urban competitiveness: A case study of European cities. *Socio-Economic Planning Sciences*, 96, 102109.
<https://doi.org/10.1016/j.seps.2024.102109>
- Jhawar, A., Garg, S. K., & Khera, S. N. (2017). Improving logistics performance through investments and policy intervention: A causal loop model. *International Journal of Productivity and Quality Management*, 20(3), 363-391. <https://doi.org/10.1504/IJPM.2017.082638>
- Ju, M., Mirović, I., Petrović, V., Erceg, Ž., & Stević, Ž. (2024). A novel approach for the assessment of logistics performance index of EU countries. *Economics*, 18(1), 20220074. <https://doi.org/10.1515/econ-2022-0074>
- Kahreman, Y. (2025). Türkiye'nin üretken kapasite performansının incelenmesi. *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, 12(1), 1-23. <https://doi.org/10.17541/optimum.1515558>
- Kara, K., Yalçın, G. C., Simic, V., Baysal, Z., & Pamucar, D. (2024). The alternative ranking using two-step logarithmic normalization method for benchmarking the supply chain performance of countries. *Socio-Economic Planning Sciences*, 92, 101822. <https://doi.org/10.1016/j.seps.2024.101822>
- Kaya, Ö. (2025). Designing green and safe micro mobility routes: An advanced geo-analytic decision system based approach to sustainable urban infrastructure. *Engineering Science and Technology, an International Journal*, 64, 102027. <https://doi.org/10.1016/j.jestch.2025.102027>
- Korucuk, S., Aytekin, A., Görçün, Ö., Simic, V., & Görçün, Ö. F. (2024). Warehouse site selection for humanitarian relief organizations using an interval-valued fermatean fuzzy LOPCOW-RAFSI model. *Computers & Industrial Engineering*, 192, 110160. <https://doi.org/10.1016/j.cie.2024.110160>
- Madić, M., & Radovanović, M. (2015). Ranking of some most commonly used non-traditional machining processes using ROV and CRITIC methods. *UPB Sci. Bull., Series D*, 77(2), 193-204.
- Martí, L., Puertas, R., & García, L. (2014). The importance of the logistics performance index in international trade. *Applied economics*, 46(24), 2982-2992. <https://doi.org/10.1080/00036846.2014.916394>
- Maruf, M., & Özdemir, K. (2024). Ranking of tourism web sites according to service performance criteria with CRITIC and MAIRCA Methods: The case of Turkey. *Uluslararası Yönetim Akademisi Dergisi*, 6(4), 1108-1117. <https://doi.org/10.33712/mana.1352560>
- Mercangoz, B. A., Yıldırım, B. F., & Kuzu Yıldırım, S. (2020). Time period based COPRAS-G method: application on the logistics performance index. *LogForum*, 16(2), 239-250.
<https://doi.org/10.17270/J.LOG.2020.432>
- Mešić, A., Miškić, S., Stević, Ž., & Mastilo, Z. (2022). Hybrid MCDM solutions for evaluation of the logistics performance index of the Western Balkan countries. *Economics*, 10(1), 13-34.
<https://doi.org/10.2478/eoik-2022-0004>
- Oğuz, S. (2023). Evaluation of customs, infrastructure and logistics services with multi-criteria decision-making methods: A comparative analysis for the top 10 countries in the logistics performance index. *Journal of Management Marketing and Logistics*, 10(4), 167-178.
<http://doi.org/10.17261/Pressacademia.2023.1837>

- Özdağoğlu, A., Ulutaş, A., & Keleş, M. K. (2022). Lojistik değerlendirme ölçütlerine göre ülke sıralamaları: Farklı yöntemlerin sıralama üzerindeki etkisi. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 9(1), 512-541. <https://doi.org/10.30798/makuiibf.913369>
- Özekenci, S. Y. (2024). BIST enerji endeksi şirketlerinin LOPCOW-CRITIC tabanlı CoCoSo yöntemleri ile finansal performans analizi. *Selçuk Üniversitesi Sosyal Bilimler Meslek Yüksekokulu Dergisi*, 27(1), 48-64. <https://doi.org/10.29249/selcuksbmyd.1400056>
- Öztaş, T., & Öztaş, G. Z. (2024). Innovation performance analysis of G20 countries: A novel integrated LOPCOW-MAIRCA MCDM approach including the COVID-19 period. *Verimlilik Dergisi*, 1-20. <https://doi.org/10.51551/verimlilik.1320794>
- Pehlivan, P., Aslan, A. I., David, S., & Bacalum, S. (2024). Determination of logistics performance of G20 countries using quantitative decision-making techniques. *Sustainability*, 16(5), 1852. <https://doi.org/10.3390/su16051852>
- Puşka, A., Nedeljković, M., Pamučar, D., Božanić, D., & Simić, V. (2024). Application of the new simple weight calculation (SIWEC) method in the case study in the sales channels of agricultural products. *MethodsX*, 13, 102930. <https://doi.org/10.1016/j.mex.2024.102930>
- Rashidi, K., & Cullinane, K. (2019). Evaluating the sustainability of national logistics performance using data envelopment analysis. *Transport Policy*, 74, 35-46. <https://doi.org/10.1016/j.tranpol.2018.11.014>
- Rezaei, J., van Roekel, W. S., & Tavasszy, L. (2018). Measuring the relative importance of the logistics performance index indicators using best worst method. *Transport policy*, 68, 158-169. <https://doi.org/10.1016/j.tranpol.2018.05.007>
- Senir, G. (2021). Comparison of domestic logistics performances of Türkiye and European Union countries in 2018 with an integrated model. *LogForum*, 17(2). <https://doi.org/10.17270/J.LOG.2021.576>
- Stević, Ž., Erceg, Ž., & Kovačević, B. (2022). The impact of sensitivity analysis on the evaluation of the logistics performance index. *Novi Ekonomist*, 16(1), 41-48. <https://doi.org/10.7251/NOEEN2231041S>
- Stojanović, I., & Puška, A. (2021). Logistics performances of Gulf Cooperation Council's countries in global supply chains. *Decision Making: Applications in Management and Engineering*, 4(1), 174-193. <https://doi.org/10.31181/dmame2104174s>
- Sarıgül, S. S., Ünlü, M., & Yaşar, E. (2023). Financial performance analysis of airlines operating in Europe: CRITIC based MAUT and MARCOS methods. *International Journal of Business and Economic Studies*, 5(2), 76-97. <https://doi.org/10.54821/uiecd.1257488>
- Taşcı, M. Z. (2024). Multidimensional performance evaluation using the hybrid MCDM method: A case study in the Turkish non-life insurance sector. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, 11(2), 854-883. <https://doi.org/10.30798/makuiibf.1439172>
- Tümenbatur, A. (2021). Orta koridor üzerindeki demir ipekyolu güzergahı ve lojistik merkez yer seçimi/ Iron silk road route and logistics center location selection on the middle corridor. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 30(3), 102-110. <https://doi.org/10.35379/cusosbil.977922>
- Ulutaş, A., Balo, F., & Topal, A. (2023). Identifying the most efficient natural fibre for common commercial building insulation materials with an integrated PSI, MEREC, LOPCOW and MCRAT model. *Polymers*, 15(6), 1500. <https://doi.org/10.3390/polym15061500>
- Ulutaş, A., Topal, A., Görçün, Ö. F., & Ecer, F. (2024). Evaluation of third-party logistics service providers for car manufacturing firms using a novel integrated grey LOPCOW-PSI-MACONT model. *Expert Systems with Applications*, 241, 122680. <https://doi.org/10.1016/j.eswa.2023.122680>
- Ünal, E. A. (2025). Kasko üretimi yapan sigorta şirketlerin performansının hibrit ÇKKV modeli ile değerlendirilmesi. *Verimlilik Dergisi*, 59(1), 77-100. <https://doi.org/10.51551/verimlilik.1530339>
- Wen, Z., & Liao, H. (2021). Pension service institution selection by a personalized quantifier-based MACONT method. *International Journal of Strategic Property Management*, 25(6), 446-458. <https://doi.org/10.3846/ijspm.2021.15651>
- Wen, Z., Liao, H., & Zavadskas, E. K. (2020). MACONT: Mixed aggregation by comprehensive normalization technique for multi-criteria analysis. *Informatica*, 31(4), 857-880. <https://doi.org/10.15388/20-INFOR417>
- World Bank (2023). International LPI. <https://lpi.worldbank.org/>.

