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RESEARCH ARTICLE

Behind the Youtube Addiction and Online Stickiness. Does Fear of Missing Out Count?

Beril Durmuş[1], Hüseyin Ekizler[2], Murat Bolelli[3]

Abstract
As social media has evolved into a predominant aspect of daily life, with over 5 billion users globally, understanding the motivations behind user engagement is essential. The purpose of this study was to examine the relationships between loneliness, self-esteem, FoMO (Fear of Missing Out), YouTube addiction, and online stickiness concepts. This study hypothesizes that self-esteem and loneliness significantly affect FoMO, which in turn influences YouTube addiction and online stickiness. Data were collected from Turkish adults using an online survey tool with convenience sampling method. Confirmatory Factor Analysis, correlation, and path analyses were conducted to test the research hypotheses. The findings indicate positive and significant correlations, as well as the effect of self-esteem on FoMO. Additionally, loneliness was found to be negatively correlated with FoMO Social Experience and positively correlated with FoMO Rewarding Experience, whereas no significant effect of loneliness on both dimensions was found. FoMO Social Experience and FoMO Rewarding Experience were positively correlated with YouTube addiction, and FoMO Social Experience had a significant effect on YouTube addiction. Finally, YouTube addiction is strongly correlated with online stickiness, and its effect on it is significant. The implications of the results are discussed, and future research areas are suggested.

Keywords: Loneliness, Self-esteem, Fear of missing Out, YouTube addiction, Online stickiness

Introduction

Social media have become an important part of daily life in the last two decades (Sampasa-Kanyinga & Lewis, 2015). Research suggests that there are 5.07 billion social media users worldwide, representing 62.6% of the global population as of April 2024. Additionally, the average daily social media use per internet user has increased to 143 min per day (Statista, 2024). This implies that if a person signed up at age 16 and lived to 70, they would spend 5.36 years on social media (Backlinko, 2021).

Used as a generic term, social media can be considered a descriptive concept for all internet-based applications that allow users to create and share content (i.e., knowledge, expe-

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riences, emotions, thoughts, information, etc.) generally in the form of videos, pictures, and text (Kaplan & Haenlein, 2010). Facebook, Instagram, Snapchat, Twitter, YouTube, Pinterest, Thumblr, Reddit, TikTok, and Foursquare are the most popular platforms among many others.

Considering the great interest in social media, numerous studies have been conducted to explain why people engage actively (by sharing) or passively (by following) in it (Dhir et al., 2018; Roberts & David, 2020). Various theories relate to the popularity of social media, such as belongingness, social comparison, validation, information foraging, and compensatory internet activity. These theories suggest that satisfaction with various needs is one of the most important drivers for engaging in such platforms, where users seek gratification in different forms through their participation (Kardefelt-Winther, 2014; Quinn, 2016; Quan-Haase & Young, 2010; Toma & Hancock, 2013).

Previous studies have suggested that social media engagement is particularly related to satisfying needs such as well-being, belongingness, connectedness, life satisfaction, self-esteem, social involvement, information sharing and collecting, and self-presentation (Beyens et al., 2016; Christofides et al., 2009; Hunt et al., 2018; Kuss & Griffiths, 2017; Nadkarni & Hofmann, 2012; Seidman, 2013; Turel & Serenko, 2012; Utz et al., 2012; Przybylski et al., 2013; Winter et al., 2014). Billions of users worldwide interact over social media applications in an attempt to satisfy these needs, where their experiences function as an inducer for behavioural reinforcement.

In particular, the more users engage in social media and the more satisfying their experiences, the stronger their drive becomes. This mechanism is asserted to create a loop of "addiction to the activities engaged" and lead to habitual and addictive behaviours towards social media use (Abel et al., 2016; Kim et al., 2010; Kuss & Griffiths, 2017). Needs satisfaction has been asserted to foster social media addiction either directly or indirectly (Barry & Wong, 2020; Przybylski et al., 2013).

Applications can be perceived as efficient means of connecting with others, sharing information, and being part of something; therefore, people may resort to using them intensively, directly enhancing the effect. Additionally, unsatisfied needs like loneliness, low self-esteem, low self-compassion, insecure self-perception, and unhappiness can function as mediators or moderators for excessive use of social media (Barry & Wong, 2020; Przybylski et al., 2013). In that case, the relationship between need satisfaction and social media use is indirect.

Nevertheless, in pursuit of fulfilment, maladaptive use of social media is reported to produce negative outcomes such as anxiety, depression, high stress levels, lower sleep quality, increased suicide incidents, reduced relationship quality, and fear of missing out (FoMO) (Adams & Kisler, 2013; Donnelly & Kuss, 2016; Kalpidou et al., 2011; Kross et al., 2013; Lup et al., 2015; Rosen et al., 2013; Tandoc et al., 2015).

FoMO is conceptualised as a feeling of missing a rewarding experience or being absent from an experience that others enjoy (Pollard, 2012; Przybylski et al., 2013). Closely related to negative or insecure self-perceptions and individuals' assessments of their relationships with others, FoMO is asserted to consist of two main components: "the desire to stay connected with what others are doing" (Przybylski et al., 2013) and "worry about others having a good time without them" (Barry & Wong, 2020). In relation to the rapid advancement of information and communication technologies that have shaped social media applications, the possibility of experiencing FoMO has increased significantly (Barry & Wong, 2020). Nourished by needs such as relatedness, belonging, and connectedness (Beyens et al., 2016; Deci & Ryan, 1985), FoMO is reported to induce problematic, addictive digital technology use (Aydın, 2018; 2022; Elhai et al., 2020; Ercengiz, 2020; Erciş et al., 2021; Kurtoğlu & Aydın, 2023; Özdemir, 2021; Sarıbay & Durgun, 2020; Teke & Yılmaz, 2024). Studies have reported two fundamental drivers that induce maladaptive use of social media and form the basis for FoMO: loneliness and low self-esteem (Abel et al., 2016; Burke et al., 2010; De Cock et al., 2014; Hunt et al., 2018; Kalpidou et al., 2011; Song et al., 2014; Xu & Tan, 2012). Mostly caused by general economic, political, and social conditions, loneliness, alienation, isolation, and related negative affects are asserted to be increasing worldwide (Blai, 1989; Lu et al., 2023; Rook, 1984; Sundberg, 1988; Wang et al., 2021; Zhu et al., 2021). Because loneliness is a strong driver for negative feelings that are undesirable (Burke et al., 2010), social media is found to be an easy and inexpensive (compared to the tangible and intangible costs of real relationships) venue by a large number of users to avoid or compensate for these feelings. Research shows that loneliness is related to not only higher consumption of social media but also FoMO, especially among younger generations (Barry & Wong, 2020).

Self-esteem can be defined as how people feel about themselves based on cognitive or affective self-evaluations (Leary & Baumeister, 2000). Social media is reported to provide safe and gratifying venues for such needs as self-expression, external validation, and self-image, which are related to self-esteem and are used to elevate them (Báachnio et al., 2016; Tian et al., 2019). Social media offers a secure space, especially for individuals with low self-esteem, where they can express themselves and connect with others without the boundaries they feel or experience in real life. On the other hand, social media also functions as a source that enables users to retrieve information about others for use in self-comparisons. Hence, it can be argued that through social media applications, people tend to both send and collect information to overcome loneliness and establish and improve a sense of self-worth, which lays the foundation for building self-esteem.

Considering the relationship between need satisfaction and social media use, it can be theorised that drivers such as self-esteem and loneliness should affect FoMO, thus reinforcing addiction and stickiness towards the applications. To examine this assumption, YouTube, which is the second most visited website in the world after Google (Alexa, 2019), was selec-

ted. On YouTube, users share and view videos on various topics, including politics, social or business events, products, people, games, music, TV, and education. It is reported that YouTube has over 2 billion monthly logged-in users (almost one-third of all internet users and 25% of the world population), with over one billion hours of content viewed every day (YouTube, 2021). Research has revealed that viewers tend to identify with their favourite YouTubers, and this one-way relationship is positively correlated with loneliness and self-esteem (Bérail et al., 2019; Tian et al., 2019). Although it is not reciprocal, these relationships are asserted to satisfy the need to belong, particularly for people who are lonely, socially depressed, or have social skills deficiencies, by replacing the absence of real relationships (Hartmann, 2016). The intensity of need and satisfaction is linked to levels of YouTube addiction (Baek et al., 2014).

Conceptual Framework

FoMO is defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent and characterised by the desire to stay continually connected with what others are doing" (Przybylski et al., 2013). The concept is suggested to have existed in various communication channels throughout history, such as newspapers, almanacks, letters, bulletins, etc., which are instrumental in satisfying curiosity about the lives of others (Wortham, 2011).

In line with technological advancements that have made it easier to send and receive information than ever before, social media applications have emerged, providing user-friendly and attractive services for sharing activities and experiences. One downside of this convenience is the increased anxiety level of individuals who fear missing out (Ellison et al., 2007). Mainly related to this self-reinforcing loop, three-quarters of young adults and nearly 70% of adults experience FoMO (JWTIntelligence, 2012; Przybylski et al., 2013).

