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COMPARISON OF THE FINANCIAL PERFORMANCES OF THE COMPANIES OPERATING IN THE RENEWABLE ENERGY SECTOR TRADING IN BORSA ISTANBUL WITH THE ENTROPY BASED TOPSIS METHOD

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Abstract

The financial performance analysis of the companies operating in the energy sector is an important indicator for the countries. Especially with the renewable energy sector gaining importance, the most basic way for companies in the renewable energy sector to be successful and ensure their continuity is to pay attention to their financial performance management and take a role in the global market. It is very important for companies to determine the status of their financial performance. Because of this situation, companies use ratio analysis, one of the methods used in the analysis of financial statements, in order to determine the status of their financial performance. It is used to determine the significant relationships between the accounts in the financial statements with the ratio analysis technique. In this method, mathematical relations are established between accounts or groups of accounts. With the results obtained with mathematical relations, it is tried to reach a judgment about the economic and financial structure of the enterprise. The aim of this study is to examine 8 companies operating in the energy sector in Turkey and operating in renewable energy sources among the companies registered in Borsa Istanbul (BIST). Using ratio analysis, one of the financial analysis methods, the financial statements of 8 companies for 2020, 2021 and 2022 is examined. Their financial performance, liquidity, leverage, operations and profitability is examined. The reason for choosing the 2020 period is that financial statements are accessible, and the number of companies in the renewable energy sector is at its maximum level. In the first chapter, energy and energy resources are defined, and the energy sector in the world and in Turkey is examined. In addition, similar studies in the literature are included in this section. In the second part, financial performance analysis and its methods are mentioned, and the multi-criteria decision-making method is mentioned. In the third part, their financial performances are analyzed and interpreted using the ratio analysis method. After these processes, the criteria are weighted objectively with Entropy methods,and then the companies are ranked according to their performances by making use of the distances from the ideal solution with TOPSIS, one of the multi-criteria decision-making (MCDM) methods. In the last part, the findings obtained as a result of the application are presented, and in the conclusion part, evaluations are made and interpreted.

Keyword

Renewable Energy, Financial Performance, Entropy,

TOPSIS

1. Introduction

Energy is among the most basic human needs. In today's conditions, the amount of energy consumption per capita in a country has become a measure of development among countries. The most important reasons for the increase in the said energy requirement are developments in technology and population growth. The discovery of energy resources and ensuring the continuity of these resources are constantly on the world

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agenda. In an economy, energy is considered a basic input. On behalf of a country, it is very important that the energy used is cheap, sufficient to meet the need, safe, and of high quality (Çoşkun, 1982). Its importance in the economic situation of the country, its role in the production processes, the rate of use of technology, and scientific approaches on the subject are once again understood.

In today's world, high demand for energy has made energy resources insufficient to meet this need. The disproportionate relationship between these two variables brought up the necessity of efficient use of energy resources and has become a common problem in all world economies. With increasing public awareness, the harm caused by fossil fuel-based energy supply to the environment has been known to everyone, and the tendency to use renewable energy sources that provide clean energy has increased with the development of technological developments. The main ones are solar, wind, biomass, and geothermal energy. The use of sun and wind has increased considerably in recent years due to the fact that they do not contain raw materials and that almost every country has them. In order to encourage its use, country governments have also introduced some legal regulations, such as tax reductions and purchase guarantees for the produced energy. As renewable energy sources have become important for countries, they have also gained an important share in the academic community in recent years. The studies carried out may be to measure or evaluate the success of countries in using renewable energy sources, as well as to develop the technology used in obtaining this energy.

The energy market consists of a wide range of market activities, starting with exploration and production, including refining, transmission, storage, distribution, and trading. While exploration and production activities for energy resources are called upstream markets, refining, transmission, storage, distribution, and marketing activities are called downstream markets (Ergül, 2015). Energy markets are markets where economies of scale and scope are valid, and government support is needed from time to time, especially in terms of international investments. Since the energy industry is a sector where large-scale and capital-intensive investments are made, companies operating in the sector create great economic power and play an active role in determining strategies and policies at both the national and international level. Countries with rich energy resources want to use these resources in a way that will provide the highest income, while countries that are importers want to reach their energy resources in the most cost-effective way. For this reason, one of the important factors that constitute the characteristics of the market is the characteristics of the countries in shopping (Bayraç, 2009). There is a delicate balance between supply and demand in energy markets. Since the demand for energy cannot make big jumps in normal conditions, there is generally a plan for production in terms of controlling energy prices. The price of energy, which is one of the basic inputs of the economy, is one of the important indicators of the general economic conjuncture, and the higher and longer the increase in energy prices, the longer and longer the effects on the macro economy (Pamir, 2003). For sustainable economic growth, it is vital to provide energy from reliable sources uninterruptedly and at affordable costs. In the world economy, many countries' desire to own and/or control energy resources, especially oil and natural gas, makes energy an indispensable political tool at the same time.

In the first part of this study, the definition of the renewable energy sector is given. In the second part, related explanations are given about the concept of MCDM. In the rest of the section, formulas on how to calculate the Entropy and TOPSIS methods used in the study are shown. In the third part, the relevant literature review is made about other studies. In the literature review stage, the studies in the energy sector and the studies on applied MCDM methods are examined. In the study, the financial performance of 8 companies operating in the energy sector, whose shares are traded in BIST, between the years 2020 and 2022 is determined by the TOPSIS methods, which are MCDM methods, which are Entropy weighting methods. The determined success order has been made.

2. Literature Review

Due to problems such as the tendency of fossil resources to be depleted and greenhouse gas emissions worldwide, studies are carried out to ensure the effective use of existing resources and to use renewable energy resources. The costs of energy resources are constantly changing due to developments in technology and political reasons. Many countries are following the energy sector carefully in order to have energy at lower costs and continuously. In addition, many countries are struggling to be the pioneers of changes in the sector in order to have a greater say in this field.

Energy is an indispensable actor in daily life, which is at the core of life. The fact that energy is at the heart of industry as well as its vital function increases its value even more. However, due to the limited energy resources and the effects it has on the environment, apart from the benefits it provides to individuals, it also comes to the fore as a political element. How this balance between economic development and energy consumption should be achieved will be answered by the policies that governments and experts are produce on this issue. Energy efficiency policies are one of the areas that need to be handled sensitively because of their direct relationship with the sustainability of economic growth and social development goals on the one hand and the key role they play in reducing total greenhouse gas emissions on the other. In this context, many studies have been carried out in recent years on energy consumption, sustainable energy resources, and energy efficiency. Henryson et al. (2000) analyzed the link between energy efficiency and energy structure and found a remarkable correlation between the exchange rates between coal and oil. Hepbasli and Utlu (2004) studied Turkey's renewable energy resources, efficient use of these resources, and policies that can be developed on this issue. The clean energy needs of countries and the necessity of meeting this need at a sufficient level have become a problem both for the economy and for the citizens. Therefore, effective and efficient use of energy resources is of great importance for countries. The fact that there is an indispensable relationship between energy and almost all fields of activity in the economy today indicates that there is a close relationship between energy use and economic growth. However, the intensity of this relationship differs from country to country. While the relationship between energy demand and economic growth in developing countries is extremely strong, it is seen that the said relationship is weaker in developed countries. In other words, the elasticity coefficient between energy consumption and GNP growth is generally lower than 1 in developed countries and higher than 1 in developing countries (Saatçioğlu and Küçüksoy, 2004). The energy sector, which stands out as a supportive and necessary resource among all sectors, gains importance in parallel with the growth of the world economy and is in a position to affect the industries, environment, and global strategies of countries. Countries give special importance to the energy sector in order to grow economically. The availability of limited resources and the increase in demand day by day carry the energy sector to a critical point (İskenderoğlu et al., 2015). The energy sector directly concerns other sectors and supports the welfare and economic growth of countries. Energy has a very important place in the development of states (Aktaş and Alioğlu, 2012). Obtaining energy at low costs within the country is very important in order to be one step ahead in the competitive environment in the international market. At this stage, it is not only important that the energy source potential is high. In addition, the quality of energy, transportation possibilities, storage methods, distribution, and technological possibilities are important. Having technologies that will enable the transformation of energy types among themselves and ensuring the continuous development of these technologies contributes to the effectiveness of energy policies. Having energy does not mean only having energy resources.

The gradual increase in energy demand causes priority to be given to supply, not nature, in meeting the increasing energy demand. However, developed countries are looking for ways not to harm nature as well as the supply of this work. For this, they are looking for new technologies and new renewable energy sources. New technologies aim to bring efficient and lower-cost electricity generation from currently used energy types. Increasing energy prices in energy-importing countries creates an inflationary effect by increasing production costs. While the rising energy import bill directs governments toward contractionary fiscal policies, the

resulting inflationary pressure causes general demand to be curtailed. The decrease in public and private sector expenditures leads to economic stagnation and unemployment. These negative effects are growing exponentially, as rising prices and the current economic recession have shaken confidence in consumer markets. On the other hand, increases in oil prices cause countries to take measures to reduce energy intensity by focusing on research and development activities and on renewable energy investments (Aydın, 2010).

In the concept of renewable energy, countries that do not have underground resources also have a much greater potential for energy production opportunities that can provide energy continuity from water, sun, wind, geothermal heat, animal waste, household waste, and similar sources. Turkey's share of renewable energy generation is quite low compared to its potential. With the geopolitical position of the country and the climatic advantages where all seasons can be experienced, it provides more effective environmentalist renewable energy investments. Renewable energy sources represent uninterrupted annual energy flows. It has the potential to meet global energy needs. However, it is often difficult to manage low or variable energy densities and not have sufficient technology to enable interruptions and convert them into usable fuels (Rogner, 2012).

Turkey's geostrategic location makes it a reliable and sustainable route between the energy producing countries in the Caspian and Middle East and the countries in need of energy. For this reason, Turkey provides the necessary support to large-scale energy projects in order to ensure the safety of energy transmission lines and to pass over them. Turkey, taking firm steps forward to become the commercial center of energy, allocates resources to joint energy projects in a win-win relationship as a bridge to energy-producing and energy-needing countries and makes diplomatic attempts to cross these lines through bilateral agreements. Turkey increases its energy imports every year to meet the increasing energy needs of its rapidly growing economy. Due to its increasing energy demand, Turkey supplies one-fourth of its energy from domestic sources and the rest from outside. It is seen that this energy need will continue in the following years (Şahin and Şahin, 2018). Turkey, which does not want to be dependent on imported energy, accelerates its domestic energy investments. Altay Topçu (2019) emphasizes that studies and investments that are reduce foreign dependency on energy and utilize domestic opportunities are support the healthy growth of Turkey. Turkey has important potential in terms of renewable energy resources. According to Ertürk (2019), our country has low reserves in terms of some fossil resources. However, it was stated that the country is very lucky in terms of renewable energy sources.

In the literature, there are various studies in which decision-making methods are used in the financial performance analysis of electricity generation companies. Dikbıyık (2015) analyzed the financial statements of companies in the energy sector between the years 2009 and 2013. As a result of the study, the items that cause the detrimental results of the activities of the companies in 29 sectors are explained. It was stated that the current assets of the companies in the energy sector were insufficient to pay their short-term debts, and it was mentioned that foreign resources were emphasized. Eyüboğlu and Çelik (2016) evaluated the 2008–2013 period data of 13 energy companies traded in Borsa Istanbul according to the criteria of liquidity, activity, financial leverage, profitability, and growth rates. The weights of the ratios were determined by Fuzzy AHP and then the Fuzzy TOPSIS method was used to rank the energy companies. The ranking of the criteria according to their weights is liquidity and profitability, growth rate, financial leverage ratio, and activity ratio.

Shin et al. (2016) wanted to examine the relationship of renewable energy use with financial performance over time, covering the years 2007–2013. As a result of their research, it has been determined that the use of renewable energy has a positive effect on financial performance. Sağır and Doğanalp (2016), in their study, used an indefinite multi-criteria decision-making method to process various resources that Turkey has use in energy production. Here, the target is to determine the importance of the decision-making elements by means of the uncertain TOPSIS method in order to determine and evaluate the options available in the energy field, and to examine and evaluate the energy resources in the light of these decision-making elements. The three energy sources discussed in the study were as follows: fossil, renewable, and nuclear energy. Şahin and Saygılı (2018) applied the TOPSIS method to 21 companies operating in the soil-based sector traded in

the BIST between 2009-2016 and compared them according to their stock prices. As a result, it has been determined that there is no parallelism between TOPSIS ranking and stock prices. Metin et al. (2017) analyzed the financial data of 11 energy companies traded in the BIST with TOPSIS and MOORA multivariate decision methods. The financial statements of the companies for the 5-year period between 2010-2015 are discussed. First, the financial ratios of the companies were determined, and then the financial data of energy companies were reduced to a standard value with the MOORA and TOPSIS methods based on these ratios. In both methods, financial data revealed different values. 66 different rankings were made through MOORA and TOPSIS, and only 3 companies had the same performance order. According to another result of the study, there is no company that draws the best or the worst graph in the performance rankings as of the examined period. Öztel, Aydın, and Köse (2018) evaluated the corporate sustainability performance of an electricity generation company (Akenerji) operating in Turkey between 2010 and 2016 according to 14 criteria in terms of economic, environmental, and social impacts, using Entropy and TOPSIS methods. Bağcı and Yiğiter (2019) compared the financial performances of 15 energy companies traded in Borsa Istanbul between 2008 and 2017 in terms of 16 criteria using SD (standard deviation) and WASPAS methods. According to the results of this study, Orge Energy has the highest performance, and Akenerji has the lowest performance. Karakul and Özaydın (2019) evaluated the financial performances of 8 electricity generation companies registered in Borsa Istanbul in terms of seven criteria using TOPSIS and VIKOR methods. In the study, Aksa Energy and Enerjisa companies are at the top in terms of financial performance, while Akenerji, Aksu Energy, and Bomonti Electric companies are at the bottom. Bağcı H., Yiğiter Ş.(2019), in the study, the financial performances of energy companies registered in BIST between 2008 and 2017 were analyzed with SD and WASPAS methods, which are multi-criteria decision making methods. In the results of working; it has been stated that the WASPAS method gives more reliable results, and the companies with the best and worst performance in the energy sector are specified. Avcı Can (2019) analyzed the performance analysis of companies operating in the energy sector with the MOORA and ARAS methods, one of the MCDM methods, to reach the company ranking and compared the achieved ranking with the Fortune-5002016 ranking. As a result of the study, it is seen that the list order reached by MCDM methods and the list order that he compares are different from each other. Orçun (2019) evaluated the financial performances of 5 electricity generation companies traded in Borsa Istanbul for the years 2016 and 2017 according to 8 criteria using Entropy and WASPAS methods. Ayen Energy is the company with the highest performance in both years. Aksa Energy had the lowest performance in 2016, and Zorlu Energy in 2017. Kara (2019) analyzed the financial performance of companies in the energy sector traded on the stock exchange between 2012 and 2018. It fulfilled 9 criteria with the AHP and TOPSIS methods. While the rankings of the companies did not change much over the years, sudden ups and downs were observed in the rankings of Aksu and Odas. Ağ and Kuloğlu (2020) examined the 2019 performances of energy companies in Borsa Istanbul, with the help of the Data Envelopment Analysis (DEA) method. According to the results of this study, Akenerji, Aksu Energy, Ayen Energy, Enerjisa Energy, and Zorlu Energy companies are the companies with the highest performance. Çiftçi and Yıldırım (2020) analyzed the financial performances of 6 energy companies in Borsa Istanbul between 2011 and 2019 in terms of 20 criteria with the help of the Gray Relational Analysis Method and the Gray Entropy Method. The study findings showed that Aksa Energy had the highest performance, while Zorlu Energy had the lowest. Işık and Koşaroğlu (2020), using SD and MAUT methods, evaluated the financial performances of 5 oil companies in Borsa Istanbul between 2010 and 2019 by considering 8 criteria. They are found to be the company with the highest performance. Kara and Uslu (2020) compared the relative performances of 21 electricity distribution companies operating in Turkey between 2013 and 2018 using the non-parametric Data Envelopment Analysis (DEA) method. Karcıoğlu, Yalçın and Gültekin (2020) used Heuristic Fuzzy Logic and Entropy methods with 13 criteria to analyze the financial performances of 8 energy companies in Borsa Istanbul between 2013 and 2017. While the best performing companies were Odaş and Aksu Energy, the worst performing companies were Aksa Electric and Ayen Electric. Kuvat and Güler (2020) analyzed the financial performances of 8 energy companies traded in Borsa Istanbul between 2014 and 2017 in terms of 10 criteria using the fuzzy TOPSIS method. According to this study, Enerjisa and

Odaş companies ranked at the top in terms of financial performance in all years, while Bomonti Electric took the last place. Mercan and Çetin (2020) evaluated the financial performances of 7 electricity generation companies in the Borsa Istanbul Electricity Index between 2014 and 2018 according to 5 criteria using the COPRAS and VIKOR methods. According to both methods and all years, Enerjisa company is in the top place in terms of financial performance, while Akenerji and Zorlu are in the last place. Yenioğlu and Toklu (2021) compared the performances of 21 electricity distribution companies operating in Turkey between 2011 and 2016 with the help of Stochastic Data Envelopment Analysis. In their study, Büyükarıkan and Eryılmaz (2020) analyzed the financial performances of 4 agricultural companies operating in the BIST using 2012 and 2013 data using the DuPont analysis method. According to their results, there is a significant relationship between active capital and return on investment. Topal (2021), in his study, carried out the financial performance evaluation of 10 electricity generation companies on the Forbes 500 list with the entropy-based CoCoSo method. As a result of the study, companies were ranked according to financial performance. According to Rastogi et al. (2021), financial performance measurements of renewable energy companies in India and the USA between the years 2015-2019 were measured with ROE, and their performance trends are investigated using the k-mean algorithm. In addition, the factors affecting financial performance are tried to be explained by economic policies. As a result of the research, they determined that changes in government regulations and tariff policies are common factors in determining the future of the firm. In addition, it are concluded that tariffs and policies for renewable energy companies should be framed in a way that encourages companies to increase their investments in clean energy generation.

3. Research Methodology

In the literature review, the financial analyses of the companies in the energy sector are mostly made, but the financial analyses of the companies in the renewable energy sector are not particularly encountered in the Turkish literature. This study is aimed at revealing the financial structure of the companies in the renewable energy sector, which is becoming increasingly important, to analyze and interpret their performance. Valuation, from a financial point of view, can be considered a factor that determines the performance of a firm's activities. When considered from this point of view, valuation has the ability to influence the decisions of financial investors in estimating the firm's value in market conditions as close to the truth as possible. Therefore, this process is a helpful element in calculating the success and failure of the business, the performance measurement of employees and managers, and the tax accrual of the tax to be paid to Chartered Accountants in England Wales (ICAEW, 2018). With a wider scope, the purpose of valuation is to calculate the monetary amounts of the assets and liabilities of a firm and the results of its activities over a certain period of time in the most realistic way possible (Baktöre et al., 2000).

By using all the financial statements of the companies with renewable energy sources in the field of activity for the year 2020-2022, among the companies registered in Borsa Istanbul (BIST) serving in the energy sector in Turkey, their financial structures are examined, and their financial performances are analyzed and interpreted. The analysis is carried out by using the financial statements of 8 companies operating in the renewable energy sector, whose shares are traded in BIST, for the years 2020-2022. The selection of companies is based on their energy production based on renewable energy sources. The reason for choosing the 2020 period is that the number of companies in the renewable energy sector that can access financial statements is at the maximum level.As renewable energy sources; solar, hydroelectric, wind, geothermal, biomass, and wave energy are covered. The application data was accessed via the Public Disclosure Platform (KAP). The aim of this study is to analyze the financial structure, liquidity, activity (effectiveness), and profitability for the years 2020–2022, using the ratio analysis method, which is a type of financial analysis, on energy companies whose stocks are traded in Borsa Istanbul (BIST) to reach the success rankings by considering them in the meantime. When the table is examined, it is seen that 8 companies are included in the scope of the research.

Table 1: List of Companies Analyzed

Row number	BIST	Trade Name
1	AKENR	AKENERJI ELECTRICITY GENERATION INC.
2	AKSUE	AKSU ENERGY AND TRADE INC.
3	AYEN	AYEN ENERGY INC.
4	ENJSA	ENERJISA ENERGY INC.
5	NATEN	NATUREL RENEWABLE ENERGY TRADE INC.
6	PAMEL	PAMUKOVA RENEBABLE ELECTRICITY GENERATION INC.
7	YAYLA	YAYLA ENERGY PRODUCTION TOURISM AND CONSTRUCTİON TRADE INC.
8	ZOREN	ZORLU ENERGY ELECTRICITY GENERATION INC.

In the study, the TOPSIS method is chosen from the MCDM methods. The MCDM process consists of four stages: defining the problem, determining the alternatives and comparison features, or, in other words, determining the criteria, determining the appropriate solution method for the problem, and completing the decision-making process by evaluating the results (Kentli and Kar, 2011). The MCDM method preferred in practice is TOPSIS, the details of which are given in the next section.The reason for choosing this method is that its applicability is easy and it is one of the most basic methods. TOPSIS logic is based on the selected alternative having the shortest geometric distance from the best solution and the longest geometric distance from the worst solution. With this method, a criterion with low performance creates a trade-off balance with good performance in another criterion, allowing compromises between the criteria. Moreover, since the negative and positive ideal solutions are determined with TOPSIS, it is a feature that distinguishes it from other MCDM methods in that it can be interpreted according to their ideality among the alternatives to be selected. Multi-criteria decision analysis, according to Langemeyer et al. (2016), is a multi-step process consisting of a set of methods for structuring and formalizing decision-making processes in a transparent and coherent manner. When there are many alternatives for solving a problem, it is important to find the most suitable alternative with the best cost criteria, the lowest environmental impact, and good energy efficiency. In such a case, multi-criteria decision analysis methods are used to compare alternatives (Zlaugotne et al., 2020). The criteria weights are determined by the Entropy method, and the ranking was carried out with TOPSIS. It is thought that the result to be reached will be a resource that can give ideas to investors and other researchers interested in this subject.

The financial performances of the enterprises, which are the subject of the study, are tried to be determined by using the TOPSIS method, and the Microsoft Office Excel program was used in the solution of the model. Within the scope of the application, a total of 14 decision criteria (financial performance ratio) and 8 decision alternatives (firm) are discussed.

Table 2: Ratios Used in Financial Performance Analysis

Ratio Type	Ratio Name	Calculation	Ideal Value
Liquidity Ratios	Current Ratio	Current Assets / Current Liabilities	Benefit
	Acid-Test Ratio	Current Assets – Inventories / Current Liabilities	Benefit
	Cash Ratio	Cash And Cash Equivalents / Current Liabilities	Benefit
Leverage Ratios	Financial Debt Ratio	Total Debt/Total Assets	Cost
	Leverage Ratio	Total Debt/EBITDA	Cost
Efficiency Ratios	Asset Turnover Ratio	Net Sales / Average Total Assets	Benefit
	Receivables Turnover Ratio	Net Credit Sales / Average Accounts Receivable	Benefit
	Inventory Turnover Ratio	Cost Of Goods Sold / Average İnventory	Benefit
	Equity Turnover	Annual Net Sales / Average Stockholders' Equity	Benefit
Profitability Ratios	Return On Assets Ratio	Net İncome / Total Assets	Benefit
	Gross Profit Margin	Gross Profit/ Revenue	Benefit
	EBITDA Margin	EBITDA / Sales Revenue	Benefit
	Net Profit Margin	Net İncome/Revenue	Benefit
	Return On Equity Ratio	Net İncome / Shareholder's Equity	Benefit

In order to carry out the analysis with the TOPSIS multi-criteria decision making method in the study, the importance degrees of the financial performance ratios, which are determined as criteria in the decision problem, are weighted with the Entropy method.

a. Entropy

In MCDM methods, the weighting of the criteria is generally carried out in two ways. Among these weighting methods, subjective weighting includes the evaluations of the decision-maker, while objective weighting includes the quantitative features of the alternatives, and one of the objective weighting methods is the Entropy Method (Bakır and Atalık, 2018). In cases where the decision matrix data is clear, entropy is used to calculate the weight, or, in other words, to measure the amount of useful information provided by the existing

information (Ömürberk et al., 2017). In this method, the smaller the Entropy value, the smaller the disorder value in the system (Yavuz and Baki, 2019). The strength of the Entropy Method is that it provides a more objective and clear analysis by considering the information about the alternatives without the need for the evaluations of the decision-makers. The entropy method consists of 4 steps, as shown below (Kenger, 2017). The amount of useful information can be measured with the entropy method (Wu, Sun, Liang, & Zha, 2011).

Step 1: Creating the Decision Matrix

At this stage, the decision matrix (Equation 1), which shows the values of the alternatives according to the criteria, is created with the help of it. X_{ij}, $i.\ j$ of the alternative. indicates the value of the criterion. The decision matrix includes n criteria and m alternatives.

$$D = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & x_{12} & & x_{1n} \\ x_{21} & x_{22} & & x_{2n} \\ \vdots & \vdots & \dots & \vdots \\ x_{m1} & x_{m2} & & x_{mn} \end{bmatrix}$$

Step 2: A normalized decision matrix is created with the help of Equation (2).

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, \forall\ i, j$$

Step 3: Entropy values of the criteria are found by Equation (3) and Equation (4).

$$k = \frac{1}{(\ln(n))}$$

$$E_j = -k \sum_{i=1}^{m} [P_{ij} \ln P_{ij}]$$

Step 4: Finding Degrees of Differentiation are calculated by Equation (5).

$$d_j = 1 - e_j \quad j = 1, 2, \dots, n$$

Step 5: The criterion weights (wj) are calculated by Equation (6).

$$w_j = \frac{1 - E_j}{\sum_{i=1}^{m} (1 - E_j)}, \qquad \sum_{i=1}^{m} w_j = 1$$

Additional information:

Since the entropy method includes the logarithm function in Equation (7), it is problematic to find negative numbers in the data. To overcome this problem, some transformations have been proposed in the literature (Chang & Wang (n.d.); Zhang et al., 2014). However, there is no fully accepted method in the literature. The most important reason for this is the problem of not maintaining proportional differentiation in the data while

performing the transformation. In this study, a linear normalization transformation is proposed. The following conversion is done for the values found in the negative number criterion (column) xij:

$$x'_{ij} = \frac{x_{ij} - \min_{i \in I} x_{ij}}{\max_{i \in I} x_{ij} - \min_{i \in I} x_{ij}}$$

Here max_{ij} and min_{ij} are the largest and smallest values in the criterion, respectively. With this transformation, the data will be moved to the range [0,1]. For values of 0, a very small value such as 0.00001 is assigned.

b. TOPSIS

The TOPSIS Method is a widely used method in terms of being understandable and having very good computational efficiency with its simple logic, allowing the performance of each alternative to be measured based on a simple mathematical equation, and quickly determining the best alternative with its subjective input (Wang et al., 2018). At the core of the TOPSIS approach is the idea that the most chosen alternative is not only the closest to the positive ideal solution but also the farthest from the negative ideal solution (Chang et al., 2010). The steps of the process can be explained as follows:

Step 1: Creating the Decision Matrix

The decision matrix is formed as follows and stated in Equation (8).

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

Step 2: Calculate value r_{ij} by calculated decision matrix

The formulation of this process is given in Equation (9) in the figure below.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$$

$$(i = 1, \dots, m \; ; j = 1, \dots, n)$$

Step 3: Calculate value vij by calculating weight decision matrix.

The weighted standard decision matrix is created as stated in Equation (10).

$$v_{ij} = r_{ij} \times w_j \quad i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n.$$

Where w_j is the weight of the j^{th} criterion and $\sum_{j=1}^{n} w_j = 1$.

Step 4: Determine the ideal (A) and negative ideal (A^-) solutions*

Finding the positive and negative ideal solution set is formulated as follows as stated in Equation (11) and Equation (12).

$$A^* = \{(\max_i v_{ij} \mid j \in C_b), (\min_i v_{ij} \mid j \in C_c)\} = \{v_j^* \mid j = 1,2,\ldots,m\}$$

$$A^- = \{(\min_i v_{ij} \mid j \in C_b), (\max_i v_{ij} \mid j \in C_c)\} = \{v_j^- \mid j = 1,2,\ldots,m\}$$

Step 5: Calculate measures every alternative from the positive ideal solution and the negative ideal solution.

By means of this formula, the distance values from the maximum and minimum values of each column are calculated. This calculation is performed as follows, as indicated in Equation (13) and Equation (14), respectively.

$$S_{ij}^* = \sqrt{\Sigma_{j=1}^n (v_{ij} - v_j^*)^2}$$

$$S_{ij}^- = \sqrt{\Sigma_{j=1}^n (v_{ij} - v_j^-)^2}$$

Step 6: Calculating Relative Closeness to the Ideal Solution

The closeness value (Ci^*) to the positive ideal solution is calculated by the formula below as stated in Equation (15).