- Wu, H. W., Zhen, J., & Zhang, J. (2020). Urban rail transit operation safety evaluation based on an improved CRITIC method and cloud model. *Journal of Rail Transport Planning & Management*, 16, 100206. <https://doi.org/10.1016/j.jrtpm.2020.100206>
- Yalman, İ. N., Koşaroğlu, Ş. M., & Işık, Ö. (2023). 2000-2020 Döneminde Türkiye Ekonomisinin Makroekonomik Performansının MEREC-LOPCOW-MARCOS Modeliyle Değerlendirilmesi. *Finans Politik & Ekonomik Yorumlar*, 60(664), 57-86.
- Yıldırım, B. F., & Mercangoz, B.A. (2020). Evaluating the logistics performance of OECD countries by using fuzzy AHP and ARAS-G. *Eurasian Economic Review*, 10(1), 27-45. <https://doi.org/10.1007/s40822-019-00131-3>
- Yürüyen, A. A., & Ulutaş, A. (2024). Assessing the urban competitiveness of european cities using LOPCOW-RAWEC methodologies. *Int J. Knowl. Innov Stud*, 2(3), 179-189. <https://doi.org/10.56578/ijkis020305>
- Yürüyen, A. A., Ulutaş, A., & Özdağoğlu, A. (2023). Lojistik işletmelerinin performansının bir hibrit ÇKKV modeli ile değerlendirilmesi. *Business & Management Studies: An International Journal*, 11(3), 731-751. <https://doi.org/10.15295/bmij.v11i3.2245>
- Zafar, S., Alamgir, Z., & Rehman, M. H. (2021). An effective blockchain evaluation system based on entropy-CRITIC weight method and MCDM techniques. *Peer-to-Peer Networking and Applications*, 14(5), 3110-3123. <https://doi.org/10.1007/s12083-021-01173-8>

Is the Fear Index Still Frightening for the New Members of BRICS? A Study on the Stock Markets and VIX Relationship

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Abstract

The phenomenon of globalization continues to increase the integration of stock markets over time. While this integration complicates effective portfolio diversification, it also amplifies volatility spillovers during periods of financial depression. Such spillovers predominantly flow from US markets to global markets. The BRICS bloc, with its economic objectives, holds the potential to mitigate or eliminate the influence of Western markets. This potential is likely to strengthen with the inclusion of new member countries and the other countries expected to join in the near future. This study aims to examine whether the stock market relationships of the countries that joined BRICS in 2024 with US markets have undergone any changes. In this context, the impact of the VIX on these countries' stock markets before and after their membership was analyzed using the Toda-Yamamoto test. The findings reveal that, in the pre-membership period, there was causality from the VIX to two out of the three countries under study. However, these effects disappeared in the post-membership period. The empirical findings obtained were also supported by multivariate (BEKK) GARCH models. It was determined that the risk transmission observed during the pre-membership period disappeared in the post-membership period. The study demonstrates that BRICS membership serves as a threshold that eliminates the influence of US markets on the stock markets of new member countries. This finding provides predictive insights for the stock markets of countries that are potential candidates for future BRICS membership. Moreover, this result provides significant evidence that the stock markets of newly joined countries may present an opportunity for portfolio diversification for investors.



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1. INTRODUCTION

The acceleration effect of technological advancements on globalization, particularly over the past half-century (Vos, 1988), is an undeniable fact. In the economic sphere, the emergence of powerful e-commerce platforms and the establishment of various regional trade associations have propelled international trade to unprecedented levels compared to the past. Meanwhile, the continuously evolving and diversifying FinTech products have significantly contributed to the integration of financial markets.

The growing integration of both real and financial markets has long been viewed predominantly through its positive aspects, turning it into a widespread phenomenon. Globalized markets have offered companies opportunities to expand far beyond their local markets. Countries and corporations in need of funding have gained access to a broader spectrum of financing opportunities through global markets. Similarly, investors have benefited from a vast universe of financial instruments, enabling them to undertake speculative investment moves and diversify their portfolios for effective risk management.

However, alongside these and many other positive gains of financial globalization, there are also existing and potential negative aspects it brings. Moreover, these negative aspects have become increasingly pronounced over the years as globalization intensifies. Since the early stages of globalization, companies that adapted more quickly to globalization have come from countries with higher incomes and better macroeconomic conditions (Claessens & Schmukler, 2007). This has led to much faster development of financial globalization in Western countries (Arshanapalli & Doukas, 1993; Eichengreen & Park, 2005) and has created a mutually reinforcing cycle for these countries economically. This situation has further deepened the power asymmetry between national economies.

Some of the negative effects of the strengthening of financial globalization have not been limited to the macroeconomic level but have also impacted financial investments. Nowadays, there are minimal differences between Western economies and their financial markets (Bentes, 2015, p. 205). This situation has significantly reduced the benefits of portfolio diversification for investors (Patel et al., 2022, p. 1). The increasing integration of financial markets has amplified the volatility spillover between markets (Alfreedi, 2019; Jebran & Iqbal, 2016; Ji et al., 2020). Events such as the 1997 Asian Crisis (Chanchaoenchai & Dibooglu, 2006), the 2000 dotcom bubble (Zhou & Sornette, 2003), the 2001 Enron Scandal (Ivaschenko, 2004), the 9/11 attacks (Mun, 2005), the 2008 Mortgage Crisis (Mensi et al., 2016) and COVID-19 Crisis (Akhtaruzzaman et al., 2021) are significant examples of how financial crises quickly transformed from a regional scale to a global one.

There are various uncertainty indices (e.g., TEU, EPU, FSI, MCI, FCI) and volatility indices (e.g., VIX, OVX, GVZ, EMP, IDEMV) that are calculated based on different macroeconomic indicators, financial instruments, or commodities to measure uncertainties and/or risks in financial markets and economies (see Akdeniz & Catik, 2017; Huang et al., 2023; Ilhan et al., 2022; Li et al., 2023; Siriopoulos & Fassas, 2013, for more details on indices). Among these indices, the VIX is one of the most frequently

used in the international literature and is widely recognized by economic agents. The VIX (CBOE's Volatility Index) reflects the expected 30-day volatility of S&P 500 index options, serving as an indicator of uncertainty and risk levels (Whaley, 2009) in the stock markets. A high VIX level suggests expectations of volatile market conditions in the future. Although the VIX is based on the S&P 500 index, it is regarded as a measure of uncertainty not only specific to the US markets but also across global markets (Altinkeski et al., 2024; Cheuathonghua et al., 2019; Smales, 2022). This situation can be addressed within the scope of financial market integration and volatility spillover, particularly originating from US stock markets to other stock markets.

The transmission channels between VIX and stock markets have been examined from various perspectives in the literature. One of these perspectives relates to investors' risk perceptions (Gozgor et al., 2016, p. 36). VIX is also referred to as the "fear index" because it reflects market confidence among investors (Lu & Zeng, 2023, p. 335). In this context, considering the transmission within the scope of investor sentiment constitutes one of these perspectives (Smales, 2017). During periods when investors are optimistic, stock markets are positively affected, while during periods of pessimism, they are negatively affected (Fernandes et al., 2014). It has also been found that investors' pessimistic expectations regarding a country/region's economy are not limited to stock markets but also spillover into other financial market instruments (Cipriani & Guarino, 2008). In addition, it has been determined that investor sentiment is contagious and that this contagion can even include irrationality (Huang & Wang, 2017). In this context, many researchers have examined the relationship between the VIX and stock markets from a behavioral finance perspective (Akin & Akin, 2024; Griffith et al., 2020). Since the introduction of the Asian Disease Problem, it has been well-known how framing influences the perception of risk and uncertainty (see Kahneman & Tversky, 1979; Tversky & Kahneman, 1981, for more details). This effect has also been observed in the way changes in the VIX are perceived by investors (Sarwar, 2012). On the other hand, another psychological effect found in the relationship between VIX and stock markets is related to loss aversion (Akin & Akin, 2024; Demirer et al., 2018; Fassas et al., 2020).

BRICS (Brazil, Russia, India, China, and South Africa) stands out as a bloc symbolizing the strengthening of emerging economies in the globalization process. These countries possess the potential to exert significant influence on the balances within the global financial system due to their economic scale and geopolitical positions. Formed as a response to the increasing dominance of Western-centered financial systems over the world economy, this union aims to weaken US hegemony and create a more balanced distribution of economic power. In 2024, with the inclusion of Egypt, Iran, Ethiopia, Saudi Arabia, and the United Arab Emirates, the number of BRICS member countries has reached 10. As a result, BRICS now accounts for approximately 40% of the global population and 30% of the world's gross domestic product.