The antecedents of FoMO are low self-esteem, loneliness, low needs satisfaction, lower feelings of acceptance and approval, and social anxiety, which foster high engagement in social media (Alt, 2015; Barry et al., 2017; Bérail et al., 2019; Blackwell et al., 2017; Hunt et al., 2018; Oberst et al., 2017). Studies have shown that individuals with high levels of FoMO are more likely to experience stress, anxiety, depression, sleeplessness, social media addiction, sleep problems, diminished well-being, and lower self-esteem (Adams et al., 2017; Alt, 2015; Baker et al., 2016; Beyens et al., 2016; Oberst et al., 2017). Additionally, high levels of FoMO are associated with eating disorders, poor mental health, and low self-esteem.

Taking previous studies into consideration, it can be asserted that using FoMO antecedents to examine related causal relationships is productive (Barry & Wong, 2020; Beyens et al., 2016; Blackwell et al., 2017; Elhai et al., 2018; Przybylski et al., 2013; Rozgonjuk et

al., 2021; Stead & Bibby, 2017). Loneliness and self-esteem constructs are efficient in studying FoMO. One of the theoretically closest concepts to FoMO, loneliness, is shown to be correlated with self-reported FoMO. Together with loneliness, FoMO affects addictive social media engagement (Alt, 2015; Barry et al., 2017; Blackwell et al., 2017; Song et al., 2014). Although people tend to use social media applications to avoid or compensate for loneliness (Burke et al., 2010; De Cock et al., 2014; Xu & Tan, 2012), experimental research on the relationship between concepts indicates that limiting social media use significantly reduces both loneliness and FoMO, suggesting that these concepts work as self-reinforcing constructs that strengthen each other (Hunt et al., 2018).

The other research variable, self-esteem, is a result of individuals' positive or negative self-evaluations (Smith et al., 2015). Social media applications can be instrumental in self-assessment in various ways. The internet provides data to establish a basis for benchmarks that result in a subjective sense of self-worth or value. People gather information about others, develop frames of "norms," "standards," or "expected values" concerning family, wealth, achievements, success, well-being, life in general, and also compare themselves with others using content they find on the internet. Social media can also be used for external validation that affects self-esteem. Components such as wealth, fame, body image, belongings, lifestyle, affiliations, etc., are subjected to both social comparison and external validation and are instrumental in forming self-esteem. Especially when self-worth is strongly related to others' approval or acceptance, social media is proven to be even more influential (Stapleton et al., 2017). On the other hand, social media applications can also serve as a tool to compensate for the lack of popularity and friendships in real life, helping to increase self-esteem. In line with this argument, research has revealed that social media can bridge social capital among college students who have low self-esteem (Steinfield et al., 2008).

Taking all into consideration, it can be asserted that people with lower self-esteem are prone to engage in social media more intensively (Báachnio et al., 2016; Hunt et al., 2018), and there is a negative correlation between self-esteem and FoMO (Barry & Wong, 2020; Buglass et al., 2017; Kalpidou et al., 2011).

Although listed among the most popular social media applications (Alexa, 2019), YouTube is asserted to be fundamentally different from other platforms as it does not contain traditional social networking features and is thus seen more as a content provider (Kaplan & Haenlein, 2010; Kuss & Griffiths, 2017). There are various reasons for this differentiation.

First, YouTube focuses on content viewing, whereas others focus more on user interactions (Khan, 2017). Second, YouTube supports and offers longer videos called video blogs or "vlogs." Utilising this feature, almost anything can be shared in detail, from news to lectures, to individual experiences to art, with few length or file size limitations. Third, having the advantage of the ability to provide longer videos, YouTube appeals to a distinct user profile

that can be categorised into two main groups: viewers and content creators. Although the first group is almost similar to other social media users, there is a great deal of diversity among the latter. Content creators include individuals, companies, interest groups, non-profit organisations, teachers, professional content developers, and hobbyists (Khan, 2017). Fourth, in relation to the reasons mentioned above, vlogs are more efficient at facilitating deeper and wide-ranging emotional expressions than other platforms (Tian et al., 2019). Fifth, the dynamics of the relationship between YouTubers and followers differ from other social media applications. YouTubers share their personal information, interests, opinions, experiences about life, products, services, etc., in other words, they engage in self-sharing activities to build a base of viewers and sustain their attention (Chen, 2016; Ferchaud et al., 2018). Viewers generally remain anonymous and watch content, making the relationship between YouTubers and viewers non-reciprocal. In line with the nature of this process, YouTube is more addictive for content creators than viewers (Balakrishnan & Griffiths, 2017). Sixth, compared to other social media platforms where people tend to share carefully arranged and pictured "positive," "happy," "healthy," "wealthy," "selected" moments of their lives, which presents an edited or filtered perception for others, YouTubers appear real and natural due to the format that allows them to share a great deal of information and emotions about themselves, intentionally or unintentionally (Tian et al., 2019).

It is theorised that YouTube can be used to create online relationships that function as surrogates for real relationships and help people overcome personal problems (Caplan & High, 2010; Ferris, 2001). If this is the case, then YouTube should be instrumental in strengthening self-esteem and reducing loneliness.

One of the biggest challenges for social media platforms is to allow users to stay longer or stick around on their websites or applications. The more time users spend on them, the better it is for the company in terms of visibility and profitability. One way to achieve this goal is to focus on developing features that can be used for satisfying the needs of users, thereby keeping them on the platform.

Stickiness is defined as a user's willingness to return to and prolong their visits to the platform or application (Teng, 2010). Research has revealed that continuance motivation and sharing behaviours are the main determinants of stickiness (Chiang and Hsiao, 2015). Sharing behaviour is related to individuals' willingness to share, and continuance motivation refers to individuals' continuous inner drive or motivation to share their experiences, ideas, feelings, thoughts, or content with others.

Users' needs, environmental, and personal factors such as social norms, identification, reputation, self-expression, interactivity, altruism, confidence, and self-efficacy have a significant impact on sharing behaviour (Chang and Chuang, 2011; Chiang and Hsiao, 2015; Choi and Chung, 2013; Compeau and Higgins, 1995; Hsu and Lin, 2008; Jiacheng et al., 2010;

Lee et al., 2011; Marakas et al., 1998; Park et al., 2011; Yang et al., 2010). Stickiness can be considered a habit (Wu et al., 2010).

Users gain intangible benefits—although sometimes they receive tangible benefits like ad revenues, sponsorships, or direct payments as well—in the form of appreciation and praise as viewers like, share, or comment on their posts. This mechanism not only builds reputation and self-esteem but also fosters addictive social media use by reinforcing the drive for it.

Considering all this, studying the relationships among self-esteem, loneliness, FoMO, YouTube addiction, and online stickiness concepts can contribute to the current literature. Based on the literature review, the research model presented in Figure 1 was developed, and it has four hypotheses to be tested.

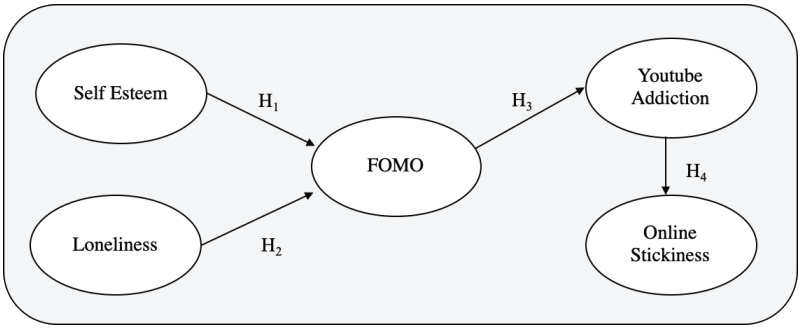

Figure 1. Research Model

H_1: Self-esteem is related to FoMo.

H_2: Loneliness is related to FoMo.

H_3: FoMo is related to YouTube addiction.

H_4: Youtube addiction is related to online stickiness.

Methodology

Instruments

Developed by Przybylski et al. (2013), the FoMO scale was designed as a 10-item, single-dimension instrument that was evaluated on a 5-point Likert scale. Turkish adaptation was conducted by Gökler et al. (2016). In the initial validation study by Przybylski et al. (2013), the Cronbach's alpha reliability coefficient for the scale was found to be .90, indicating excellent reliability. In Gökler et al. (2016), $\alpha = .81$, reflecting strong internal consistency. Items

included statements such as “It bothers me when I miss an opportunity to meet up with friends” and “I fear my friends have more rewarding experiences than me.”

Rosenberg’s Self-Esteem Scale was adapted to Turkish by Çuhadaroğlu (1986). The scale was originally developed as a 10-item, single-dimension instrument and is evaluated on a 5-point Likert scale. The Cronbach’s alpha reliability coefficient in the initial validation study was .89 (Rosenberg, 1965), indicating high reliability. In the Turkish adaptation by Çuhadaroğlu (1986), α = .89, thereby maintaining high reliability. Items included statements such as “On the whole, I am satisfied with myself” and “I feel that I am a person of worth, at least on an equal plane with others.”

Loneliness Scale The Loneliness Scale used in this study was adapted from Hays and DiMatteo’s (1987) short form of Russell et al.’s (1980) UCLA Loneliness Scale. The initial validation study consists of 20 items, but the short form used here contains eight items. The Cronbach’s alpha reliability coefficient in the initial validation study by Russell et al. (1980) was.94, indicating excellent reliability. For the short form by Hays and DiMatteo (1987), α = .85, indicating good reliability. Items included statements such as “I feel excluded” and “I feel isolated from others.”