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$$

3.Analysis of the Research and Findings

3.1. Entropy Method

1. Creating a Decision Matrix

The first step of the Entropy method, which is one of the MCDM methods, is the creation of the decision matrix. In order to create this decision matrix, the financial ratios calculated through the financial statements of the 8 companies included in the study are calculated. With the ratio analysis method, the required 14 financial ratios are calculated for the years covering the study. The decision matrix created with the application data created by calculating through the data provided from KAP is stated by transferring to MS Excel as stated in Equation (1):

Table 3 : Financial Ratio Calculated for 2020

2020														
	Current Ratio	Acid-Test Ratio	Cash Ratio	Financial Debt Ratio	Leverage Ratio	Asset Turnover Ratio	Receivables Turnover Ratio	Inventory Turnover Ratio	Equity Turnover	Return On Assets Ratio	Gross Profit Margin	EBITDA Margin	Net Profit Margin	Return On Equity Ratio
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14
AKENR	0,60	0,59	0,35	90,32	101,91	0,32	25,68	604,69	5,25	-15,94	9,06	19,29	-49,59	-260,59
AKSUE	0,19	0,18	0,03	68,16	79,76	0,20	7,92	16,97	0,77	-11,06	65,60	71,83	-56,04	-43,24
AYEN	0,34	0,34	0,12	69,18	73,80	0,19	13,96	0,00	0,70	-3,07	33,33	43,65	-16,11	-12,40
ENJSA	0,83	0,81	0,09	39,56	71,01	0,91	7,31	106,92	3,11	4,53	25,92	16,27	5,00	-208,63
NATEN	2,47	2,29	1,78	31,95	44,92	0,15	11,11	6,10	0,30	8,15	52,38	49,79	878,89	21,02
PAMEL	1,81	1,81	1,51	37,75	40,11	0,12	34,08	0,00	0,21	5,83	59,98	70,94	46,82	9,73
YAYLA	0,55	0,53	0,24	33,57	41,27	0,09	3,61	22,61	0,16	-3,35	-37,97	-50,43	-35,44	-5,51
ZOREN	0,49	0,49	0,12	69,57	89,27	0,43	7,24	106,68	4,36	0,37	17,68	21,18	0,86	3,52

Table 4 : Financial Ratio Calculated for 2021

2021														
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14
AKENR	0,96	0,95	0,43	70,50	87,96	0,39	14,25	393,02	5,41	-25,50	15,34	19,51	-64,58	-349,10
AKSUE	0,49	0,47	0,34	75,84	84,25	0,22	6,58	18,57	1,24	-24,00	68,38	60,44	-108,88	-134,56
AYEN	0,62	0,62	0,21	62,40	67,48	0,35	9,57	0,00	1,17	2,51	36,03	41,56	7,09	9,16
ENJSA	0,90	0,87	0,03	34,20	70,16	1,09	7,17	72,18	3,70	8,15	27,11	17,58	7,47	27,66
NATEN	2,09	2,09	1,33	20,71	27,42	0,17	2,72	33,04	0,24	16,54	32,09	41,07	42,28	5,79
PAMEL	0,38	0,38	0,28	16,90	27,15	0,07	20,84	0,00	0,10	2,20	24,14	44,42	32,95	3,14
YAYLA	0,19	0,16	0,02	22,14	33,74	0,06	5,70	10,58	0,10	4,66	-4,49	-27,48	77,06	7,39
ZOREN	0,68	0,66	0,15	67,12	82,55	0,41	5,33	63,36	2,74	-0,30	16,01	18,51	-0,74	-1,97

Table 5: Financial Ratio Calculated for 2022

2022														
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**	**K1**
AKENR	1,11	1,10	0,39	51,77	74,63	0,96	12,78	10,63	652,91	4,67	-8,80	9	11,18	-9,21	-43,00
AKSUE	0,20	0,19	0,05	68,50	88,16	0,31	7,94	21,16	35,02	2,35	2,32	69,22	69,66	7,38	17,34
AYEN	1,46	1,46	0,91	40,51	55,17	0,89	19,04	16,42	0,00	2,22	20,96	37,86	39,55	23,46	56,03
ENJSA	0,70	0,65	0,27	32,26	63,55	1,87	14,86	12,76	68,29	5,46	32,03	18,74	10,26	17,17	93,77
NATEN	1,85	1,83	0,94	18,61	26,37	0,14	1,55	1,59	42,75	0,18	7,98	35,98	41,27	88,03	4,59
PAMEL	0,12	0,12	0,09	3,81	33,67	0,07	21,64	10,18	0,00	0,10	22,54	50,79	64,34	326,21	33,05
YAYLA	0,55	0,46	0,37	7,50	20,76	0,06	30,45	3,97	8,40	0,08	26,77	-22,55	-56,52	475,87	35,91
ZOREN	0,60	0,58	0,13	51,04	73,89	0,58	5,99	6,40	69,85	2,53	0,22	12,96	15,34	0,37	0,93

Fixing the Decision Matrix; Since the presence of a negative index value in the decision matrix causes problems in the calculation, the negative values in the relevant criteria columns of the decision matrix are turned into positive. Equations (7) are used for calculation purposes.

2. Normalization of the Adjusted Decision Matrix

The normalization process was carried out using Equation (2). The normalized decision matrices are shown in the figure below:

Table 6: Matrix with Normalization for 2020

2020														
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,08	0,08	0,08	0,21	0,19	0,13	0,23	0,70	0,35	0,00	0,09	0,11	0,01	0,00
AKSUE	0,03	0,03	0,01	0,15	0,15	0,08	0,07	0,02	0,05	0,04	0,20	0,19	0,00	0,14
AYEN	0,05	0,05	0,03	0,16	0,14	0,08	0,13	0,00	0,05	0,11	0,13	0,15	0,03	0,16
ENJSA	0,11	0,11	0,02	0,09	0,13	0,38	0,07	0,12	0,21	0,18	0,12	0,10	0,05	0,03
NATEN	0,34	0,33	0,42	0,07	0,08	0,06	0,10	0,01	0,02	0,21	0,17	0,16	0,76	0,18
PAMEL	0,25	0,26	0,36	0,09	0,07	0,05	0,31	0,00	0,01	0,19	0,18	0,19	0,08	0,17
YAYLA	0,08	0,08	0,06	0,08	0,08	0,04	0,03	0,03	0,01	0,11	0,00	0,00	0,02	0,16
ZOREN	0,07	0,07	0,03	0,16	0,16	0,18	0,07	0,12	0,29	0,14	0,11	0,11	0,05	0,17

Table 7: Matrix with Normalization for 2021

2021														
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,15	0,15	0,15	0,19	0,18	0,14	0,20	0,67	0,37	0,00	0,08	0,11	0,05	0,00
AKSUE	0,08	0,08	0,12	0,21	0,18	0,08	0,09	0,03	0,08	0,01	0,29	0,20	0,00	0,09
AYEN	0,10	0,10	0,08	0,17	0,14	0,13	0,13	0,00	0,08	0,15	0,16	0,16	0,13	0,15
ENJSA	0,14	0,14	0,01	0,09	0,15	0,39	0,10	0,12	0,25	0,18	0,13	0,10	0,13	0,16
NATEN	0,33	0,34	0,48	0,06	0,06	0,06	0,04	0,06	0,02	0,22	0,15	0,16	0,18	0,15
PAMEL	0,06	0,06	0,10	0,05	0,06	0,03	0,29	0,00	0,01	0,15	0,11	0,17	0,16	0,15
YAYLA	0,03	0,03	0,01	0,06	0,07	0,02	0,08	0,02	0,01	0,16	0,00	0,00	0,22	0,15
ZOREN	0,11	0,11	0,05	0,18	0,17	0,15	0,07	0,11	0,19	0,13	0,08	0,11	0,13	0,15

Table 8: Matrix with Normalization for 2022

2022															
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**	**K1**
AKENR	0,17	0,17	0,12	0,19	0,17	0,20	0,11	0,74	0,27	0,00	0,08	0,10	0,00	0,00	0,17
AKSUE	0,03	0,03	0,02	0,25	0,20	0,06	0,07	0,04	0,13	0,06	0,23	0,19	0,02	0,11	0,03
AYEN	0,22	0,23	0,29	0,15	0,13	0,18	0,17	0,00	0,13	0,17	0,15	0,15	0,03	0,18	0,22
ENJSA	0,11	0,10	0,09	0,12	0,15	0,38	0,13	0,08	0,31	0,23	0,11	0,10	0,03	0,25	0,11
NATEN	0,28	0,29	0,30	0,07	0,06	0,03	0,01	0,05	0,01	0,10	0,15	0,15	0,10	0,09	0,28
PAMEL	0,02	0,02	0,03	0,01	0,08	0,01	0,19	0,00	0,01	0,18	0,19	0,19	0,33	0,14	0,02
YAYLA	0,08	0,07	0,12	0,03	0,05	0,01	0,27	0,01	0,00	0,20	0,00	0,00	0,48	0,15	0,08
ZOREN	0,09	0,09	0,04	0,19	0,17	0,12	0,05	0,08	0,14	0,05	0,09	0,11	0,01	0,08	0,09

Step 3: Finding Entropy Values for Criteria

Entropy values will be calculated after the normalized decision matrix process. The k value, which is a logarithmic function, was calculated to obtain the entropy values. The value of k in the range $0 \leq ej \leq 1$ is a constant. To find the k value, the formula $k = (\ln(m))-1$ was applied. Since there are 8 decision points during the ratio analysis, $k = (\ln(8))-1 = 0.48$. Equation (3) is used for this.

Table 9 : Values Obtained by the Entropy Method of 2020

2020													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	-0,21	-0,21	-0,21	-0,33	-0,31	-0,27	-0,34	-0,25	-0,37	0,00	-0,21	-0,24	-0,03	0,00
AKSUE	-0,10	-0,09	-0,04	-0,29	-0,28	-0,21	-0,19	-0,08	-0,15	-0,14	-0,32	-0,32	0,00	-0,27
AYEN	-0,14	-0,15	-0,10	-0,29	-0,27	-0,20	-0,26	0,00	-0,14	-0,25	-0,27	-0,28	-0,11	-0,29
ENJSA	-0,25	-0,25	-0,08	-0,22	-0,27	-0,37	-0,18	-0,26	-0,33	-0,31	-0,26	-0,23	-0,15	-0,11
NATEN	-0,37	-0,37	-0,36	-0,19	-0,21	-0,17	-0,23	-0,03	-0,08	-0,33	-0,30	-0,29	-0,21	-0,31
PAMEL	-0,35	-0,35	-0,37	-0,21	-0,19	-0,15	-0,36	0,00	-0,06	-0,32	-0,31	-0,31	-0,21	-0,30
YAYLA	-0,20	-0,19	-0,16	-0,20	-0,20	-0,12	-0,11	-0,10	-0,05	-0,24	0,00	0,00	-0,07	-0,29
ZOREN	-0,18	-0,19	-0,10	-0,29	-0,30	-0,31	-0,18	-0,26	-0,36	-0,28	-0,24	-0,24	-0,14	-0,30

Table 10 : Values Obtained by the Entropy Method of 2021

2021													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	-0,29	-0,29	-0,29	-0,32	-0,31	-0,28	-0,32	-0,27	-0,37	0,00	-0,20	-0,24	-0,15	0,00
AKSUE	-0,20	-0,20	-0,26	-0,32	-0,31	-0,20	-0,22	-0,11	-0,21	-0,04	-0,36	-0,32	0,00	-0,22
AYEN	-0,23	-0,23	-0,19	-0,30	-0,28	-0,26	-0,27	0,00	-0,20	-0,28	-0,29	-0,29	-0,27	-0,29
ENJSA	-0,28	-0,28	-0,05	-0,22	-0,28	-0,37	-0,23	-0,26	-0,35	-0,31	-0,26	-0,23	-0,27	-0,29
NATEN	-0,37	-0,37	-0,35	-0,16	-0,16	-0,17	-0,12	-0,16	-0,07	-0,33	-0,28	-0,29	-0,31	-0,28
PAMEL	-0,17	-0,17	-0,23	-0,14	-0,16	-0,09	-0,36	0,00	-0,03	-0,28	-0,25	-0,30	-0,30	-0,28
YAYLA	-0,11	-0,09	-0,04	-0,17	-0,19	-0,08	-0,20	-0,07	-0,03	-0,29	0,00	0,00	-0,33	-0,29
ZOREN	-0,24	-0,24	-0,16	-0,31	-0,30	-0,28	-0,19	-0,24	-0,31	-0,27	-0,20	-0,24	-0,26	-0,28

Table 11 : Values Obtained by the Entropy Method of 2022

2022															
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**	**K1**
AKENR	0,17	0,17	0,12	0,19	0,17	0,20	0,11	0,74	0,27	0,00	0,08	0,10	0,00	0,00	0,17
AKSUE	0,03	0,03	0,02	0,25	0,20	0,06	0,07	0,04	0,13	0,06	0,23	0,19	0,02	0,11	0,03
AYEN	0,22	0,23	0,29	0,15	0,13	0,18	0,17	0,00	0,13	0,17	0,15	0,15	0,03	0,18	0,22
ENJSA	0,11	0,10	0,09	0,12	0,15	0,38	0,13	0,08	0,31	0,23	0,11	0,10	0,03	0,25	0,11
NATEN	0,28	0,29	0,30	0,07	0,06	0,03	0,01	0,05	0,01	0,10	0,15	0,15	0,10	0,09	0,28
PAMEL	0,02	0,02	0,03	0,01	0,08	0,01	0,19	0,00	0,01	0,18	0,19	0,19	0,33	0,14	0,02
YAYLA	0,08	0,07	0,12	0,03	0,05	0,01	0,27	0,01	0,00	0,20	0,00	0,00	0,48	0,15	0,08
ZOREN	0,09	0,09	0,04	0,19	0,17	0,12	0,05	0,08	0,14	0,05	0,09	0,11	0,01	0,08	0,09

Equation (4) was used to find entropy values for the criteria. The entropy values obtained are shown in the figure below:

Table 12: Ej Values Between 2020-2022

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
2020-e_j	-0,86	-0,86	-0,68	-0,97	-0,97	-0,86	-0,89	-0,47	-0,74	-0,90	-0,92	-0,92	-0,44	-0,90
2021-e_j	1,90	1,89	1,75	1,93	1,96	1,84	1,92	1,53	1,76	1,87	1,89	1,92	1,91	1,93
2022-e_j	-0,88	-0,87	-0,84	-0,89	-0,95	-0,79	-0,90	-0,45	-0,78	-0,88	-0,90	-0,92	-0,57	-0,90

5. Finding Degrees of Differentiation

The degrees of differentiation were found using Equation (5). The obtained degrees of differentiation are shown in the figure below

Table 13: D_J Values Between 2020-2022

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
2020-d_j	1,86	1,86	1,68	1,97	1,97	1,86	1,89	1,47	1,74	1,90	1,92	1,92	1,44	1,90
2021-d_j	1,90	1,89	1,75	1,93	1,96	1,84	1,92	1,53	1,76	1,87	1,89	1,92	1,91	1,93
2022-d_j	1,88	1,87	1,84	1,89	1,95	1,79	1,90	1,45	1,78	1,88	1,90	1,92	1,57	1,90

6. Calculation of Entropy Criterion Weights

The importance weights of the criteria were found using Equation (6). The resulting importance weights are shown in the figure below:

Table 14: Importance Weights of Criteria for 2020-2022

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14
2020-wj	0,07	0,07	0,07	0,08	0,08	0,07	0,07	0,06	0,07	0,07	0,08	0,08	0,06	0,07
2021-wj	0,07	0,07	0,07	0,07	0,08	0,07	0,07	0,06	0,07	0,07	0,07	0,07	0,07	0,07
2022-wj	0,07	0,07	0,07	0,07	0,08	0,07	0,07	0,06	0,07	0,07	0,07	0,08	0,06	0,07

According to the results of the application carry out with the Entropy method, the most important financial performance criterion in 2020 is determined as the Financial Debt Ratio, Leverage Ratio, Gross Profit Margin, EBITBA Margin (0.08); Current Ratio , Cash Ratio , Acid-Test Ratio, Asset Turnover Ratio , Equity Turnover Receivables Turnover Ratio , Return On Assets, Return On Equity (0.07); Inventory Turnover Ratio , Net Profit Margin (0.6).

In 2021, the most important financial performance criterion is determined as the Leverage Ratio (0,08); Current Ratio , Cash Ratio , Acid-Test Ratio, Financial Debt Ratio, Asset Turnover Ratio ,Inventory Turnover , Receivables Turnover Ratio, Equity Turnover, Return On Assets, Gross Profit Margin , EBITBA Margin, Net Profit Margin **,** Return On Equity (0,07); Inventory Turnover Ratio (0,06).

In 2022, the most important financial performance criterion is determined as the Leverage Ratio, EBITBA Margin (0,08); Current Ratio , Cash Ratio , Acid-Test Ratio, Financial Debt Ratio , Asset Turnover Ratio , Receivables Turnover Ratio, Equity Turnover, Return On Assets , Gross Profit Margin, Return On Equity (0,07); Inventory Turnover Ratio, Net Profit Margin (0,06).

After weighting the importance levels of the financial performance ratios with the Entropy method, TOPSIS application is carried out in order to perform the performance analysis. Before the implementation phase, the characteristics of the criteria were determined. In this direction, Current Ratio, Acid-Test Ratio, Cash Ratio, Asset Turnover Ratio, Receivables Turnover Ratio, Inventory Turnover Ratio Equity Turnover, Return On Assets, Gross Profit Margin, EBITDA Margin, Net Profit Margin, Return On Equity are benefit criteria; Financial Debt Ratio, Leverage Ratio is considered as a cost criterion.

3.2. Topsıs Method

1. Creation of the Standard Decision Matrix

The ratio analysis data calculated in the study is applied using the TOPSIS method. At this stage, the normalization process of the decision matrix determined at the beginning of the analysis section is performed. The creation of the standard decision matrix was carried out using Equations (8) and (9). The standard decision matrices obtained as a result of applying the formula are shown in the figure below:

Table 15: Creation of the Standard Decision Matrix for 2020

2020													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,18	0,18	0,15	0,54	0,51	0,29	0,53	0,97	0,69	-0,70	0,08	0,14	-0,06	-0,77
AKSUE	0,06	0,06	0,01	0,41	0,40	0,18	0,16	0,03	0,10	-0,49	0,55	0,53	-0,06	-0,13
AYEN	0,10	0,11	0,05	0,42	0,37	0,17	0,29	0,00	0,09	-0,13	0,28	0,32	-0,02	-0,04
ENJSA	0,25	0,25	0,04	0,24	0,35	0,82	0,15	0,17	0,41	0,20	0,22	0,12	0,01	-0,62
NATEN	0,74	0,72	0,75	0,19	0,22	0,13	0,23	0,01	0,04	0,36	0,44	0,37	0,99	0,06
PAMEL	0,54	0,57	0,63	0,23	0,20	0,11	0,71	0,00	0,03	0,26	0,50	0,53	0,05	0,03
YAYLA	0,17	0,17	0,10	0,20	0,20	0,08	0,07	0,04	0,02	-0,15	-0,32	-0,37	-0,04	-0,02
ZOREN	0,15	0,15	0,05	0,42	0,44	0,39	0,15	0,17	0,58	0,02	0,15	0,16	0,00	0,01

Table 16: Creation of the Standard Decision Matrix for 2020

2021													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,35	0,35	0,29	0,48	0,48	0,30	0,48	0,97	0,74	-0,64	0,16	0,19	-0,41	-0,93
AKSUE	0,18	0,17	0,23	0,52	0,46	0,17	0,22	0,05	0,17	-0,60	0,73	0,58	-0,69	-0,36
AYEN	0,23	0,23	0,14	0,43	0,37	0,27	0,32	0,00	0,16	0,06	0,38	0,40	0,04	0,02
ENJSA	0,33	0,32	0,02	0,23	0,38	0,83	0,24	0,18	0,51	0,20	0,29	0,17	0,05	0,07
NATEN	0,77	0,78	0,89	0,14	0,15	0,13	0,09	0,08	0,03	0,41	0,34	0,39	0,27	0,02
PAMEL	0,14	0,14	0,19	0,12	0,15	0,05	0,70	0,00	0,01	0,06	0,26	0,43	0,21	0,01
YAYLA	0,07	0,06	0,01	0,15	0,18	0,05	0,19	0,03	0,01	0,12	-0,05	-0,26	0,49	0,02
ZOREN	0,25	0,25	0,10	0,46	0,45	0,31	0,18	0,16	0,37	-0,01	0,17	0,18	0,00	-0,01

Table 17: Creation of the Standard Decision Matrix for 2020

2022													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,39	0,40	0,27	0,45	0,44	0,40	0,27	0,99	0,56	-0,17	0,09	0,09	-0,02	-0,33
AKSUE	0,07	0,07	0,03	0,60	0,53	0,13	0,17	0,05	0,28	0,04	0,65	0,55	0,01	0,14
AYEN	0,52	0,53	0,63	0,35	0,33	0,37	0,40	0,00	0,27	0,39	0,36	0,31	0,04	0,44
ENJSA	0,25	0,23	0,19	0,28	0,38	0,79	0,31	0,10	0,66	0,60	0,18	0,08	0,03	0,73
NATEN	0,65	0,66	0,65	0,16	0,16	0,06	0,03	0,06	0,02	0,15	0,34	0,33	0,15	0,04
PAMEL	0,04	0,04	0,06	0,03	0,20	0,03	0,46	0,00	0,01	0,42	0,48	0,51	0,56	0,26
YAYLA	0,19	0,17	0,26	0,07	0,12	0,03	0,64	0,01	0,01	0,50	-0,21	-0,45	0,81	0,28
ZOREN	0,21	0,21	0,09	0,45	0,44	0,24	0,13	0,11	0,31	0,00	0,12	0,12	0,00	0,01

Step 2. Creating the Weighted Standard Decision Matrix

At this stage, each value in the standard decision matrix is multiplied by the criterion weights obtained by the Entropy Method, according to the column in which they were located, and the weighted standard decision matrix is obtained. The calculation is carried out using Equation (10). The weighted standard decision matrices are shown in the figure below:

Table 18: Weighted Matrix in 2020 Topsis Method

2020													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,01	0,01	0,01	0,04	0,04	0,02	0,04	0,05	0,04	-0,05	0,01	0,01	0,00	-0,05
AKSUE	0,00	0,00	0,00	0,03	0,03	0,01	0,01	0,00	0,01	-0,03	0,04	0,04	0,00	-0,01
AYEN	0,01	0,01	0,00	0,03	0,03	0,01	0,02	0,00	0,01	-0,01	0,02	0,02	0,00	0,00
ENJSA	0,02	0,02	0,00	0,02	0,03	0,06	0,01	0,01	0,03	0,01	0,02	0,01	0,00	-0,04
NATEN	0,05	0,05	0,05	0,01	0,02	0,01	0,02	0,00	0,00	0,03	0,03	0,03	0,05	0,00
PAMEL	0,04	0,04	0,04	0,02	0,01	0,01	0,05	0,00	0,00	0,02	0,04	0,04	0,00	0,00
YAYLA	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00	-0,01	-0,02	-0,03	0,00	0,00
ZOREN	0,01	0,01	0,00	0,03	0,03	0,03	0,01	0,01	0,04	0,00	0,01	0,01	0,00	0,00

Table 19: Weighted Matrix in 2021 Topsis Method

2021													
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,02	0,02	0,02	0,03	0,03	0,02	0,03	0,05	0,05	-0,04	0,01	0,01	-0,03	-0,06
AKSUE	0,01	0,01	0,01	0,04	0,03	0,01	0,02	0,00	0,01	-0,04	0,05	0,04	-0,05	-0,02
AYEN	0,02	0,02	0,01	0,03	0,03	0,02	0,02	0,00	0,01	0,00	0,03	0,03	0,00	0,00
ENJSA	0,02	0,02	0,00	0,02	0,03	0,05	0,02	0,01	0,03	0,01	0,02	0,01	0,00	0,01
NATEN	0,05	0,05	0,06	0,01	0,01	0,01	0,01	0,00	0,00	0,03	0,02	0,03	0,02	0,00
PAMEL	0,01	0,01	0,01	0,01	0,01	0,00	0,05	0,00	0,00	0,00	0,02	0,03	0,01	0,00
YAYLA	0,00	0,00	0,00	0,01	0,01	0,00	0,01	0,00	0,00	0,01	0,00	-0,02	0,03	0,00
ZOREN	0,02	0,02	0,01	0,03	0,03	0,02	0,01	0,01	0,02	0,00	0,01	0,01	0,00	0,00

Table 20: Weighted Matrix in 2022 Topsis Method

2022														
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	**K11**	**K12**	**K13**	**K14**
AKENR	0,03	0,03	0,02	0,03	0,03	0,03	0,02	0,05	0,04	-0,01	0,01	0,01	0,00	-0,02
AKSUE	0,00	0,00	0,00	0,04	0,04	0,01	0,01	0,00	0,02	0,00	0,05	0,04	0,00	0,01
AYEN	0,04	0,04	0,04	0,02	0,02	0,02	0,03	0,00	0,02	0,03	0,02	0,02	0,00	0,03
ENJSA	0,02	0,02	0,01	0,02	0,03	0,05	0,02	0,01	0,04	0,04	0,01	0,01	0,00	0,05
NATEN	0,04	0,05	0,04	0,01	0,01	0,00	0,00	0,00	0,00	0,01	0,02	0,02	0,01	0,00
PAMEL	0,00	0,00	0,00	0,00	0,01	0,00	0,03	0,00	0,00	0,03	0,03	0,04	0,03	0,02
YAYLA	0,01	0,01	0,02	0,00	0,01	0,00	0,04	0,00	0,00	0,03	-0,01	-0,03	0,05	0,02
ZOREN	0,01	0,01	0,01	0,03	0,03	0,02	0,01	0,01	0,02	0,00	0,01	0,01	0,00	0,00

Step 3. Determination of Positive Ideal and Negative Ideal Solution Values

After the weighted standard decision matrix step, the positive and negative solutions required for TOPSIS should be obtained. At this stage in the study, the rates are divided into two categories: benefit and cost. If a high rate is positive for the company, it is called a benefit, or vice versa, if a high rate is negative, it is called a cost. 12 of the 14 ratios in the study were determined as benefits and 2 as costs. Positive and negative ideal solution values were found using Equations (11) and (12), respectively. The positive ($v+$) and negative ($v-$) ideal solutions obtained in this direction are shown in the figure below:

Table 21: Positive and Negative Ideal Solution Values

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14
2020-$v+$	0,05	0,05	0,05	0,01	0,01	0,06	0,05	0,05	0,04	0,03	0,04	0,04	0,05	0,00
2020-$v-$	0,00	0,00	0,00	0,04	0,04	0,01	0,01	0,00	0,00	-0,05	-0,02	-0,03	0,00	-0,05
2021-$v+$	0,05	0,05	0,06	0,01	0,01	0,05	0,05	0,05	0,05	0,03	0,05	0,04	0,03	0,01
2021-$v-$	0,00	0,00	0,00	0,04	0,03	0,00	0,01	0,00	0,00	-0,04	0,00	-0,02	-0,05	-0,06
2022-$v+$	0,04	0,05	0,04	0,00	0,01	0,05	0,04	0,05	0,04	0,04	0,05	0,04	0,05	0,05
2022-$v-$	0,00	0,00	0,00	0,04	0,04	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,03	0,00	-0,02

Step 4. Calculating Distance to Positive and Negative Ideal Points

After calculating the S_i^+ and S_i^- values, the distance values of the TOPSIS method to the ideal points are calculated. While finding these values, the formula related to all the calculated financial ratios of the business in the study and the S_i^+ and S_i^- values found is applied. This formula is specified in Equations (13) and (14). Table 22 shows the Maximum Ideal Distance to Point values.

Table 22: Distance to the Maximum Ideal Point in the Topsis Method for the Years 2017-2021

	2020		2021		2022	
	S_i^+	S_i^-	S_i^+	S_i^-	S_i^+	S_i^-
AKENR	0,15	0,12	0,15	0,12	0,14	0,12
AKSUE	0,15	0,11	0,16	0,11	0,14	0,13
AYEN	0,14	0,11	0,12	0,12	0,09	0,13
ENJSA	0,12	0,17	0,11	0,15	0,11	0,12
NATEN	0,09	0,16	0,10	0,11	0,12	0,13
PAMEL	0,10	0,07	0,13	0,09	0,12	0,10
YAYLA	0,17	0,11	0,16	0,10	0,15	0,07
ZOREN	0,13	0,09	0,13	0,09	0,14	0,06

Step 5. Calculating Relative Closeness to the Ideal Solution

After the distance values to the maximum ideal point are found, the last stage of TOPSIS is started. In the last stage, the C_i^* score value was calculated. The resulting value is between 0 and 1. If the C_i^* score value

is close to 1, it is shown that it is at the positive ideal point, and if it is close to 0, it is close to the negative ideal point. The success of the enterprises is shown by ordering the C_i * score values obtained from the largest to the smallest. The firm with the highest C_i* score becomes the best firm. This formula is specified in Equations (15). Table 23 shows the results of the C_i* score value and the ranking of the enterprises.

Table 23: $\boldsymbol{C_i}$* and Success Ranking in the Topsis Method for the Years 2020-2022

	2020		2021		2022	
	S_i^+	S_i^-	S_i^+	S_i^-	S_i^+	S_i^-
AKENR	0,15	0,12	0,15	0,12	0,14	0,12
AKSUE	0,15	0,11	0,16	0,11	0,14	0,13
AYEN	0,14	0,11	0,12	0,12	0,09	0,13
ENJSA	0,12	0,17	0,11	0,15	0,11	0,12
NATEN	0,09	0,16	0,10	0,11	0,12	0,13
PAMEL	0,10	0,07	0,13	0,09	0,12	0,10
YAYLA	0,17	0,11	0,16	0,10	0,15	0,07
ZOREN	0,13	0,09	0,13	0,09	0,14	0,06

According to the ranking results obtained by the TOPSIS method, the top three most successful enterprises for 2020 are NATEN ($\boldsymbol{C_i}$* =0.64), ENJSA ($\boldsymbol{C_i}$* =0.58) and AYEN ($\boldsymbol{C_i}$* =0.46); For 2021, ENJSA ($\boldsymbol{C_i}$* = 0.57), NATEN ($\boldsymbol{C_i}$* =0.53) and AYEN ($\boldsymbol{C_i}$* =0.51); For 2022, it has been determined as AYEN ($\boldsymbol{C_i}$* =0.58), ENJSA, NATEN ($\boldsymbol{C_i}$* =0.52) and AKSUE, AKENR ($\boldsymbol{C_i}$* =0.48). According to the application results, the most unsuccessful enterprises are YAYLA ($\boldsymbol{C_i}$* =0.39); For 2021, it was determined as YAYLA ($\boldsymbol{C_i}$* =0.38) and for 2022 it was determined as ZOREN ($\boldsymbol{C_i}$* =0.31).