The existence of BRICS and its initiatives hold significant importance not only for the political and macroeconomic impacts it creates but also for financial investments. For investors, BRICS has the potential to offer a diversification opportunity, especially against increasingly integrated Western financial markets. Additionally, during periods of financial crises or depressions in Western markets, BRICS may serve as a safe haven. Moreover, volatility transmission between markets may affect investors' risk perception (Gong et al., 2022). When one market becomes more volatile, investors may perceive increased risks in other markets as well and adjust their positions accordingly. As a result, investor sentiment can increase the volatility (Rupande et al., 2019) in these financial markets as well. The sharp diversification of financial markets in investors' perceptions, in a political and geopolitical context, has the potential to prevent risk transmission and herd behavior (see Shiller, 1995, for more details) within the scope of behavioral finance.

In recent years, with the acceleration of globalization and financial integration, studies on the relationships between stock markets, risk transmissions, and volatility spillovers have generally been limited to developed economies. Particularly, there is a limited number of studies on the relationships between emerging markets or frontier markets and the US markets and/or how these relationships have evolved during periods of global economic uncertainty. This situation forms the main motivation of the study.

The study has a multi-dimensional objective perspective. The first is to make an inference about whether the stock markets of BRICS member countries offer investors an opportunity to diversify their portfolios. Another objective is to determine whether BRICS membership contributes to the stock markets of newly joined countries in avoiding global risks and uncertainties. In this way, it will be possible to predict whether BRICS could provide potential protection against financial risk transmission caused by globalization for the financial markets of countries that may join the union in the near future.

2. LITERATURE

Research on spillovers and contagion among stock markets has gained significant momentum in recent years. The connectedness between markets is of critical importance in terms of investment forecasting and portfolio diversification. Particularly during periods of financial depression in globally influential stock markets, offering alternatives to investors is vital for enhancing resilience during such times.

In the literature, various variables are used to measure the risk transmission mechanism between global markets. Some of these include volatility indices (Balcilar et al., 2023; Elsayed et al., 2022; Tian et al., 2021), credit spreads (Bostanci & Yilmaz, 2020; Caporale et al., 2021; Kumar & Singh, 2024), currency market volatilities (Albrecht & Kočenda, 2025; Huynh et al., 2023) and monetary policies (O'Donnell et al., 2023). One of the frequently utilized variables in studies on risk transmission

originating from US stock markets is the VIX. Table 1 reports some studies examining the effects of VIX on global stock markets.

Table 1. Studies on the Impact of the VIX

Author(s)	Dependent Variable(s)	Findings
Sarwar (2014)	European Stock Markets	It has been found that the VIX significantly impacts European stock markets, particularly during financial crisis periods. Moreover, uncertainty-driven fears are observed to be more persistent in Europe compared to the US markets.
Ding et al. (2014)	VSTOXX, VDAXNEW, VXJ, VSMI	It has been found that there is an asymmetric bidirectional relationship between VIX and other market volatility indices. It has also been determined that the effect of VIX is greater during both tranquil and crisis periods.
Kang et al. (2014)	Japan and Korea Stock Markets	It has been determined that the VIX has a negative relationship with stock markets.
Buncic and Gisler (2016)	17 Stock Markets	The use of VIX has been found to improve volatility forecasting across all 17 stock markets.
Kim et al. (2016)	6 OECD Stock Markets	The study has identified that the VIX explains the correlations and volatilities of OECD countries during and after the US financial crisis.
Sarwar and Khan (2017)	Emerging Stock Markets	It has been determined that the effects of the VIX on emerging stock markets are present in all periods, with a heightened impact during crisis periods. Furthermore, the uncertainty in US stock markets exerts a suppressive influence on emerging stock markets that is stronger than the impact of their own lagged values.
Chang et al. (2018)	US and European Stock Index ETFs	It has been found that VIX has a strong negative effect on European ETFs in the short term.
Cheuathonghua et al. (2019)	42 Stock Markets	It has been determined that VIX has an asymmetric effect on markets, with its impact being more intense in markets with high volatility and low trading volume. Additionally, it has been reported that VIX spillovers make a stronger impact on returns in developed country markets and on volatility in emerging country markets.
Marfatia (2020)	Dynamic Correlations Between the US Stock Market and 20 International Stock Markets	VIX has been identified as the Granger cause of the dynamic correlation between the US and 17 stock markets.
Wang et al. (2020)	19 Equity Indices	The study examines the forecasting performance of VIX and the EPU index on 19 equity indices. It has been determined that VIX has a stronger predictive capability (on 12 equity indices) compared to the EPU index.
Ceylan (2021)	Dynamic Correlations Between US, UK, Germany and France Stock Markets	It has been found that shocks in VIX lead to an increase in correlations between the stock markets of four countries.
Grima et al. (2021)	Dow Jones, DAX, CAC40, FTSE100, MIB, SSEC, Nikkei225	It has been found that there is cointegration between VIX and all indices except CAC40 and MIB.
Li et al. (2023)	23 Stock Markets	In a study conducted using various uncertainty and volatility indices, VIX was found to demonstrate the best performance in economic forecasting, with a significant increase in its forecasting power reported after the COVID-19 pandemic.
Altinkeski (2024)	20 Developed and 20 Emerging Countries	A high level of connectedness between VIX and both developed and emerging market stock markets has been reported.

On the other hand, as a result of its mission and expansion efforts, BRICS' relationship with US stock markets has increasingly gained attention in the literature. Kishor and Singh (2014) reported that news originating from the US affects the stock markets of BRICS countries, except for China and Brazil. Syriopoulos et al. (2015) found significant return and volatility spillover between the US and BRICS stock markets and business sectors. Mensi et al. (2016) found a strong asymmetric relationship in volatility spillovers between the US and BRICS countries, as well as significant dynamic correlations among the stock markets. Additionally, they determined that the 2008 Financial Crisis heavily impacted the Brazil, India, China, and South Africa markets. McIver and Kang (2020) examined volatility spillover between the US and BRICS countries. They found that spillover increased following the onset of the 2008 Financial Crisis and in the post-European debt crisis period. Additionally, the study revealed that the US, Brazilian, and Chinese stock markets are net volatility transmitters, whereas the Russian, Indian, and South African stock markets are net recipients.

In addition, VIX is one of the commonly used variables to determine the relationships between the US and BRICS stock markets (Bouri et al., 2018; Mensi et al., 2014; Sarwar, 2012; Smales, 2022; Wang & You, 2023). These studies generally conclude that VIX has an asymmetric effect on BRICS, with the asymmetry being reduced during crisis periods when VIX rises or becomes more volatile. However, some limited studies (Shahzad et al., 2022; Zhang & Giouvris, 2022) have found that the relationship between VIX and BRICS markets disappears periodically.

3. DATA AND METHODOLOGY

3.1. Data

The study aims to examine the relationship between the VIX and the stock markets of the new member countries of BRICS before and after their membership. As part of the BRICS+ concept, Egypt, Iran, Ethiopia, Saudi Arabia, and the United Arab Emirates joined the group in 2024. However, Ethiopia and Iran were excluded from the study due to Ethiopia's lack of an organized stock exchange and incomplete access to Iran's stock market data.

The research developed six different VAR models, with VIX as the independent variable and the stock markets of Egypt, the United Arab Emirates, and Saudi Arabia as the dependent variables. The first three models represent the period before these countries joined BRICS, while the latter three models represent the period after their BRICS membership.

The study utilized benchmark indices of the countries, incorporating daily closing prices (USD) into the research. Only trading days when all markets were open were included. The data was sourced from Refinitiv Eikon and analyzed using their natural logarithmic values. The countries, their benchmark indices, index codes, and research periods are detailed in Table 2.

Table 2. Variables and Periods

Countries	Benchmark Indices	Index Codes	Periods	Dates
Egypt	Egyptian Exchange 30	EGX 30	Before BRICS Membership	01 Jan 2023 – 31 Dec 2023
UAE	FTSE Abu Dhabi Securities Exchange	FTSE ADX		
Saudi Arabia	Tadawul All Share Index	TASI	After BRICS Membership	01 Jan 2024 – 01 Dec 2024

In the remainder of the study, the variables will be referred to by their index codes. Symbol (B) will be added next to the index codes for the pre-membership period, while symbol (A) will be used for the post-membership period.

3.2. Methodology

The Toda-Yamamoto test was employed in the study to determine whether causality exists among the variables. The Toda-Yamamoto test is based on the Granger Causality (Granger, 1969). However, it differs in that it can be applied even if the time series is non-stationary or cointegrated (Wolde-Rufael, 2005, p. 896). Additionally, it operates using the asymptotic properties. This enables it to provide more valid and reliable results, particularly in large samples and makes it applicable even when the time series do not exhibit a normal distribution.