The Online Stickiness Scale developed by Tsao (2014) consists of four items measured on a 5-point Likert scale. The initial validation study reported α = .79, indicating acceptable reliability. This scale assesses user engagement and propensity to revisit online content. Items include statements such as “I would visit this website as often as I can” and “I intend to prolong my staying on this website.”

YouTube Addiction Scale adapted from Moghavvemi et al. (2017). The Cronbach’s alpha reliability coefficient in the initial validation study was .83, indicating good reliability. Items included statements such as “When I use YouTube, I lose track of time” and “Time goes by very quickly when I am using YouTube.”

All statements in the adapted scales were evaluated on a five-point Likert scale ranging from 1 (Totally Disagree) to 5 (Totally Agree), except for the Loneliness Scale, which was evaluated on a scale ranging from 1 (Never) to 5 (Always).

Sampling and Data Collection

This study aimed to test the effects of self-esteem and loneliness on FoMO, which leads to YouTube addiction in the first phase and online stickiness in the second phase. The target population of this research is Turkish adults who use YouTube. An online Turkish questionnaire was developed using a survey tool, and the link was posted on various social media platforms for sampling. The study was approved by ethics committee of Altınbaş University

on 25.04.2023 (register number: E-96136591-050.06.04-44095). And informed consent form was obtained from the participants for the study. The questionnaire was mainly divided into three sections: demographic profile questions (gender, marital status, education level, age and monthly income), YouTube usage behaviour of respondents (daily average time and number of videos watched on YouTube), and questions-statements related to the constructs in the research model. All participants voluntarily responded to the questionnaire, where a screening question was initially administered ("Do you watch YouTube videos?"). Those who answered this question positively were allowed to continue the survey, and a total of 1084 valid responses were collected during the period April 28 and May 11, 2023. Considering a 5% error margin and 95% confidence interval, the sample size exceeded the minimum sample size requirement.

Demographic Profile of the Sample

Table 1 presents the demographic profile of the sample. The mean age of the participants was 30.5 years with a standard deviation of 7.9 years, ranging between 18 and 70 years. A total of 54.7% of all participants (n=593) were in the 19-29 age group and 31.8% (n=345) were in the 30-39 age group; hence, the sample could be considered young. The majority of respondents were female (62.1%) and single (64.3%), and the sample was reported to be highly educated because most of them (83.8%) hold at least a Bachelor's degree. Most respondents (48%) had an income level around the minimum wage, which is parallel to Turkey's wage distribution. The sample's daily average time spent on YouTube varied; nevertheless, a majority of them (54.2%) indicated that they spend less than 1 hour on a daily basis, and 44.7% stated that they are watching 1 to 3 videos on average.

Table 1
Demographic Profile of the Sample

Variable	Category	Frequency	Percentage	Variable	Category	Frequency	Percentage
Gender	Female	673	62.1%	**Monthly Income**	<5000 TL	520	48.0%
	Male	409	37.7%		5001-10,000 TL	375	34.6%
	Rather not to say	2	0.2%		10,001-15,000 TL	105	9.7%
Marital Status	Married	387	35.7%		> 15,000 TLs	84	7.7%
	Single	697	64.3%				

Variable	Category	Frequency	Percentage	Variable	Category	Frequency	Percentage
Education	High school and less	90	8.3%	**Average number of videos on YouTube**	1	63	5.8%
	Vocational school	86	7.9%		1-3	485	44.7%
	Bachelor	612	56.5%		3-5	318	29.3%
	Master's	266	24.5%		5-8	114	10.5%
	PhD	30	2.8%		More than 8	104	9.6%
Age Group	19-29	593	54.7%	**Daily Average Time on YouTube**	Less than 1 h	588	54.2%
	30-39	345	31.8%		1-3 hours	372	34.3%
	40-49	110	10.1%		3-5 hours	88	8.1%
	50 and more	36	3.3%		5 h or more	36	3.3%

Findings

Validity and Reliability

Standard confirmatory factor analysis (CFA) procedures were performed using IBM SPSS Amos 26. The CFA results indicated an acceptable model fit ($\chi^2(224)=873.810$ $p<.001$; GFI=.936; AGFI=.915; CFI=.962; TLI=.953; RMSEA=.052). The assessment of the measurement model provided significant and sufficient convergent and discriminant validity and construct reliability. We followed Fornell-Larcker criterion for convergent and discriminant validity.

As stated in Table 2, the composite reliability (CR) of all constructs was greater than.75, indicating high reliability and evidence for convergent validity (Chin, 1998). The item factor loadings were all above .596, further confirming convergent validity (Bagozzi and Yi, 1988). Average variance extracted (AVE) scores exceeded the threshold of 0.50. Additionally, the constructs showed high internal consistency among the items with at least .75 Cronbach's alpha (α) score. The square roots of AVEs were greater than the correlation of constructs (see Table 3) and revealed an adequate level of discriminant validity (Fornell & Larcker, 1981).

Table 2
Validity and Reliability of Measures

Factors and Items	Factor Loadings
Self Esteem-Belief (α=.92; CR=.91; AVE=.67)	
At times, I think I am not good at all.	.923
On the whole, I am satisfied with myself.	.863
I feel that I am'm a person of worth, at least on an equal plane with others.	.746
I certainly feel useless at times.	.753
I am able to do things as well as most other people.	.791

Factors and Items	Factor Loadings
Online Stickiness (α =.92; CR=.92; AVE=.74)	
I would visit this website as often as I can.	.906
I intend to prolong my staying on this website.	.844
I would stay a longer time on the LINE than other applications.	.836
I intend to link to this website every time I am online.	.845
Self Esteem - Affective (α =.86; CR=.85; AVE=.53)	
I take a positive attitude toward myself.	.777
All in all, I am inclined to feel that I am a failure.	.763
I feel I do not have much to be proud of.	.751
I feel that I have a number of good qualities.	.749
I wish I could have more respect for myself.	.596
Loneliness (α =.81; CR=.76; AVE=.51)	
I feel left out.	.705
I feel isolated from others.	.673
I am unhappy being so withdrawn.	.759
FOMO-Social Experience (α =.75; CR=.75; AVE=.50)	
It bothers me when I miss an opportunity to meet up with friends.	.689
It is important that I understand my friends ‘‘in jokes’’.	.675
When I miss out on a planned get together it bothers me.	.752
FOMO-Rewarding Experience (α =.89; CR=.89; AVE=.81)	
I fear others have more rewarding experiences than me.	.888
I fear my friends have more rewarding experiences than me.	.908
YouTube Addiction (α =.94; CR=.94; AVE=.89)	
When I use YouTube, I lose track of time.	.937
Time goes by very quickly when I am using YouTube.	.949
GFI=*.936; **AGFI=****.915; **CFI=****.962; **TLI=****.953; **RMSEA=****.052; χ^2 (224)=873.810 p<.001*	

CR: Composite Reliability, AVE: Average Variance Extracted, GFI: Goodness of Fit, AGFI: Adjusted Goodness of Fit Index, CFI: Comparative Fit Index, TLI: Tucker-Lewis Index

In the preliminary analysis, Pearson correlations were also examined (see Table 3). Apart from loneliness, all the constructs were significantly associated with YouTube addiction and online stickiness, supporting previous studies. In particular, the association between YouTube addiction and online stickiness (r=.721) was found to be remarkably high.

Table 3
Correlations and Square Roots of AVEs

	1	2	3	4	5	6	7
1. Self Esteem – Belief	**.818**						
2. Online Stickiness	.086**	**.858**					
3. Self Esteem – Affective	-.138**	.073*	**.730**				
4. Loneliness	-.323**	.041	.441**	**.713**			
5. FoMo – Social Experience	.673**	.165**	.257**	-.128**	**.706**		
6. FoMo – Rewarding Experience	.072*	.170**	.429**	.169**	.372**	**.898**	
7. YouTube Addiction	.154**	.721**	.109**	.017	.230**	.118**	**.943**

*Note: Diagonal values are the square roots of the AVEs: ** p<.01 and * p<.05*

Assessment of the Structural Model

The second procedure is the assessment of the structural model; thus, path analysis was conducted. The structural model was found to fit the data ($\chi^2(176)=763.800$ p<.001; GFI=.936; AGFI=.916; CFI=.962; TLI=.955; RMSEA=.056), as all the fit indices obtained were satisfactory.

Table 4
Hypothesis Testing

Hypothesis and Related Paths	β	t	Std. β	Result
H_{1a}: Self Esteem – Belief →FoMo – Social Experience	.636	20.384**	.733	Supported
H_{1b}: Self Esteem – Belief → FoMo – Rewarding Experience	.134	4.783**	.149	Supported
H_{1c}: Self Esteem – Affective → FoMo – Social Experience	.421	11.135**	.376	Supported
H_{1d}: Self Esteem – Affective → FoMo – Rewarding Experience	.540	12.518**	.468	Supported
H_{2a}: Loneliness → FoMo – Social Experience	ns	-	ns	Not Supported
H_{2b}: Loneliness → FoMo – Rewarding Experience	ns	-	ns	Not Supported
H_{3a}: FoMo – Social Experience →YouTube Addiction	.302	6.912**	.241	Supported
H_{3b}: FoMo – Rewarding Experience → YouTube Addiction	ns	-	ns	Not Supported
H_4: YouTube Addiction → Online Stickiness	.648	25.069**	.720	Supported
GFI=.936; **AGFI**=.916; **CFI**=.962; **TLI**=.955; **RMSEA**=.056; χ^2 (176)=763.800 p<.001				

*** p<.001; * p<.01; **ns:** not significant.*

Table 4 and Figure 2 demonstrate the relationships of the paths, indicating that both self-esteem dimensions—belief and affective—had significant positive effects on FoMO dimensions—rewarding experience and social experience; thus, H_1 was fully supported. In detail, self-esteem-belief (β=.636, t=20.384, p<.001) and self-esteem-affective (β=.421, t=11.135, p<.001) had a significant effect on FoMO-social experience.