Conclusion

Energy has been one of the most current issues in the world from the past to the present, and it is becoming more and more important. Many disasters that occur in the world, such as wars, global warming, and deterioration of the natural structure, are directly or indirectly based on the wrong consumption of energy resources. The gradual decrease in resources leads societies to new searches. For this reason, projects and cooperation between countries are organized to increase the use of renewable energy. The energy trade structures of the countries and their support for each other will be one of the issues that will be further emphasized by determining future targets. While making future-oriented decisions, companies consider the current situation and the past performances of the company and make analyses. As a result, they aim to maximize the value of the company with the decisions they make. One of the most important supporters of the current situation of the companies and the determination of their performance development in the past periods is financial analysis. With the data obtained as a result of financial analysis, companies determine the steps to be taken and company policies. As a result of the development of technology and industry, energy has an important place in human life. Energy consumption allows us to get an idea of the development level of countries. Especially in developing countries, energy consumption is increasing rapidly. The fact that energy production facilities require high-cost investments causes energy-dependent countries such as Turkey to import energy to meet their energy needs, incur high costs, and become one of the most important expense items.

However, since the need for energy increases very rapidly in countries that are dependent on foreign energy, the increase in the external debt of these countries is affected to a significant extent, and this situation has a serious negative impact on the economic structure of the countries. However, in order to be able to reach a strong position in the global competition that has emerged with the developments in the industry, it is necessary to produce industrial products while keeping costs low.

The aim of the study was in this direction, from the idea that the financial performances of companies could be measured with TOPSIS, and the application is carried out in this direction, and the relationship between them and stock returns is examined. The reason for choosing the TOPSIS method is its applicability. In the literature, studies have been carried out for different sectors using this method. In this context, the financial performances of the companies listed in BIST and operating in the renewable energy sector for the period of 2020–2022 were evaluated with the TOPSIS method, which is one of the multi-criteria decision-making methods, since it is the first period in which the maximum number of companies can be reached. While selecting the companies to be included in the application, companies that produce renewable energy equipment or companies that use non-renewable energy sources in energy production are not included in the evaluation. Most of the companies included in the application use non-renewable energy sources as well as renewable energy sources in energy production, since the production is realized using only renewable energy sources in 2020–2022, and the number of companies listed in the BIST is very few. The results to be achieved will reflect the total performance of the company.

Ratio analysis is used to measure their financial performance. First, the results of the ratio analysis were evaluated within themselves. Afterwards, the ratio values reached were defined as criteria, and their weights among performance indicators are determined by the Entropy method. In order to have information about the performance of the enterprise with a single value and to be able to make an evaluation at once for all companies in the sector with this single value reached, the TOPSIS method is applied. When the asset structure of companies with renewable energy sources among their production activities is examined, it is seen that fixed assets are predominantly fixed. From the point of view of the sector, electricity, etc., energy production realizations, it can be interpreted that the investments made are long-term. In addition, the equipment used by companies in the renewable energy sector seems logical considering their land investments.

In this context; in the comparison of liquidity ratios for 2020, NATEN has the highest liquidity ratio and AKSUE has the lowest. The low liquidity ratio indicates that there may be difficulties in paying the debts. In 2021, NATEN has again be the company with the highest liquidity ratio. The company with the lowest liquidity was YAYLA . For 2022, while NATEN has the best ratio, AKSUE has the lowest liquidity ratio. The rate of NATEN company is much higher than the sector average, and it has been interpreted that there may be idle funds because the money cannot be used well. When the activity analysis rates are examined, it is expected that the turnover rate of the companies that consume their stocks quickly is also high. In this situation, for AKENR, ENJSA, and ZOREN, it can be said that the stock turnover rate is high. However, since some of these companies use renewable energy sources and some of them use both renewable and non-renewable energy sources, their stock ratios may have a misleading result. When an analysis is carried out according to the fields of activity, it is seen that companies using hydroelectric, wind, and solar energy generally have rapid turnover in terms of their stocks. In connection with the speed, the number of days left in stock also decreases as the speed increases. According to the analysis of the financial structure ratios, it is concluded that AKENR company is in a risky situation for the years 2020, 2021, and 2022 due to its high leverage ratio and negative equity. In the event of the liquidation of the business, there is a risk of not being able to collect their receivables for the lenders. The firm with the lowest level of financial leverage and below the industry average is PAMEL. This indicates that the company is safe. When the profitability ratios are examined, it is evaluated that the averages of the renewable energy sector are not at high levels. In the comparison between companies, it seems that the ratio of NATEN between the years 2020-2022 is in a profitable position, mostly because it is above the sector average. When the structure of the energy sector is examined, it is seen that enterprises use financial

debt more than equity. Although this situation is positive in terms of resource costs, it is a negative indicator in terms of the risk incurred. When examined in this context, it can be concluded that financial debt and financial debt elements are important indicators in the analysis of enterprises as an effect of the sector structure. Long-term investments—in other words, the return on investments made in fixed assets—may be longer than expected, and therefore companies may have to bear additional costs. In addition to long-term investment decisions, it is important to manage current assets efficiently. A sufficient level of net working capital should be kept in case of a negative situation. In future studies, it is recommended to make an evaluation on a different and broader scale of financial criteria. The decision-making model created in this study can be applied to decision problems such as site selection, product selection, and different performance evaluations in future studies.

In practice, all of the financial ratios calculated from the annual data for 2020 were defined as criteria, and they are weighted using the Entropy method in order to determine their weights objectively. After this stage, performance indicators are ranked by being reduced to a single score with TOPSIS, one of the multi-criteria decision-making methods. These ratios, which are determined according to the weighting achieved in the first application, can also be described as the main indicators of financial performance. According to TOPSIS results, the top three most successful enterprises for 2020 are NATEN, ENJSA, and AYEN; for 2021, ENJSA, NATEN, and AYEN; and for 2022, it has been determined as AYEN, ENJSA, NATEN, AKSUE, and AKENR. According to the application results, the most unsuccessful enterprises are YAYLA for 2020 and ZOREN for 2022. Turkey is very rich in renewable energy sources, especially wind and solar. Investments in these resources are increasing, but they are insufficient compared to the investments of other countries. Our country is largely foreign-dependent in the energy sector, and the increasing level of indebtedness in foreign currency also negatively affects the profitability of the company in the sector. This situation causes an increase in input costs and inflationary pressure on a macroscale in production companies where energy is a source. Renewable energy sources should be supported by investments, and an industry approach based on fossil fuel consumption should be abandoned. In addition, making investments in this direction will reduce foreign dependency and alleviate the current debt burden. In future studies, it is recommended to make an evaluation on a different and broader scale of financial criteria. The decision-making model created in this study can be applied to decision problems such as site selection, product selection, and different performance evaluations in future studies.

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THE IMPORTANCE OF THE BRAND IN THE MARKETING OF FINANCIAL SERVICES

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Abstract

Brand is an element that distinguishes a company's products and services from its competitors. The importance of the brand in the finance sector is quite great. For the consumer, the brand causes the company's products and services to be perceived as higher quality and more reliable. In today's competitive environment, brands in the financial services sector have marketing strategies that they must implement to differentiate themselves. The aim of the article is to touch upon the important points that brands must make in order to be preferred and to survive and differentiate in an ever-changing competitive environment. The article covers topics such as increasing brand value and brand image, creating high brand credibility, engaging in CSR activities, existing in the digital world, creating brand loyalty and brand awareness.

Keyword

Financial Services,
Brand,
Digital Marketing

1.INTRODUCTION

Financial services are the economic services provided by the financial sector, that is, it refers to the sector in which the system provides various services related to financial transactions such as money, investment, capital, credit, and risk management. These services help individuals, businesses, governments, and other organizations meet their financial needs and run financial activities smoothly. The importance of the brand in the marketing of financial services is quite high. A brand is a special identification mark, such as a name, symbol, logo, term or design, used to differentiate a product, service or company from other products or services. The brand is also seen as a repository for all the value produced by the company's brand campaigns. In recent years, the brand has become representative of the customer experience that the entire company offers to its customers. Therefore, the brand can be a

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platform for the company's strategy because every company's activity is identified with the brand. (Kotler, 2017)

Since we live in a digital age, customers can now easily follow the promises made by brands during the positioning phase. In this age where everything can be easily tracked, brands cannot make promises they cannot keep to avoid appearing inconsistent because people find reliable and consistent brands more attractive. On the other hand, brands that personalize products and services to meet customers' real needs are also attractive to customers. For example, the use of artificial intelligence-based personalized smart tips offered by some banks in their mobile applications is one of the features that make these banks that offer the application attractive. It is very important for brands to have a clear differentiation. As brands gain humanoid features, their brand values also increase. Having humanoid features; in other words, human-centered brands that are more genuine and honest, that accept their flaws and do not try to appear perfect, treat their customers as friends and gain their loyalty. These features increase the brand values and brand images of the brand.

Increasing brand value means increasing both company revenues and moral value in the eyes of the consumer. Brand image reflects the beliefs consumers have about the brand (Keller,1993) Positive beliefs of consumers have a positive effect on brand image. What the consumer thinks about the brand is very important in determining the value of the brand. Even if brands earn high profits, they cannot increase their brand value unless they can establish a good relationship with consumers. The corporate social responsibility activities implemented by the company may affect the consumer's attitude towards the brand. If the company carries out consistent CSR activities, it attracts the attention of consumers and gains their trust. Trust is one of the most important factors in financial services, and brand concept is an important element in building trust. A good brand history increases consumer interest and trust in the financial services provider. Customer experience is also important when choosing financial services. When using applications that provide financial services, consumers pay attention to user-friendliness and the brand's ability to provide privacy and security. A good user experience ensures that the brand is preferred and used continuously. This article contains a literature review exploring the importance of branding in the marketing of financial services.

2. LITERATURE REVIEW

2.1 Brand Identity

Brand identity is what comes to mind in the mind of the target audience. Brand identity reflects how the brand should be perceived by its target consumers, which highlights the psychological connection between the brand and consumers (Alvarado-Karste and Guzmán, 2020). Brand identity is the highest level of the consumer-brand relationship and is more strategic, unlike brand image, which focuses on short-term results. Brand identity communicates the personality and uniqueness of the brand to consumers, ensuring their recognition, support and appreciation (Barros et al., 2020). The psychological bond formed between consumers and brands is called consumer-brand identity. It represents the psychological state in which consumers perceive and feel a sense of belonging to a brand (So et al., 2017). Social identity theory argues that consumers, influenced by creating and maintaining their social image, are more inclined to choose goods or services that can verify their social identity.

The brand identity has not been created well enough if consumer perceptions vary widely. Brand personality is supportive in the areas of conveying the features of the product offered to consumers, providing enthusiasm, explaining the consumer-brand bond, guiding the development of the brand, consumer behavior patterns, and providing insight. The set of human characteristics that can be associated with a brand is defined as brand identity. The greater the similarity between the consumer's self-concept and the brand personality, the more likely the consumer will have a positive attitude towards the brand (Torres et al., 2017). Moreover, two basic mechanisms motivate consumer brand identity: The first is the need for consistency, and the other is the need for self-esteem. In the first, consumers may seek a brand with a distinct identity that matches their true self (Yeh et al., 2016). High identity similarity/congruence between consumers and the brand facilitates strong consumer affiliation and creates brand identity (Lam et al., 2013).

Brand-consumer similarity plays an important role in the brand identification approach that leads to brand loyalty (Torres et al., 2017). In line with the second mechanism, the need for self-esteem, consumers can help create their ideal identities by purchasing unique brands (Yeh et al., 2016). Consumers are likely to find brand identities more attractive because the perception of their brand identity matches their own perceptions, such matches allowing them to perceive themselves more fully and authentically.

There are some important points to make to create a brand identity. The logo of the brand shows the corporate aspect of the business and becomes permanent in the mind of the consumer as awareness increases. When a consumer sees the logo of the brand whose products or services they like, they act with a sense of trust. In short, brand identity can be considered as a whole with the logo. In addition to representing the institution, the logo helps the business differentiate itself from its competitors by creating awareness. To ensure your logo grabs the attention of your target audience and garners the desired recognition, it is crucial to understand your target audience's preferences, establish a memorable design, and craft an original logo incorporating your brand's distinct colors. It is important to associate colors with the brand in the process of creating a brand identity. Every brand strives to stand out from its competitors by creating awareness, so brands use colors that correspond to emotions. Businesses aiming to create a brand personality use typography to choose the fonts they will use in their brand visual works and brand logo. While brands create their own personalities with fonts, they can also achieve effective visual integrity for the messages they send out.

Another essential step in crafting a brand identity is to create a website. While websites are used as virtual environments that businesses use to express themselves, they also play the role of digital brand identity for businesses. While websites shed light on many unknowns about the brand, they are one of the special areas that should reflect the brand identity in terms of design, colors and language used. Nowadays, consumers frequently refer to companies' websites to get to know brands, so it would be correct to say that an unupdated website is among the factors that damage brand identity. It is important to share a certain template and design style through various media during the process of consumers getting used to the brand. A characteristic structure of the brand can be built by arranging photographs and icons in a certain template, especially in posts made on social media. Consistency is important in creating brand identity. By adopting a specific template layout, consistency can be achieved throughout the brand's photography and icon designs. When a standard design for the brand is created, it is important to use social media and, if necessary, traditional media effectively to create visual familiarity with this design. Brand identity can be quickly adopted with the integrity provided by visual works.

2.2 Brand Image

Some academics (Park & Park, 2019) have asserted that the topic of brand image has been an intriguing focal point in marketing literature. Besides, brand image has wielded considerable influence in discerning between companies and serves as a potent instrument in marketing endeavors (Park & Park, 2019). Similarly, the examination of brand image has been acknowledged as the core of research in marketing and advertising. It not only functions as a foundation for strategic challenges in marketing mix but also plays a crucial part in establishing enduring brand equity (Aaker, 1996; Keller, 1993). Keller (1993) asserted that brand image is characterized by the impressions of the brand, as revealed through the associations linked to the brand stored in the consumer's mind. Furthermore, a sharp brand image has assisted customers in understanding the brand's expectations and in distinguishing the brand from its competitors.

Hence, it has improved the likelihood that clients will buy the brand (Hsieh et al., 2004). A company or its offerings that consistently maintain a positive reputation among the public would undoubtedly secure a more advantageous position in the market, a sustainable competitive edge, and an augmentation in both market share and performance. Preceding research has indicated that brand image served as a predictor of customer satisfaction and exerted a positive influence on customer satisfaction (Anwar et al., 2019)

In the financial services sector, creating a strong brand image is very important because people share their personal information, make investments, and benefit from credit opportunities with banks that provide financial services. In addition to these services, daily transactions such as money transfers, cash withdrawals, and bill payments are among the services used. Brand image plays a big role in consumers choosing a bank. Brand image has been defined in different ways in the literature. According to Aaker (1996) and Keller (1993), brand image is the information about the brand in the consumer's mind. In other words, consumers create the image of a brand with the information they have in their minds, and for this, consumers do not need to have experienced the product or service of a brand. Perceptions about the brand can form directly or indirectly over time. Every person may have different thoughts about a brand, so brand image may differ according to consumers. Dobni and Zinkhan (1990) defined brand image as the personality that consumers give to the brand or the meanings they attribute to the brand.

According to Aaker (1997), brand personality means associating the brand with human characteristics. Aaker (1997) emphasized that there is a relationship between the consumer's self and brand image in this idea, which he defined as 'Brands as individuals'. In other words, consumers prefer the brand they find close to them (Sirgy, 1982). For banks operating in the financial services sector, brand image is very important to reduce perceived risk and gain a sustainable competitive advantage (Bravo et al., 2010).

2.3 Brand Value

Brand value refers to the total value of a brand as perceived by customers. Brand value reflects how meaningful and attractive the brand is to the customer. According to Aaker (2010), Brand value is brand loyalty, brand awareness, perceived quality, and brand associations. In other definitions in the literature, brand value is explained in two separate parts: financial brand value and consumer-based brand value. Financial brand value consists of the material values of the company, such as machinery and buildings. Consumer-based brand value is the reputation that the brand creates in the mind of the consumer. To measure consumer-based brand value, characteristics such as brand loyalty, brand associations, brand awareness, and perceived quality are examined. Brand loyalty is the behavioral pattern in which customers are loyal to the brand and constantly benefit from the products or services of the same brand. Loyal customers prefer the same brand regardless of the price factor. Financial service providers implement different marketing strategies such as various reward programs and incentives to foster customer loyalty. One of the reasons why customers are loyal to a brand is the functional benefits they get from the brand. Thanks to the functional benefits, customers' work is carried out in an orderly and easy manner. A customer with brand loyalty also has a positive attitude towards the brand. Loyal customers use the brand they are loyal to for a long period of time rather than other service and product providers in the same category.

One of the reasons why consumers develop service loyalty is the difficulties they experience in evaluating services before purchasing (Ang and Buttle,2006). Customers who are loyal to the brand's services are more likely to advocate for the brand, pay more, and buy more. Four components of brand loyalty are mentioned in the literature; Cognitive loyalty, Affective loyalty, Conative loyalty, Action loyalty.

According to Oliver (1997), cognitive loyalty is related to beliefs about brand superiority in terms of the perceived quality of the brand. Cognitive loyalty is defined as the consumer having positive thoughts and beliefs about the brand's services and products. Therefore, cognitive loyalty may increase the consumer's likelihood of choosing the brand's products and services, and may cause the brand to gain a competitive advantage. However, it is not enough alone.

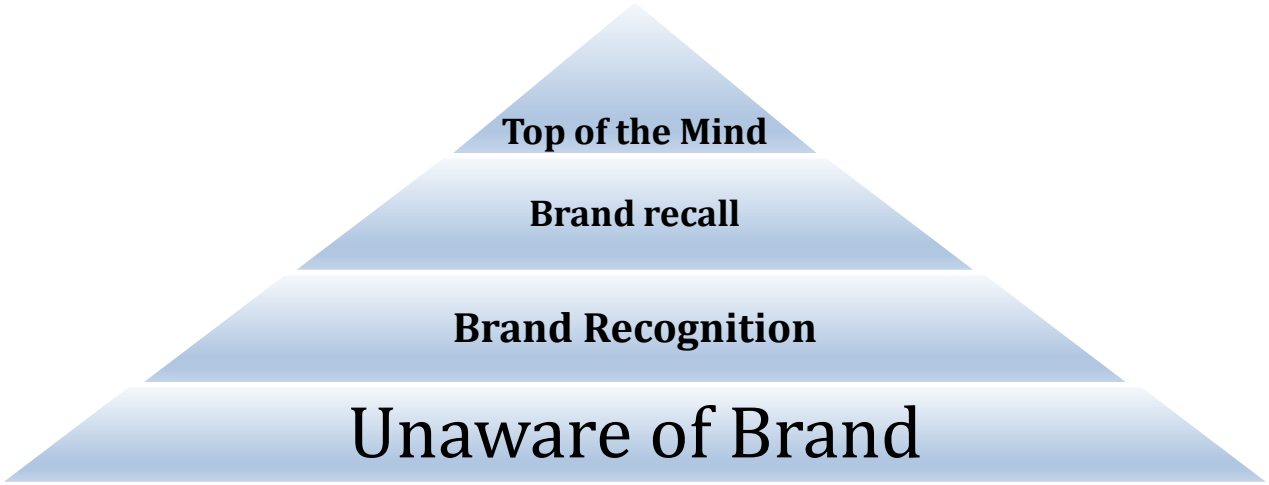
Affective loyalty is the consumer thinking of the brand as a friend or establishing an emotional relationship with the brand. Consumers have difficulty changing the brand to which they have an affective loyalty. Therefore, affective loyalty to the brand is a very good gain in the long run.

Conative loyalty is a type of loyalty in which the consumer has the intention to constantly choose the products and services of the same brand. This type of loyalty is important for brand management because the consumer's active intention to choose the same brand affects the success of the brand. Action loyalty is a type of loyalty in which the customer purchases the services or products of a particular brand by taking action. In other words, action loyalty is a concrete indicator of the customer's loyalty. By

successfully managing these four loyalty components, brands can acquire and retain customers. Thus, they gain a competitive advantage.

Even if a brand has the best products and services in the world, if consumers are not aware of this brand, it will be difficult for the brand to achieve success. Brand awareness is being aware of and remembering the existence of a brand.Having a good brand awareness of consumers increases the likelihood of choosing the brand. By creating good brand awareness, the brand can attract new customers and gain a competitive advantage. Research shows that brands that are remembered by the consumer are more likely to be chosen during the selection process.

David Aaker's Awareness Pyramid shows the awareness level of consumers about a brand.



Source: Aaker, David, Building Strong Brands. The Free Press, New York, 1996, s. 330.

Figure 1
Pyramid of Awareness

At the Unaware of Brand level, consumers are not aware of the existence of the brand. Therefore, the consumer has no information about the brand's products and services. In this case, the brand needs to develop marketing strategies to raise awareness. The concept of brand recognition in Aaker's awareness pyramid shows the level of verbal or visual recognition of the brand by consumers. In other words, this concept in the pyramid is related to whether the consumer recognizes the brand from its logo or name. The concept of brand recall is related to how much the brand has a place in the consumer's mind (Aaker,1996). For example, in financial services, the concept of brand recall is used to measure which brand the consumer tends to prioritize. This concept is very important for creating brand loyalty. The last concept in the pyramid, top of the mind, is the highest level of brand awareness and refers to the degree to which consumers recognize or remember a brand as the first brand associated with a product or service category (Aaker,1996).

Brands that provide financial services need to constantly improve their service quality in order to increase their brand value. Brands that meet customers' expectations and needs are successful. For example, brands that offer a user-friendly mobile application and website provide a good customer experience. Moreover, taking customer feedback into consideration is important in making improvements and providing quality service.

2.4 Brand Credibility

Brand credibility means the reliability of the information conveyed to consumers by the company. Accordingly, consumers perceive that companies, which they believe to possess high credibility, have both the capability and the willingness to fulfill their promises (Erdem and Swait,1998).

In order to brands' marketing communications, the message they want to give to consumers to have a meaningful impact, brand credibility must first be established (Sternthall et al., 1978). Brand credibility

allows brands to gain a competitive advantage by differentiating themselves from other companies. Brands with high credibility are perceived as reliable and respected brands. Brand credibility can be shaped by factors such as the brand's quality and performance, past reputation, superior features and advantages over its competitors, and ethical behavior. Brands with high brand credibility gain the loyalty of their customers and have the chance to gain new customers. It is an important strategy for brands that want to be successful in the long term to increase their brand credibility. For consumers, brand credibility gains great importance, especially in situations of uncertainty, and affects purchasing behavior (Chaudhuri and Holbrook 2001). The notion of credibility encompasses two primary dimensions: trustworthiness and expertise. In other words, for a brand to be perceived as credible, it must be seen as both willing and capable of delivering on its promises.Trustworthiness implies that a brand is willing to deliver what is promised, while expertise implies that it is capable of delivering (Erdem & Swait, 1998). The higher the credibility of a brand's signal regarding its product positioning, the lower the perceived risks for consumers, and consequently, the reduced information gathering and processing costs incurred by consumers during decision-making (Srinivasan & Ratchford, 1991). Higher signal credibility may also heighten consumer perceptions (or expectations) of quality, as consumers might deduce that more credible brands possess higher quality compared to less credible ones (Wernerfelt, 1988). Finally, credible brands may increase consumers' quality perceptions (Aaker, 1991) since brand signals may influence the psychophysical process by which objective quality levels are transferred into perceived levels (Park & Srinivasan, 1994). In summary, brand credibility is anticipated to enhance expected utility by (1) elevating perceived quality and/or increasing expected quality and (2) reducing perceived risk and information costs (Erdem,1998). Erdem and Swait (1998). It is worth noting that Erdem and Swait (1998) specifically investigated and validated the significance of credibility in brand equity.

Consumers look for features that create a perception of high credibility in financial service providers, such as reliability and stability, good customer service, service diversity, advanced internet and mobile banking, strong reputation, and low risk.

2.5 Corporate Social Responsibility Activities Implemented by Brands

The concept of corporate social responsibility has various definitions and has continued to evolve, both in meaning and practice. Perhaps the most detailed among the current definitions is the one offered by the International Organization for Standardization (ISO), wherein they define social responsibility as "the responsibility of an organization for the impacts of its decisions and activities on society and the environment, achieved through transparent and ethical behavior that contributes to sustainable development.

Companies initiate CSR initiatives as a corrective response to challenges arising from their operations or pre-existing conditions predating the establishment of the company. From an altruistic perspective, organizations also implement CSR as a philanthropic endeavor to aid underprivileged communities by providing amenities and other empowering infrastructures.

Participating in CSR activities is recognized as a strategy to enhance an organization's ethical reputation. Berrone, Surroca, and Tribo (2007) contend that companies possessing a robust ethical identity proceed to attain significant stakeholder satisfaction, thereby positively influencing the financial performance of the firm.

In today's intensely competitive environment, the way companies address social problems and their activities in this direction affect consumers' attitudes toward the brand. CSR activities can increase consumers' preference for the brand's products or services and their long-term relationship with the brand. For this reason, brands that provide financial services that want to make a difference pay attention to their ethical stance and social issues. The impact of CSR activities on consumers' brand perception from the 1980s to the present has been proven by many studies. That's why brands use CSR activities as a marketing strategy. A consistent CSR activity implemented by brands is effective in creating a long-term relationship between the brand and the consumer. In addition, it is seen that CSR activities are

effective in factors that strengthen the consumer's bond with the brand, such as brand image, customer loyalty, and brand value. However, in order to the brand to be perceived as carrying out a successful CSR activity, the activity must be compatible with the brand. So, the CSR activities implemented by the brand and the company's behavior must be consistent with each other.

Hoeffler and Keller (2023) state that in cases where the fit between the brand and CSR is perceived to be high, consumers will reflect positive associations regarding the social event to the brand. CSR activities implemented by banks, which are financial service providers, include projects such as social entrepreneurship supports, local community projects, environmental responsibility, sustainable credit and investment products, culture and arts.

The gains achieved by businesses with the influence of their understanding of corporate social responsibility are not just gains expressed in numbers reflected in economic indicators.

Research has shown that businesses provide various benefits in many areas other than this. When these benefits are examined, the following findings emerge: With the effect of gaining social prestige, the corporate image gains value, and this is reflected in the brand value of the company. Companies that attach importance to corporate social responsibility can borrow under better conditions and their stock value increases. Corporate social responsibility makes it easier for companies to enter new markets and ensure customer loyalty, and the company experiences increases in efficiency and quality, and risk management becomes more effective. If insincere or deceptive practices of businesses in their corporate social responsibility practices are noticed, they are punished very severely by the stakeholders. The reputation a business loses in this way may be so great that it cannot be restored even if serious costs are incurred.

In recent years, there has been an increasing emphasis on developing a healthy company or corporate culture. In some ways, this point began with the emergence of websites and global superpowers like Google. These companies have revolutionized the workplace and strengthened the concept of company culture. Every business now works hard to develop a unique workplace culture that reflects their values and identity. Pursuing CSR activities is one way to develop an individual company culture and identity. The value of the brand is expressed by the good work it does.

2.6 Digital marketing strategy for financial services brands

Digital marketing (DM) encompasses the practice of marketing through electronic platforms, utilizing various technological devices (American Marketing Association, 2021). Over the last two decades, Digital marketing (DM) has revolutionized global marketing by employing electronic media and tools such as social media, television, radio channels, SMS, email, search engines, websites, mobile apps, electronic billboards, and social networks. The incorporation of innovative devices and techniques in digital advertising and marketing has brought about increased convenience, extended reach, cost-effectiveness, and the ability to overcome geographical and temporal boundaries. Digital marketing employs diverse technologies, including artificial intelligence (AI) and the Internet of Things (IoT), to achieve marketing objectives in both consumer-to-consumer and business-to-consumer environments (Buhalis & Volchek, 2021; Chaffey & Ellis-Chadwick, 2019; Dwivedi et al., 2020; Petrescu, Krishen, & Bui, 2020).

Digital marketing sites based on retail platforms and social media marketing communities (e.g., Twitter, Facebook, LinkedIn, Instagram etc.) both strenghthen and replace conventional marketing methods (Dwivedi, Kapoor, & Chen, 2015; Kapoor et al., 2018).The decline of the newspaper industry, evidenced by newspaper circulations reaching their lowest point since 1940 in 2018, has heightened customer affinity for online advertising and marketing (Grieco, 2020). Following 2005, there was a notable surge in the utilization of online social forums within digital media, accompanied by the expansion of offerings, including platforms like YouTube (Lips, 2018). Social networks emerged as a cost-effective solution to broaden the scope of digital marketing, giving rise to the social media marketing (SMM) paradigm and its associated marketing analytics. Social media marketing(SMM) is an integrative process aimed at promoting goods and services on social media platforms, with the potential to target a much broader consumer base compared to traditional forms of marketing (Dwivedi et al., 2015).

In today's technology world, companies have now understood the importance of digital marketing. Nowadays, most companies have social media accounts. Social media gives the opportunity to communicate directly with customers. This direct communication is often more effective and less costly. Considering the intensity of competition in the sector, the brand's digital presence, which is a necessity of the new world, enables the company to differentiate itself from its competitors and gain an advantage. Some services, such as banking and accounting, have effectively moved online industry-wide, often through branded websites.

Social media is often positioned as a secondary online communication medium to branded websites to support offline marketing activities such as marketing communications and customer service. Social media platforms offer opportunities to establish long-lasting and solid personal communications with potential and existing customers. Social media affects customers' perceptions of brand trust, risk, and service quality. Consumers want brands' online service applications to ensure customer privacy. For example, consumers attach great importance to privacy in mobile banking applications. It is important to specifically evaluate service quality and security in online banking because the service quality and privacy that customers perceive in web-based services differs from traditional service delivery (Kaura et al., 2015).