A linear method has been chosen for the causality test because, despite the high frequency of the time series, the limited period covered allows for the neglect of regime changes and structural breaks. Hence this approach aims to prevent the incorporation of noise into the model due to the additional degrees of freedom in nonlinear models, which can sometimes lead to incorrect results.

Toda and Yamamoto (1995) proposed a model that allows valid inferences to be drawn from the classical Granger Causality test statistic using a VAR model that includes a procedure ensuring the asymptotic χ^2 distribution of the Wald statistic. The Toda-Yamamoto method is based on the VAR (k+dmax) model and artificially increases the lag of the appropriate VAR model through the maximum order of integration. In the model, k is the appropriate lag order chosen based on information criteria and dmax is the maximum order of integration, determined by the unit root tests. In the Toda-Yamamoto method, the augmented VAR model is as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^k \alpha_{1i} Y_{t-i} + \sum_{j=k+1}^{d_{max}} \alpha_{2j} Y_{t-j} + \sum_{i=1}^k \phi_{1i} X_{t-i} + \sum_{j=k+1}^{d_{max}} \phi_{2j} X_{t-j} + \sum_{i=1}^k \Omega_{1i} X_{2t-i} + \sum_{j=k+1}^{d_{max}} \Omega_{2j} X_{2t-j} + \dots + \varepsilon_{it} \quad (1)$$

Hence "X₁ does not Granger cause Y" if $\Phi_{1i} = 0 \forall i$ or "X₂ does not Granger cause Y" if $\Omega_{1i} = 0 \forall i$.

In this context the Toda-Yamamoto method consists of a three-step application process (Abolghasemi & Dimitrov, 2021, p. 4543):

- Determination of the maximum order of integration (dmax) and selecting the optimal lag length (k)
- Estimation of the augmented VAR model (k+dmax)
- Conducting the Modified Wald Test (MWALD)

The VAR models to be tested in the study are as follows:

Model 1:

$$EGX30(B)_t = \alpha_0 + \sum_{i=1}^k \alpha_{1i} EGX30(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \alpha_{2i} EGX30(B)_{t-j} + \sum_{i=1}^k \phi_{1i} VIX(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \phi_{2j} VIX(B)_{t-j} \quad (2)$$

Model 2:

$$FTSEADX(B)_t = \beta_0 + \sum_{i=1}^k \beta_{1i} FTSEADX(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \beta_{2i} FTSEADX(B)_{t-j} + \sum_{i=1}^k \Omega_{1i} VIX(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \Omega_{2j} VIX(B)_{t-j} \quad (3)$$

Model 3:

$$TASI(B)_t = \delta_0 + \sum_{i=1}^k \delta_{1i} TASI(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \delta_{2i} TASI(B)_{t-j} + \sum_{i=1}^k \psi_{1i} VIX(B)_{t-i} + \sum_{j=k+1}^{d_{max}} \psi_{2j} VIX(B)_{t-j} \quad (4)$$

Model 4:

$$EGX30(A)_t = \vartheta_0 + \sum_{i=1}^k \vartheta_{1i} EGX30(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \vartheta_{2i} EGX30(A)_{t-j} + \sum_{i=1}^k \zeta_{1i} VIX(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \zeta_{2j} VIX(A)_{t-j} \quad (5)$$

Model 5:

$$FTSEADX(A)_t = \Upsilon_0 + \sum_{i=1}^k \Upsilon_{1i} FTSEADX(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \Upsilon_{2i} FTSEADX(A)_{t-j} + \sum_{i=1}^k \emptyset_{1i} VIX(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \emptyset_{2j} VIX(A)_{t-j} \quad (6)$$

Model 6:

$$TASI(A)_t = \Pi_0 + \Pi_{1i} TASI(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \Pi_{2i} TASI(A)_{t-j} + \sum_{i=1}^k \varrho_{1i} VIX(A)_{t-i} + \sum_{j=k+1}^{d_{max}} \varrho_{2j} VIX(A)_{t-j} \quad (7)$$

The null hypothesis in the relevant models is rejected, and the independent variable is determined to be the Granger cause of the dependent variable if $\phi_{1i} \neq 0 \forall i$ or $\Omega_{1i} \neq 0 \forall i$ or $\psi_{1i} \neq 0 \forall i$ or $\zeta_{1i} \neq 0 \forall i$ or $\emptyset_{1i} \neq 0 \forall i$ or $\varrho_{1i} \neq 0 \forall i$.

4. RESULTS

4.1. Descriptive Statistics

Table 3 presents descriptive statistics for variables in the study.

Table 3. Descriptive Statistics of Variables

Variables	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	J-B
VIX(B)	2.8240	3.3239	2.4815	0.1854	0.1453	2.0959	8.7921 [0.01]
EGX 30(B)	6.4137	6.7330	6.1619	0.1445	0.8551	2.5041	30.9165[0.00]
FTSE ADX(B)	7.8763	7.9378	7.8300	0.0241	0.6149	2.8561	14.9512 [0.01]
TASI (B)	7.9855	8.0682	7.8846	0.0422	-0.2318	2.1837	8.5937 [0.01]
VIX(A)	2.7363	3.5177	2.4449	0.1834	1.0599	4.0810	51.9094 [0.00]
EGX 30(A)	6.4827	6.9018	6.2373	0.1716	1.2414	3.1712	56.7749 [0.00]
FTSE ADX(A)	7.8338	7.8938	7.7713	0.0219	0.0647	3.5857	3.2992 [0.19]
TASI (A)	8.0801	8.1381	8.0278	0.0262	0.2355	2.3181	6.2951 [0.04]

Note: J-B is Jarque-Bera normality test

When Table 3 is examined, it is observed that the VIX had a lower average in 2024 compared to 2023. Among the stock indices, EGX 30 and TASI exhibited an increasing average in the subsequent period, while FTSE ADX experienced a decline in its average. It is also evident that EGX 30 had significantly higher market volatility compared to the other stock indices in both periods. The Jarque-Bera normality test results indicate that the distribution of the time series is not normal (except for FTSE ADX (A)).

4.2. Unit Root Tests

To determine the maximum order of integration in the models, stationarity tests were conducted for the variables included in the study. In this context, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were applied. For the ADF unit root test, the Akaike Information Criterion (AIC) was used to determine the appropriate lag length. For the PP unit root test, the spectral estimation method was selected as Bartlett kernel, and the suitable bandwidth was determined using the Newey-West method. Results are presented in Table 4.

Table 4. Unit Root Tests

Variables	ADF(Intercept)		ADF (Intercept and Trend)		PP (Intercept)		PP(Intercept and Trend)	
	Lvl	1 st Dif.	Lvl	1 st Dif.	Lvl	1 st Dif.	Lvl	1 st Dif.
VIX(B)	-1.946(3)	-9.756***(2)	-3.139(2)	-9.734***(2)	-2.236(1)	-17.840***(3)	-3.198 (3)	-17.802***(3)
EGX 30(B)	0.120(4)	-7.703***(3)	-2.551(4)	-7.895***(3)	0.220(1)	-14.384***(2)	-2.732(2)	-14.628***(3)
FTSE ADX(B)	-2.630(0)	-14.730*** (0)	-2.510(0)	-14.763*** (0)	-2.655(3)	-14.730*** (1)	-2.566(3)	-14.763*** (1)
TASI (B)	-1.251(1)	-11.677*** (0)	-1.714(1)	-11.675*** (0)	-1.176(3)	-11.702*** (2)	-1.588(3)	-11.701*** (2)
VIX(A)	-3.118** (2)	-16.852*** (0)	-3.607** (2)	-16.822*** (0)	-3.245** (3)	-16.782*** (2)	-3.696** (3)	-16.752*** (2)
EGX 30(A)	-1.628(2)	-12.899*** (0)	-1.499(2)	-12.900*** (1)	-1.723(6)	-16.782*** (7)	-1.684(5)	-16.754*** (8)
FTSE ADX(A)	-2.241(2)	-10.927*** (1)	-2.151(2)	-10.946*** (1)	-2.154(4)	-13.328*** (9)	-2.045(5)	-13.400*** (9)
TASI (A)	-1.736(8)	-5.755*** (7)	-2.375(8)	-5.768*** (7)	-2.055(4)	-13.691*** (1)	-2.635(4)	-13.692*** (1)

Note: Values in parentheses indicate lag lengths (for ADF test) and bandwidths (for PP test). The symbols *** denote 1%, ** denote 5% significance levels.

When Table 4 is examined, it is observed that all variables in the study are I(1) according to both ADF and PP unit root test results. Accordingly, the maximum order of integration in the models is determined as 1.

4.3. Causality Tests

In the first step of the Toda-Yamamoto test, VAR models were estimated to determine the optimal lag orders. The AIC was used to identify the optimal lag orders. The optimal lag orders for the models are presented in Table A1 (Appendix A).