Furthermore, self-esteem-belief (β=.134, t=4.783, p<.001) and self-esteem-affective (β=.540, t=12.258, p<.001) had a significant effect on FoMO-rewarding experience.

Loneliness was found to have an insignificant effect on FoMO-social and FoMO-rewarding experiences; thus, H_2 was not supported. FoMO was found to be partially affecting YouTube addiction. FoMO-social experience (β=.302, t=6.912, p<.001) had a significant effect on Youtube addiction, whereas FoMO-rewarding experience had an insignificant effect, H_3 was partially supported. Finally, YouTube addiction (β=.648, t=25.069, p<.001) as independent variable, had a significant effect on online stickiness, implying that H_4 was also supported.

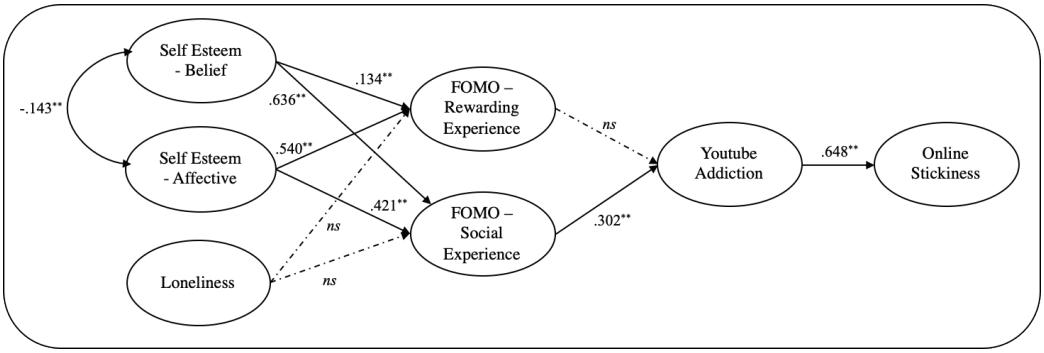

Figure 2. Path Model

Conclusion and Discussion

The purpose of this study was to examine the relationships between YouTube addiction, online stickiness, and FoMO concepts through their predictors of self-esteem and loneliness. Therefore, the effects of self-esteem and loneliness on FoMO are tested in the first phase. After studying the antecedents of FoMO, its effects on YouTube addiction is examined. Finally, the link between YouTube addiction and stickiness is reviewed.

The first finding of the study is the positive and significant effect of self-esteem (affective and belief) on FoMO. Previous studies have suggested that self-evaluations, either cognitive or emotional, are related to needs such as approval, acceptance, and validation, which directly affect the level of self-esteem. In this sense, correlations found between self-esteem belief, self-esteem affective, FoMO-rewarding experience, and FoMO-social experience are likely to suggest that those needs tend to be verified, addressed, and satisfied through friendships and social comparisons. In line with the developments on the internet and telecommunication technologies, a growing industry of social media applications is providing efficient and user-friendly tools that can be used for satisfying those motives. Hence, considering that a significant portion of relationships (not only personal but also professional ones as well) are started, lived, or ended online in our times, it can be argued that social media can be taken as a "preferred venue" in which communication and relatedness needs are satisfied in one way or another. On the other hand, social media applications are also claimed to enhance the natural human drive to seek information as well (Gazzaley & Rosen, 2016). To identify opportunities, avoid threads, understand what is going on, what others are doing, protect themselves from risks, decide their place in the social hierarchy, etc. people seek information constantly even though they cannot possibly process all the data out there (Whiting & Williams, 2013; Roberts et al., 2014; Abel et al., 2016). One other point of view that may contribute to the discussion is that, according to social comparison theory, individuals determine their own personal worth based on comparisons with others (Festinger, 1954). In other words, people

compare themselves with others and establish a sense of self-value according to the results (Abel et al., 2016). Social media is providing sufficient—even at an annoying level—accessible opportunities to obtain information about others that can be used for this purpose (Roberts & David, 2020). Easy access to technology and information encourages people to compare their lives with others, which generally adversely affects psychological well-being negatively (Tian et al., 2019). In line with the results of previous studies, considering the effects of connectedness and communication needs, the drive for assessing self-worth, and information collection as a basis for subjective self-esteem perception, it can be said that lower self-esteem and poor self-image is positively correlated with excessive use of social media (Hunt et al., 2018), creating concerns about disconnecting with others and not experiencing rewarding activities that others enjoy, hence inducing FoMO. This study's results show that, especially for those whose self-esteem is dependent on what others do or if others' experiences are more pleasant than theirs, the concept functions as a reinforcer for FoMO. In such cases, vulnerable or dependent self-esteem structures can be theorised. Current literature on self-esteem tends to focus mostly on the self-assessment and self-evaluation aspects of the concept. Results of this study offer a different perspective, suggesting a positive relationship between self-esteem and FoMO that may urge adoption of a new approach to explain the concept better. In light of the findings mentioned above, studies on high and low self-esteem and the relationship between FoMO can be suggested for further investigation.

Loneliness did not have a significant effect on both dimensions of FoMO. Although study results indicate correlations between loneliness and FoMO in line with the literature, no significant effect was found (Alt, 2015; Barry et al., 2017; Blackwell et al., 2017; Burke et al., 2010; De Cock et al., 2014; Song et al., 2014; Xu & Tan, 2012). Specifically, social experience is negatively correlated to loneliness, whereas rewarding experience is positively correlated to FoMO. Looking deeper into the questionnaire items, social experience represents staying up to date or being on the same page with friends; hence, the negative correlation found with FoMO is self-explanatory. On the other hand, rewarding experiences represent fear of others having better payoffs in terms of experiences, and loneliness is found to strengthen this feeling. Nevertheless, loneliness was not found to have a significant effect on both FoMO social and rewarding experiences. Considering previous findings suggesting that limiting social media engagement reduces loneliness and FoMO, it can be theorised that the relationship between constructs is reciprocal but not unilateral. Therefore, further studies are suggested to take loneliness as a complementary construct rather than an antecedent for the FoMO concept.

Another finding of this research is the significant effect of FoMO Social Experience on YouTube addiction. YouTube is fundamentally different from other platforms since the relationship between YouTubers and viewers is generally non-reciprocal. An interesting fact about engaging in social media is that to satisfy the need to belong, efforts do not need to be mutual.

In other words, even following or sharing without the other party doing the same thing seems to be enough to feel good and involved. This mechanism tends to create an unorthodox form of relationship called a "parasocial relationship" in which followers consume media about someone they do not actually know or meet before (Horton & Wohl, 1956; Dibble, Hartmann, & Rosaen, 2016). In an attempt to compensate for their lack of real relationships, individuals develop bond parasocial connections to satisfy their need to belong (Horton & Wohl, 1956; Hartmann, 2016). Considering that the human brain is flawed in terms of distinguishing between real friends and parasocial relationships, it can be argued that even one-way connections can be substitutes for real relationships to satisfy social needs (Kanazawa, 2002). In line with the literature, this study's findings indicate that FoMO social experiences induce YouTube addiction. In an aspect, it can be asserted that YouTube is providing a substitute for social relationships even if it is claimed as "parasocial" and from the other perspective, it can be said that online YouTube meetings satisfy social needs, and FoMO can be reduced by attending such gatherings. Another interesting finding is that although both social and rewarding experiences are positively correlated with FoMO, the latter does not have a significant effect on YouTube addiction. YouTube is reported to be more addictive for content creators than for viewers (Balakrishnan & Griffiths, 2017). Therefore, it can be asserted that regular users who are "just watching" are indifferent in terms of feeling rewarded simply because of the non-reciprocal nature of the application. On the other hand, since all the passively engaged users have the same experience, it is not possible to increase the individual payoff in terms of rewarding experiences due to the one-way nature of YouTube; thus, everyone has the same rewards, and no one is better than others. An important point is that the dataset of the study does not have a YouTube viewer–content creator distinction; therefore, it is not possible to conduct difference analyses. It can be suggested for future studies to differentiate the two groups to further enlighten the subject.

Finally, YouTube addiction was found to have not only a strong correlation but also a significant effect on online stickiness, as expected. Literature suggests that stickiness is a habitual behaviour (Wu et al., 2010) that is strengthened by various tangible and intangible benefits, such as ego gratification, identification, reputation building, sponsorships, and direct advertisement. This study asserts that self-esteem, FoMO, and YouTube addiction constructs affect online stickiness, which requires further research.

This study examined the relationships among self-esteem, loneliness, FoMO, YouTube addiction, and online stickiness concepts. Findings indicated positive effects of self-esteem on FoMO, but loneliness was not found to affect the construct. On the other hand, FoMO social experience has shown a positive effect on YouTube Addiction and YouTube addiction on online stickiness. The positive effect of self-esteem on FoMO is particularly interesting and requires further research, especially taking needs satisfaction, self-value, and vulnerable-dependent self-esteem concepts into consideration. Although correlations were found between

loneliness and FoMO, no direct effect was observed. Therefore, the relationship between loneliness and FoMO might present another fertile area for further research. Finally, studies on interactions between specific YouTube features and parasocial relationships may also contribute to the growing literature.