The perceived risk is much less in 'low involvement' online services such as food ordering and delivery, real estate agencies because personal data is shared less. Therefore, the perceived risk associated with brand-customer interactions is low. In financial services, security and privacy issues are very important. Gaining customer trust in the marketing of such services is critical for financial services brands to maintain their success. Customers want to carry out their financial services confidentially and securely. If this situation is achieved, customer loyalty occurs. Therefore, it is necessary to focus on risk and trust to minimize the risk of the brand switching to and managing online services. Creating and maintaining healthy customer relationships depends on reducing risk perception and increasing brand trust. Social media is both accessible because it is easy to find and use by a wide audience, and scalable because network effects play a very important role. Thanks to its scalability, a certain age range that uses financial services can be directly reached. The quality of customer-brand relationships develops through the meaningful interplay of brand behaviors and customer behaviors.

Social media offers a channel that enables brands that provide financial services for such interactions. If customers feel they have established a trusting relationship with the financial services brand, they will feel less vulnerable when using the brand's online applications. Social media offers financial services brands unprecedented access to market segments and demographic groups previously thought difficult to reach through traditional marketing approaches. Young adults are among these groups, and today it has become almost impossible to attract young adults to the brand with traditional marketing methods. Research shows that almost two-thirds of social media users learn about brands and services through social media channels, and 17% feel more connected to brands they see on social media than brands they do not (Nielsen, 2012). That's why social media can be a powerful tool for many financial services brands.

Social networking offers the chance to learn customer wants and needs and react proactively and provide the consumer with information about the service and product (Erskine, 2017). Monitoring customer feedback on social networks is important for financial service providers. Because this way financial service providers can make service improvements. There are two ways in which information on social networks can be used effectively to influence consumers' preferences. The first is electronic word-of-mouth communication (e-Wom). Social networks provide a platform for EWOM and influence consumers' preferences (Ye et al., 2010) Latter; following the feedback given by customers allows the brand to improve its services (Hamouda, 2018).

Technological developments have created various channels for the banking sector, making it easier for consumers to access services (Jebarajakirthy and Shankar 2020). There has been an increase in the use of conversational AI chatbots used through mobile banking to provide customers with cost-effective and personalized solutions . Conversational AI chatbots (CAIC) aim to provide information to people, solve their problems, and establish social relations with them.The mobile banking industry uses Conversational AI chatbot via mobile devices. The experience that the Conversational AI chatbot offers

to the customer must be meaningful, because users' adoption and trust in such innovations depends on the experience they will have.

CONCLUSION

The importance of the brand in the marketing of financial services is quite high. Brand is an element that enables the company's products and services to be distinguished by consumers. Consumers can recognize the brand from the elements such as the logo, name and color used by the company. Additionally, when choosing a product or service, consumers pay attention to whether it is branded or not because branded products and services are considered to be of higher quality and reliability. No consumer wants to waste their money and time, so they prefer reliable brands. It is not enough for a company to have the best products and services in the world.

Because, if the consumer is not aware of the brand, they cannot access the brand's products and services. Therefore, brands need to implement the most accurate marketing strategies. At the stage when the consumer is aware of the brand and purchases its products and services, the brand must provide the consumer with a very good brand experience. Because customers with good experiences show loyalty to the brand and prefer the brand's products and services for a long time. There are many brands in the market offering the same service and product. Therefore, brands need to implement various strategies to differentiate themselves in this intense competitive environment. That is, in an intensely competitive environment, companies must constantly follow the agenda and innovate. It is inevitable that brands do not innovate will fall behind in the competition.

Following customer feedback and making product and service improvements as a result of this feedback allows the company to gain a competitive advantage.

The CSR activities carried out by the brand are one of the factors that attract the consumer to the brand. However, the CSR activities implemented by the brand and the behavior of the brand must be consistent and compatible. If the consumer perceives the brand as inconsistent, the brand will lose the consumer's trust. Since we live in a digital age where every information can be easily followed, the brand should not make promises it cannot keep during the positioning phase. One of the features that appeal to consumers is that brands personalize their products and services for customers. For example, the use of artificial intelligence-based personalized smart tips offered by some banks in their mobile applications makes the brand attractive to consumers. Companies with high brand value are attractive to consumers. Increasing the brand value of the company means increasing both company revenues and moral value in the eyes of the consumer. Brand image is consumers' beliefs about the brand.

Consumers' positive beliefs about the brand have a positive effect on brand image. It is very important for the brand to establish good communication with consumers for the success of the brand. For good communication, the brand should not make promises it cannot keep. If the consumer perceives that the brand is reliable, a healthy communication is maintained and the company increases its credibility. Company credibility means the reliability of the information conveyed by the company to consumers. That is, consumers look for features such as high credibility, service diversity, high brand value, high brand image, advanced internet and mobile banking, and a good customer experience in brands that provide financial services.

This article contributes to the literature by underlining the importance of the brand in the marketing of financial services and consumers' interactions with the brand. The article explains consumers' brand perceptions and how the brand plays a distinctive and differentiating role among consumers. In the article, we emphasize how brands should differentiate themselves in an intensely competitive environment. We also emphasize that innovation and continuous improvement of products and services through customer feedback provides competitive advantage, how customer experience affects brand loyalty, how a good customer experience increases brand loyalty and shapes customers' long-term brand preferences. By discussing the effects of CSR on consumers, we underlined that brands carrying out these activities create trust in consumers. We stated that the brand's healthy communication with the consumer, the consistency and reliability of the brand increase the likelihood of consumers choosing the brand. The article contributes to academic studies in this field by presenting various perspectives to the literature.

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The Effects of Green Supply Chain Management Practices on the Performance of the Turkish Iron and Steel Industry

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Abstract

Sustainability is fundamental to complete development since it minimizes the negative impacts of work that is beneficial to the society. Some sectors, such as the Iron and Steel Industry (ISI) have served the development of humanity for centuries and have enabled humanity to create new tools and build solid structures. ISI is a main material provider for different industries such as household appliances, car production, building, and medical devices. The importance of iron and steel for humanity is obvious and the sector serves humanity for being an advanced civilization. On the other hand, iron and steel production requires complex production methods, high energy consumption, and toxic materials. The industry that is so important for the development of civilization harms the planet and threatens all living creatures when it doesn't have environmental consciousness. The iron and steel sector should make its production model more environmentally friendly. In this context, this study aims to detect the application level of Green Supply Chain Management (GSCM) practices in the Turkish Iron and Steel (ISI) Industry and explore the effects of GSCM practices on 3 performance aspects (environmental, operational, and economic) of Turkish ISI. Findings indicate that every single GSCM practice has a different level of positive and significant impact on environmental and operational performance. However, the findings suggest that the effects of GSCM practices on economic performance have a positive relationship, but the relationship is not significant. Only, green purchasing has a significant impact on economic performance.

Keyword

GSCM,
Iron and Steel Industry,
GSCM performance outcomes,

1. INTRODUCTION

The iron and steel industry (ISI) which makes a great contribution to GDP across the world is crucial, especially for developing countries (Cheng et al., 2020). ISI is directly related to other sectors since it is one

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of the main material providers for automotive, construction, household appliances, railways, and defense industry, etc. Although the industry contributes to the development of humanity, from an environmental perspective it harms human beings due to high energy consumption requirements, use of toxic materials, and poor waste management systems. Complex production methods which ignore negative environmental impacts have caused inevitable environmental issues which have lasted for decades such as ozone layer depletion, global warming, water, soil, and air pollution, regional acid rains, and diseases (Zhu et al., 2012).

According to World Steel Organization statistics, Global crude steel production is about 1,900 million tons **(**Mt**)** globally and nearly 20 Gigajoules (GJ) energy consumption is required to produce a ton of steel. Globally, annual ISI energy consumption covers nearly 20% of the total industrial energy consumption. The sector mainly uses fossil fuels to generate energy and releases harmful material into the environment. International Energy Agency (IEA) has stated that ISI is responsible for nearly 6.7% of the total Carbon Dioxide (CO2) emissions of the world. These statistics show that ISI is highly polluting and the second largest energy-consuming sector in the world (Tsai et al., 2007; Olmez et al., 2016; Mousa et al., 2016).

Iron and steel production which includes steps like sintering, coke production, pelletizing, etc. has complicated production processes that may vary due to the type of used raw material and energy resources (Sun et al., 2020; Fabian, 1958). The furnace that requires high energy consumption and generates high heat to melt the iron ore is the basic tool for ISI and preference of the type of the furnace changes the production techniques. Blast furnaces (BF) and basic oxygen furnaces (BOF) are the most preferred melting techniques across the globe, and they nearly cover %75 of global steel production. Electric Arc Furnace (EAF) is the second most used technique after BF and BOF, it covers about 25% of steel production in the world. The use of EAF is limited because EAF is a secondary production technique that requires waste iron and scraps to melt. Since iron is a durable product, the recycling of iron and steel is limited. Lastly, open hearth technology nearly covers less than %1 and it continues to decline due to its higher negative environmental and economic effects (Huitu et al., 2013; Sun et al., 2020). These polluting production techniques direct ISI to follow GSCM practices which enable to control of negative side effects of product and production processes on the environment at every stage of production starting from the beginning to the final phase in which the product is disposed of or used by the final user (Al-Sheyadi et al., 2019). In this context, this study aims to assess the application level of GSCM practices of Turkish ISI and detect if these practices influence the operational performance (OP), environmental performance (EP), and economic performance (ECP) of companies. This study aims to answer.

'How does each GSCM activity affect the environmental, economic, and operational performance of ISI?'

The paper is organized as follows: In section 2, a literature review and hypotheses are presented. Section 3 discusses the research survey, sample, data collection, and method. The results and data analyses are explained in Section 4. The discussion and conclusion are presented in sections 5 and 6.

2. LITERATURE REVIEW

2.1. The shift from Supply Chain Management to GSCM

Increasing competition has driven companies to aggressively increase production capacity to take advantage of economies of scale. In many cases, companies apply hazardous production methods to make a profit (Zhu et al., 2012). The shift from 4P to 4C puts the consumer's wants and needs at the center of the business. Increasing consumer awareness toward the natural environment forces companies to prefer sustainable production methods, use renewable energy resources, and start recycling because many studies

proved that consumers' purchase decision is directly linked with the GSCM performance of companies. (Lee et al., 2021; Chen et al., 2012; Chavez et al., 2016). Market expectations and feedback direct industries to increase their green performance and company image by creating and adding value at every single stage of the value chain. For a successful value chain, establishing communication channels between customers and suppliers is crucial to satisfy the consumers' needs properly (Chavez et al., 2016).

The recent development of related technology has made a great contribution to the development of GSCM. Industry 4.0 revolution, sustainable energy resources, and changing business climate have contributed to the development of environmentally friendly products and processes. (Wang & Gupta, 2011; Khan et al., 2022).

2.2. GSCM and ISI (Iron and Steel Industry)

GSCM literature has been a popular and attractive research field for decades. In GSCM studies, scholars assessed different aspects, used different methods, and developed different models to examine GSCM practices. Various studies show that there are differences between sectors and countries. In this section, some studies that analyze the GSCM performance of the iron and steel sector in different countries and the GSCM performance analyses of other sectors in Turkey will be presented to identify the research gap. Iron and steel production requires complex production processes that cause high environmental damage such as carbon emission, and soil, and water pollution, so an environmentally friendly approach is needed. GSCM practices are essential for environmentally friendly production since they cover every step of production. Most of the studies which target ISI in different countries mainly focus on 3 main performance aspects which are economic, environmental, and operational. GSCM literature suggests that GSCM practices generally affect a firm's environmental performance positively, but operational and environmental performance can differ based on distinctive factors. A study conducted in China found that Carbon Dioxide (CO_2) reduction practices affect environmental performance positively, but they did not observe a certain effect on economic performance (Zhang et al., 2012). Another study conducted in India by Goyal et al. (2018) indicates that ESE (Environmental Sustainability Enablers) increased the environmental performance of Indian ISI. The company, which is chosen as a case study, attempted to apply ESE and put in a huge effort and they experienced a significant environmental performance increase.

Some other studies examine other performance dimensions rather than environmental performance. Xu et al. (2016) propose a cost reduction strategy for GSCM of ISI by applying a method that aims to reduce waste amount and cost. The optimization model which provides cost reduction strategies is offered as a future guidance for the steel industry. Khorasani and Almasifard (2018) propose a model that aims to minimize overall expenditure but additionally aims to reduce the negative impact on the natural environment. The model focuses on uncertainties about consumers, suppliers, production, demand capacity, etc. The study suggests that the model can support GSCM under uncertain conditions. Also, they reveal that bad management of the supply chain (SC) increases the uncertainty of business practices, and it may cause a negative impact on performance. Pang et al. (2011) mentions GSCM as the solution to sustainable development and claims lowering input and pollution level and rising utilization is the required step for sustainable development. They claim that GSCM provides economic benefits to ISI and in addition to economic benefits for business, it provides social and environmental benefits to the society. Another study conducted in Indonesia found energy consumption is the main factor that directly affects the success of GSCM applications in ISI. Also, they stated that the proportion of reusable materials should be increased since it is found as the most important performance metric (Yu et al., 2022).

As it is presented in this part ISI and GSCM have been examined by different scholars across the globe. Different studies that directly target ISI have attempted to find out different aspects of the relationship between GSCM and ISI.

2.3. GSCM studies in Turkey

In Turkey's GSCM literature, scholars target different sectors such as the cement industry (Kazancoglu et al., 2018), the aluminum sector (Atrek & Özdağoğlu, 2014), the electric industry (Andiç et al., 2012) the automobile industry (Gozde et al., 2019), hotels (Akandere & Zerenler, 2017), the chemical industry(Coskun & Bozyigit, 2019), the health care sector (İre et al., 2017) and SME's (Kasap & Ufuk, 2019). Every different study brings a new contribution to the existing literature because there are some differences across the different sectors.

For instance, Yıldız (2020) analyzes the effects of GSCM practices which are internal environmental management, green purchasing, cooperation with customers, and eco-design on environmental and economic performance through surveys from 191 manufacturing firms in Istanbul and Kocaeli. The results show that green purchasing and cooperation with customers don't significantly affect environmental and economic performance. On the other hand, internal environmental management affects environmental performance positively, but eco-design affects both environmental and economic performance positively. Cankaya and Sezen (2018) examine the relationship between GSCM practices and the performance of organizations in terms of economic, environmental, and social. They found that GSCM practices affect environmental performance as it was mentioned in GSCM literature but the effect of GSCM on social and economic performance was not as obvious as environmental performance, but some GSCM practices affect social and economic performance in a small portion. Dinçer et al. (2018) evaluate the financial and economic performance outcomes of GSCM. They examined beverage and food corporations that are traded on the Istanbul Stock Exchange (BIST). They found that decreasing pollution and increasing reverse logistic applications reduce operational costs, but they cannot find a significant connection between GSCM and profitability. Also, they found that bigger firms are better at conducting GSCM than smaller firms.

As it is presented in this chapter, GSCM attracts scholars to work in different sectors and every different sector contributes to the literature. The effects of GSCM practices which are Internal Environmental Management (IEM), Green Purchasing (GP), ECO Design (ECO), Cooperation with Consumer (CC), and Investment Recovery (IR) on operational, economic, and environmental performance can be different across industries. In this context, the GSCM literature in Turkey and other countries has been examined, and it is found that there is no GSCM study that aims to examine the effects of GSCM practices on Turkish ISI which has high energy consumption, carbon footprint, and pollution. The sector has a high potential to effectively apply GSCM. The supply chain starts from the raw material phase and the Iron and Steel Industry is the main material provider for automobiles, household appliances, medical devices, etc. In Turkey's literature, many studies were conducted in the automobile, household, medical device industry, etc. but the Iron and Steel sector was not examined. This study aims to fill that gap in the literature. As stated in the literature, different studies in different sectors have common points but there are also certain differences. Different industries of different countries should be examined to see the bigger picture. Therefore, it is important to find out the relationship between GSCM practices and the performance outcomes of Turkish ISI.

3. METHOD

In GSCM literature, GSCM practices are collected under 5 different headings which are Internal Environmental Management (IEM), Green Purchasing (GP), Cooperation with Consumers (CC), Eco Design

(ECO), and Investment Recovery (IR). Performance outcomes are collected under 3 headings which are Operational Performance (OP), Economic Performance (ECP), and Environmental Performance (EP). In this study, ECO and CC are collected under the same factor. The new factor is named CC+ECO. (It is explained in the following parts.) Figure 1. represents the research model of this study. This study aims to explain, every single relationship between GSCM practices and 3 different performance outcomes rather than a superficial explanation of GSCM and performance. In this context, 12 hypotheses were developed by examining the existing literature. Some of the resources that were used to develop the hypotheses are presented in Table 1.

Table 1. Resources used to develop hypotheses.

	Related Literature
Hypothesis 1(a, b, c, d)	**(Zhang et al., 2012; Liu, 2015)**
Hypothesis 2(a, b, c, d)	**(Xu et al., 2016; Liu, 2015)**
Hypothesis 3(a, b, c, d)	**(Liu, 2015; Huang et al., 2020; Goyal et al., 2018)**

H1a: Internal Environmental Management (IEM) has a positive impact on the Environmental Performance of ISI

H1b: Green Purchasing (GP) has a positive impact on the Environmental Performance of ISI

H1c: Cooperation with Consumer +Eco design (CC+ECO) has a positive impact on the Environmental Performance of ISI

H1d: Investment Recovery (IR) has a positive impact on the Environmental Performance of ISI

H2a: Internal Environmental Management (IEM) has a positive impact on the Economic Performance of ISI

H2b: Green Purchasing (GP) has a positive impact on the Economic Performance of ISI

H2c: Cooperation with Consumer + Eco design (CC +ECO) has a positive impact on the Economic Performance of ISI

H2d: Investment Recovery (IR) has a positive impact on the Economic Performance of ISI

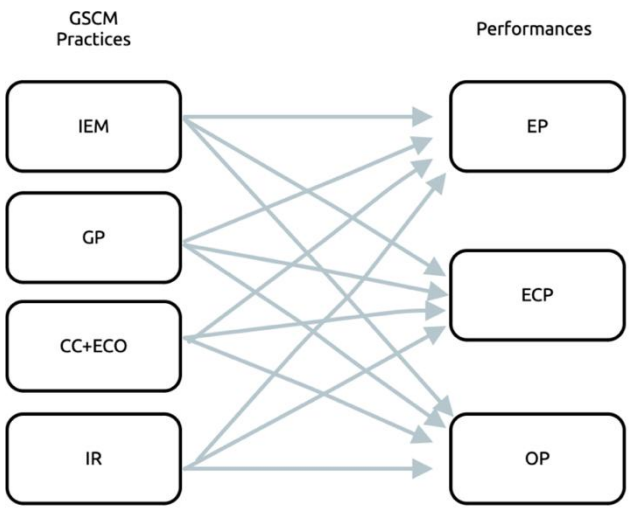
H3a: Internal Environmental Management (IEM) has a positive impact on the Operational Performance of ISI

H3b: Green Purchasing (GP) has a positive impact on the Operational Performance of ISI

H3c: Cooperation with Consumer +Eco design(CC+ECO) has a positive impact on the Operational Performance of ISI

H3d: Investment Recovery (IR) has a positive impact on the Operational Performance of ISI

Figure 1. Research Model



3.1. Sample And Data Collection

According to the Turkish Steel Producers Association, there are nearly 41 crude steel producers in Turkey. Additionally, hot rolling mill plants which are supplied billet iron, etc. by integrated iron and steel companies are included in this study. In this context, nearly 120 hot rolling mill plants were included in this study. In total, nearly 161 iron and steel companies were detected, and questionnaires were sent to these companies. In return 72 usable questionnaires were collected through e-mail across Turkey. Questionnaires were filled out by the high-level managers in the companies. The positions of managers (72) who filled out the questionnaire were supply chain managers (29,2%), upper-level managers (23,6%), logistic managers (18,1%), marketing managers (12,5%), finance managers (5.6%) and (11%) others. The questionnaire is presented in the appendix.

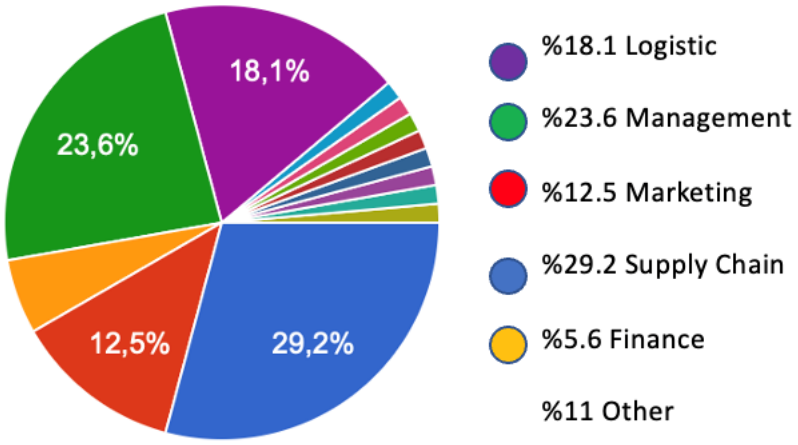


Figure 2. Working Areas of Managers

3.2. Determining Test Statistics and Organizing Data

To analyze the result that is gathered through an online survey over 2 months (April & June 2023), SPSS 27.0.1 package program which is commonly used in social science studies employed. Correlation analysis and regression analysis were determined to test the hypotheses. Before testing the hypotheses, some reliability and validity analyses such as factor analysis, item-to-total correlation, and inter-item correlation matrix were conducted.

3.3. Scale

In this study, a validated measurement scale which is created by Zhu et al. (2008) is used. The scale consists of two parts. The first part which aims to find out the GSCM practice level has 21 measurement items underlying 5 different factors which are IEM (Internal environmental management), GP (Green Purchasing), CC(Cooperation with Consumers), ECO(Eco design), and IR(Investment recovery). The second part which aims to find out the effects of GSCM practices on different performance perspectives has 17 items underlying 3 performance dimensions which are Economic Performance (ECP), Operational

Performance (OP), and Environmental Performance (EP). (See Appendix A) In the GSCM literature, the scale is used in different sectors and different countries. Zhu et al. (2008) stated that the validity of the scale is a continuing process and every different study which targets different industries and different countries contributes to the validation and development of the scale.

3.3.1. Reliability of the scale

Two parts of the scale were tested for reliability. Firstly, an item-to-total correlation was conducted for GSCM practices implementation and performance outcomes parts. IR1(Sale of excess inventories/materials) was found as -0.103 and ECP5(Decrease of fine for environmental accidents) is found as 0.070. Also, an inter-item correlation matrix for each different factor was conducted and ECP5 was found lower than 0.50 or has a negative relationship with some other items. According to these tests' results, IR1 and ECP5 items were decided to be removed from the scales.

After calculating item to total correlation & inter-item correlation matrix and removing insufficient items from the scale, Cronbach's Alpha test was conducted. Table 2. below shows the Cronbach's alpha results of the scale. Cronbach's Alpha degree for the GSCM application scale was found as ''IEM (.823), GP (.847), CC (.884), ECO (.754), IR (.768)''. The Cronbach's Alpha degree for performance scale was found as ''EP (.916), ECP (.845), OP (.820). The findings are statistically sufficient. Cronbach Alpha results are displayed in Table 2.

Table 2. Cronbach Alpha Results

Scale name	Number of Items	Cronbacht's Alpha
1-GSCM APPLICATIONS	20	.903
1.1 Internal environmental management (IEM)	7	.823
1.2 Green purchasing(GP)	5	.847
1.3 Cooperation with customers (CC)	3	.884
1.4 Eco-design (ECO)	3	.754
1.5 Investment recovery(IR)	2	.768
2- PERFORMANCE OUTCOMES	16	.856
2.1 Environmental performance (EP)	6	.916
2.2 Economic performance (ECP)	4	.845
2.3 Operational performance (OP)	6	.820

3.3.2. Factor Analysis

Zhu et. all, (2008) stated that the scale can be adapted to different sectors and different countries due to their different conditions. In order to evaluate the GSCM performance of different sectors, the scale can be modified according to the sector. In this context, factor analysis should be employed to observe if the items are loaded under the desired factors or not. The KMO test is crucial before doing a factor analysis. KMO

value is bigger than 0.70 for GSCM practice implementation and performance outcomes scales, so factor analysis can be applied. (Table 3. and Table 4.)

Factor analysis for GSCM practice implementation was conducted and factor analysis results indicate that GSCM practice items were collected under 4 different factors. CC and ECO were identified as different factors by Zhu and others, but in this study, they are loaded under a single factor. The new factor is named CC+ECO. Other factors are identified as IEM, GP, and IR. IEM1(commitment of senior managers to GSCM practices), IEM2(commitment of mid-level managers to GSCM practices), and IEM3(ISO 14001 certification) are loaded under undesired factors and factor weights of IEM1, IEM2, and IEM3 are not suitable, so they are removed from the scale after factor analysis.

Table 3. KMO and Factor analysis results of GSCM practices implementation

KMO		.798		
Bartlett's Test	Approx. Chi-Square	934.983		
	df	190		
	Sig.	<.001		
Favtor Analysis				
Component	1	2	3	4
IEM4			.652	
IEM5			.779	
IEM6			.700	
IEM7			.756	
GP1	.803			
GP2	.490			
GP3	.733			
GP4	.705			
GP5	.792			
CC1		.806		
CC2		.873		
CC3		.808		
ECO1		.535		
ECO2		.412		
ECO3		.493		
IR2				.859
IR3				.861

The items of the performance scale were collected under convenient factors as it is mentioned by Zhu. The result of factor analysis for performance outcomes indicates that the factor weights are enough, and they are loaded under 3 factors which are EP, ECP, and OP. (Table 4.) The findings are statistically significant. After factor analysis is conducted, the hypothesis can be tested.

Table 4. KMO and Factor analysis results of performance outcomes

KMO		.773	
Bartlett's Test of Sphericity	Approx. Chi-Square	832.380	
	df	120	
	Sig.	<.001	
Factor Analysis			
Component	1	2	3
EP1	.849		
EP2	.848		
EP3	.896		
EP4	.916		
EP5	.800		
EP6	.618		
ECP1		.889	
ECP2		.908	
ECP3		.926	
ECP4		.859	
OP1			.755
OP2			.820
OP3			.627
OP4			.452
OP5			.485
OP6			.834

4. RESULTS

4.1. Descriptive Statistic

Descriptive statistics are conducted to examine GSCM application levels of iron and steel producers. Table 5. shows the descriptive statistic result of GSCM practices implementation. The means of IEM change between 4,11 and 3,89. IEM has the highest mean (4,00) in GSCM applications. It shows managers and

employees are aware of the importance of GSCM practices and internal environmental management and highly respect for GSCM. After Internal environmental management, CC+ECO has the second-highest mean value which changes between 3,85 and 3,21. It shows ISI considers cooperation with consumers in addition to reducing the use of energy and harmful materials. IR has a 3,40 mean value which makes it the third biggest value. This value shows some firms in ISI started to reduce inventory levels by selling scrap materials and excess capital equipment. Lastly, the means of GP change between 3,60 and 2,64. GP has a 3,11 mean value which indicates that Green Purchasing practices are the lowest GSCM practice that ISI minds. Even though some of the companies started to communicate with suppliers about environmental concerns, ISI has a low interest in GP.

Table 5. Descriptive Statistic Result of GSCM practices implementation

APPLİCATİONS		Mean	Std. Deviation
IEM	IEM4	3,89	0,76
	IEM5	3,94	0,69
	IEM6	4,04	0,64
	IEM7	4,11	0,78
IEM mean		4	0,72
GP	GP1	3,60	0,85
	GP2	2,64	0,98
	GP3	3,38	0,94
	GP4	3,24	0,99
	GP5	2,69	1,03
GP mean		3,11	0,96
CC+ECO	CC1	3,21	0,92
	CC2	3,29	0,90
	CC3	3,44	0,89
	ECO1	3,64	0,86
	ECO2	3,85	0,64
	ECO3	3,67	0,82
ECO mean		3,52	0,84
IR	IR2	3,72	1,04
	IR3	3,07	0,94
IR mean		3,40	0,99

Table 6. shows the descriptive statistic result of GSCM performance outcomes. Environmental performance (EP) is the most important dimension with a mean value of 3,71. Means of EP changes between 3,56 and 3,88. Environmental performance is the highest performance outcome of GSCM. It shows that the

companies in ISI consider reducing harmful materials, pollution, and energy consumption. GSCM causes an advancement in the environmental performance of companies. Operational performance (OP) is the second important performance dimension with a 3.43 mean value. Means of OP changes between 3,15 and 3,72. The OP shows companies consider product quality, product diversification, and increasing the product amount, etc. Economic performance (ECP) has a 2,58 mean value and it is the lowest mean value of performance dimensions. Means of ECP change between 2,47 and 2,69. Results show that GSCM has a lower effect on the Economic Performance of ISI such as cost of energy consumption, profitability, raw materials, etc. Descriptive statistics indicate that GSCM practices affect environmental performance the most with the 3,71mean value. Operational performance is detected as the second highest performance outcome which is affected by GSCM practices. Environmental performance is detected as the lowest performance outcome which is affected by GSCM practices. However, descriptive statistics is not enough to explain the relationship between GSCM practices and performance outcomes, so correlation and regression analyses are required to explain the relationship.