When Table A1 is examined, it is determined that $k=1$ for Model 1, $k=2$ for Models 2 and 3, and $k=3$ for Models 4, 5 and 6 (Appendix A). The maximum order of integration (d_{max}) for all models in the study is 1. The condition $k \geq d_{max}$ is satisfied for all models. Accordingly, analyses will be conducted based on the VAR ($k+d_{max}$) model to determine Granger causality.

Before determining causality, diagnostic tests for the established VAR models were conducted. For this purpose, Autocorrelation LM tests were applied to check for autocorrelation problems in the models. Additionally, the inverse roots of autoregressive polynomial in the models were examined to determine whether the models were stationary at the specified lag orders.

When Table A2 is examined, it is observed that the probability values at all lag orders in all models are greater than 0.05. Therefore, it has been determined that there is no autocorrelation problem in the models (Appendix A). Similarly, when Figure A1 is examined, it is seen that the inverse roots of autoregressive polynomial in all models are less than 1 and inside of the unit circle (Appendix A). Accordingly, it can be stated that all models are stationary at the specified lag orders.

The MWALD (Modified Wald) test was applied to the models to test causality. The test results are reported in Table 5.

Table 5. MWALD Tests

Period	Models	H_0	χ^2	Prob.	Decision
Before BRICS Membership	1	$VIX(B) \nRightarrow EGX\ 30(B)$	1.8350	0.1755	Accept
	2	$VIX(B) \nRightarrow FTSE\ ADX(B)$	11.7553	0.0028	Reject
	3	$VIX(B) \nRightarrow TASI(B)$	23.2475	0.0000	Reject
After BRICS Membership	4	$VIX(A) \nRightarrow EGX\ 30(A)$	1.5065	0.6807	Accept
	5	$VIX(A) \nRightarrow FTSE\ ADX(A)$	6.2765	0.0989	Accept
	6	$VIX(A) \nRightarrow TASI(A)$	3.6171	0.3058	Accept

Note: In determining the probability values, "k degrees of freedom" were used as the basis.

Upon examining Table 5, it can be observed that the null hypotheses in Model 1, Model 4, Model 5, and Model 6 could not be rejected. However, the null hypotheses in Model 2 and Model 3 were rejected, leading to the conclusion that the independent variable VIX(B) is the Granger cause of the dependent variables FTSE ADX(B) and TASI(B).

A significant portion of studies in the literature has found that US stock market movements have an impact on the BRICS countries (Kishor & Singh, 2014; Syriopoulos et al., 2015). They have also determined that risk transmission, especially during crisis periods, shows a noticeable increase (McIver & Kang, 2020; Mensi et al., 2016). Studies examining this relationship through the VIX variable have generally found similar results (Bouri et al., 2018; Mensi et al., 2014; Sarwar, 2012; Smales, 2022; Wang & You, 2023). This suggests that the attention reallocation mechanism (Ceylan, 2021; Mondria & Quintana-Domeque, 2013) operates strongly. According to the research findings, new members of the bloc were under a similar effect before their membership, but this effect ceased after their membership. Whether this is a temporary psychological impact for international investors will be clarified in future studies.

Unexpected progress in this regard (which may actually be expected by many) can be China and India completing their rise as new volatility transmitters, having prepared the ground with their exchange rate competitiveness and strengthened it with the know-how they have acquired.

5. ROBUSTNESS CHECK

GARCH-based methods were applied in order to examine the robustness of the empirical findings. Before applying the GARCH models on the time series made stationary by first-order differencing, an ARCH-LM pre-test was conducted to ensure the presence of ARCH effects. The ARCH-LM test reveals the regressive characteristics of the analyzed series (Bailey, 1909). The results presented in Table A3 support the presence of ARCH effects in the series (Appendix A).

For the robustness check, the volatility structures (variance-covariance) of the series were first cross-examined using the Bivariate BEKK-GARCH test (Engle & Kroner, 1995). In BEKK-GARCH models, using a (1,1) lag order to determine volatility spillovers between series generally yields successful results (Horpestad et al., 2019; Xie et al., 2021). Hence, the BEKK-GARCH (1,1) model has been used to detect the risk transmission dynamics between the series. The results related to the models are presented in Table B1 (Appendix B). It is observed that both ARCH and GARCH effects exist between the series in the period before the countries' BRICS membership (see, $A_{(1,2)}$ and $B_{(1,2)}$ parameters in Table B1). When examining the off-diagonal parameters of the A matrix, it is found that shocks in VIX(B) have a statistically significant effect at the 1% level on FTSE ADX(B) (coeff: -3.500) and TASI(B) (coeff.: 4.382). Looking at the off-diagonal parameters of the B matrix, it is identified that volatility transmission exists from VIX(B) to EGX30(B) and FTSE ADX(B) at the 1% level of statistical

significance. In the post-membership period, both ARCH and GARCH effects disappear. These results are consistent with the findings of the Toda-Yamamoto test.

The volatility causality of the series has also been examined for the robustness check. In this context, the VAR-BEKK-GARCH method has been used. In the first stage, a Diagonal BEKK-GARCH (1,1) model was constructed. The model results are presented in Table A4 (Appendix A). In the second stage, Granger causality tests were applied to the residuals of the series in the model. According to the results presented in Table 2B, volatility causality exists between VIX(B) and both FTSE ADX(B) and TASI(B) in the pre-membership period (Appendix B). However, in the post-membership period, no statistically significant volatility causality was found from VIX(A) to the other variables. The findings obtained from the volatility causality are fully consistent with the results of the Toda-Yamamoto test.

6. CONCLUSION AND RECOMMENDATIONS

Numerous recent studies have shown that price and volatility movements in the US stock markets tend to spill over into global markets. Strong integration among international stock markets makes it challenging to construct effectively diversified portfolios. Another common finding in the literature is that risk transmission significantly increases during crisis periods. This can be observed in recent financial crises, where many initially began as regional events but quickly evolved into global phenomena. Examining and defining the dynamics between global stock markets is crucial both for financial investments and macroeconomic stability.

For investors, particularly those with low-risk appetite or hedging objectives, accurately identifying alternatives that offer diversification, hedging, or safe-haven properties under different conditions is vital. This is not only important for protecting investors' benefits but also for ensuring the continued healthy transfer of these funds to the real economy.

Although the BRICS bloc may pose potential risks due to political polarization, it is of critical importance to global economic balances. Its presence also has the potential to limit risk transmission between financial markets. However, most studies to date have generally reported various forms of connectedness between Western markets and BRICS. The nature of these linkages varies depending on the periods and conditions examined in these studies, highlighting the need for ongoing research to define these dynamics better.

This study investigates whether there are differences in the linkage characteristics between US markets and the countries that joined the BRICS bloc as of 2024. Specifically, it examines the causality of VIX as an independent variable on the stock markets of these new member countries before and after their membership. The findings reveal that Egypt's stock market shows no relationship with VIX in both pre- and post-membership periods. Meanwhile, causality from VIX to UAE and Saudi Arabia's stock markets, which existed in the pre-membership period, ceased after their membership. Similar findings were obtained in the multivariate GARCH models conducted to ensure the robustness of the empirical

findings. At the same time, there was risk transmission from the VIX to the UAE and Saudi Arabia's stock markets during the pre-membership period, this transmission disappeared in the post-membership period.

The findings offer various insights for investors and for the stock markets of countries potentially joining BRICS in the future. They suggest that the stock markets of new member countries can be utilized for portfolio diversification in the short term. Additionally, the BRICS threshold appears to have the potential to reduce or eliminate the impacts of Western markets on these countries.

Despite the novelty and relevance of the study, it has certain limitations. Long-term relationships between markets should be revisited as the time horizon expands. Furthermore, the safe-haven characteristics of these markets during a potential Western-origin financial crisis should also be tested. A promising research motivation lies in exploring how the BRICS threshold impacts the financial markets of future member countries. Additionally, inter-market linkages within the BRICS bloc should be examined. Although previous studies have analyzed relationships among the founding member countries, the inclusion of new members may reshape these linkages.

Ethics Committee approval was not required for this study.

The author declares that the study was conducted in accordance with research and publication ethics.

The author confirms that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The author declares that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article.

The author affirms that the entire research process was performed by the sole declared author of the study.