Limitations

This study is not without limitations. First, self-report measures are used to obtain the data. Use of different, more sensitive scales can be suggested to compare and contrast the results of this study. Second, although the sample size is adequate, using a different dataset with participants from different countries may increase the generalizability of the results as well as enable cross-cultural comparisons. Third, given this is a cross-sectional study, longitudinal research can help explore exploring the causal relationships between the concepts.

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RESEARCH ARTICLE

Model Proposal for Evaluation of Technology Development Process: Conceptualisation and Scale Development*

Fethi Aslan[1]

Abstract
Traditional approaches based on intuitive decisions of executivies, teams, or individuals often prove inadequate in managing complex technology development processes. Theoretical models proposed for successful technology development processes emphasize the necessity of standardized processes. However, empirical evidence regarding the applications and results of these models is limited. In this context, a model has been developed to examine how standardized technology development processes are implemented at the organizational level in companies. This model is defined by a scale that includes dimensions of technical research, business research, development, and performance. The proposed model is based on data obtained from companies with the highest R&D expenditure in Turkey. The findings provide evidence that a structured technology development process at the corporate level is necessary for success. It has been revealed that technical and business research phases are particularly determining factors in the development process. Additionally, it has been determined that the correct implementation of these processes has a positive impact on the performance of the process.

Keywords: Technology development, Standardised process, Exploratory factor analysis, Confirmatory factor analysis, Scale development

Introduction

As a result of globalisation, national businesses increasingly face competition from foreign businesses in distant regions of the world (Griner, Keegan, & Goldin, 2000, p. 19). Businesses are under pressure from the increasing complexity of customer demands and rapid changes in user experience, quality, performance and consumer attitudes. In addition, the intensity of competition and the pace of technological development are increasing businesses' challenges (Iansiti, 1995, p. 259).

New technologies can be applied to existing or new products, services and processes. These new technologies may change the conditions of competition and contribute to the

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emergence of new markets (UNFCCC, 2017, s. 6). Businesses have been looking for new solutions for a long time to gain competitive edge and adapt to changing conditions. Developing appropriate technologies to meet current needs and future trends is recognised as a key solution. Related to this solution, it is also necessary to shorten the technology development time and increase the success rate (Griner et al., 2000, p. 29). In this way, businesses can maintain their competitive advantage and increase their growth potential.

The technology development process encompasses all decisions, actions, and capabilities involved in defining activities from idea exploration (opportunities) to transitioning to production. Its goal is to develop new items, components, systems, products, methods, or to enhance existing products and processes. This involves preparing the correct information at the appropriate level of detail and systematically implementing. As stated in the definition, technology development is a complex process involving many activities. It requires long-term effort and is characterised by high uncertainty. This is why careful planning and a flexible management approach are so important. Uncovering the unknown is the source of uncertainty. Uncertainty and complexity increase enterprises' risk levels in the technology development process. A high risk level leads to the failure of technology development activities (UNFCCC, 2017, p. 6). One of the main reasons for these risks is that technology development activities are carried out without a standardised process. Although technology development activities can be successfully completed without a standardised process, achieving successful results depends on individual skills (Richrath, Plano, & Nesbitt, 2016, p. 1). However, to increase the chances of success in technology development activities, organisations need more than just individuals' skills. Therefore, organisations are focusing more on business strategies and processes (Catlin, Scanlan, & Willmott, 2015, p. 1).

A clear definition of the research focus is crucial for addressing the research gap and enhancing the potential to generate new knowledge. Furthermore, clarifying the research scope contributes to a better understanding of the study and enhances its credibility. To this end, a comprehensive review of the literature was undertaken to examine studies that emphasise the importance of the field and to identify topics that have not previously been addressed. The study conducted by (Branscomb & Auerswald, 2002, p. 16) revealed that there is a substantial body of research on strategy, management, organisational motivation and financial issues related to technology development activities. Nevertheless, it was observed that research on the technology development process is scarce and that the number of documented studies is relatively limited. According to Carbonell, Rodriguez Escudero, & Munuera Aleman (2004, p. 83), studies on measuring the success of new products using the stage-gate evaluation approach are insufficient. According to Stern (2008, p. 132), the technology development process is long term and its results cannot be fully predicted in advance. A long period is required between the initiation of technology development activities and the achievement of clear results and impact. Therefore, there is a need for clear and precise information on how

the technology development process takes place. A study conducted by PwC revealed that organic growth of organisations is more than twice as high as other growth models (mergers, acquisitions, etc.). Agreements such as mergers, acquisitions and partnerships is frequently to procure assets pertaining to research and development capabilities, intellectual property rights and products. Consequently, the utilisation of internal R&D activities is considered a pivotal factor in the growth models adopted by firms (Wobig, 2015, p. 1). Furthermore Richardson (2017, p. 3), stated that the lack of setting common priorities for the implementation of activities at the organisational level may make comprehensive decision-making and implementation difficult. The lack of an integrated decision-making and implementation mechanism hinders agility. It becomes difficult to make the right decisions to stop low-performing technology development activities and focus on high-performing activities. Finally, according to Kolossovski (2019), in the product development process, 4 out of every 7 product ideas are found valuable, 1.5 of them are attempted and only 1 of them is successful. This situation is important in demonstrating difficulties in development and commercialisation phases of product development process.

Furthermore, studies on research and development, product and innovation management, which are either directly or indirectly related to technology development, have been analysed within a broad conceptual framework. Carbonell et al. (2004), examined the relationship between the various dimensions of fit/unfit criteria and new product success throughout the product development process in 957 firms in the mechanical equipment, computer equipment, electrical machinery, electronic equipment, measuring instruments and motor vehicles and other transport equipment industries in Spain. The study involved 77 firms and found that the relative impact of the five dimensions of fit/unfit criteria on new product success variedvaries depending on the stage of the development process and technological innovation. Song & Montoya-Weiss (2001), developed a theoretical model in their study to examine the regulatory effect of perceived technological uncertainty on the new product development process. Günday (2007), examined the influence of firm structure, firm characteristics, firm strategy, sectoral conditions, and relationship factors on innovativeness. In the second stage of the study, the effect of innovation on firm performance was analysed.

The study presents evidence based on survey data obtained from 169 firms. The evidence indicates that innovation determinants exert a significant positive effect on the firm's innovative ability. Furthermore, innovativeness is an effective factor in both production and innovation performance. Ernst, Hoyer, & Rübsaamen (2010), investigated the effects of cross-functional collaboration between sales, marketing and R&D on the new product development process and performance in a new product development project in the highest-income enterprises in Germany. The findings of this study indicate that collaboration between sales and R&D is crucial for new product success, particularly during the concept and product development stages. Tekin (2016), investigated the impact of innovation knowledge and in-

novation management on innovation capabilities and new product success in 10 firms within the Turkish white goods sector. The findings indicated that innovation capability significantly influences product success. Guimaraes, Paranjape, & Walton (2019), examined the impact of organisational culture, competitive intelligence, technology management, innovation project management, and absorptive capacity on new product development success. According to their findings, factors other than strategic leadership significantly influence the success of new product development. Meier & Kock (2022), examined the impact of agility in the organisation of research and development (R&D) units within an industrial firm operating globally in the field of mechanical engineering across more than 80 countries. In this context, they developed a six-dimensional scale, including agility culture, customer integration, autonomy, an iterative work method, cross-functional capabilities, and a horizontal hierarchy. The developed scale demonstrated a direct correlation between agility in R&D organisation and front-end success.

A comprehensive review of the existing literature provided valuable insights into gaps in the literature. This analysis has also helped us identify specific areas where our current research can make meaningful contributions. The reviewed existing studies provide a summary of the various factors and methodologies related to technology development, innovation product development processes in different industries and contexts. These studies deepen existing knowledge about technology development, innovation and product development processes, while also highlighting areas for further unexplored research. Previous studies have typically examined the technology development process as part of innovation and product development processes. However, as Kolossovski (2019) also highlighted, the probability of success decreases rapidly as the process progresses. The evaluation of innovation or product development process alone does not provide sufficient information about the technology development process. Therefore, it is necessary to place greater emphasis on the deepening of the technology and innovation literature, with a focus on the entire process from idea generation to the transition from technology to product/production. In previous studies, industries with different levels of technology (e.g., mechanical, computer equipment, electrical machinery, biotechnology, chemicals, and pharmaceutical industries) were examined separately. There is a need for evidence on the applicability of a comprehensive model that encompasses the practices related to technology development processes in industries with high, medium-high, medium-low, and low levels of technology. Finally, previous studies have generally focused on performance factors related to market and financial success. There is a need for evidence on process performance factors, including technical success, timing, and budgeting to determine whether the process has been successfully implemented.

In this context, a three-stage approach was used to determine the scope of the research. The first of these, as shown in Figure 1, is the internal R&D activities among the technology acquisition and development methods.