Table 6. Descriptive Statistic Result of GSCM Performance Outcomes

Performance Outcomes		Mean	Std. Deviation
EP	EP1	3,71	1,01
	EP2	3,72	0,92
	EP3	3,56	0,92
	EP4	3,63	0,86
	EP5	3,79	0,63
	EP6	3,88	0,69
EP Mean		3,71	0,84
ECP	ECP1	2,50	0,87
	ECP2	2,64	1,03
	ECP3	2,69	0,91
	ECP4	2,47	0,93
ECP Mean		2,58	0,94
OP	OP1	3,49	0,73
	OP2	3,35	0,75
	OP3	3,40	0,74
	OP4	3,72	0,77
	OP5	3,47	0,77
	OP6	3,15	0,83
OP Mean		3,43	0,77

4.2.Correlation Analysis

Correlation represents the degree of the relationship between variables. The correlation coefficient value is between 1 and -1. Table 7. shows the correlation ratios of GSCM practices and performance outcomes. Firstly, the correlation coefficient between environmental performance (EP) and GSCM practices was examined. The correlation coefficient between EP and IEM is found 0,429(moderate). The correlation coefficient between EP and CC+ECO is found 0,476(moderate). These ratios are statistically significant and show that EP has a moderate correlation coefficient with IEM and CC+ECO. CC+ECO and EP have the highest relationship degree. Also, IEM and EP have the second-highest relationship degree. GP and IR have a low correlation coefficient with environmental performance, but they are statistically significant. Secondly, the correlation between economic performance and GSCM practices was examined. Economic performance has a low correlation coefficient with GP (0,303) and nearly does not correlate with IEM, CC+ECO, and IR(Investment Recovery). Thirdly, the correlation between operational performance and GSCM practices was examined. Every single GSCM practice and operational performance has a low but significant correlation coefficient. Correlation coefficient degrees between GSCM practices and OP are found as IEM (0,388), GP (0,262), CC+ECO (0,261), and IR (0,337). The findings are statistically significant. IEM has the highest correlation degree with OP, compared to other GSCM practices. After detecting the correlation coefficient between variables, regression analysis is applied to discover the causal relationship between dependent and independent variables and test the hypotheses.

Table 7. Correlation Analysis Results

	IEM	GP	CC+ECO	IR	EP	ECP	OP
IEM	1						
GP	.573**	1					
CC+ECO	.529**	.635**	1				
IR	.003	-.152	-.060	1			
EP	**.429****	**.252***	**.476****	**.355****	1		
ECP	**.179**	**.303****	**.179**	**.079**	.078	1	
OP	**.388****	**.262***	**.261***	**.337****	.515**	.085	1

4.3. Regression Analysis

Regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables. In simple linear regression analysis, it is assumed that there is a linear relationship between two variables. In multiple regression analysis, it is assumed that there is a linear relationship between more than two variables. The general linear regression model can be stated by the equation:

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + \varepsilon_i$$

where,

y_i=dependent variable

x_i=explanatory variables

β_0= constant term

β_k=slope coefficients for each explanatory variable

ε_i=the model's error term

In order to ensure the accuracy of the multiple regression model, it is important to ensure that the following assumptions are met:

- There is a linear relationship between the dependent variables and the independent variables.
- The independent variables are not too highly correlated with each other.
- The observations are independently and randomly selected from the population.
- Residuals should be normally distributed with a mean of 0 and a variance σ.

After it was determined that these features were met, regression analysis was employed.

In this part, GSCM practices which are organized according to the factor analysis result are examined, and every possible relationship between GSCM practices and performance outcomes are controlled one by one. Table 8. shows regression analysis between GSCM practices and EP (Environmental Performance).

Table 8. Regression analysis of GSCM practices and EP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.184	Constant	1.644	.526	3.127	.003	15.823
		IEM	.518	.130	3.978	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.064	Constant	2.974	.349	8.527	<.001	4.748
		GP	.238	.109	2.179	.033	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.226	Constant	1.884	.411	4.585	<.001	20.481
		CCE+ECO	.520	.115	4.526	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
EP	.126	Constant	2.750	.313	8.774	<.001	10.083
		IR	.284	.089	3.175	.002	

Results indicate that the data obtained are statistically significant. (P<.001). R^2 indicates the percentage of the impact which the independent variable has on the dependent variable and F indicates the significance

level of a regression model. When regression and correlation analyses are examined to explore the effects of GSCM practices on environmental performance, it is found that GSCM practices have a positive impact on EP, and it supports hypotheses H1a, H1b, H1c, and H1d. CC+ECO has the biggest percentage of affecting Environmental Performance while GP has the lowest.

Table 9. shows the regression analysis between GSCM practices and Economic Performance. Regression analysis of ECP and GSCM practices shows that Green Purchasing has the highest impact on economic performance while investment recovery has the lowest percentage. Hypothesis H2b is the most supported hypothesis in economic performance hypotheses. Hypothesis H2d has the lowest support for economic performance hypotheses. H2a and H2c also have low support. They are not found statistically significant. Mainly, the impact of GSCM practices on ECP is positive but very low to declare a certain positive relationship. Findings indicate that GSCM factors have the lowest impact on the economic performance of firms when compared to other performance dimensions (EP and OP). Only GP has a certain and significant effect on economic performance.

Table 9. Regression analysis of GSCM practices and ECP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.032	Constant	1.973	.558	3.536	<.001	2.304
		IEM	.210	.138	1.518	.134	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.092	Constant	1.947	.335	5.818	<.001	7.054
		GP	.278	.105	2.656	.101	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.032	Constant	2.141	.448	4.781	<.001	2.318
		CCE+ECO	.191	.125	1.522	.132	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
ECP	.006	Constant	2.602	.326	7.991	<.001	.442
		IR	.062	.093	.665	.508	

Table 10. shows the regression analysis of operational performance and GSCM practices. The results indicate that IEM has the biggest impact on operational performance. IR is also significantly high. GP and CC+ECO have a lower impact on operational performance when they are compared to other GSCM practices but all operational performance hypotheses H3a, H3b, H3c, and H3d are supported, and they are significant.

Table 10. Regression analysis of GSCM practices and OP

Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.150	Constant	1.970	.419	4.697	<.001	12.381
		IEM	.365	.104	3.519	<.001	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.069	Constant	2.830	.272	10.407	<.001	5.171
		GP	.085	.085	2.274	.026	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.068	Constant	2.648	.353	7.508	<.001	5.099
		CCE+ECO	.223	.099	2.258	.027	
Dependent Variable	R^2	Independent variable	B	Stt. Error	t	sig.	F
OP	.114	Constant	2.715	.247	11.005	<.001	8.979
		IR	.211	.070	2.997	.004	

5. DISCUSSION

This study aimed to examine the effects of GSCM practices on the environmental, operational and economic performance of the Turkish iron and steel industry.

Findings align well with the existing GSCM literature in which there are different studies that target diverse sectors (Yıldız, 2020; Cankaya and Sezen, 2018; Dinçer et al. (2018).

This study covers iron and steel sector because different sectors should be analyzed individually due to differences in their production processes and other internal and external factors. The environmental performance increase for the companies that apply GSCM practices is found positive almost in every study, but operational performance and economic performance depend on distinctive factors. The majority of the GSCM studies indicate that GSCM practices tend to increase the environmental performance of organizations. Similar to GSCM literature, in this study we found that GSCM practices have an important positive impact on environmental performance. Additionally, operational performance was found to be affected by GSCM practices in the iron and steel sector, but its significance was relatively low compared to environmental performance. However, the effect of GSCM practices on economic performance is not as significant as their impact on operational and environmental performance. Even if there are some studies that found a positive relationship between economic performance and GSCM practices (Zhang et al., 2012; Liu, 2015), the majority of the studies indicate there is no direct, significant and positive impact of GSCM on economic performance. In support of this, this study found that GSCM practices have no significant and direct impact on the economic performance of Turkish iron and steel sector. In some studies, the authors mention indirect effects of GSCM practices on economic performance (Al-Sheyadi et al., 2019) such as cost saving, positive image, good performance in stock market, good positioning in consumer's mind etc. however these factors are not only affected by GSCM performance of the organizations, there are other contributing conditions to these factors. GSCM is only a small portion of positive image, good performance in stock market and good positioning in consumer's black box. Based on literature and the result of this study

it can be argued that GSCM practices have no significant cost reduction impact. Conversely, it can cause additional costs for different processes in the iron and steel sector.

When the results of the analyses were compared to the other GSCM studies, the results were interpreted according to the results of other studies in GSCM literature. The results of correlation and regression analyses were found relatively low in this study however, due to the destructive earthquake that happened in Turkey during the data collection period, the attendance rate for the questionnaire was low so, the results were calculated based on 72 proper questionnaires. However, the results are significant and compatible with the literature.

6. CONCLUSION

The iron and steel industry (ISI) is considered a highly polluting industry and it requires environmentally friendly approaches for the sustainable development of countries. In this study, the effects of GSCM practices on different performance aspects of the Turkish Iron and Steel Sector are analyzed. An online survey was conducted, and it was filled out by managers of 72 hot rolling mill plants and integrated iron and steel companies from different regions of Turkey. The answers of the managers were converted into scientific data by a series of analyses. Firstly, reliability tests were conducted for the scale, and after that, a factor analysis was conducted to examine how the items were collected under different factors. Then, correlation and regression analyses were conducted to test the hypotheses. According to the findings, GSCM practices obviously increase the environmental performance of factories in ISI. It means GSCM helps businesses reduce the negative effects of their operations on the natural environment and it is crucial for sustainability. An increase in environmental performance is an important result, especially for a polluting industry. IEM and CC+ECO have the biggest impact on environmental performance. Additionally, the effects of GSCM practices on operational performance are found significant. It means GSCM contributes to business operations for a seamless workflow and increases production quality and efficiency. It is also an important finding because it indicates that GSCM is not only an environmental approach, and it contributes to business operations. IEM and IR have the biggest impact on operational performance. Lastly, the effect of GSCM practices on economic performance is examined and the results indicate that even if there is a positive contribution to economic performance, the relationship rate is too low and the effect on economic performance is not remarkable. Only green purchasing has a significant but low relationship with economic performance. In conclusion, findings suggest that GSCM practices and performance outcomes are statistically significant and GSCM practices contribute to a firm's different performance dimensions, especially in Environmental Performance (EP) and Operational Performance (OP). In Table 11. all hypotheses and results are summarized.

Table 11. Evaluations of the hypotheses

Hypotheses	Used Analses	Explanation
· H1a: Internal Environmental Management (IEM) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	IEM has the second highest impact on environmental management when it is compared to other GSCM practices. The impact is found positive and moderate.
· H2a: Internal Environmental Management (IEM) has a positive impact on the Economic Performance of ISI	Correlation&Regression	IEM has a positive impact on economic performance, but findings don't indicate a significant impact on economic performance.

· H3a: Internal Environmental Management (IEM) has a positive impact on the Operational Performance of ISI	Correlation&Regression	IEM has the highest impact on operational performance when it is compared to other GSCM practices.
· H1b: Green Purchasing (GP) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	Since the implementation of GP practices by ISI is low, the impact on environmental performance is found low but GP has a positive impact on environmental performance.
· H2b: Green Purchasing (GP) has a positive impact on the Economic Performance of ISI	Correlation&Regression	GP has the highest impact on economic performance when compared to other performance areas. The impact is found positive but low because GP is the lowest application that ISI minds.
· H3b: Green Purchasing (GP) has a positive impact on the Operational Performance of ISI	Correlation&Regression	GP has a positive but low impact on operational performance. The impact is found positive but low because GP is the lowest application that ISI minds.
· H1c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Environmental Performance of ISI	Correlation&Regression	CC+ECO has the highest impact on environmental performance. The impact rate is the highest impact rate when it is compared to all possible relationships between GSCM practices and performance outcomes.
· H2c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Economic Performance of ISI	Correlation&Regression	CC+ECO has a positive impact, but the impact rate is very low and it is not significant.
· H3c: Cooperation with Consumer (CC) +ECO design has a positive impact on the Operational Performance of ISI	Correlation&Regression	CC+ECO has a positive impact, but the impact rate is very low.
· H1d: Investment Recovery (IR) has a positive impact on the Environmental Performance of ISI	Correlation&Regression	IR has a positive impact on environmental performance and the impact rate is detected as moderate.
· H2d: Investment Recovery (IR) has a positive impact on the Economic Performance of ISI	Correlation&Regression	IR has a positive impact on economic performance but the impact rate is the lowest one that effect economic performance and it is not significant.
· H3d: Investment Recovery (IR) has a positive impact on the Operational Performance of ISI	Correlation&Regression	IR has a positive impact on environmental performance and the impact rate is detected as moderate.

Since GSCM is a wide topic, this study has some limitations. The data used in this study was gathered within 2 months. The questionnaire assesses the economic and other performance indicators; however, they can be affected by other external factors.

For future research, the other external factors that support or hinder GSCM practices can be examined. A similar study can be conducted in different time periods and the results can be compared. Different studies that target different industries may bring a new approach to the literature. This study didn't find a direct effect of GSCM practices on economic performance, except for Green Purchasing (GP). However, GSCM may have a positive indirect effect such as an increase in the stock market due to taking a good place in consumer's and investor's mind by adopting environmental practices so indirect effects on economic performance can be examined in future research.

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Appendix A

NUMBERS	FACTORS	CODES	GSCM practices	Likert Scale				
				1	2	3	4	5
1	IEM	IEM1	Senior managers are committed to GSCM practices.					
2		IEM2	Mid-level managers support GSCM practices.					
3		IEM3	The facility has ISO 14001 certification.					
4		IEM4	Environmental compliance and auditing programs are applied carefully.					
5		IEM5	Cross-functional cooperation for environmental improvements exists.					
6		IEM6	Total quality environemntal management is considered.					
7		IEM7	Environmental management systems exist.					
8	GP	GP1	Cooperation with suppliers for environmental objectives is considered.					
9		GP2	ECO labelling of products is considered.					
10		GP3	Environmental audit for suppliers' internal management is considered.					
11		GP4	Suppliers' ISO 14000/14001 certificate is considered.					
12		GP5	Second- tier suppliers's environmentally friendly practices are considered.					
13	CC	CC1	Cooperation with customer for eco-design is considered.					
14		CC2	Cooperation with customers for cleaner-production is considered.					
15		CC3	Cooperation with customer for green packaging is considered.					
16	ECO	ECO1	Products are designed to require reduced consumption of material/energy.					
17		ECO2	Products are designed to be easily reused, recycled and recovered.					
18		ECO3	Products are designed to avoid or reduce the use of hazardous products and/or manufacturing process.					
19	IR	IR1	Excess inventories/materials are sold.					
20		IR2	Scrap and used materials are sold.					
21		IR3	Excess capital equipments are sold.					

NUMBERS	FACTORS	CODES	Performance Outcomes of GSCM Practices	Likert Scale				
				1	2	3	4	5
1	EP	EP1	Reduction of air emission.					
2		EP2	Reduction of waste water.					
3		EP3	Reduction of solid wastes.					
4		EP4	Decrease of consumption for hazardous/harmful/toxic materials					
5		EP5	Decrease of frequency for environmental accidents					
6		EP6	Improvement of an enterprise's environmental situation					
7	ECP	ECP1	Decrease of cost for materials purchasing.					
8		ECP2	Decrease of cost for energy consumption.					
9		ECP3	Decrease of fee for waste treatment.					
10		ECP4	Decrease of fee for waste discharge.					
11		ECP5	Decrease of fine for environmental accidents.					
12	OP	OP1	Increase in the amount of goods delivered on time.					
13		OP2	Decrease in inventory levels.					
14		OP3	Decrease in scrap rate.					
15		OP4	Increase in product quality.					
16		OP5	Increase in product line .					
17		OP6	Improvement of capacity utilization.					

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REVIEW ARTICLE

Empirical Neuromarketing Studies: An Overview of Turkiye

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Abstract

The study aims to compile an overview of the empirical neuromarketing studies conducted in Turkish literature in the extent of neuroscience measurement methods. Within the scope of this study, which examines how measurement methods in the context of neuroscience have developed in the field of marketing between 2015 and 2022 by Turkish authors, solely empirical neuromarketing studies published in Web of Science(WOS), Google Scholar, Research Gate and Dergipark databases have been examined and the current situation in the field is evaluated in terms of neuroscience measurement processes. In this regard, the neuromarketing concept and the measurement tools used within this scope were explained first, and then the use of the measurement tools are examined and discussed on a literature basis.

Keyword

Neuromarketing in Turkiye,
Neuromarketing Tools,
EEG,
GSR,
Eye-Tracking

1.INTRODUCTION

Advanced technologies developed in neuroscience has lead marketing field to combine traditional way of conducting consumer data with neuroscientific methods to boost the attempts of better understanding consumer behavior. The reason behind this is the intense competitive environment and the fact that consumers conveniently access information thanks to the internet sources which has led to increased concerns about understanding how consumers think and decide. The fact that traditional market research and information-gathering techniques do not always produce effective results has led businesses to seek more reliable and accurate methods to gather useful data. This is because current methodologies often focus on informed responses from consumers, in part, to questions posed by researchers. At the same time, most research questions are produced in the consciousness of researchers and in their minds reflecting their personal thoughts (Zaltman, 2000:6).

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According to Ustaahmetoglu(2015) data collection via traditional research methods is not always a guide to businesses with a survey technique based on verbal expression from respondents. The matter that consumers do not only make rational actions on decision stages has led companies to research methods aimed at accurately predicting consumer behavior. Over the years, with the development of technology and neuroscience, neuromarketing techniques have been added as an alternative to traditional methods. In order for data analysis to be carried out properly in line with the explanations given above, traditional research methods and neuromarketing research methods must be used together. The advantageous and disadvantageous points of both methods can only be minimized in this way. As a result, technical advances in neuroscience have started to be implemented in the field of marketing. The information obtained through neuroscience help to achieve effective decision making and competitive advantage.

Businesses desire to achieve the predetermined organizational goals at a lower cost by designing appropriate product and marketing communication tools. It is examined that neuroscientific techniques are used to achieve the stated strategic objectives.(Arily&Berns,2010) Additionally, Arily and Berns(2010) claim that two main reasons are backed this increase observed in the application of neuroscientific techniques within the marketing field. First, neuroscientific techniques start offering faster and lower cost solutions than traditional market research techniques, and neuroscientific methods provides additional information that traditional market research techniques cannot provide.

In parallel with this, Kesek and Gedik(2017) states that managing consumers with only traditional marketing policies is no longer a valid method. At this point, neuroscience has emerged, an interdisciplinary field of study that enables technology to be easier to measure consumer responses to a marketing stimuli. With neuroscience, the emotions of consumers are analyzed with the measurement tools used in their psychological conditions and used in research development activities. With the research results, studies are carried out for a better marketing service to consumers. (Hatip, 2008)

Measuring the change in activity in different brain regions when measuring the brain's reactions to a product reveals not only why consumers choose that product, but also which brain part is active in this choice. In other words, medical science is revealing the secrets of the nervous system one by one. Although it is possible today to understand the mental structure of the brain's reactions to stimuli, messages and advertisements, it is becoming increasingly easier to make sense of the results thanks to the advancing and rapidly digitalizing medical technology (Müdok, 2013).

Consequently, marketers may study factors that can affect the consumer decision process by means of neuroscience. Every decision is actually a choice, investigation of the reasons behind these choices may be carried out by neuroscience researchers. Consequently, neuromarketing, as a discipline of neurology and marketing, attempts to reveal the relationship between the consumer nervous and decision making system (Hubert and Kenning, 2008). However, neuromarketing is not just brain measurement activities used to reveal the reasons behind consumer preferences (Yücel and Çubuk, 2014). As Ural (2008) stated, it shows which brain regions are active during consumers' product selection and offers the opportunity to develop new products and materials through the findings. Therefore, academics and market practitioners utilize neuromarketing in different areas of marketing including branding, advertising, packaging design, product development and for different purposes.

Neuromarketing is an emerging field that requires meticulous understanding, offers cheaper and faster results than traditional methods and provides marketers with confidential information (Ariely and Berns ,2010). Parallel to global literature, studies conducted in Turkey has gain popularity regarding the number of papers published on databases. However, the number of neuromarketing empirical studies which offers potential

useful insights on consumer behavior is lacking comparing to the world literature. Neuromarketing studies conducted with an empirical approach in Turkey is reviewed in this study on a literature basis. The main motivation of this study is to highlight useful insights from consumers responses to marketing stimuli measured by neuromarketing tools, make contributions to both the academic and business world and to pave the way for future researches. It is crucial to examine findings of neuromarketing studies by utilizing neuroscientific tools for better understanding the local market in Turkey and consumer behavior, learning how to take competitive advantage, analyzing the evolution of consumer behavior and shaping business strategies accordingly.

In this respect, this study which consist of two parts, first focuses on the definitions and development of the concept of neuromarketing, examines the methods and techniques used by neuromarketing. In the second part of the study, academic empirical studies conducted in the field of neuromarketing in Turkey were examined within the scope of the research. This literature review is conducted with the expectation of shedding light on new researches on neuromarketing field.

1.1 The Concept of Neuromarketing

Neuromarketing is defined as a branch of marketing that uses various technologies to determine the subconscious reactions of consumers to products and brands in order to create effective marketing strategies. It brings together marketing, neuroscience and psychology to examine the way the brain works in decision-making stage (Kumar,2015:525).

According to Oliviera and Giraldi(2017) neuromarketing deals with various tools traditionally used in medicine, psychiatry and psychology, together with various sub-fields of different marketing types in neurological, biological and metabolic feedback processes; It is an interdisciplinary science that uses traditional marketing tools to better understand the physiological behavior and thoughts of both conscious and unconscious consumers .

Kumar(2015) states that Gerry Zaltman, who suggested combining brain imaging technologies with marketing in the late 1990s and integrated the fMRI device into marketing studies for the first time, is considered the pioneer of the field of neuromarketing. Although, Zaltman is shown as the founding name of the field, the concept of neuromarketing and the general framework of neuromarketing were first introduced in 2002 by Ale Smidts in his study "The Study Of The Cerebral Mechanism To Understand Consumer Behavior In Order To Improve Marketing Strategies".

Plessis(2005) highlights that the nervous system in human body consists of neurons, that is, nerve cells, and regulates the functioning of organs and systems in the face of internal and external influences by effectively/quickly performing tasks such as stimulation, arousal and evaluation in the body. Neurons, which are the research subject of neuroscience, form neural networks and enable functions including learning, perception, memory, cognition and information processing. Neurophysiological measures in neuromarketing research focus on central nervous system activity. Physical measurements, on the other hand, are based on measurements of various reactions created in our body by the peripheral nervous system, which provides mutual communication between our brain and body (Gedik and Kesek 2017: 52). The measurement of how the human brain, which has a very complex thinking ability, responds to marketing stimuli is performed by neuroimaging techniques. Neuromarketing, which deals with the mental part of the purchasing process, seeks answers to the questions of "why" and "how" in the decision process of consumers (Bayır, 2016:48-49). Accordingly, Yücel and Coşkun(2018) states that the concept of neuromarketing, which provides a clearer understanding of consumer behavior and a place in the subconscious, enables the measurement of emotional commitment, attention and retention parameters in consumers.

2 NEUROMARKETING TOOLS

Neuromarketing commonly utilizes brain imaging technologies and biometric measurement techniques when measuring consumers' brain responses to a stimuli. Apart from these, psychometric measurement techniques are also used (Varan et al., 2015:178).

Thanks to the electricity observed in different parts of the human brain with brain imaging technologies, comments can be made about what consumers react more to. Biometric measurements include computer-controlled systems developed to measure a consumer's physical and behavioral responses. It is possible to list the most used biometric measurement techniques in neuromarketing as measuring eye movements, facial movements, galvanic responses, skin electricity and sweating (Shiv and Yoon, 2012). Accordingly, the three techniques and measurement tools used in neuromarketing measurements are classified below.

2.1 Biometric Measurements

Bodily reactions occurring through the peripheral nervous system can be internal or external. These physiological reactions have a direct connection with our mind, and since physiological reactions occur before our conscious awareness arises, unconscious reactions created by marketing stimuli play a very important role (Erdemir and Yavuz, 2016: 23).

Biometric measurements aim to measure biological and physiological responses. It intends to monitor the reactions of the whole body except the brain: techniques for instance, facial expressions, breathing rate, contraction, voice pitch, eye tracking (Eye-Tracking), galvanic skin response (GSR) can be called biometric measurement.

2.1.1 Galvanic Skin Response-GSR

As an automatic response of the autonomous nervous system, the skin, especially the palms, show typical reactions to cases that are both pleasurable and stressful. By monitoring these reactions, the pleasurable or disturbing parts of images or products are detected (Plassmann et al., 2015). For instance, increased sweating with emotional reactions is an indication that the electrical resistance of the skin increases and this causes excitement.

2.1.2 Eye Tracking

The eye tracking technique, one of the most common methods used in neuromarketing studies, was developed by Mowrer in 1936 (Özdoğan, 2008: 135). It allows us to follow where and how long eye movements focus, and what route the eye follows. Just as we can track the data of a single user, the combination of hardware and software that enables tracking of the data of a group offers the opportunity to make inferences about what the viewer(s) actually sees and what they focus on. It is most common to record pupillary responses, usually by directing infrared rays at the eye. Eye tracking technique, which is easy and cost-effective for neuromarketing research, is used in placing products, designing shelves, website design, and using eye-catching elements in commercials.

2.1.3 Facial Action Coding System -FACS

People react to stimuli from the environment, either voluntarily or involuntarily, with facial expressions. In marketing research, reactions to products, advertisements and shelf layouts are observed using the face coding

technique and improvements are made accordingly. Paul Ekman identified 6 basic facial expressions with the coding method he calls Facial Action Coding System (FACS). These expressions: They are the reflections of anger, fear, sadness, surprise, pleasure and disgust on the face (Giray and Girişken,2013).

2.2 Neurometric Measurements

With neurometric measurement methods, neurological activities of cognitive and emotional reactions in the brain are observed. The frequently used neurometric measurement devices are fMRI (Functional Magnetic Resonance Imaging), EEG (Electroencephalography), PET (Positron Emission Tomography), MEG (Magnetoencephalography) (Yücel, 2016:26).

2.2.1 Functional Magnetic Resonance Imaging-FMRI

fMRI has a working principle that follows the increase in hemoglobin caused by oxygen consumption during neural activity with high-scale magnetic field and radio waves (Kulich et al., 2009). In other words, when any cognitive process is started, the blood flow to the region accelerates due to the energy need that arises in the activated brain regions. For this reason, the level of hemoglobin, which carries oxygen in the blood, also increases in the relevant region. With this method, which has been used frequently recently, it has been tried to reveal how the concepts of learning, perception and emotion are shaped.

2.2.2 Electroencephalography- EEG

EEG is a brain imaging method, measures the electrical activities occurring in the brain. With this method, the electrical activity fluctuations of the neuron group in the cerebral cortex are recorded, and after the recorded data is converted into numerical data and formulated, it provides feedback on activities such as motivation, attention, and sensory interest (Kesek and Gedik, 2017:77).

2.2.3 Positron Emission Tomography-PET

PET, which is a technologically very important imaging device among nuclear medicine imaging techniques, "involves intravenous injection of a radioactive marker that binds to glucose in the brain and emits special signals by breaking down through positron heating" (Kesek and Gedik, 2017:86). This method clarifies in which parts of the brain the activities take place.

2.2.4 Magnetoencephalography- MEG

It is a remarkable technique for measuring and imaging magnetic regions in the brain. The magnetic field created by electrochemical signals and neural activities is observed with MEG technique (Yücel, 2016:33). Although it is a useful technique for examining deeper details in the brain, its high cost limits its use.

2.2.5 Functional Near-Infrared Spectroscopy -fNIRS

fNIRS is an emerging low-cost, noninvasive neuroimaging technique and may be viewed as a viable alternative to fMRI (Fishburn, Norr, Medvedev, & Vaidya, 2014). fNIRS is a method of monitoring brain oxygenation. This technique investigates hemodynamic changes in the cerebral cortex. fNIRS is widely used in clinical and scientific research. Based on existing neuroimaging studies, functional near-infrared spectroscopy appears to be a reliable neuroimaging measure for analyzing emotional states by examining changes in hemodynamic response in the prefrontal cortex (PFC) (Chong, Lu, and Tang, 2019).

2.3 Psychometric Measurements

Marketing and management research conducted with traditional survey methods is tested for reliability using psychometric measurement methods. The answers people give to some issues may require timidity and they may not answer the questions correctly. For example, a person who smokes a lot may say that his consumption is less. For this purpose, attitudes and behaviors can be analyzed with implicit association tests, which are the basis of psychometric tests (Yücel, 2016:39).

3. Neuromarketing Studies in Turkey

Neuromarketing has begun to be researched, implemented and widespread in developed and developing countries. In fact, with the increasing interest and curiosity in neuromarketing in Turkey, it has been opened as a master's degree program in several universities and awareness has begun to increase. In Turkey, branding, packaging and advertising activities are carried out with neuromarketing techniques. The number of articles, theses, and books published in the field of neuromarketing in Turkey is relatively low when compared to the world literature. Research companies serving in Turkey are Think Neuro, Neuromar Aectspots, Ipsos Turkey and Millward Brown. They are large-scale companies that invest in brand value and customer loyalty. (Bayır, 2016: 89).

METHODOLOGY

This study aims to examine empirical researches with neuroscience measurement tools conducted in Turkey within the scope of neuromarketing between 2015 and 2022 since the early empirical studies were started to be conducted and the number of academic papers has gradual increase in 2015. For this purpose, Web of Science, Google Scholar, Research Gate and Dergipark databases were examined using the keyword 'neuromarketing in Turkey', and in creating the basic data pool, the relevant keyword was included in the title, keywords, abstract or content section or the Turkish version of the relevant study was included. Attention was paid to the fact that it was conducted by the researchers in Turkey. Two acceptance criteria were determined during the examination process of the obtained studies. These acceptance criteria were determined as (1) the research being an empirical study, (2) neurometric or biometric measurement tools being used. The reason for this is to understand the level of use of neuromarketing techniques in Turkey beyond theoretical studies.