REFERENCES

- Abolghasemi, Y., & Dimitrov, S. (2021). Determining the causality between US presidential prediction markets and global financial markets. *International Journal of Finance & Economics*, 26(3), 4534-4556. <https://doi.org/10.1002/ijfe.2029>
- Akdeniz, C., & Catık, A. N. (2017). Türkiye için finansal koşulların bir analizi: Faktör ve VAR modellerinden bulgular. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 12(1), 99-120. <https://doi.org/10.17153/oguiibf.298767>
- Akhtaruzzaman, M., Boubaker, S., & Sensoy, A. (2021). *Financial contagion during COVID-19 crisis*. *Finance Research Letters*, 38, 101604. <https://doi.org/10.1016/j.frl.2020.101604>
- Akin, I., & Akin, M. (2024). Behavioral finance impacts on US stock market volatility: An analysis of market anomalies. *Behavioural Public Policy*, 1-25. <https://doi.org/10.1017/bpp.2024.13>
- Albrecht, P., & Koçenda, E. (2025). Event-driven changes in volatility connectedness in global forex markets. *Journal of Multinational Financial Management*, 77, 100896. <https://doi.org/10.1016/j.mulfin.2024.100896>

- Alfreedi, A. A. (2019). Shocks and volatility spillover between stock markets of developed countries and GCC stock markets. *Journal of Taibah University for Science*, 13(1), 112-120.
- Altinkeski, B. K., Dibooglu, S., Cevik, E. I., Kilic, Y., & Bugan, M. F. (2024). Quantile connectedness between VIX and global stock markets. *Borsa Istanbul Review*, 24(1), 71-79.
<https://doi.org/10.1016/j.bir.2024.07.006>
- Arshanapalli, B., & Doukas, J. (1993). International stock market linkages: Evidence from the pre-and post-October 1987 period. *Journal of Banking & Finance*, 17(1), 193-208. [https://doi.org/10.1016/0378-4266\(93\)90088-U](https://doi.org/10.1016/0378-4266(93)90088-U)
- Bailey, W. W. (1909). March Notes. *Journal of Education*, 69(10), 266-267.
<https://doi.org/10.1177/002205740906901007>
- Balcilar, M., Elsayed, A. H., & Hammoudeh, S. (2023). Financial connectedness and risk transmission among MENA countries: Evidence from connectedness network and clustering analysis. *Journal of International Financial Markets, Institutions and Money*, 82, 101656.
<https://doi.org/10.1016/j.intfin.2022.101656>
- Bentes, S. R. (2015). On the integration of financial markets: How strong is the evidence from five international stock markets?. *Physica A: Statistical Mechanics and Its Applications*, 429, 205-214.
<https://doi.org/10.1016/j.physa.2015.02.070>
- Bostanci, G., & Yilmaz, K. (2020). How connected is the global sovereign credit risk network?. *Journal of Banking & Finance*, 113, 105761. <https://doi.org/10.1016/j.jbankfin.2020.105761>
- Bouri, E., Lien, D., Roubaud, D., & Hussain Shahzad, S. J. (2018). Fear linkages between the US and BRICS stock markets: A frequency-domain causality. *International Journal of the Economics of Business*, 25(3), 441-454. <https://doi.org/10.1080/13571516.2018.1505241>
- Buncic, D., & Gisler, K. I. (2016). Global equity market volatility spillovers: A broader role for the United States. *International Journal of Forecasting*, 32(4), 1317-1339.
<https://doi.org/10.1016/j.ijforecast.2016.05.001>
- Caporale, G. M., Catik, A. N., Helmi, M. H., Akdeniz, C., & Ilhan, A. (2021). The effects of the Covid-19 pandemic on stock markets, CDS and economic activity: Time-varying evidence from the US and Europe. *Empirica*, 51(2), 529-558. <https://doi.org/10.1007/s10663-024-09608-0>
- Ceylan, Ö. (2021). Dynamics of global stock market correlations: The VIX and attention allocation. *Journal of Applied Economics*, 24(1), 392-400. <https://doi.org/10.1080/15140326.2021.1949257>
- Chancharoenchai, K., & Dibooglu, S. (2006). Volatility spillovers and contagion during the Asian crisis: Evidence from six Southeast Asian stock markets. *Emerging Markets Finance and Trade*, 42(2), 4-17.
<https://doi.org/10.2753/REE1540-496X420201>
- Chang, C. L., Hsieh, T. L., & McAleer, M. (2018). Connecting VIX and stock index ETF with VAR and diagonal BEKK. *Journal of Risk and Financial Management*, 11(4), 58.
<https://doi.org/10.3390/jrfm11040058>
- Cheuathonghua, M., Padungsaksawasdi, C., Boonchoo, P., & Tongurai, J. (2019). Extreme spillovers of VIX fear index to international equity markets. *Financial Markets and Portfolio Management*, 33, 1-38.
<https://doi.org/10.1007/s11408-018-0323-6>
- Cipriani, M., & Guarino, A. (2008). Herd behavior and contagion in financial markets. *The BE Journal of Theoretical Economics*, 8(1), 0000102202193517041390. <https://doi.org/10.2202/1935-1704.1390>
- Claessens, S., & Schmukler, S. L. (2007). International financial integration through equity markets: Which firms from which countries go global?. *Journal of International Money and Finance*, 26(5), 788-813.
<https://doi.org/10.1016/j.jimonfin.2007.04.002>
- Demirer, R., Omay, T., Yuksel, A., & Yuksel, A. (2018). Global risk aversion and emerging market return comovements. *Economics Letters*, 173, 118-121. <https://doi.org/10.1016/j.econlet.2018.09.027>
- Ding, L., Huang, Y., & Pu, X. (2014). Volatility linkage across global equity markets. *Global Finance Journal*, 25(2), 71-89. <https://doi.org/10.1016/j.gfj.2014.06.002>
- Eichengreen, B., & Park, Y. C. (2005). Why has there been less financial integration in Asia than in Europe?. In Y. C. Park, T. Ito, and Y. Wang (Eds.), *A new financial market structure for East Asia*, (pp. 84-103). Elgar Online.

- Elsayed, A. H., Gozgor, G., & Lau, C. K. M. (2022). Risk transmissions between bitcoin and traditional financial assets during the COVID-19 era: The role of global uncertainties. *International Review of Financial Analysis*, 81, 102069. <https://doi.org/10.1016/j.irfa.2022.102069>
- Engle, R. F., & Kroner, K. F. (1995). Multivariate simultaneous generalized ARCH. *Econometric Theory*, 11(1), 122-150. <https://doi.org/10.1017/S0266466600009063>
- Fassas, A., Papadamou, S., & Philippas, D. (2020). Investors' risk aversion integration and quantitative easing. *Review of Behavioral Finance*, 12(2), 170-183. <https://doi.org/10.1108/RBF-02-2019-0027>
- Fernandes, M., Medeiros, M. C., & Scharth, M. (2014). Modeling and predicting the CBOE market volatility index. *Journal of Banking & Finance*, 40, 1-10. <https://doi.org/10.1016/j.jbankfin.2013.11.004>
- Gong, X. L., Liu, J. M., Xiong, X., & Zhang, W. (2022). Research on stock volatility risk and investor sentiment contagion from the perspective of multi-layer dynamic network. *International Review of Financial Analysis*, 84, 102359. <https://doi.org/10.1016/j.irfa.2022.102359>
- Gozgor, G., Lau, C. K. M., & Bilgin, M. H. (2016). Commodity markets volatility transmission: Roles of risk perceptions and uncertainty in financial markets. *Journal of International Financial Markets, Institutions and Money*, 44, 35-45. <https://doi.org/10.1016/j.intfin.2016.04.008>
- Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 37(3), 424-438. <https://doi.org/10.2307/1912791>
- Griffith, J., Najand, M., & Shen, J. (2020). Emotions in the stock market. *Journal of Behavioral Finance*, 21(1), 42-56. <https://doi.org/10.1080/15427560.2019.1588275>
- Grima, S., Özdemir, L., Özen, E., & Romãnova, I. (2021). The interactions between COVID-19 cases in the USA, the VIX index and major stock markets. *International Journal of Financial Studies*, 9(2), 26. <https://doi.org/10.3390/ijfs9020026>
- Horpestad, J. B., Lyócsa, Š., Molnár, P., & Olsen, T. B. (2019). Asymmetric volatility in equity markets around the world. *The North American Journal of Economics and Finance*, 48, 540-554. <https://doi.org/10.1016/j.najef.2018.07.011>
- Huang, T. C., & Wang, K. Y. (2017). Investors' fear and herding behavior: Evidence from the Taiwan stock market. *Emerging Markets Finance and Trade*, 53(10), 2259-2278. <https://doi.org/10.1080/1540496X.2016.1258357>
- Huang, Y., Xu, W., Huang, D., & Zhao, C. (2023). Chinese crude oil futures volatility and sustainability: An uncertainty indices perspective. *Resources Policy*, 80, 103227. <https://doi.org/10.1016/j.resourpol.2022.103227>
- Huynh, T. L. D., Nasir, M. A., & Nguyen, D. K. (2023). Spillovers and connectedness in foreign exchange markets: The role of trade policy uncertainty. *The Quarterly Review of Economics and Finance*, 87, 191-199. <https://doi.org/10.1016/j.qref.2020.09.001>
- Ilhan, A., Akdeniz, C., & Ozdemir, M. (2022). Analyzing exchange market pressure dynamics with Markov regime switching: The case of Turkey. *Organizations and Markets in Emerging Economies*, 13(1), 238-259.
- Ivaschenko, I. V. (2004). Coping with financial spillovers from the United States: The effect of US corporate scandals on Canadian stock prices. *Journal of Multinational Financial Management*, 14(4-5), 407-424. <https://doi.org/10.1016/j.mulfin.2004.03.002>
- Jebzan, K., & Iqbal, A. (2016). Examining volatility spillover between Asian countries' stock markets. *China Finance and Economic Review*, 4, 1-13. <https://doi.org/10.1186/s40589-016-0031-1>
- Ji, Q., Liu, B. Y., Zhao, W. L., & Fan, Y. (2020). Modelling dynamic dependence and risk spillover between all oil price shocks and stock market returns in the BRICS. *International Review of Financial Analysis*, 68, 101238. <https://doi.org/10.1016/j.irfa.2018.08.002>
- Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2), 363-391. <https://doi.org/10.2307/1914185>
- Kang, S. H., Ki-Hong, C., & Yoon, S. M. (2014). The impact of global volatility on Asian financial markets. *Journal of the Korean Data Analysis Society*, 16(4A), 1179-1787.