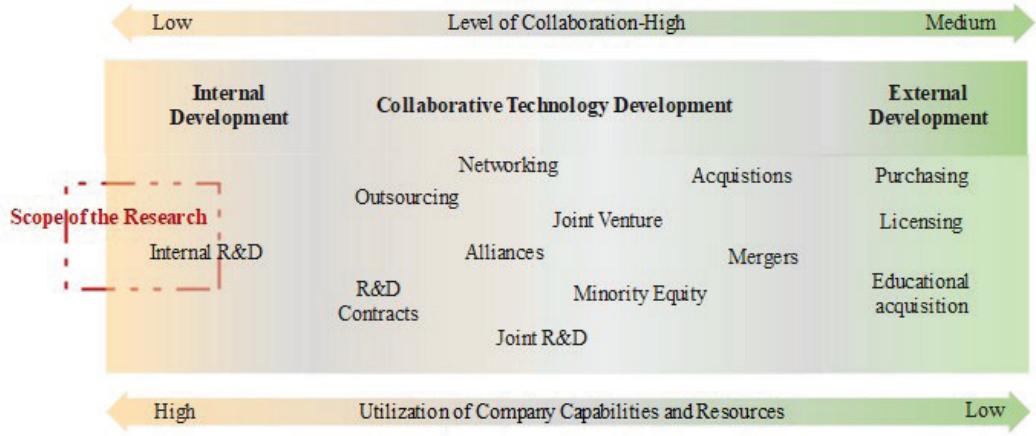

Figure 1. The Technology Acquisition Model

(Adapted from the studies of Chiesa, Frattini, Lazzarotti, & Manzini, 2009; Gallardo, 2013)

The second stage in determining the scope of the research is related to defining the evaluation process. Technology development projects/programmes are a process that involves inputs, activities, outputs, outcomes and impacts. The evaluation was conducted within the framework of a methodology that considered the factors shown in Figure 2. Therefore, the scope of the research was conducted within the framework of a methodology that considers the evaluation factors shown in Figure 2. The inputs provide information about the firm's characteristics. Activities refer to actions intended to obtain desired outputs by utilising resources. The immediate and tangible outcomes generated by activities must be measured for long-term results and impacts to achieve lasting benefits (Griffin, 1993, p. 115). In the evaluation approach, the relationship between inputs and outputs is expressed as efficiency the relationship between objectives and outcomes is expressed as effectiveness, and the relationship between needs and impact is expressed as benefit and sustainability. Different purposes can be associated with evaluation (Arnold, Åström, Glass, & Scalzi, 2018, p. 15). The purpose of this study was to determine the level of goal achievement depending on the implementation level of the activities.

The final stage in determining the scope of the research is related to the level at which the evaluation will be conducted. "*Organisational level focuses on organisational structures, processes, resources, and management issues"* (Bolger, 2000, p. 4) . At the organisational level Figure 3, evaluation addresses the overall performance factors and capabilities of the organisation in fulfilling its tasks. These factors refer to internal regulations, processes, and

plans that determine how individuals' abilities should be utilised and directed (United Nations Development Programme, 2008, pp. 6–7). Assessing capacity at the organisational level addresses issues at the organisational level. However, it also influences and is directly influenced by individual-level as well as sectoral and environmental interactions (Bolger, 2000, p. 4).

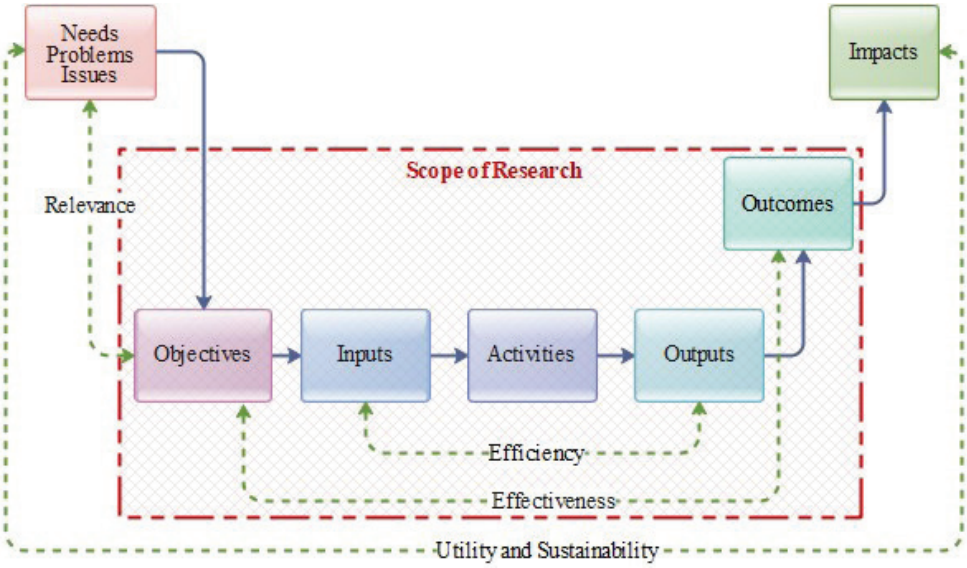

Figure 2. Theory of Evaluation (Change) (Arnold et al., 2018)

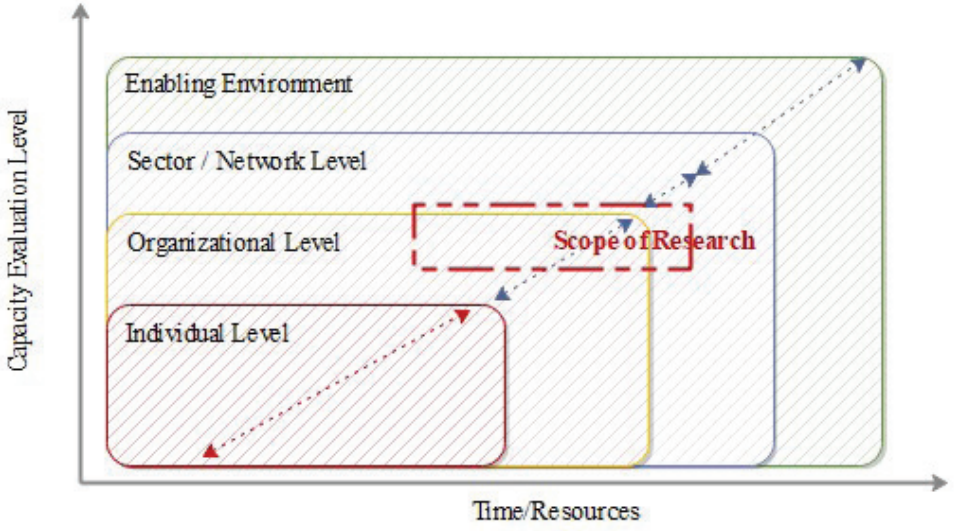

Figure 3. Capacity Development: Conceptual Framework (Bolger, 2000)

Considering the scope of the study and the methodology employed, it is inevitable that there will be some limitations. The first is that this study focuses solely on internal technology development activities within the firm. Therefore, the proposed model does not provide evidence of its suitability for technology acquisition from external sources and technology development processes through collaboration. In addition, it presents information regarding outputs and outcomes achieved through inputs and activities. Finally, despite considering privacy principles related to the obtained data, research outcomes may not fully reflect the actual situation because of participant bias.

The aim of this study is to develop an evaluation model for measuring the standard process and performance of technology development activities, which will serve as a reference for conducting such activities. The model is characterised by a structure consisting of four dimensions: technical research, commercial research and performance. If the proposed model is successfully implemented, all personnel involved in the process will perform their activities based on predictable and evidence-based decisions. Once the proposed model is fully implemented, resources are efficiently used, ensuring minimal deviations in cost, time, and technical requirements. As a result, the success rate increased.

In line with this objective, the study relies on evidence from managers and experts working in research and development, technology development and innovation in the top 500 businesses with the highest R&D expenditures in Türkiye.

Method

This study was conducted in accordance with the positivist paradigm. The phenomena examined in this research were approached objectively in the context of causal relationships, in accordance with the conceptual framework. In this context, a quantitative methodology was employed in the study to examine phenomena objectively within the framework of causal relationships. The study has both exploratory and descriptive aspects. The data in this study were collected using the survey method.

Verbal informed consent was obtained from all participants before the study and the ethics committee approval of this study was obtained from Ethics Committee for Social and Human Sciences Research at Fırat University. (Date: 14.11.2019; Number: 5).

In this study, the use of quantitative methods aims to:

1. Enable the generalisation of findings to the population by measuring the implementation level and frequency of a formal and structured technology development process in the selected sample.

2. Provide evidence to identify and justify fundamental relationships between variables.

3. Ensure obtaining objective results through statistical tests (Sun, 2012, p. 7; Walwyn & Chan, 2019, p. 14)

Factor and Item Acquisition Processes

Technology development processes consist of a series of activities that occur from the idea stage to the market launch stage (Pleschak, 1997, p. 11). Technology development processes involve defining each stage and organisational structure, standardising activities accordingly (Möller, Menninger, & Rober, 2011, p. 6). The fundamental idea of technology development process is to ensure that businesses allocate their limited resources to the right projects, thereby minimising technology development costs, development time and deviations in technical performance requirements. By following these processes, businesses develop solutions to the challenges they encounter and achieve success. Although each business may have unique processes and activities, these processes and activities often do not take place within a universally accepted framework (Pleschak, 1997, p. 11). Technology development processes are designed in different ways but with the same purpose in mind. The existence of various approaches creates uncertainty for implementers in selecting the appropriate approach (Ajamian & Koen, 2002). Technology can be aimed at meeting an existing need; however, it can also result from entirely new ideas that can create novel requirements (Stern, 2008, p. 11). The purpose of business processes is to ensure that tasks performed at the organisational level are performed in a systematic manner, in a sequence of consecutive steps, and following a specific methodology (Dumas, La Rosa, Mendling, & Reijers, 2018, p. 9).