While filtering the studies, care was taken to ensure that they met all the criteria at the same time. During the review process, books, thesis and conference papers were not included in the scope of the research. 26 studies were deemed appropriate for evaluation.

FINDINGS

The 26 neuromarketing studies included in the review were classified according to the methods used, the year of publication, the title of the study, their findings were stated and presented as suggestions for future studies.

As a result of the analysis of experimental academic studies (articles) published in Turkey, it is seen that the first studies in the field appeared in 2015 and continue to increase thereafter. Although studies are generally carried out in the fields of business, advertising and communication, there is also interest in the field from other different disciplines.

The keywords mainly used to describe the studies varies and repeatedly used ones are demonstrated below in the figure 1.1. Furthermore, the most common 7 keywords are listed below in figure 1.2

Figure 1.1

Figure 1.2

Empirical Neuromarketing Studies Using EEG Method

	Tittle	Authors	Year	Method	Findings
1	A research on neuromarketing and perception management in terms of new trends in marketing	Alyar, P., Pirtini, S., and Yücel, N.	2021	EEG	According to the findings obtained by EEG method; It was observed that the reactions to the images used for the research were different between those with prices and those without prices. Due to this difference, the images are divided into two groups. It has been determined that the parietal region of the brain, which plays a role in combining stimuli from various sensory organs, is not active when images without prices are watched silently, but this region is activated when the same images are watched with sound. Reactions are received to images shown with or without sound, but it has been observed that the intensity of the reaction changes in visuals with sound. The visuals with price and campaign date in the advertisement were examined. It was observed that certain regions of the participants' brains reacted to the visuals. It has been determined that when the price is voiced, activity increases in the frontal region of the brain, which is responsible for conscious thinking, and the response disappears in the temporal region, which has many functions including speech, memory and hearing. When visuals with sound, silence and price were shown to the participants, a decrease in the reaction of the participants to the advertisements shown with the sound element was observed.
2	An experimental study on consumers' perceptions of electronic commerce sites with EEG method,	Coşkun, P. & Yücel, A.	2021	EEG	It has been determined how elements such as menus, simple appearance, readable texts, background of the webpage, text color, webpage map and accessibility on the websites prepared by the companies are perceived by the customers and what they pay attention to. The parts that must be included in an effective e-commerce site design for consumers are social approval, reference point, feeling of missing out, colors and check-out mechanism. The study demonstrated that the reference point, colors and the feeling of missing the opportunity are important for consumers.
3	The effect of restaurant lighting on food selection from the menu,	Şahin, E. & Yazıcıoğlu, İ.	2020	EEG	Evaluations were made according to liking, attention, memory and cognitive load parameters. Accordingly, in bright light, participants examine the menu more carefully, like it more and remember it more. However, they have a hard time choosing. In dim light, the level of appreciation and attention decreases, the menu is less memorable, but participants do not have difficulty in making a choice. Orders placed in both conditions were examined, an increase in order items was observed in dim light, but this did not affect the turnover. There was an increase in dessert orders in the dim light environment. While turnover in other categories was observed to decrease in dim light, turnover in the dessert category increased.
4	Measuring consumer brand perceptions in terms of neuromarketing by using the EEG method: An experimental study on the automotive industry	Yücel, A.& Şimşek, A., İ	2019	EEG	It is aimed to determine the automobile brand perceptions of consumers according to the variables of comfort, security, fuel economy, quality service, prestige, performance, stylish design, durability and quality. It has been revealed that that consumers have moved away from rationality in a sense, focusing on abstract concepts such as stylish design, quality service and prestige.

	Tittle	Authors	Year	Method	Findings
5	Determining the Effect of Anti-Smoking Public Advertisements on Individuals Using Neuroimaging Method	Özer, D. & Özüpek, M. N	2018	EEG	It was concluded that women are more sensitive than men to the sounds and music used in anti-smoking public spots, and their general perception is more positive. In addition, the reactions to the public service announcement were measured by separating smokers and non-smokers in the subject group. Accordingly, it has been observed that women react more and men react less.
6	Do Our Brains and Tongues Speak the Same? Comparison of Survey and EEG Methods: A Research in Terms of Brand Personality Measurement	Öztürk, S., A., Yücel, N., and Bayır, T.	2018	EEG	It has been observed that the Turkcell brand operator is associated with more brand personality attributes than the Vodafone brand operator. In the research, operator brands were identified with an adjective attributed to brand personality that emerged after the survey analysis. In the second stage of the research, the identified brand was subjected to EEG analysis as a personality. In other words, the EEG method was used as a filter of the survey method. Thus, clearer and deeper information was obtained. As a result of these analyses, it was seen that the statements of the consumers and what was in their minds were not identical.
7	Measurement of Effect of the Smell on the Decision Process of Informed Users in Terms of Neuromarketing,	Dermirtürk & Yücel	2017	EEG	It has been revealed that smell has a significant effect on emotion and decision-making mechanism. It has a positive impact on the decision-making process by creating positively charged emotions and feelings towards the brand; It has been confirmed to be an effective sensory stimulant in establishing an emotional bond with the brand. Moreover, it has been verified that smell is an effective sensory stimulant that creates an emotional connection with the brand and recalls the brand by evoking the memories and experiences of informed users through emotions and feelings, creating awareness and difference and take a place in the minds of informed users.

Empirical Neuromarketing Studies Using Eye-Tracking Method

	Tittle	Authors	Year	Method	Findings
1	Packaging in marketing communication strategies: a neuromarketing research	Taşçı, M. A. & Baygül Özpınar, Ş	2022	Eye-Tracking	The findings reveal that highlighting the brand name on the packaging by writing it in capital letters has a positive effect on attention, and giving more space to visuals reflecting the content of the product attracts the consumer's attention.
2	Reflections of Self-Discrepancy Theory on Consumers' Online Purchasing Behavior	Tomris Küçün, N. , Duman Alptekin, H. , Çetin, C. & Eroğlu, S.	2021	Eye-Tracking	According to the temperature maps obtained from the eye tracking device, it has been observed that as the current body perception exceeds the ideal weight, attention to the relevant visual decreases. According to self-discrepancy theory; The existence of a difference between the real self and the ideal self-causes tension. As the difference increases, the tension will also increase. It will result in anger, aggression and fear. Although the results obtained support this acceptance of the theory, it has been observed that this tension state is not high in individuals with ideal body size and those with below ideal body size, while the tension state increases in individuals with above ideal body size. In general, it was concluded that overweight increases avoidance behavior along with self-discrepancy. Additionally, it was concluded that the determining factor in consumer behavior is individual differences and self-perceptions rather than gender differences.
3	Examination of Hedonic Consumption Themed Advertising Images Using Eye Tracking ,	Emül,S.& Yücel A.	2021	Eye-Tracking	It was concluded that both male and female participants did not focus on the images in which the ice cream object was in a single form. However, the concentration on the ice cream image in broken form was almost the same for men and women. The only image where the focus is intense on the ice cream image in its entire form is the image in which it is placed together with the image of the car. In this image, the car logo did not attract as much attention as the text on the image; That is, the focus on the texts and the ice cream logo is higher for male and female participants.
4	The Evaluation of the Perception of Advertising Attractiveness and Advertising Strategies in Different Genders over Disinfectant Ads	Sucu, A., Baruönü, Ö. and Yücel, N.	2021	Eye-Tracking	Differences were detected between the attention and focus levels of male and female participants to the verbal and visual messages in disinfectant advertisements. Accordingly, it has been determined that women focus more on visual and written messages than men, think more about the focused object and carry out a detailed analysis. In the survey conducted after eye tracking, male and female participants were asked whether they remembered the brand names in the advertisements they watched. While 6 of the women and 4 of the men remembered the brand name, 9 of the women and 11 of the men stated that they did not remember the brand names.

Empirical Neuromarketing Studies Using Eye-Tracking Method

	Tittle	Authors	Year	Method	Findings
5	Analysis of the effectiveness of different types of commercials using eye tracking and survey methods	Toker, A. & Sulak, H	2021	Eye-Tracking	It has been shown that different advertising appeals attract the attention of the consumer and this increases product/brand recall. It has been determined that positioning brands and logos in the middle of the screen in commercials is more eye-catching, and although it varies depending on the social structure, the use of humor and emotionality is more appreciated by the consumer.
6	Digital marketing in the tourism sector: analysis of the web sites of Elazığ hotels by eye-tracking	Yücel,N.& İnan, M	2020	Eye-Tracking	It has been observed that on the websites of 4-star and above hotels operating in Elazığ, the section with the hotel name and logo generally attracts more attention. On the other hand, It was determined that the links did not attract much attention on the web pages including Home Page, About Us, Our Rooms, Facilities, Gallery, Restaurants, Meeting Rooms, SPA, Reservation, Contact (Contact Us).
7	How consumers browse dishwashing detergent shelves in stores? An eye-tracking research	Akgül, D. & Güneş , V.	2019	Eye-Tracking	It was concluded that gender and income level do not have a significant effect on the choice of dishwashing detergent, marital status and having children have an effect on brand and product selection, and shopping frequency affects the time spent in front of the shelf.
8	Contextual effect and measurement of attention to advertisements via eye tracking method	Yaman, C. , Tomris Küçün, N. , Güngör, S. & Eroğlu, S.	2018	Eye-Tracking	Data on context and recall revealed remarkable results. It has been revealed that the recall rates of advertisements used with text and visuals in context are high, while the recall rates of advertisements that are not positioned in context are low. It has been observed that advertisements associated with news texts attract more attention than advertisements that are not associated with news texts. It has also been observed that the focus on remembered brands is high. This confirms the relationship between focusing and remembering. In addition, according to the findings, it has been revealed that brands with high awareness attract attention at a level that can compete with brands with relatively low awareness, even if they do not use visuals or emphasize them.
9	A Research on Green Marketing Application in Terms of Consumer Perception with Neuromarketing Technique	Tayfun, N., &Öçlü, B	2015	Eye-Tracking	It can be understood from surveys results that the participants have not yet established a greener understanding and state that they do not regularly pay attention to whether the products are environmentally friendly or not in every purchase. Participants pay more attention to the words cooling and freshness in the advertising frame shown to them. The term energy efficiency almost does not attract attention. Survey results and heat map results do not support each other.

Empirical Neuromarketing Studies Using GSR Method

	Tittle	Authors	Year	Method	Findings
1	Biometric analysis of stress levels of digital natives and digital immigrants within online shopping processes	Küçün, N., et al.	2018	GSR	Slowing down internet speed increases the stress levels of digital immigrants compared to digital natives. There was no significant difference in internet addiction levels between the two groups. Additionally, it was concluded that the determining factor in consumer behavior is individual differences and self-perceptions rather than gender differences.
2	Determining the level of confidence use of different tractor models using galvanic skin response sensor	Beyaz, A. , Beyaz, R. & Gerdan, D.	2015	GSR	When the data of the tractor operator was examined, it was observed that the tractor brand with a high level of safety equipment and a stable structure had a low feeling of trust due to its late response, while the tractor brand with a low level of safety equipment, contrary to expectations, was more agile and created a feeling of trust due to its sudden response to operator reactions.

Empirical Neuromarketing Studies Using fMRI Method

	Tittle	Authors	Year	Method	Findings
1	Testing the Level of Liking of a Product by fMRI Technique within Neuromarketing: Example of Truck as a Product	Çimen, S., &Candan, F. B.	2020	fMRI	According to the data obtained from the behavioral test results, the most liked truck group was clustered as B1 and the least liked truck group was grouped as B2. These results are compatible with the data obtained from the fMRI device. fMRI test results were compared with similar study results in the literature and it was observed that the findings overlapped with each other. While preparing the images, brand logos and data that may remind you of the brand were cleaned. However, it was emphasized that the truck drivers' familiarity with the brands from the general outline of the trucks should be taken into consideration.

Empirical Neuromarketing Studies Using fNRS Method

	Tittle	Authors	Year	Method	Findings
1	Detecting the effect of voice-over in tv ads via optic brain imaging (fNRS) and in-depth interview methods	Girişken, Y. & Çakar, T.	2016	fNRS	The results show that the use of voice-overs during TV commercials likely caused a decrease in participants' attention and emotional engagement levels.
2	An investigation of the neural correlates of purchase behavior through fNIRS.	Cakir, M. P., Çakar, T., Girisken, Y. and Yurdakul, D.	2018	fNRS	It has been shown that neural activations can be used to decipher purchase or non-purchase decisions with 85 percent accuracy, provided sensitivity to the budget constraint is provided as an additional factor.

Empirical Neuromarketing Studies Using FACS Method

	Tittle	Authors	Year	Method	Findings
1	Neuroscience in Marketing: Assessment of Advertisement Memory by means of Facial Action Coding Analysis	Bozoklu, Ç., P. & Alkibay, S.	2016	FACS	The scenes of the ads that trigger the highest emotional responses consist of brand-specific and ad-specific information. It was concluded that melancholic, Turkish classical music placed in advertisements with negative emotional content was an effective stimulus.

Empirical Neuromarketing Studies Using Multiple Methods

	Tittle	Authors	Year	Method	Findings
1	A neuromarketing research about the effect of colors on discount perception	Devrimsel, M. Y.	2020	GSR & Eye-Tracking	The effect of colors on discount perception was measured in the study. It was determined that the colors on discount labels have a close relationship with consumers' discount perceptions. Accordingly, it was observed that red labels have a strong effect on consumers' discount perceptions in male and female subjects, while white discount labels promote a weak effect on discount perceptions for both genders.
2	Analyzing Brand Mascots In TV Commercials Using Neuromarketing Galvanic Skin Response and Facial Coding Analysis Techniques	Daglı,O.& Uluç,T.,	2021	GSR &FACS	Facial muscle movements in Brand Mascots, skin conductivity and questions asked in face-to-face interviews; In the Fish Cracker group, when the high level of positive stimulation and stimulus were taken into account with the stimulus taken in seconds and the answers given to the questions, it could be interpreted as having a strong determinant on the purchasing tendency on the participants. Attributing the ability to speak to the Fish Cracker character, the humorous approach of the Brand Mascot, his sympathetic attitudes and being a permanent brand mascot contribute to the character's recognizability and preference.
3	A Zero-Sum Game: Customers' Switching Behavior in The Turkish GSM Market-A Neuromarketing Analysis	Boz, H., & Koç, E.	2019	FACS, Eye Tracking	It is revealed that existing customers are affected by the promotions prepared by GSM operators. It has been observed that even if existing customers are satisfied with their GSM operator, they may change their operator if they see an attractive offer from a different operator.
4	Determination of user experience on food business websites using neuromarketing techniques	Babaç,E. & Yüncü, H.	2022	EEG, Eye Tracking	The findings reveals that the website's structured visual contents were more effective at capturing users' attention and maintaining their focus throughout. The research found that the individuals' anxiety levels were higher on the experiment 2 webpage because it contained unplanned visual information. In light of the study's findings, experts can produce the visual information they utilize on websites for the food industry considerably more effectively.

DISCUSSION

In the research, neuromarketing and the tools used in the context , which is still a relatively new field of study, are tried to be discovered, and the ways of using neuroscience techniques in the field of social sciences were aimed to be revealed. In 26 experimental neuromarketing studies that fit the research constraints, it is found the conducted research are related with marketing field on advertising, promotion, consumer behavior. In light of this overview empirical studies conducted on neuromarketing field in Turkey demonstrates that Eye-Tracking and EEG methods are the ones utilized most commonly. GSR, FACS, FMRI, fNRS are the other measurement methods derived in consumer researches. PET and MEG are shown to have quite limited usage within predetermined constraints of overview.

The relatively higher use of EEG and Eye-tracking among the neurometric methods discussed highlights to an important point. It demonstrates that there is an increasing trend on the use of single method on empirical studies. However, incorporating neurometric measurement tools such as fMRI and fNIRS used in neuromarketing studies into integrated measurement processes can provide more comprehensive information about the consumer brain.

In parallel to this, the insufficient number of studies conducted with multiple methods is relatively small. The combination of neurometric (EEG) and biometric (GSR, Eye-Tracking, FACS) tools provides much more meaningful results by combining the stimulation process based on brain nerves and the physical reactions of consumers. (Juarez et al., 2020) The main reasons for the low number of studies conducted with integrated measurement are the cost of the tools used and the prejudiced attitudes of the people who will be subjected to the study towards neuroscience measurement tools. In addition, since neuromarketing requires interdisciplinary work, is high in cost, and is a relatively new field of study, the number of experimental studies conducted in Turkey is not high.

When the current studies are examined, it is possible to make suggestions for future research on certain topics.Studies in the literature emphasize the relationship between perception management and marketing strategies. Perception management plays a critical role in influencing consumers' decision-making processes. However, in order to manage consumer perception correctly, marketing messages must be conveyed effectively. At this point, more research can be done on the difficulties in the communication process and successful perception management strategies. Neuromarketing research provides a more in-depth understanding of creating and managing consumer perception.

Research indicates that the combined use of visual and auditory stimuli enables consumers to perceive messages better. However, in cases where numerical values are included, the negative effect of a second sensory stimulus is emphasized. This finding emphasizes the importance of marketers using visual and auditory stimuli in a balanced manner. Investigating this issue from different aspects provides an idea for future studies.

A study on the effectiveness of electronic commerce sites and how they are perceived by consumers was conducted using the EEG analysis method. This type of research is important for understanding the consumer experience on online platforms. Data obtained through the use of EEG makes a valuable contribution to understanding the effects of design elements on websites on consumers. In order to gain more information in the field of neuromarketing in Turkey, an expanded research can be conducted to include neuromarketing strategies of social media campaigns. This study can provide a broader perspective including digital marketing and consumer interaction and contribute to the development of new strategies that will provide competitive advantage in Turkey's dynamic marketing environment.

Moreover, a study on the effect of lighting, one of the restaurant ambiance factors, on food selection from the menu was conducted using neuromarketing tools. Such studies are important in understanding consumers'

sensitivity to visual and emotional elements in the service sector. In addition, the hotel and tourism industry can optimize their ambience using findings from neuromarketing research.

In a study where automobile brand perception was examined using the EEG analysis method, it was tried to determine how consumers perceive automobile brands. Such research is important for understanding how brand perception affects consumers' emotional and cognitive responses. Brand managers can strengthen their brand strategies by using insights from neuromarketing research.

Furthermore, a study examining the effects of anti-smoking public service announcements and the music and sounds used on individuals using EEG analysis offers an important perspective on the effectiveness of public service announcements. Such studies are important for understanding the relationship between emotion and brain activity in the design of social awareness campaigns.

In several studies, data collected through traditional scales were compared with data collected through EEG. This comparison is important to evaluate whether the neuromarketing approach provides a more in-depth and direct understanding than traditional research methods.

The basis of the neuromarketing approach emphasizes the importance of consumers' sensory and unconscious reactions. This is critical to understanding the role of emotional interactions and subconscious factors in the consumer decision-making process. As a result, experimental neuromarketing studies conducted in Turkey reveal important findings in terms of consumer behavior, brand perception and marketing strategies. Evaluating these studies allows us to understand the developments in the field of marketing and evaluate this information from a local perspective. These contexts should be adapted to rapidly developing and changing customer needs and emerging technologies.

The limitations of experimental neuromarketing studies in Turkey should also be taken into consideration. The difficulty of generalizing these studies, which are limited to a specific brand or sector, may encourage the use of more diverse and comprehensive sample groups in prospective studies. Additionally, how neuromarketing will affect marketing strategies in Turkey with technological developments should also be evaluated

CONCLUSION

To conclude, the concept of neuromarketing which can be named as a relatively novel consumer research field is discussed and neuroscientific measurement methods are presented followingly in this overview. The empirical studies in Turkey related to marketing are highlighted and demonstrated the extent of developments in use of neuroscientific tools for identifying consumer decision stages. This study aims to be the pioneer for presenting only the studies which utilize neuromarketing methods and the studies based solely on theory instead of practice is kept out the scope of this overview. Although, the overview has several limitations in terms of surveilled databases and methodologies, it offers a systematic list of studies conducted earlier and may inspire future researchers about the topics covered earlier in the marketing field in Turkey. The conference papers, master and PHD thesis are not included in this study however, they may provide further insights to understand the situation of the field.

Neuromarketing studies, which have been used effectively in marketing in the world since the early 2000s, were later reflected in marketing research in Turkey. The number of articles, papers, theses and books published in the field of neuromarketing in Turkey is quite lower comparing to the world literature. Additionally, there are relatively fewer companies with a commercial research purpose. Despite all this, it is possible to say that a lot of progress has been made in this regard, thanks to the brain-related research carried out in the last 10-15 years. Of course, these studies do not mean that all the mysteries of the brain have been

solved. In other words, it is a fact that there is still a long way to go and it will take years for humanity to achieve this in this complex structure of the market.

It can be concluded that neuromarketing studies in Turkey are not as intense as in the world, however it is thought that neuromarketing studies will increase in the near future. Several universities include courses related to neuromarketing field in their curricula and even offer Master programs that provide neuromarketing training. This will increase the number of academics working in this field. As the benefits of neuromarketing are seen concretely, businesses' interest in this field will increase.

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RESEARCH ARTICLE

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Cost Analysis of Stopwatch Circuits Made with Arduino Development Board and Digital Integrated Circuits

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Abstract

Applications such as stopwatch, digital clock and counter are among the most frequently used applications in the digital world. In this study, we focus on the stopwatch circuit by taking it as an example. The main function of a stopwatch is to keep, control and manage time. The goal here is how to design and realize a low cost, power efficient and less latency stopwatch. In this project, the 4-digit up counter was designed and implemented using Arduino development board and classical digital circuit elements. It was also simulated using the Proteus package program. A comparison was made between the two presented methods in terms of cost, performance and power consumption. As a result of the comparison, the lowest cost, highest performance and least power consumption were obtained from the circuit made using classical digital integrated circuits. Therefore, digital systems designed with classical digital integration are much more advantageous, especially when mass production is needed.

Keyword

Cost analysis,
Stopwatch,
Arduino development board,
Digital integrated circuit

1. INTRODUCTION

In this study, a digital stopwatch circuit will be designed with both classical digital integrated circuits and the Arduino development board. Both circuits will be compared in terms of cost, speed and power consumption. The main purpose of this study is to directly apply development platforms such as Arduino without any research, even in the simplest circuits. However, circuits that perform the same function can be designed and implemented in a more economical and high-performance way using classical circuits. Here, the Stopwatch is considered only as an example circuit. This is valid for all electronic circuits. Of course, comparisons of other technologies and methods can also be made in this type of study. However, not only the cost comparison was made here, but also their performance and energy consumption were compared. It was thought that doing them all together would not only increase the cost but also lead to distraction of the reader.

A stopwatch is a timepiece designed to measure the amount of time that elapses between its activation and deactivation. A large digital version of a stopwatch designed for viewing at a distance, as in a sports stadium, is called a stop clock. In manual timing, the clock is started and stopped by a person pressing a button. In fully automatic time, both starting and stopping are triggered automatically, by sensors. The timing functions are

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traditionally controlled by two buttons on the case. Pressing the top button starts the timer running, and pressing the button a second time stops it, leaving the elapsed time displayed. A press of the second button then resets the stopwatch to zero. (Wikipedia, 2023)

Figure 1. Digital stopwatch (www.wharton.co.uk, 2023)

Digital stopwatch is an important timing device widely used in both industrial and daily life. Compare with conventional mechanical stopwatch, the main property of digital stopwatch includes low coast, high precision and high reliability (Yu Han Shen, 2018).

1.1. Counters

The most basic digital circuits of digital system applications such as stopwatch, digital clock and scoreboard are counters. Counters are used as the basic circuit in the stopwatch, which is the main element of this study. The performance of the counters also constitutes the performance of the stopwatch. Counters are used in this study, both in the stopwatch made with a classical digital integrated circuit and in the stopwatch made with Arduino. A 2-bit asynchronous counter is shown in Figure 2 (Demirel, 2021).

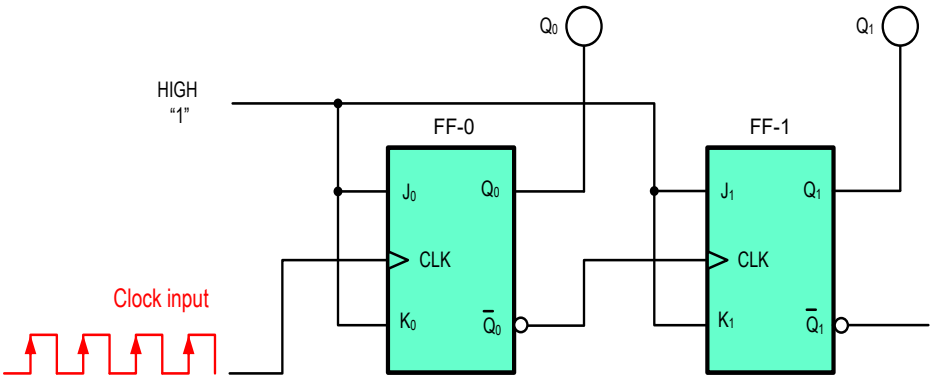

Figure 2. Two-bit asynchronous binary up counter

1.2. Propagation Delay

The time (delay time) until the input wave passes through the flip-flop (integrated) and reaches the output is called propagation delay (t_{PLH} and t_{PHL}). Propagation delay is one of the most important parameters to be considered in logic ICs. Because it is the main factor that determines the speed of integrated devices. Figure 3 shows the propagation delays (t_{PLH} and t_{PHL}) occurring in a two-bit asynchronous counter. In the figure, the time between the rising edge of the first clock pulse and the rising edge of the first flip-flop's output is indicated by t_{PLH}, which means low level to high level. The time between the rising edge of the second clock pulse and the falling edge of the first flip-flop's output is also indicated by t_{PHL}, which means high level to low level. (Floyd, 2014).

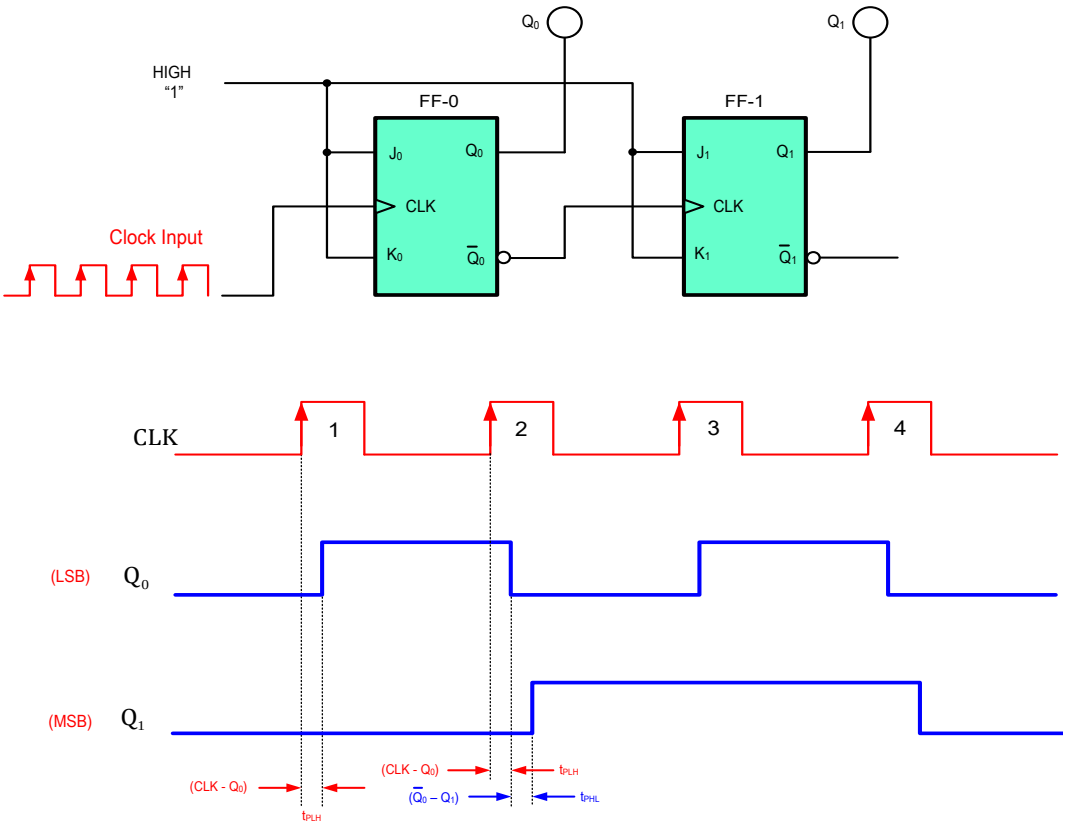

Figure 3. Propagation delays in a 2-bit asynchronous binary counter.

Propagation delay is not a valid parameter only for counters. It is also used for the delay between input and output of logic gates and even for the delay between input and output of integrated circuits and microprocessors. It is the most important parameter that determines the performance of circuits and systems.

1.3. The Arduino Platform

Is an open-source building and programming platform for electronics. Most devices can receive and send information from it, and it can even send commands to a particular electronic device over the internet. It programs the board using software and a hardware circuit board (Kondaveeti et al, 2021). Due to its user-friendly or simple interface, Arduino is frequently used in microcontroller programming today. Like any microcontroller, an Arduino is a circuit board with a chip that can be programmed to perform a wide range of tasks (Srinivasan et al, 2021). It sends information from the computer program to the Arduino microcontroller before sending it to the particular circuit or machine with multiple circuits to carry out the specific command. An Arduino board's components can be divided into two groups: software and hardware (Demirel, 2022).

Hardware Components :

The Arduino development board is made up of numerous parts that work together to make it function (Louis, 2016). As depicted in Figure 4.