- Kim, H. S., Min, H. G., & McDonald, J. A. (2016). Returns, correlations, and volatilities in equity markets: Evidence from six OECD countries during the US financial crisis. *Economic Modelling*, 59, 9-22. <https://doi.org/10.1016/j.econmod.2016.06.016>
- Kishor, N., & Singh, R. P. (2014). Stock return volatility effect: Study of BRICS. *Transnational Corporations Review*, 6(4), 406-418. <https://doi.org/10.5148/tncr.2014.6406>
- Kumar, P., & Singh, V. K. (2024). Cross-border sovereign risk transmission in BRICIT Nations: Unveiling asymmetries and the role of country risk premiums. *Borsa Istanbul Review*, 24(6), 1263-1274. <https://doi.org/10.1016/j.bir.2024.07.010>
- Li, Z. C., Xie, C., Zeng, Z. J., Wang, G. J., & Zhang, T. (2023). Forecasting global stock market volatilities in an uncertain world. *International Review of Financial Analysis*, 85, 102463. <https://doi.org/10.1016/j.irfa.2022.102463>
- Lu, R., & Zeng, H. (2023). VIX and major agricultural future markets: Dynamic linkage and time-frequency relations around the COVID-19 outbreak. *Studies in Economics and Finance*, 40(2), 334-353.
- Marfatia, H. A. (2020). Investors' risk perceptions in the US and global stock market integration. *Research in International Business and Finance*, 52, 101169. <https://doi.org/10.1016/j.ribaf.2019.101169>
- McIver, R. P., & Kang, S. H. (2020). Financial crises and the dynamics of the spillovers between the US and BRICS stock markets. *Research in International Business and Finance*, 54, 101276. <https://doi.org/10.1016/j.ribaf.2020.101276>
- Mensi, W., Hammoudeh, S., Nguyen, D. K., & Kang, S. H. (2016). Global financial crisis and spillover effects among the US and BRICS stock markets. *International Review of Economics & Finance*, 42, 257-276. <https://doi.org/10.1016/j.iref.2015.11.005>
- Mensi, W., Hammoudeh, S., Reboredo, J. C., & Nguyen, D. K. (2014). Do global factors impact BRICS stock markets? A quantile regression approach. *Emerging Markets Review*, 19, 1-17. <https://doi.org/10.1016/j.ememar.2014.04.002>
- Mondria, J., & Quintana-Domeque, C. (2013). Financial contagion and attention allocation. *The Economic Journal*, 123(568), 429-454. <https://doi.org/10.1111/j.1468-0297.2012.02530.x>
- Mun, K. C. (2005). Contagion and impulse response of international stock markets around the 9-11 terrorist attacks. *Global Finance Journal*, 16(1), 48-68. <https://doi.org/10.1016/j.gfj.2005.05.002>
- O'Donnell, N., Shannon, D., & Sheehan, B. (2023). A vaccine for volatility? An empirical analysis of global stock markets and the impact of the COVID-19 vaccine. *The Journal of Economic Asymmetries*, 28, e00331. <https://doi.org/10.1016/j.jeca.2023.e00331>
- Patel, R., Goodell, J. W., Oriani, M. E., Paltrinieri, A., & Yarovaya, L. (2022). A bibliometric review of financial market integration literature. *International Review of Financial Analysis*, 80, 102035. <https://doi.org/10.1016/j.irfa.2022.102035>
- Rupande, L., Muguto, H. T., & Muzindutsi, P. F. (2019). Investor sentiment and stock return volatility: Evidence from the Johannesburg Stock Exchange. *Cogent Economics & Finance*, 7, 1600233. <https://doi.org/10.1080/23322039.2019.1600233>
- Sarwar, G. (2012). Is VIX an investor fear gauge in BRIC equity markets?. *Journal of Multinational Financial Management*, 22(3), 55-65. <https://doi.org/10.1016/j.mulfin.2012.01.003>
- Sarwar, G. (2014). US stock market uncertainty and cross-market European stock returns. *Journal of Multinational Financial Management*, 28, 1-14. <https://doi.org/10.1016/j.mulfin.2014.07.001>
- Sarwar, G., & Khan, W. (2017). The effect of US stock market uncertainty on emerging market returns. *Emerging Markets Finance and Trade*, 53(8), 1796-1811. <https://doi.org/10.1080/1540496X.2016.1180592>
- Shahzad, S. J. H., Bouri, E., Rehman, M. U., & Roubaud, D. (2022). The hedge asset for BRICS stock markets: Bitcoin, gold or VIX. *The World Economy*, 45(1), 292-316. <https://doi.org/10.1111/twec.13138>
- Shiller, R. J. (1995). Conversation, information, and herd behavior. *The American Economic Review*, 85(2), 181-185.

- Siriopoulos, C., & Fassas, A. (2013). Dynamic relations of uncertainty expectations: A conditional assessment of implied volatility indices. *Review of Derivatives Research*, 16, 233-266. <https://doi.org/10.1007/s11147-012-9085-x>
- Smales, L. A. (2022). Spreading the fear: The central role of CBOE VIX in global stock market uncertainty. *Global Finance Journal*, 51, 100679. <https://doi.org/10.1016/j.gfj.2021.100679>
- Smales, L. A. (2017). The importance of fear: Investor sentiment and stock market returns. *Applied Economics*, 49(34), 3395-3421. <https://doi.org/10.1080/00036846.2016.1259754>
- Syriopoulos, T., Makram, B., & Boubaker, A. (2015). Stock market volatility spillovers and portfolio hedging: BRICS and the financial crisis. *International Review of Financial Analysis*, 39, 7-18. <https://doi.org/10.1016/j.irfa.2015.01.015>
- Tian, M., Li, W., & Wen, F. (2021). The dynamic impact of oil price shocks on the stock market and the USD/RMB exchange rate: Evidence from implied volatility indices. *The North American Journal of Economics and Finance*, 55, 101310. <https://doi.org/10.1016/j.najef.2020.101310>
- Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1-2), 225-250. [https://doi.org/10.1016/0304-4076\(94\)01616-8](https://doi.org/10.1016/0304-4076(94)01616-8)
- Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453-458.
- Vos, R. (1988). Savings, investment and foreign capital flows: Have capital markets become more integrated? *The Journal of Development Studies*, 24(3), 310-334. <https://doi.org/10.1080/00220388808422072>
- Wang, J., Lu, X., He, F., & Ma, F. (2020). Which popular predictor is more useful to forecast international stock markets during the coronavirus pandemic: VIX vs EPU?. *International Review of Financial Analysis*, 72, 101596. <https://doi.org/10.1016/j.irfa.2020.101596>
- Wang, N., & You, W. (2023). New insights into the role of global factors in BRICS stock markets: A quantile cointegration approach. *Economic Systems*, 47(2), 101015. <https://doi.org/10.1016/j.ecosys.2022.101015>
- Whaley, R. E. (2009). Understanding the VIX. *Journal of Portfolio Management*, 35(3), 98-105. . <https://doi.org/10.3905/JPM.2009.35.3.098>
- Wolde-Rufael, Y. (2005). Energy demand and economic growth: The African experience. *Journal of Policy Modeling*, 27(8), 891-903. <https://doi.org/10.1016/j.jpolmod.2005.06.003>
- Xie, Q., Liu, R., Qian, T., & Li, J. (2021). Linkages between the international crude oil market and the Chinese stock market: A BEKK-GARCH-AFD approach. *Energy Economics*, 102, 105484. <https://doi.org/10.1016/j.eneco.2021.105484>
- Zhang, H., & Giouvris, E. (2022). Measures of volatility, crises, sentiment and the role of US 'Fear' Index (VIX) on herding in BRICS (2007-2021). *Journal of Risk and Financial Management*, 15(3), 134. <https://doi.org/10.3390/jrfm15030134>
- Zhou, W. X., & Sornette, D. (2003). Evidence of a worldwide stock market log-periodic anti-bubble since mid-2000. *Physica A: Statistical Mechanics and its Applications*, 330(3-4), 543-583. <https://doi.org/10.1016/j.physa.2002.12.001>

APPENDIX A. SUPPLEMENTARY DATA

The following are the supplementary data to this article.