In businesses with a well-organised structure, an integral part of a process and are executed in a suitable manner according to this process. It should be noted that this process is a comprehensive set of activities that enable businesses to transform inputs through various stages into outputs to achieve their objectives (Çetindamar, Phaal, & Probert, 2016, p. 2).

A standard process ensures clarity and consistency regarding where, how, and when each stage and activity constitutes a business process in a business will be executed. In organisations with structured processes, even if the same task is assumed by different individuals over time, it is expected that these tasks will be performed in the same manner (Robbins, & Barnwell, 2006, p. 111). Activities in a standard technology development process serve as guiding principles to support effective and efficient technology development efforts. This process focuses on best rather than mandatory rules (United States Department Of Energy, 2007, p. 4). The objective is to identify and synchronize what needs to be done at different stages of the process and by different working groups to align with common goals. However, a standard technology development process does not contain information about how it should be

implemented and by whom, as it lacks an implementation plan feature (Doerry, 2010, p. 22) .

However, a standard technology development process does not contain information about how it should be implemented or by whom, as it lacks an implementation plan feature.

The scale development process was conducted in four stages. In the first stage, potential scale items and factors were determined by utilizing activities and stages obtained from normative technology development models. In the second stage, the scope validity of the scale was tested, and in the final stage, empirical evaluations were conducted.

Establishing a conceptual foundation is crucial to the scale development process. The conceptual foundation guides the researcher on what should be included in the developed model. Additionally, it defines the boundaries of the model, allowing the researcher to focus and reduce ambiguity in scope (Carpenter, 2018, p. 13). In the process of scale item generation, either inductive or deductive methods or a combination of both, can be applied. In the deductive method, items are created by scanning relevant literature and existing scales in the field. On the other hand, in the inductive method, items are generated based on information and qualitative data obtained through focus groups and individual interviews (Boateng, Neilands, Frongillo, Melgar-Quiñonez, & Young, 2018, p. 1).

In this study, the deductive method was used during the item development phase. For this purpose, 32 normative models widely accepted in the literature were analyzed. The selected normative models comprise both academically based models and models applied in the public and different industries. The activities and stages included in these normative models were classified by thematic analysis method. Normative models consist of different numbers of stages and activities depending on the level of detail. The identified common themes form a potential scale item pool. During the creation of the item pool, all normative models were examined, and a comprehensive approach that considered the activities agreed upon in the current studies was adopted. Additionally, to measure the performance of the process, relevant items (pertaining to performance) were obtained by referring to the literature.

Table 1
*Thematic Analysis of Normative Model Items**

Factors	Items	References
Business Research	Market Potential	(Schulz, Clausing, Fricke, & Negele, 2000), (Loutfy & Belkhir, 2001), (Cooper, 2006), (Kausch, 2007), (Canez, Puig, Quintero, & Garfias, 2007), (Gaubinger & Rabl, 2014)
Technical Research	Technology Development Capability	(Myers & Marquis, 1969), (Schulz et al., 2000), (Loutfy & Belkhir, 2001), (Ajamian & Koen, 2002), (Cooper, 2006), (Lind, 2006), (Whitney, 2007), (Crill & Siegler, 2017), (Kausch, 2007), (Gaubinger & Rabl, 2014),

Factors	Items	References
Development	Protection of Technology	(Canez et al., 2007), (Myers & Marquis, 1969), (Office of Technology Assessment (OTA), 1982), (United States Government Accountability Office (GAO), 2006), (Cooper, 2006), (Kausch, 2007), (Miller, Bustamante, Roesch, Boshell, & Ayuso, 2015)
Performance	Compliance of Technical Success with Budget and Time Schedules (Earned Value Approach)	(Moser, 1985), (Chiesa et al., 2009), (Association for Project Management, 2013)

* Partial analysis results have been included

The number of factors was determined considering the number of stages in the normative models, which are partially presented in Table 2. The existing technology development models were created with 2 to 7 stages. In most models, a 4-stage structure was predominantly used.

Table 2
*Stages of Normative Technology Development Process**

Stages	Number of Stages	References
1-Idea Generation, 2-Project Planning, 3-Technology Concept, 4-Technology Development	4	(Gaubinger & Rabl, 2014)
1-Invention, 2-Project Scope, 3-Technology Concept Development, 4-Technology Development, 5-Technology Optimization, 6-Technology Transfer	6	(Caetano, Araujo, Amaral, & Guerrini, 2011)
1-Explore, 2-Development, 3-Technology Transition	4	(United States Government Accountability Office, 2006)
1-Basic Research, 2-Applied Research, 3-Development	3	(Bronzino, 1992)
1-Target İdentification, 2-Lead Discovery 3-Preclinical Trial 4- Clinical Trial 5-Approval	5	(Romasanta, Van der Sijde, & Van Muijlwijk-Koezen, 2020)

* Partial analysis results have been included

After identifying the stages and activities, scale items and factors were derived within the context of the model using an interpretive approach. To establish a clear, comprehensible, and consistent conceptual framework for the intended construct to be measured, it is necessary to define each factor of the scale. For this purpose, descriptions of technical and commercial research, development, and performance factors have been provided.

New technology development is a discovery process involving technical and business research activities that require a search for new knowledge. This situation arises from the presence of broad objectives and significant uncertainties at this stage (Sheasley, 1999, p. 52). In these stages, even simple changes in assumptions can lead to significant financial and technical risks. Allocating business resources to a technology initiative may result in neglecting other initiatives (Day, 2008, p. 52). A successful research phase can prevent interruptions and the emergence of conceptual and outcome changes within the process (Harmancioglu,

McNally, Calantone, & Durmusoglu, 2007, p. 422). The technical and business research factor, which examines technology, markets, and financial matters, represents the initial stages of the technology development process. It is designed to define the stages consisting of exploratory activities. These two factors consist of activities from generating technology ideas to determining the characteristics of technology, including conceptual development stage. Activities that involve in-depth examination and analysis related to the market, competition, and customers. The technical research factor consists of activities that analyse the feasibility of technology ideas, such as its suitability, feasibility, implementation possibilities, intellectual property status, and firm capabilities. Effective research activities assist in early termination of unpromising and unfeasible ventures.

The development phase defines activities aimed at practical advancement of technology. Activities during this stage are based on information obtained during the technical and business research stages. The technology requirements, working principles, and physical characteristics are defined. Additionally, the feasibility of the technology is demonstrated through laboratory and real-world application environments, and outputs that can be subject to intellectual property rights are generated. These activities also encompass processes related to the transition of the technology to the final product/production stage.

The final factor in the model is related to measuring the performance of the process. Performance refers to measuring how successful a task is being executed. The process includes decision-making, planning, problem-solving, monitoring interactions and evaluation activities. If the process is carried out successfully, the business shows good performance and becomes successful (Lusthaus, Adrien, Anderson, Carden, & Montalván, 2002, p. 76). The aim of this factor is to assess the business's success and performance during the technology development process. Objective measurements are necessary to ensure the success of the technology development process and the accuracy of decisions. Accurate analyses can be conducted using proper measurements. These accurate analyses by providing a foundation for sound decisions, facilitate the achievement of objectives (Milbergs & Vonortas, 2006, p. 2). At the organisational level, measuring performance can be conducted to encompass one or more criteria, such as effectiveness, efficiency, compliance, and financial feasibility (Lusthaus et al., 2002, p. 76). In this study, the identified performance factor was derived from criteria related to measuring operational outcomes. These criteria include technical performance (product's technical functionality and quality), development cost, and development time. The success of the process is evaluated based on meeting all these criteria at the highest level (Tatikonda & Rosenthal, 2000, pp. 76–77).

Research Population and Sample

The aim of this study is to examine the technology development process at the firm level. Therefore, implementing the sample in businesses where technology is developed will ensure

line with the research purpose. For this purpose, the universe of research is constituted by the top 500 businesses in Türkiye that made the highest R&D expenditures in 2020. The R&D 500 firm list is based on the R&D data declared by the top 500 businesses in Türkiye in terms of export ranking, businesses disclosing R&D data on the Public Disclosure Platform, and businesses approved by the Ministry of Industry and Technology of the Republic of Türkiye as R&D centres. However, some businesses' names were not disclosed, yet they were included in the ranking, resulting in a total of 472 businesses comprising the research universe (Turkishtime, 2021, p. 26). The research employed the scale development methodology. Expert opinions were sought for content validity. The survey method was utilized for exploratory and confirmatory factor analyses. Survey data were collected through Google Forms during the period from November 2021 to May 2022, based on the responses of R&D, innovation, technology unit managers, and experts. During this period, data were collected from the same research population in two stages at different time points. The data collected in the first stage were intended for exploratory factor analysis, while the data from the second stage were gathered for confirmatory factor analysis. Analyzing issues such as missing data, outlier values, and multicollinearity was conducted. In total, 625 responses were used in the study. The distribution of responses was examined based on the classification established by the OECD in 2001 according to R&D intensities. Accordingly, 180 respondents (28.80%) were from the high-tech industry, 284 (45.4%) from the medium-high-tech industry, 94 (15.04%) from the medium-low-tech industry and 67 (10.72%) from the low-tech industry.