- Microcontroller: At its core, the development board functions as a miniature computer that can send and receive data and commands to the peripheral devices it is connected to. Every board uses a different microcontroller, and each one has different requirements.
- External Power Supply: The Arduino development board is powered by this power supply, which has a regulated voltage range of 9 to 12 volts.
- USB plug: This port on the board is extremely important. Using a USB cable, it is used to upload (burn) a program to the microcontroller. In situations where the external power supply is not present, it also has a regulated 5V power source that powers the Arduino board.
- Internal Programmer: Without an external programmer, the developed software code can be uploaded to the microcontroller via a USB port.

- Reset button: This button can be used to restart the Arduino microcontroller and is present on the board.
- Analog Pins: Analog input pins from A0 to A7 are typically available. The analog input and output are handled by these pins.
- Digital I/O Pins: These pins range from 2 to 16 for digital input (typically). The digital input and output are done using these pins.
- Power and GND Pins: The development board has pins that can pass 3.3 and 5 volts as well as ground through them. (Badamasi, 2014)

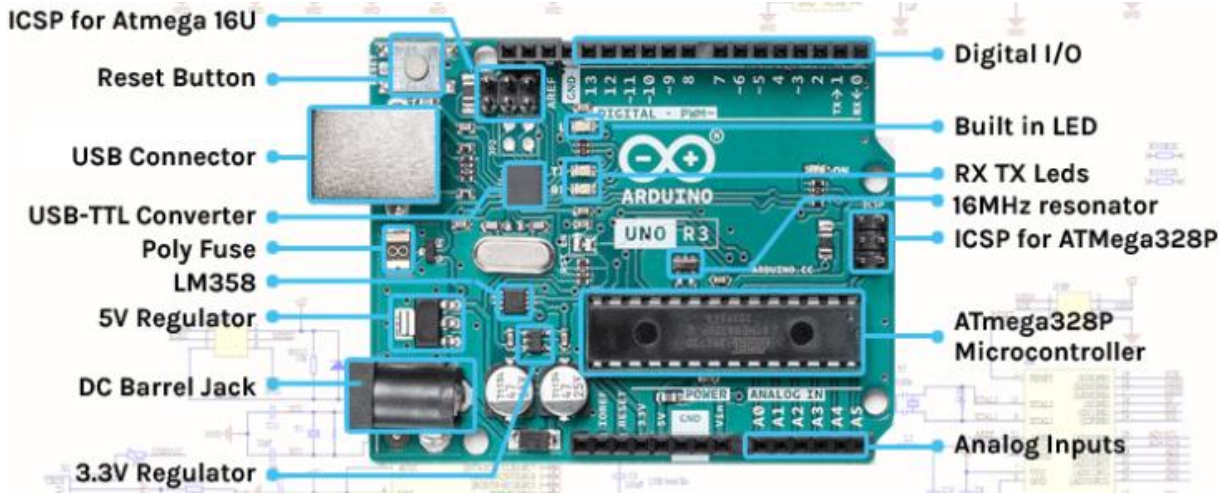

Figure 4. Labeled diagram of an Arduino Board

Software Components :

A "sketch" is the term used to describe the Arduino program code. The Arduino IDE is the name of the program used to create these sketches for an Arduino (Louis, 2016). The following components are included in this IDE:

- Text editor: Here, a simplified version of the C++ programming language can be used to write the code that has been simplified.
- Message area: It shows errors and provides feedback for exporting and saving the code.
- Text: The console presents the text output generated by the Arduino environment, which includes error messages in their entirety and other information.
- Console Toolbar: This toolbar includes a variety of buttons, including Verify, Upload, New, Save, Open, and Serial Monitor.

2. METHOD AND MATERIAL

In this project, we will use two different approaches to design a 3-digit up counter. The first approach will use a traditional digital counter (using IC74LS93 and BCD-to-seven-segment-display drive 74LS47) to implement the first circuit and the second approach will use an Arduino to design a counter. The simulation will be done using the Proteus programming language. The propagation delay time between input and output signals in both experimental lab and simulation result by (software) circuits will be used as the basis for comparison between all methods presented. Oscilloscope and other measuring devices with 100 MHz bandwidth used in the experiments are measuring devices with international certificates and accreditation.

2.1. Traditional (Classical) Digital Counter

Technically, the classical counter diagram contained four main modules as shown in Figure 5; they were: the 555 timer, decade counter 74LS93, the BCD to 7-segment-display driver 74LS47, and the 7-segment LED 4 display.

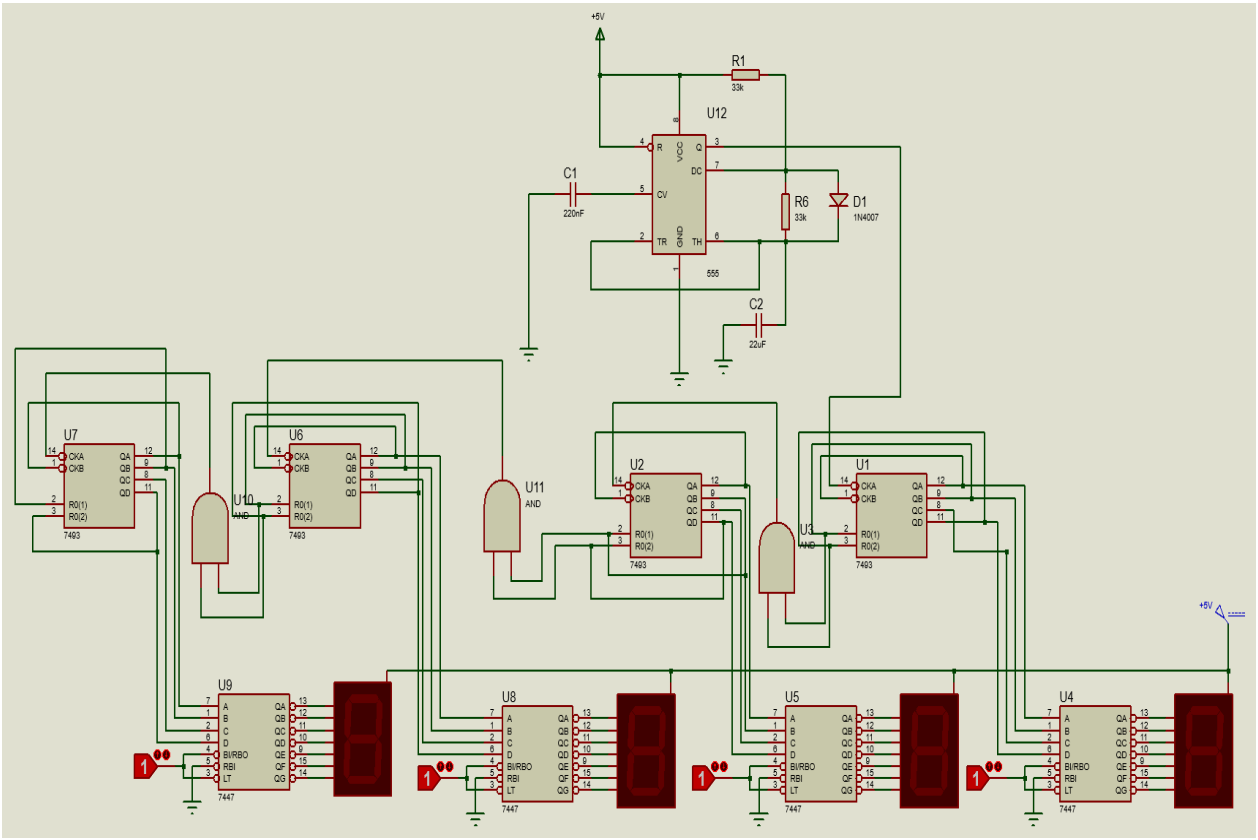

Figure 5. Schematic of the classical digital circuit

The first module. The 555 timer, was an IC[3] and produced a 1 Hz signal at the output pin 3. In other words we wanted the 555 timer circuit to keep time by sending an electrical pulse to the second module, the decade counter 74LS93, every second. There were some external electronic passive components such as resistors, capacitors and, diode associated with the 555 timer IC. Resisters values were R1=33KΩ, R2= 33KΩ, and capacitors values were C1=220nF, C2=22nF. The diode value was 1N4007. The external components determined the frequency of the output signal. The second module, the decade counter 74LS93, was an IC. This IC would count the number of electrical pulses arriving at the input pin 14. The number of pulses counted would appear in binary form on four output pins 12, 9, 8 and 11. It should be noted that the 74LS93 IC would only be able to count from zero to nine in decimal value. When the tenth pulse arrived at the input the binary output would be reset to zero, and the IC would start counting from zero.

The third module, the BCD-to-seven-segment-display drive 74LS47 for common-anode LED types, was also an IC. The second module had four output pins corresponding to four bits of a binary number. This binary numbers would have a decimal value ranging from zero to nine. This 74LS47 IC in the third module took the four outputs of the 7493 IC and converted them to seven outputs. The four input pins of the 74LS47 IC were 7, 1, 2 and 6; the seven output pins were 9, 10, 11, 12, 13, 14, and 15. The last module was the 7-segmcnt LED display, and it received signals from the 74LS47 IC's output pins. The internal Light Emitting Diodes, LEDs. Of the 7-segment LED display would be lit up depending on the signals coming from the seven outputs of the 74LS47 IC. If the coming signal was high or 5V, then the corresponding LED would be turned on. In contrast. If the signal was low or 0V, then the corresponding LED would be turned off. The third and fourth modules (BCD-to-seven-segment-display drive 74LS47 for common-anode LED type and 7-segment LED display), these components will be used in all three approaches.

2.2. Arduino UNO Circuit

Second approach for design a counter, as shown in Figure 6, the circuit consists of Arduino as a core component, the Arduino UNO is connected to the computer by USB connector installed on the Arduino device to transfer the program to ATmega328P microcontroller. The circuit also contains BCD-to-seven-segment-display drive 74LS47 for common-anode LED type and 7-segment LED display. In this circuit we chose a Timer 1 type.

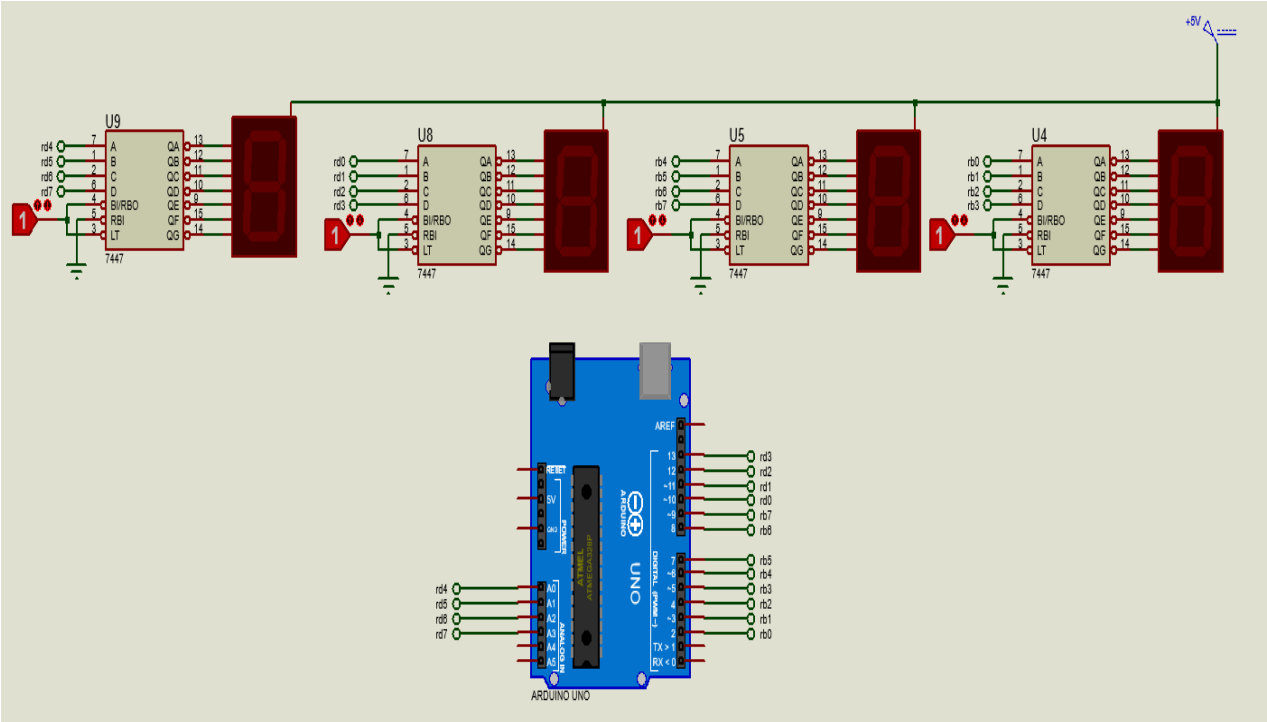

Figure 6. Schematic of the Arduino circuit

3. RESULTS

As shown in Figure 7 and Figure 8 the results we obtained by using the Proteus Simulation to measure the time delay for the three methods that were used in this study.

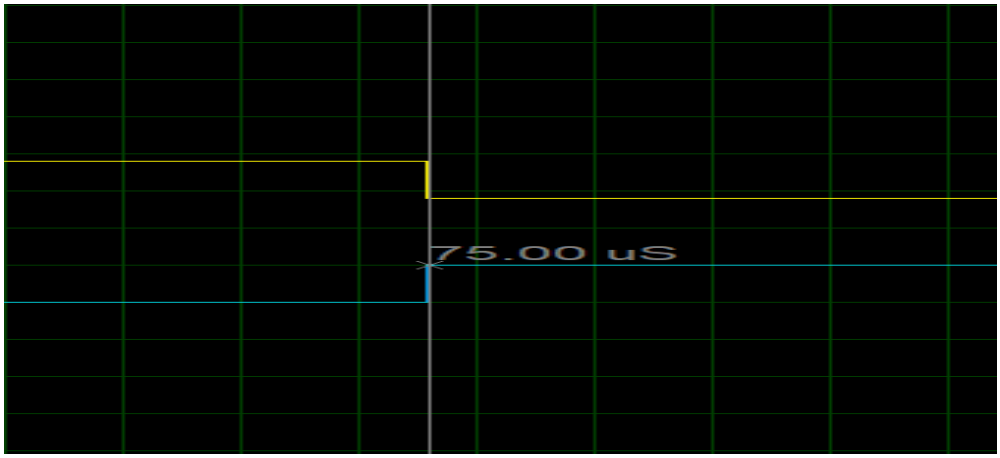

Figure 7. Proteus simulation time delay for classical digital circuit

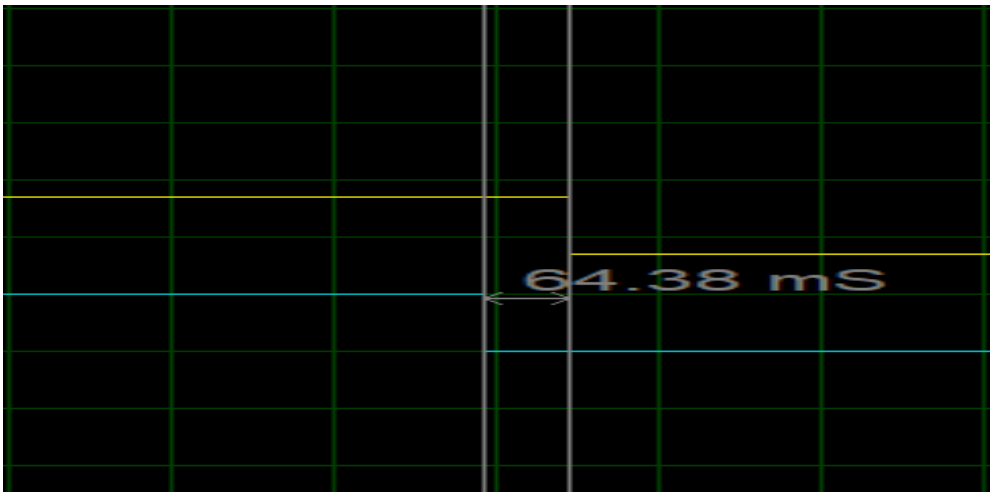

Figure 8. Proteus simulation time delay for Arduino UNO circuit

We obtained the laboratory experiments results for time delay by measured the circuits with oscilloscope as shown in Figure 9 and Figure 10.

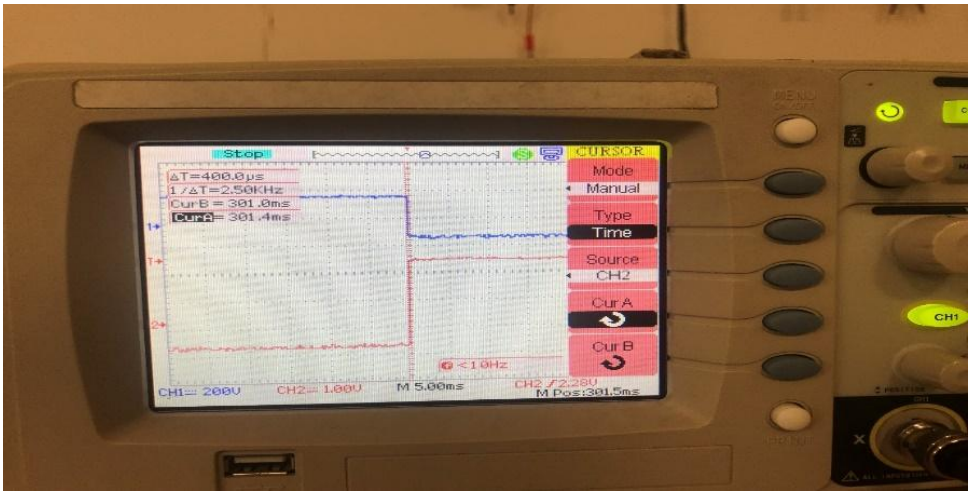

Figure 9. Experimental time delay result for classical digital circuit

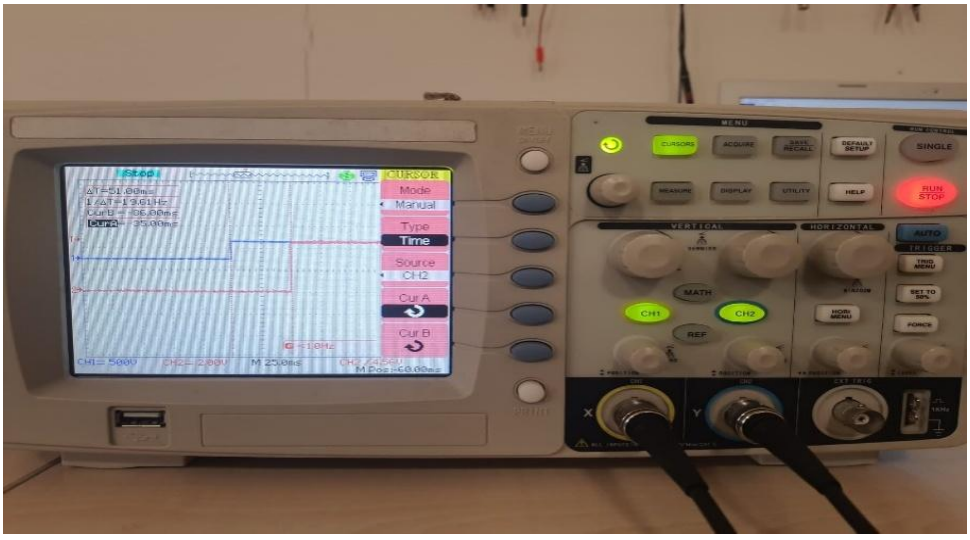

Figure 10. Experimental time delay result for Arduino circuit

Table 1 shows the measured propagation delays for both the classical digital stopwatch circuit and the stopwatch circuit built with Arduino UNO.

Table 1. Time delay results of Stopwatch Circuits

Type of Circuit	Experimental Delay	Simulation Delay
Classical	400 µs	75 µs
Arduino	51 ms	64.38 ms

Table 2 shows the measured power consumptions for both the classical digital stopwatch circuit and the stopwatch circuit built with Arduino UNO.

Table 2. Power consumption of Stopwatch Circuits

Type of Circuit	Voltage	Current	Power
Classical	5V	122.7 mA	613.5 mW
Arduino	5V	169.6 mA	848 mW

Table 3 shows the component prices and total cost for both the classical digital stopwatch circuit and the stopwatch circuit built with Arduino UNO.

Table 3. Cost of Stopwatch Circuits (According to prices from the www.direnc.net in 27.11.2023)

ARDUINO UNO PLATFORM	PRICE	CLASSICAL DIGITAL CIRCUIT	PRICE
1 x Orginal Arduino UNO Development Card	671,89 TL	4 x 74LS93 IC	31,76 TL
4 x 74LS47 7-Segment Display decoder IC	43,32 TL	1 x 555 Timer IC	3,88 TL
4 x 74LS47 7-Segment Displays	36,12 TL	4 x 7-Segment Displays	36,12 TL
1 x Bread-Board	30,69 TL	4 x 74LS47 7-Segment Display decoder IC	43,32 TL
1 x 9V DC Adapter	115,53	1 x Logic Gate IC	6,50 TL
40 x Jumper Cable	19,89 TL	2 x Resistor	1 TL
		2 x Capacitor	2 TL
		1 x Diode	1,23 TL
		1 x Bread-Board	30,69 TL
		1 x 9V Adapter	115,53 TL
TOTAL COST	**917,41 TL**	**TOTAL COST**	**248,57 TL**

4. CONCLUSION

The time delays between the inputs and outputs of the stopwatch circuit, which was first designed with two different methods, were measured in the experimental and simulation environment and are shown in Table 1. Secondly, the power consumption of the stopwatch circuit designed with two different methods was measured in the experimental environment and shown in Table 2. Finally, the costs of the stopwatch circuit implemented in both methods were determined at current market prices and are shown in Table 3.

According to Table 1. As expected in the time delay measurement, the circuit type with the least time delay was observed as the classical digital circuit (asynchronous stopwatch) in both simulation and experimental environments. As it is known, time delay is the most important parameter that determines the performance of digital systems. The less time delay, the better the performance of that system. As a result, the performance of the classic digital stopwatch is better than the digital stopwatch implemented using Arduino UNO.

Likewise, in the power consumption measurement according to Table 2, it was observed that the circuit type that consumed the least power in terms of time was the classical digital circuit (asynchronous stopwatch). Today, in addition to the performance of digital systems, one of the most important quality criteria is the energy savings of the systems. It is understood that the classical digital stopwatch circuit has a significant advantage under this heading.

Finally, both stopwatch circuits were compared in terms of cost. According to Table 3, it is seen that the cost of the Classic digital stopwatch circuit is much lower. The cost of the stopwatch circuit using Arduino UNO is more than three times (3.7 times) the cost of the classic digital stopwatch circuit. It is clear that the classical digital circuit has a great advantage, especially in mass production, and increases competitiveness significantly.

As a result, looking at all measurement results, the best results were obtained with the classical digital circuit. Performance (speed), energy saving and low cost are generally always the most important parameters in all systems. This also applies to digital systems. When these parameters were measured on a digital stopwatch circuit, it was observed that classical digital circuits had a great advantage in every aspect.

In conclusion, although circuit design and installation with the Arduino development board has become very popular in recent years, the use of Arduino for non-complex and widely used digital circuits such as stopwatches is not efficient in terms of performance, power consumption and cost. This situation has been proven in this study. If we were to make an analogy: Just as it would be illogical for a general to stand guard in a sentry box instead of a soldier in a military barracks, using Arduino even in the simplest circuits is illogical and inefficient. Even in the simplest circuits, development platforms such as Arduino are used directly without any research. As seen in this study, this situation is extremely costly. However, the same function can also be performed using classical circuits. It is both economical and much more suitable in terms of performance and power consumption. Especially in productions involving mass production, this cost will increase even more. Here the Stopwatch is just an example circuit. This is valid for all electronic circuits. Therefore, this study will shed light on the entire electronics industry.

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RESEARCH ARTICLE

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Can Crowdsourcing Create a New SOE (State owned Enterprise, Kamu İktisadi Teşebbüsleri, KIT) Approach ?

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Abstract

In this study, crowdsourcing practices and platforms ((Kitle-Kaynaklandırma Uygulama ve Platformları, KKUP) are discussed with the guidance of studies that are openly accessible from academic and practical sources. With the presupposition that there is a basic knowledge and awareness of KKUP in the reader's perspective, more detailed and concrete information about them, various and striking examples from the prac83tical experience will be given in this context, and based on these examples, the positive and open to improvement aspects of KKUP will be tried to be revealed. As a result, it will be put forward as a forward-looking idea whether a new KIT (Kamu İktisadi Teşebbüsleri in Turkish, State Owned Enterprises) can be developed, which is unique to Turkey, and a model for other countries such as Kazakhstan, based on crowdsourcing studies and other new innovative systems as collaborative endeavors between public and privateorganizations.

Keyword

Crowdsourcing Applications Public Economic Enterprises (Soes), Crowdsourcing Apps And Platforms, Human Resources Management, Digital Transformation And The Public Sector, Digital Marketing

1. As an introduction, what is KKUP?

Today, KKUP is involved in literature and practice as a new model of innovation and management (Nguyen 2022). Various positive and negative aspects of crowdsourcing applications and platforms, which are gaining more and more diversity and prevalence, are also revealed by various studies. For example, on the one hand, various platform examples are appreciated with flexible working conditions that generate income for employees and qualified data science studies that support artificial intelligence studies. On the other hand, it can take criticism of the abuse of the human force that they employ (for example, Appen ve Amazon MekanikTürk), (Capilnean, 2021). Accordingly, Appen, for instance, delivers high-quality training data and quality assurance services for autonomous vehicle manufacturers. Ability to combine 2D and 3D datasets enables Appen to support industry's most complex machine learning training data requirements (Glassdoor,

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2022) Amazon's Mechanic Turk makes possible to ubiqutiuously work from phone and computer (Vincet, 2014).

Considering all these aspects, it is thought that KKUP has many aspects that can be taken as an example and lesson for Turkey. Various remarkable academic and practical studies and initiatives on this subject are also seen more and more day by day. For example, the crowdsourcing project opportunities offered by Havelsan within the scope of the Open Innovation Platform is a recent initiative that is note-worthy (Çağlar, 2019).

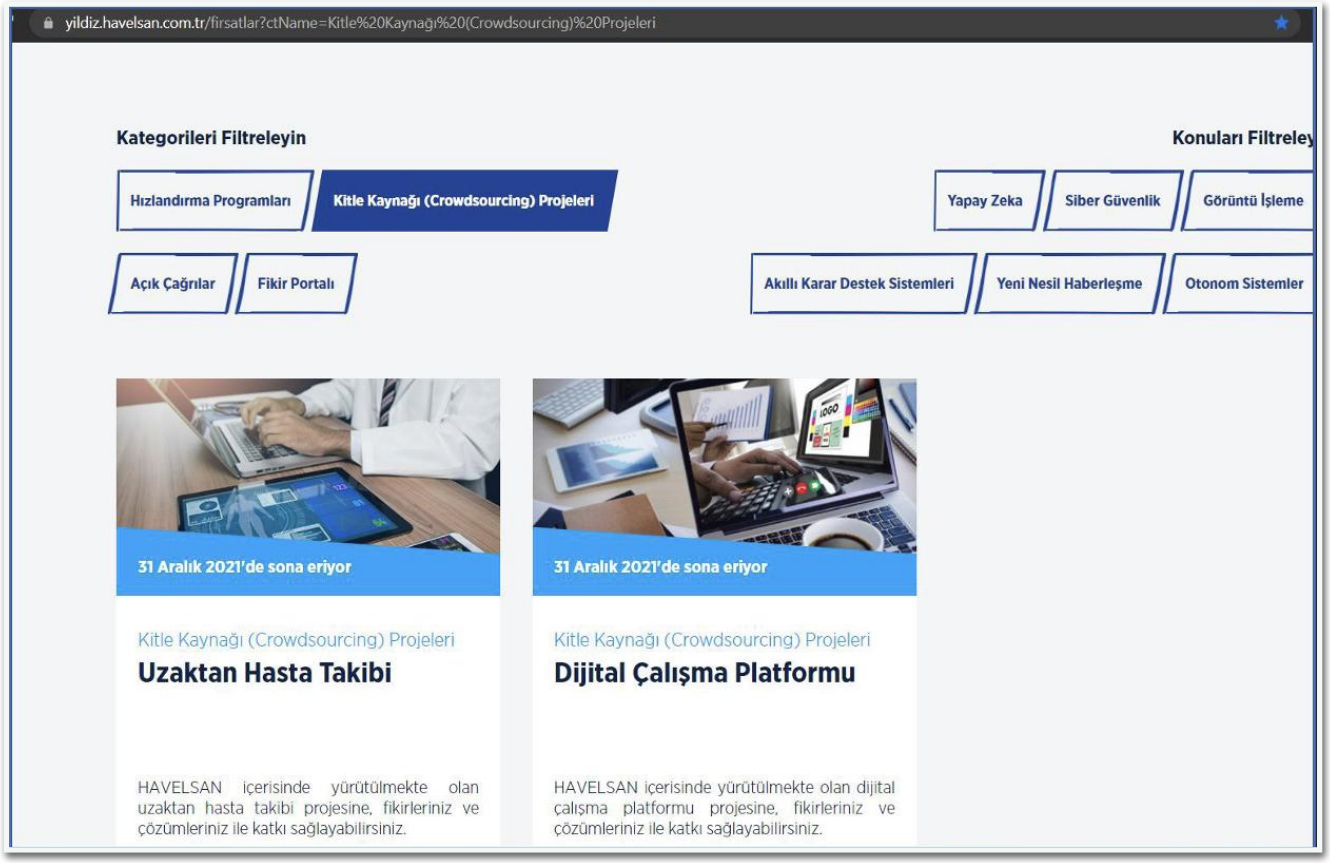

Fig. 1 *(KKP, Havelsan, 2022)*

Crowdfunding can also be used as a new generation alternative public finance method, as different implementations in the world and Turkey would examplify. For instance, again, in Turkey, it is seen that the number of practices aimed at both gaining monetary rewards and contributing to beneficial personal or social outputs and effects in return for undertaking the predetermined tasks is increasing day by day. It is known that in some of these applications, which encourage the increase in the number of steps obtained by simply walking, the inspections of public places such as gas stations in terms of cleanliness and hygiene are also included in the scope of the application (Google Play Store, 2022)

In this paper, based on openly accessible sources and contents, more detailed information about KKUP that can be guiding for developing newer public-private collaborative initiatives will be shared.