Table A1. Optimal Order of the VAR Models

Lag	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
0	-1.963314	-5.409576	-5.034068	-1.278566	-5.550348	-4.961949
1	-8.444503*	-10.40260	-9.963810	-5.901.502	-10.01950	-9.227913
2	-8.423813	-10.44883*	-10.09246*	-5.891.058	-10.05105	-9.229611
3	-8.423244	-10.41934	-10.06476	-5.909648*	-10.05780*	-9.240584*
4	-8.411211	-10.41143	-10.05587	-5.883.598	-10.03295	-9.209603
5	-8.430225	-10.38521	-10.03419	-5.862.678	-10.00948	-9.183322
6	-8.399933	-10.36976	-10.01120	-5.838.501	-9.972844	-9.165190
7	-8.380793	-10.34789	-9.980311	-5.805.293	-9.946365	-9.143939
8	-8.352704	-10.31665	-9.956540	-5.778.287	-9.932487	-9.128258

Table A2. Autocorrelation LM Tests

Lag	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.
1	8.6211	0.0712	6.5539	0.1614	5.1158	0.2756	1.8688	0.7598	1.9482	0.7452	2.2790	0.6844
2	7.6270	0.1062	2.7344	0.6032	4.3909	0.3556	3.2198	0.5217	2.5751	0.6312	1.0682	0.8992
3	6.3272	0.1760	6.6210	0.1573	3.8438	0.4275	3.3041	0.5082	1.1221	0.8907	3.1308	0.5361
4	6.9212	0.1401	3.3003	0.5088	4.9261	0.2949	3.2545	0.5161	1.9919	0.7372	1.1138	0.8920
5	0.2255	0.9940	2.2355	0.6925	1.3461	0.8534	2.5141	0.6421	1.2951	0.8622	3.4297	0.4886
6	2.5180	0.6414	3.7265	0.4442	1.9274	0.7491	0.5638	0.9669	2.1901	0.7008	5.2948	0.2583
7	4.0125	0.4043	1.5109	0.8246	3.9931	0.4069	1.4846	0.8293	7.8497	0.0972	6.2663	0.1801
8	3.8210	0.4307	3.1070	0.5400	1.6959	0.7914	1.6687	0.7963	6.7168	0.1516	4.7843	0.3101

Figure A1. AR Roots Graphs

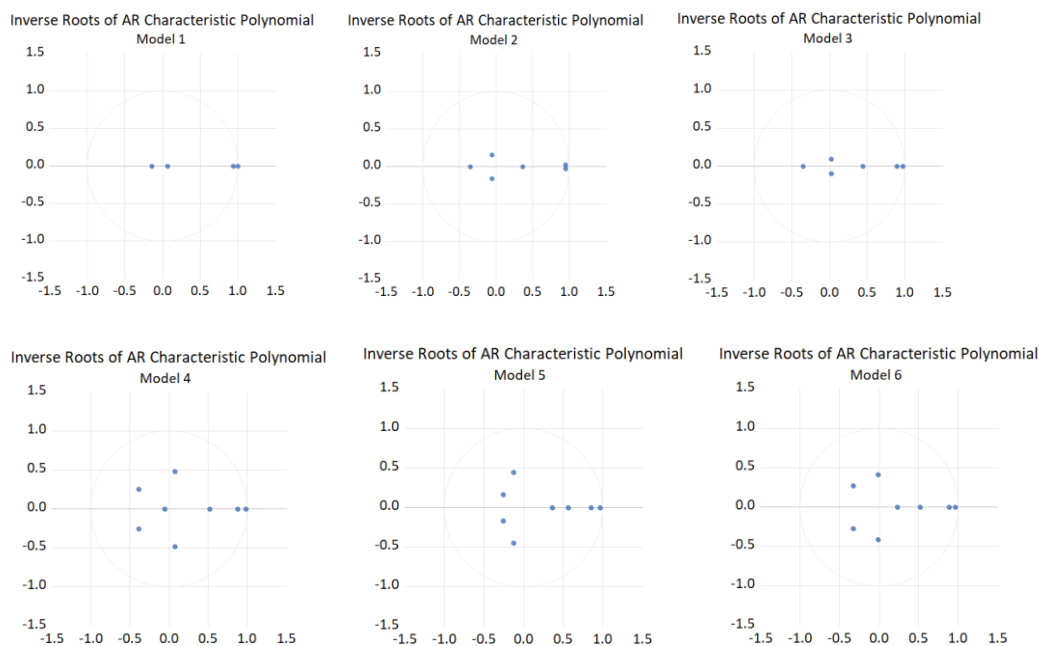


Table A3. ARCH-LM Tests

Variables	ARCHLM(1)
DVIX(B)	7.835***
DEGX 30(B)	7.521***
DFTSE ADX(B)	4.829**
DTASI (B)	5.125**
DVIX(A)	7.971***
DEGX 30(A)	7.758***
DFTSE ADX(A)	12.221***
DTASI (A)	5.201**

Note: The symbols *** denote 1%, ** denote 5% significance levels

Table A4. Diagonal BEKK-GARCH Matrix

Models	A _(1,1)	A _(2,2)	B _(1,1)	B _(2,2)
DEGX 30(B) - DVIX(B)	0.342***	0.279***	0.920***	0.893***
DFTSE ADX(B) - DVIX(B)	1.048***	0.291***	0.104	0.892***
DTASI (B) - DVIX(B)	-0.024	0.369***	-0.889***	0.935***
DEGX 30(A) - DVIX(A)	1.109***	0.334***	0.769***	0.806***
DFTSE ADX(A) - DVIX(A)	0.525***	0.330***	0.740***	0.801***
DTASI (A) - DVIX(A)	0.304**	0.314***	0.790***	0.819***

Note: The matrix values represent the model coefficients. The symbols *** denote 1%, ** denote 5% significance levels

APPENDIX B. ROBUSTNESS CHECK

Table B1. Bivariate BEKK-GARCH Matrix

Models	A _(1,2)	A _(2,1)	B _(1,2)	B _(2,1)
DEGX 30(B) - DVIX(B)	-0.256	-0.083***	-3.233***	0.034
DFTSE ADX(B) - DVIX(B)	-3.500***	0.017*	4.839***	0.085***
DTASI (B) - DVIX(B)	4.382***	-0.031***	0.393	-0.005
DEGX 30(A) - DVIX(A)	-0.018	-3.517***	0.196	-0.300***
DFTSE ADX(A) - DVIX(A)	2.536	-0.023*	-3.780	0.010
DTASI (A) - DVIX(A)	-0.042	-0.040***	-0.426	0.044***

Note: The matrix values represent the model coefficients. The symbols *** denote 1%, ** denote 5% significance levels

Table B2. VAR-BEKK-GARCH Causality Tests

Period	Models	H ₀	F stat.	Prob.
Before BRICS Membership	7	resVIX(B) $\nRightarrow$ resEGX 30(B)	1.5765	0.2089
	8	resVIX(B) $\nRightarrow$ resFTSE ADX(B)	3.2089	0.0422**
	9	resVIX(B) $\nRightarrow$ resTASI(B)	2.9272	0.0555*
After BRICS Membership	10	resVIX(A) $\nRightarrow$ resEGX 30(A)	0.0302	0.9702
	11	resVIX(A) $\nRightarrow$ resFTSE ADX(A)	0.2523	0.7771
	12	resVIX(A) $\nRightarrow$ resTASI(A)	0.0798	0.9233

Note: The symbols ** denote 5%, * denote 10% significance levels