The Use of Crowdsourcing and Applications Platforms for Digital Marketing and Other Management Functions

Search Engine Optimization is one of the areas where KKUP is used most frequently today. In this case, various information and content acquisition and classification studies aimed at meeting customer

expectations and satisfaction attract attention. It is thought that these studies can be harmonized with digital marketing and sales funneling approaches. For example, many KKUP's project tasks (sometimes supported by location data or QR codes) are designed in accordance with the perception of customer expectations and intentions and presenting the most appropriate advertising (Ad) options to (potential) customers in response to their searches. It includes marketing and sales activities aimed at improving the processes of directing to Landing Pages and sales and completion (for example, Appen Arrow, Lionsbridge projects) (PassLioness, 2020).

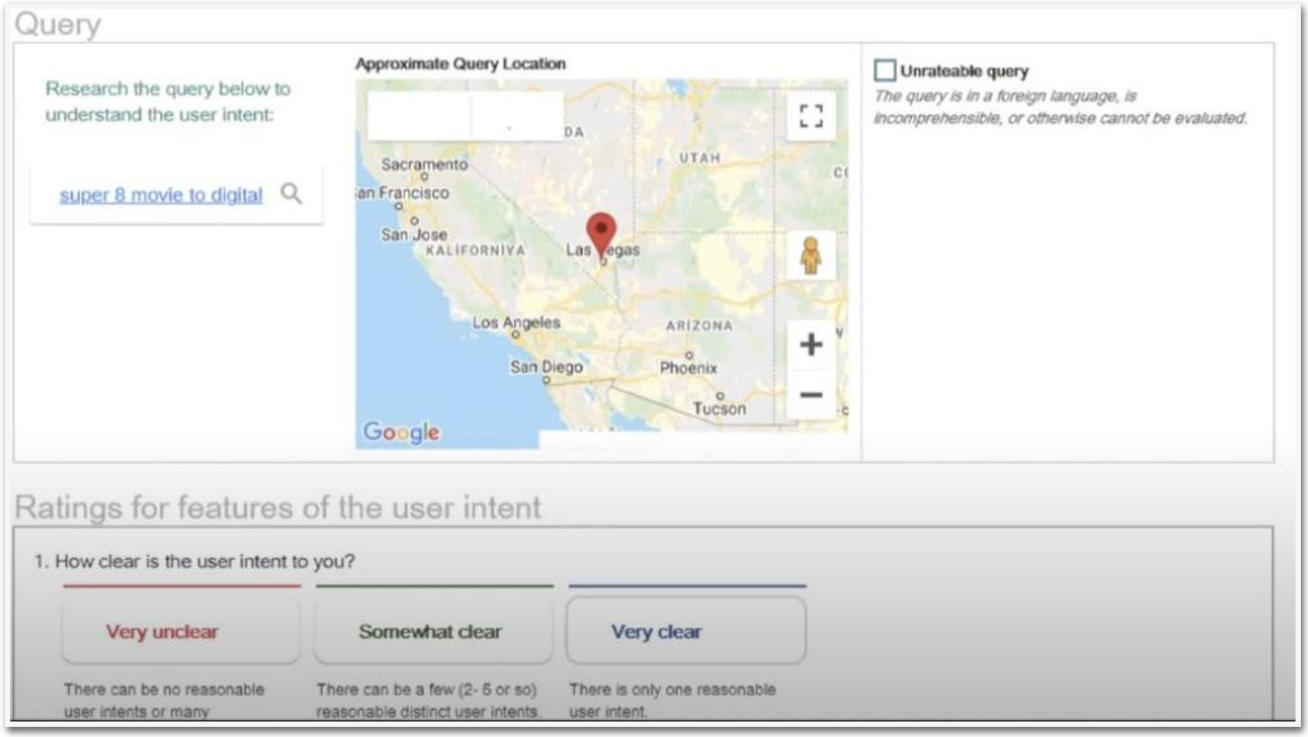

Fig. 2 *(Kadir Bakmaz, 2022)*

Again, in many KKUP projects, tasks and processes are supported to collect, label and classify textual or visual information and content, and to decide whether they are suitable for presenting to the relevant target audience user profiles, and to show (or not be show) to certain types of users, especially for certain purposes. For example, various Transperfect, Lionsbridge, and Appen project tasks can be seen within this framework. For instance, it may be requested to evaluate whether the relevant content has religious content in a project task (DataForce 2022, Exam, Pay & More, 2018). Various works can further be exemplified in this context, from captioning porn videos to tagging screenshots of terrorist-organisation-affiliated videos or classifying images and figures that are against the content control policies of Fortune 500 companies (Milland, 2019). Data trainings that contribute to the development of artificial intelligence algorithms are also supported with these studies within the scope of Search Engine Optimization, some of which require basic knowledge of local or general culture, and some require a certain level of knowledge in areas such as language or logic (LearnAction, 2020).

In addition to such studies on pre-sales (marketing) and during-sales processes, there are also various KKUP projects that focus specifically on post-sales or more general social media interactions. For example, in the Appen Amur project, users who purchase products sold on selected social media platforms are asked to evaluate this purchasing experience, including product delivery and quality, through a tool within the scope of Social Media Evaluation. The products purchased according to certain criteria (for example, automobile accessories) remain with the participants of the project and the related fees and expenses are paid back to them.

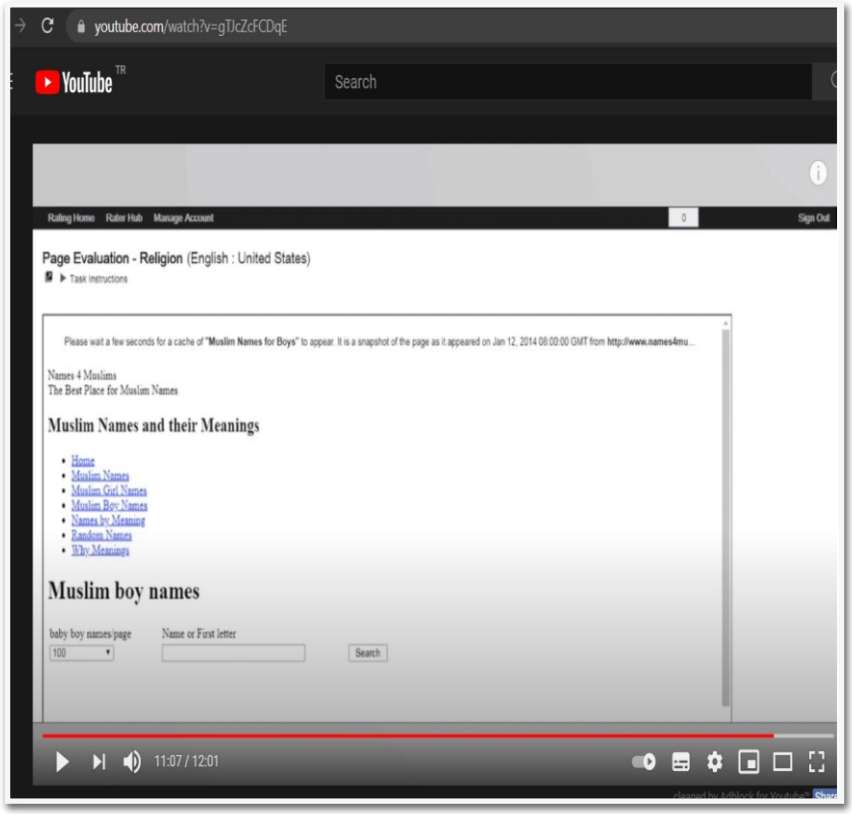

Fig. 3 (*Appen Exam Answers I How to Pass Appen Arrow Exam? | Arrow- Lionbridge Personalized Ads Assessor,10:48 onward.)*

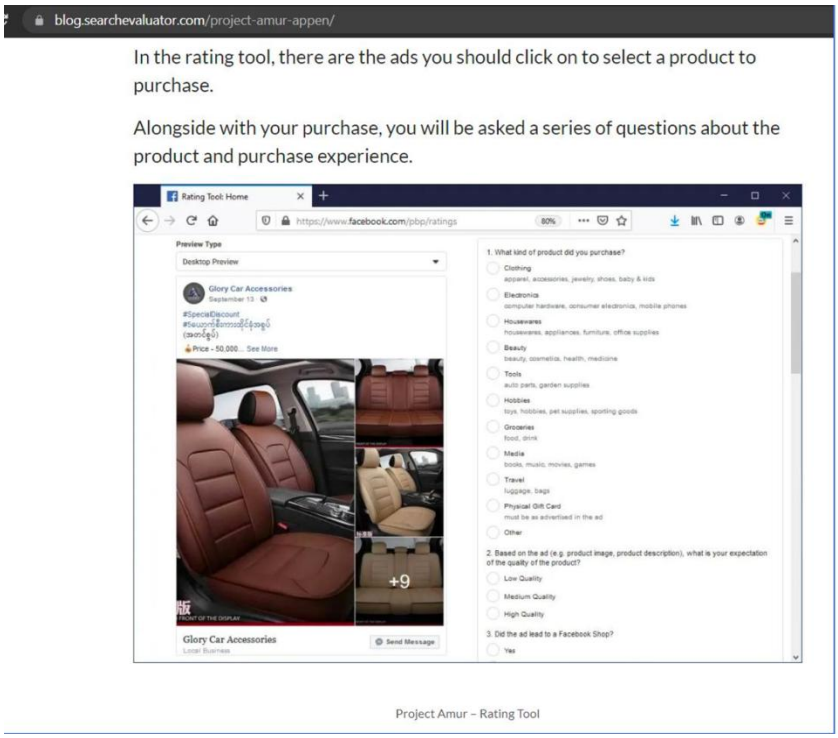

Fig. 4 (Rating Home, Facebook Page 2022)

Again, for example, in the Falcon project, which is carried out on the Appen platform and whose corporate customer is understood to be Facebook, the shared posts are interest tagged (Allen, 2017). In addition, there are various KKUP works, especially in terms of information reliability and verification. For example, the Uolo project on the Appen platform workes to investigate and evaluate the claims in the video content in Facebook using the relevant SRT Facebook tool.

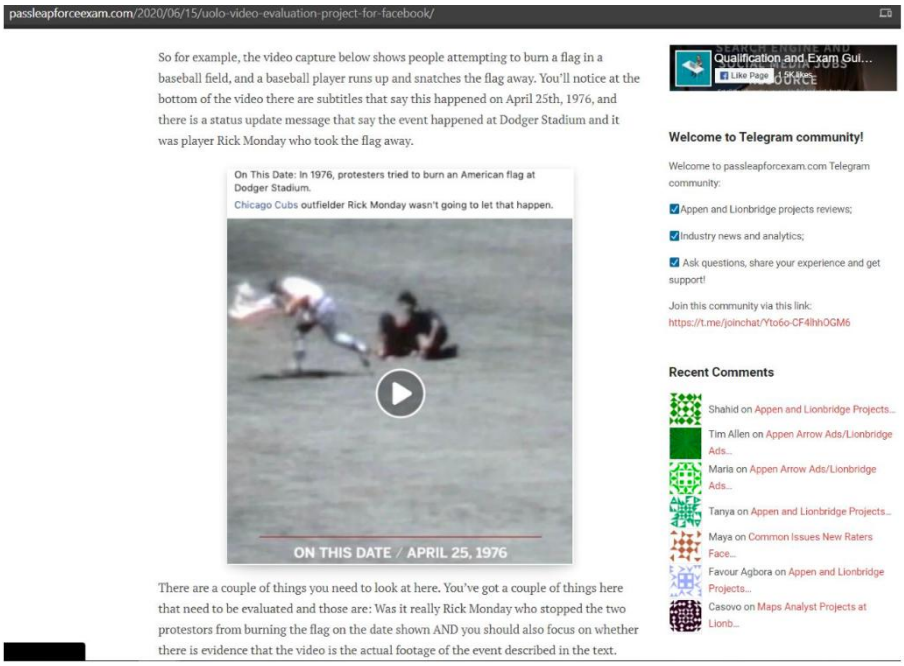

Fig. 5 (Appen Platform: First Time User Guide, Appen Success 2022)

Again, on the Appen platform, there is the Ogden project, in which the SRT Facebook tool is used to understand and evaluate whether the ads on Facebook will be wanted to be seen by people and if they do not, what would be the reasons for this (Allen, 2017).

With the prevalence of this type of project work where examples can be multiplied, it has been also observed that there has been an increase in the open information-sharing activities of third parties in recent years, even though the confidentiality provisions are valid within the projects themselves (in addition to those sources such as Appen) (Allen, 2021). In fact, there are various educational materials for how to be involved in the related projects and how to be admitted into the related works. These include various in-service and pre-service training videos and exam simulayon applications (and their advertising videos).[i]

Content and works like these also provide various information about KKUP's Human Resources functions and approaches.

The approaches of the KKUPs to Human Resources Management

Among the academic and practical studies put forward within the scope of KKUP, the extent to which these have changed or will change the work life has an important place (Schmidt, 2015). In addition to these holistic evaluations regarding the management of work life and human resources, some more specific and detailed information on how KKUP's functions such as recruitment, in-service training and performance evaluation work are also openly accessible on the Internet.

For example, inability to meet various quality standards such as minimum working hours or accuracy rate, or not using multiple accounts or failing to comply with administrative and technical rules such as IP address

conflicts/Internet connection sharing issues are some common problems encountered by new evaluators (raters) in the process of adapting to projects. Parameters such as Task Completion Rate can be used to control work productivity. For example, 45-50 tasks per hour or 1-1.3 minutes per task are met as reasonable, but situations that are well below or above this can be questioned. The criteria and related parameters may vary depending on the nature of the task (Allen, 2018(a)).

There may be disagreements between the employer and the employee regarding the practices aimed at increasing the quality and performance of KKUP's work, and various problems and problems related to the solution of these can be encountered in reality. In particular, in cases where the work is billed manually by the employee, not automatically by the system, the inconsistencies between the working hours suggested by the employee and the measurement parameters used for the control of the system, and the problems encountered during the elimination of these inconsistencies are among the first to stand out. In some cases, such problems may result in the dismissal of employees from the respective KKUP projects (Allen, 2018(b) & 2019(a)).

Situations such as the failure to provide the necessary support during these troublesome processes and experiences, and in some cases where employees think that they have been wronged and treated with inequality or injustice in some conflicts with the employers, have a negative impact on the evaluations of KKUP (Indeed, 2022).

As one example that worths underlying, Amazon's Mechanical Turkers want to be recognized as 'actual human beings: “Users signed up to Amazon’s 'crowdworking' marketplace Mechanical Turk say they're tired of being marketed as algorithms for cheap labor and have started a letter writing campaign asking Amazon CEO Jeff Bezos to recognize them as "actual human beings [...] who deserve respect, fair treatment and open communication” (Vincet, 2014). Such matters, as discussed at the beginning of the study, support the the aspects of KKUP that need improvement that complement the positive aspects. On the other hand, considering the characteristics of KKUP that brings employees and employers together, various information regarding the employer side can be given in a way that complements the employee side.

Employer Side of the KKUP

There are also various studies in KKUPs that present approaches and services for employers. For example, CloudFactory puts forward the issues such as a talented workforce, accountability for results, reliable quality, flexibility and scalability, and open cost structures to its customers to differentiate itself from other KKUPs (Wilson, 2017). Again, for example, Appen explains in the Appen Success Center how test questions should be prepared in order to ensure quality and how those who answer the questions will be evaluated in the guide prepared and presented for the first users of the Figure Eight platform, which is included in its business portfolio.

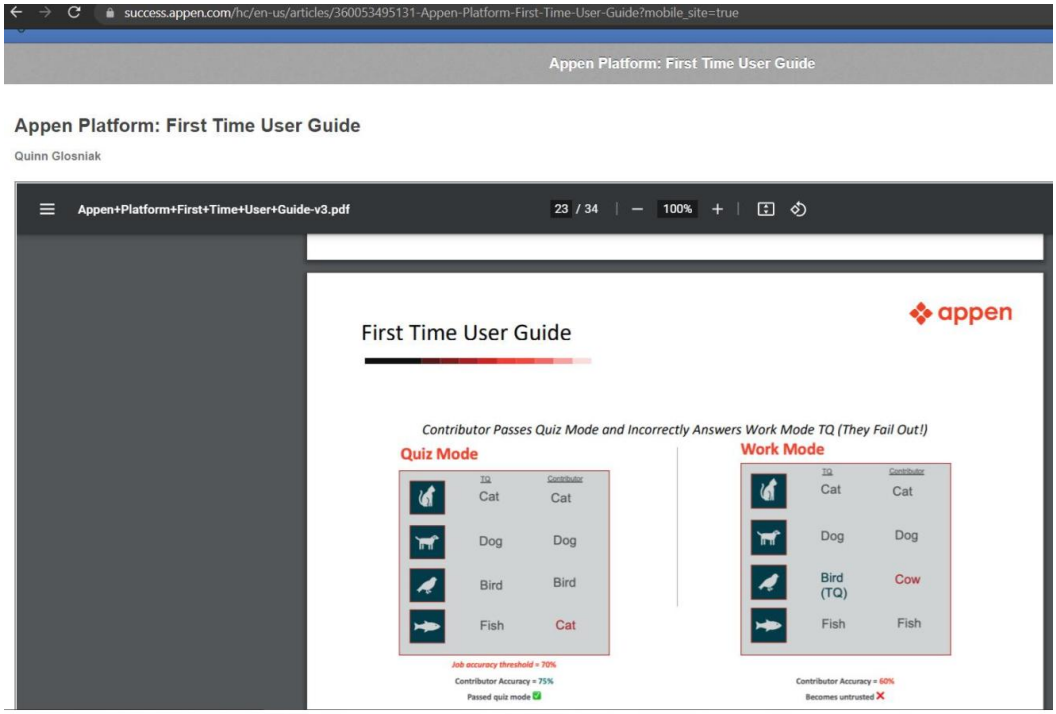

Fig. 6 *(Guide To Enterprise Analytics, Appen Success 2022)*

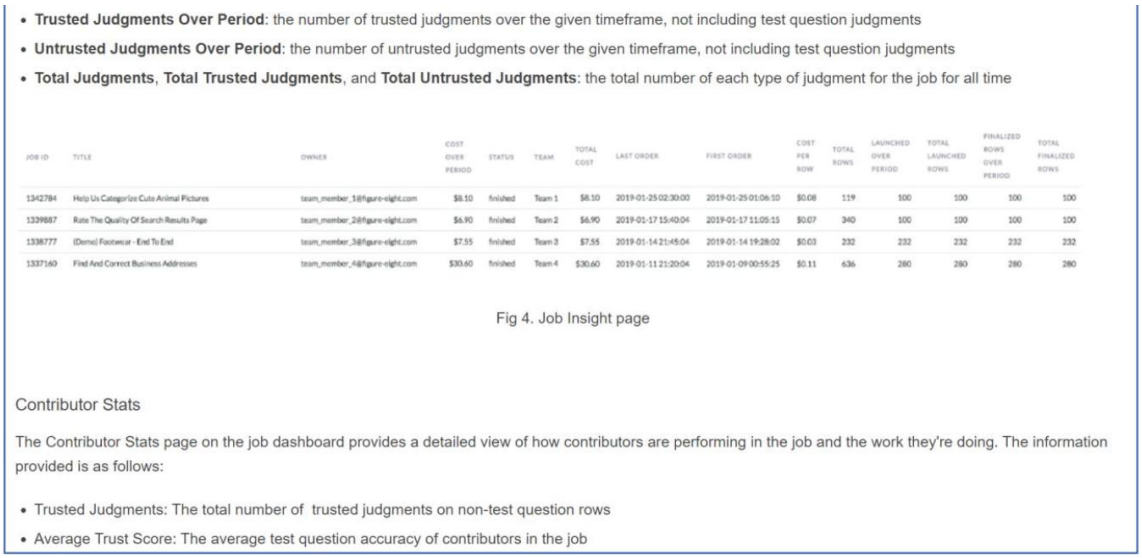

Fig. 7 *(Guide to: Advanced Analytics Page, Appen Success 2022)*

The Appen Success Center also has a variety of methods and indicators put forward as Enterprise Analytics. Accordingly, various analyzes can be performed on the basis of Business or Contributor. In this way, for example, evaluations can be made on Reliable Judgments individually or in total and at the end of a certain period.

In addition, confidence scoring for a total of a job can be made. As for more advanced analysis, for example, High Agreement (HA) and Low Agreement (LA) percentages for performing quality controls can be seen. Thus, it can be understood in which situations different contributors can give common answers (HA) or not

(LA) to task questions, and accordingly which situations are more subjective, ambiguous or difficult can be determined.

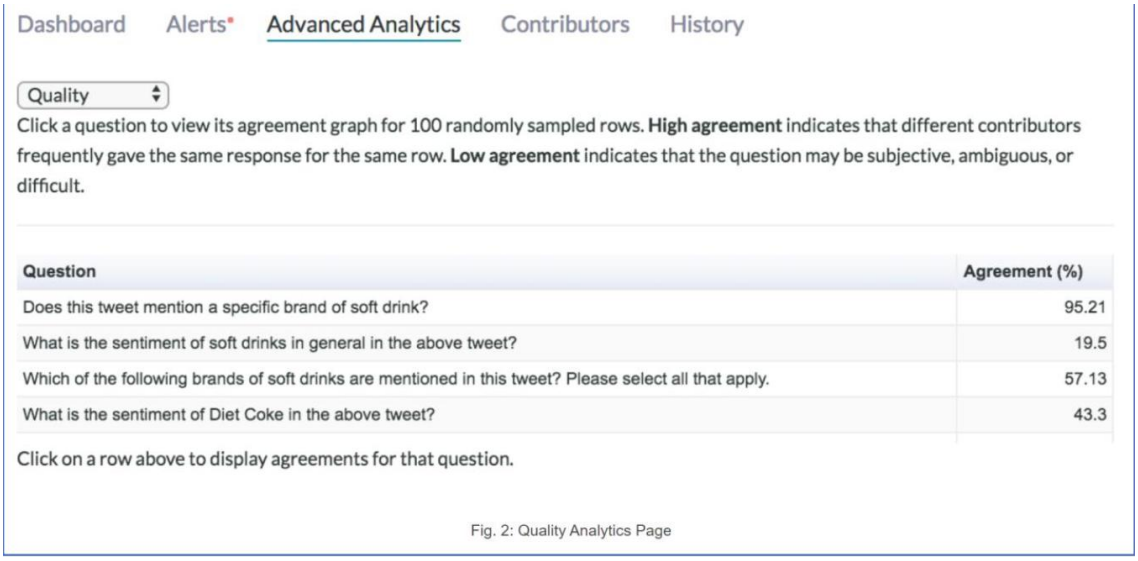

Fig.8 *(Dijital Türkiye Endeksi 2021 Basın Lansmanı TBD, 2022)*

On the other hand, employees may have various tools and methods that they can use. Among them, for example, various productivity-enhancing and tracking applications (such as RaterAide, LBTimer) are suggested (Allen, 2016). Again, as an example, it is recommended to use browser history, which shows the time elapsed in activities, to be used in KKUP projects belonging to Google or other employers (Allen, 2019(b)) (for instance, https://myactivity.google.com/myactivity).

Surely, another important point regarding these issues is how the data of both customers and employees as individual users are collected and used by the relevant vendors and employers (Indeed, 2022). At this point, the privacy and protection of personal information, and in this context, information security and reliability issues come to the fore in KKUP Projects. Essentially, at this point, it is thought that the different expansions and derivatives with respect to the roles of ordinary user, worker, employer and intermediary gradually reveal. For example, large employers and vendors collect information on individual users as potential or existing customers in order to increase their income, on the one hand, and employ individuals through KKUP (in some cases using this and similar information) in order to realize and develop these service sales. As a result, while individual consumers are willing to engage in activities that spend their time, such as watching advertisements, in order to benefit from some products and services for free, they also often benefit from jobs that make money by watching advertisements or filling out surveys through KKUPs.

In conclusion, a University-Industry-Civil Society Cooperation Model / Implementation Proposal for Turkey through Prospective KKUP.

In line with the digital transformation, important works are also carried out in Turkey. Various civil society, private and public institutions have accelerated their relevant studies in line with current developments. For example, with the pandemic, technology support and artificial intelligence use studies to support educational

activities are becoming increasingly important in educational institutions that focus on open and distance education. Surely, the hopes and opportunities that come with them also bring administrative and ethical concerns and great responsibilities (Şenocak, 2020). The latest artificial intelligence strategy prepared by the Presidential Digital Transformation Office (DDO) is also one of the recent examples of digital transformation initiatives (Resmi Gazete, 2021). Again, as an example of the role that public and state institutions will undertake, intentions and approaches for the evaluation and evaluation of public data through the private sector, which aims to "convert public data to diamonds with the private sector" can be given (Gazete Vatan, 2021). In general, it is considered that it is possible for the state to take responsibility for the development of the intermediary and implementer role undertaken by KKUP in accordance with the open innovation approach, and triple, quadruple or quintuple spiral innovation models (Sevsay et al. 2017) (TBD, 2020).

Arnkil et al (2010), defines quadruple helix as an innovative environment, where individuals, business ventures, higher education institutions and government cooperate with the aim to generate innovative ideas and projects. (Arnki*l*, et al.2010). The main idea is that the listed stakeholders (civil society, industry, university and government) cooperate towards an innovate result and contribute based on their expertise. Therefore, the role of civil society is no longer limited to using goods and services only, nowadays civilians are active participants of the innovative and digitalized processes.

In this digital transformation process, where individual and corporate roles are increasingly intertwined, positive effects and benefits such as increased performance and efficiency in the work carried out, or guaranteeing user rights and privacy can be achieved thanks to this responsibility undertaken in the public sphere. Accordingly, a new model can be developed by utilizing the good aspects of KKUP practices and improving the aspects that need improvement. For example, in the organization of appropriate public institutions, various projects for the development of citizen or customer services can be presented to the use of the participants in accordance with KKUP approaches, these works can then be audited and managed in a measurable and accountable way with the institutional performance evaluation methods of KKUP. On the other hand, by improving the support and solution services that users need when they have problems, a cultivating approach can be put forward where rights and privacy are much better secured than these at existing KKUP practices.

This type of approach may also herald the transition from State-Owned Enterprises to Crowd-Sourcing approaches. An approach of this nature can turn into an application that can pave the way for improving the positions and practices of large international technology companies that are being questioned more and more today, taking into account social and economic benefits, and in this context, can set an example for the world. Some recent studies also support these approaches. For example, the Digital Turkey Index (DTE) study put forward by the Turkish Informatics Association (TBD) both distinguished and correlated household members with their social characteristics and corporate initiatives with their economic characteristics, depending on a suitable digital need hierarchy relationship. Based on this framework, the 2020 digitalization index of Turkey has been calculated.

Accordingly, basic vital needs for individuals occupy a lesser place at the lowest level, while relational needs with society occupy a greater place at the highest level. For institutions, basic vital needs occupy a greater place at the lowest level, while relational needs with society occupy a lesser place at the highest level. A role in regulating the legal socio-economic relationship between these individuals and institutions has been proposed to public institutions within the framework of the ecosystem (EcoDiurnal, 2022). In the future, it can be expected that this hierarchy of needs relationship for the institutions will evolve in line with that of individuals, and the role of the state may also be reshaped in this case. Artificial assets, which may emerge as a hybrid of individual and corporate assets, could accelerate this process, as well. In the following years, it is planned to repeat the DTE measurements by improving the concept and application framework in collaboration with institutions such as DDO, Ankara Yıldırım Beyazıt University (AYBU) and TBD.

To support these studies, AYBU E-Government and Public Transformation Program graduate students carry out analysis on the Public Service Inventory (Service Inventory Management System, https://envanter.kaysis.gov.tr/). The services selected from the public institutions serving in various vital areas

are examined, and determinations and suggestions are made in the direction of existing service improvements and new service suggestions.

Accordingly, it is envisaged that providing the human capital and administrative and technical infrastructure that will support the education and training of KKUP-related information, both in universities and in public institutions, will have extremely beneficial results for Turkey. At this point, it is thought that the citizen science approach will support and complement these innovative studies (TEBD, 2020).

Particularly, within the scope of university-industry cooperation studies, it is thought that supporting co-creation processes, including civil society, as part of the Four Spiral Innovation System understanding, will gain a significant momentum thanks to KKUP's initiatives. It is foreseen that if these initiatives are designed and executed with a focus on social responsibility and sensitivity to the natural environment, they can also contribute significantly to the Five Spiral Innovation System (Medeni & Aktaş 2010).

However, some scholars argue that implementation of quadruple or even five-helix models might be challenging, since the civil society is extrimely heterogeneous (Roman et al., 2020) Therefore, in order to encourage the participation of the fourth helix in social innovations, an accurate quadruple helix model needs new ways of cooperating with the stakeholders. To facilitate civil society engagement, the government must adapt present techniques to the needs and expectatons of specific groups.

It can be evaluated that the implementation of Quadruple and Five-Helix Spiral Innovation Systems Related to Society, Economy, Democracy and Social Ecology, which can meet various needs in the digital age, will also provide one of the necessary conditions for the transition from the information society to the wisdom or information society (Medeni & Aktaş, 2010). Informatics, which is meant here, emphasizes knowing together in accordance with the root of the word, knowing in this context and being able to agree with each other as all common stakeholders with whom we share this life.

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