Findings

Based on the information obtained from Tables 1 and 2, a final structure consisting of 26 items and 4 factors was established. To assess the scope validity of this structure, support was sought from an evaluation group consisting of 8 experts. The structure was evaluated by an expert group comprising 2 experts in scale development, 4 experts working in the industry, and at least 2 academics who have received national or international project support. The number of questions in the initial survey form was excessive and included repetitive structures. Following the final evaluation, questions were removed from the survey that were deemed to have low clarity, terms that did not accurately define the expression, statements creating uncertainty that would prevent participants from understanding correctly, and questions that were deemed not to directly contribute to the main objectives of the survey. The Lawshe technique was applied to measure the validity of expert judgments. As a result of the expert panel evaluation, a content validity value of 0.75 was measured.

A good empirical study should have two main characteristics. These are the design of the researched model and the selection of relevant target groups approved by the participants. Kaiser-Meyer-Olkin (KMO) is a measure of sampling adequacy used in factor analysis. After the analysis, the KMO value was determined to be 0.909. Since this value is above 0.6, it can be stated that the data is sufficient for factor analysis, providing a solid basis for conducting

the analysis. The obtained value indicates that the suitability of the variables with the sample is excellent. The Bartlett's sphericity test was conducted, and the result was found to be significant with a p-value of 0.000 ($p < 0.05$), indicating that the assumption of sphericity has been met. This finding indicates that there is a significant correlation among the variables. Furthermore, the variables themselves show a certain level of correlation. They also exhibit high levels of correlation with other variables. Thus, the suitability of the obtained data for factor analysis was observed (Hair, Black, Babin, & Anderson, 2019, p. 136).

In the initial stage of scale development, a literature review and content validity assessment led to the decision to select a 4-factor structure. In determining the optimal number of factors, an approach that considered factor determination techniques along with a review of relevant literature was employed. In addition to the mentioned approaches, (Carpenter, 2018, p. 37) has suggested examining 2-factor and 6-factor structures when 3, 4, or 5 factor structures are obtained. This recommendation implies that, even if the initial 3, 4, or 5-factor structures seem reasonable, exploring alternative factor solutions can potentially identify a better factor structure. As a result of the statistical analysis, a 4-factor structure was obtained. The obtained structure was evaluated for 2 to 6 factors, and it was decided that the most suitable factor number is a 4-factor structure. Consequently, a structure consisting of 4 factors and 20 items was obtained.

Table 3
Multicollinearity Analysis

Factors	**Tolerance Value**	**Variance Inflation Factor**
Business Research	,463	2,159
Technical Research	,394	2,540
Development	,429	2,328

Dependent Variable: Performans

To determine whether the results obtained from exploratory factor analysis are sample-specific or generalizable to the population, confirmatory factor analysis was conducted in the second stage for cross-validation using the data obtained. During the confirmatory factor analysis stage, multiple collinearity analyses, validity-reliability tests, goodness of fit, and findings regarding the final structure of the model were obtained. When the VIF value is less than 5 and the tolerance value is greater than 0.2, multicollinearity problem does not occur (O'brien, 2007, p. 685). The analysis results for the presence of multicollinearity using VIF (variance inflation factor) and tolerance values are presented in Table 3. It was observed that the tolerance and VIF values are in accordance with the threshold values, which indicates that there is no multicollinearity problem.

To ensure discriminant validity, heterotrait-monotrait (HTMT) value should be below the strict threshold of 0.85 and the acceptable threshold of 0.90 or 1.00 (Gaskin, Godfrey, & Vance, 2018, p. 10). As seen in Table 4, values related to the model are below the acceptable threshold, indicating that discriminant validity has been achieved.

Table 4
Heterotrait-Monotrait (HTMT) analysis

Factors	Business Research	Technical Research	Development	Performance
Business Research	1			
Technical Research	,887			
Development	,850	,903		
Performance	,702	,778	,798	1

To establish convergent validity, it is sufficient for the average variance extracted (AVE) value to be greater than 0.5. However, even if the AVE value is less than 0.5, convergent validity can still be achieved if the composite reliability (CR) value is greater than 0.6 (Safiih & Azreen, 2016, p. 43). Accordingly, within the scope of convergent validity, the AVE and CR values were calculated for each factor, as presented in Table 5. Comparing the calculated AVE and CR values with the threshold values, it is concluded that the structure shows convergent validity.

Table 5
Validity and Reliability Results

Factors	AVE	CR	Cronbach's Alpha
Business Research	,491	,852	,825
Technical Research	,651	,848	,812
Factors	**AVE**	**CR**	**Cronbach's Alpha**
Development	,517	,882	,841
Performance	,719	,911	,817

To determine the reliability level, both composite reliability and Cronbach's alpha values were examined. In structural equation modelling, composite reliability is preferred over Cronbach's alpha for assessing reliability. In this case, for reliability, the Cronbach's alpha value should be at least 0.7, and the composite reliability should be above 0.6 (Hair et al., 2019, p. 768). As shown in Table 5, both the composite reliability value and Cronbach's alpha value are above the specified threshold, indicating that reliability has been achieved for the entire structure. This suggests that the data used in the analysis are reliable and consistent and provide a strong foundation for the interpretation and conclusions of the study.

The model fit indices are used to assess the level of fit between the model and the data used (DiStefano & Hess, 2005, p. 227). The model fit indices are presented in Table 6. As seen in the table, the fit index values of the model fall within the range of reference values, indicating that the model fits the data appropriately.

Table 6
Model Fit Indices

Model Fit indices	Obtained Value	Recommended Value
Chi-square Test ($\chi^{2/sd}$))	2,983	$1 < \chi^{2/sd} < 3$
Root Mean Square Error of Approximation (RMSEA)	0.07	RMSEA < 0.08

Model Fit indices	Obtained Value	Recommended Value
Standardised Root Mean Square Residual (SRMR)	0.026	0.00≤SRMR≤0.10
Goodness-of-Fit Index (GFI)	0.903	0.90≤GFI≤1.00
Adjusted Goodness-of-Fit (AGFI)	0.857	0.85≤AGFI≤1.00
Normed Fit Index (NFI)	0.901	0.90≤NFI≤1.00
Comparative Fit Index (CFI)	0.932	0.90≤CFI≤0.97

A model consisting of technical research, business research, development, and performance factors was obtained. The process components of the model are formed by technical research, business research, and development factors, and these factors play a determinant role in the performance factor, which is the outcome component. The structural representation of the model is shown in Figure 4.

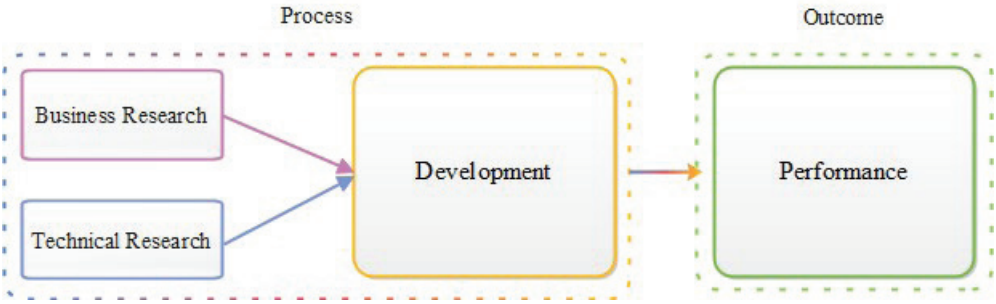

Figure 4. *Conceptual Model of Scale*

The factor loadings obtained for each item through exploratory (EFA) and confirmatory factor analysis (CFA) are provided in Table 7.

Table 7
Item Loadings in EFA and CEFA

Factor	Items	EFA	CFA
Business Research	The current state of the market is evaluated.	,77	,82
	The market potential is evaluated.	,77	,83
	The competitive situation is evaluated.	,80	,77
Technical Research	The level of openness to newness and improvement of the technology idea is evaluated.	,66	,64
	The suitability of the technology idea to scientific and technical approaches is evaluated.	,71	,68
	The restrictions imposed by existing patents on the development of the new technology are evaluated.	,66	,70
	The organization's technology development capabilities are evaluated.	,70	,73
	The application area and potential beneficiaries of the technology are evaluated.	,63	,72
	The intellectual property protection level for the technology is evaluated.	,76	,73

Factor	Items	EFA	CFA
Development	The technology is tested experimentally inin a laboratory environment for technical, performance, and functionality aspects.	,76	,68
	The technology is tested for technical performance and functionality in a real-world application environment.	,74	,73
	Responsible teams are formed to transition from technology to product development/ production.	,68	,74
	The maturity level of the technology is evaluated for its transition to the product stagep-roduction.	,65	,80
	Tests are conducted with potential beneficiaries (end-users), and feedback is collected.	,63	,65
	Evaluations regarding scaling up are carried out.	.64	.76
	Activities are carried out for the intellectual property protection of the technology.	.66	.66
Performance	The level of completed work in technology development projects is aligned with the timeline.	,86	,84
	The cost of completed work in technology development projects aligns with the planned budget.	,79	,87
	In technology development projects, technical performance aligns with the prediction.	,70	,85
	In technology development projects, technical success aligns with the budget and sche-dule.	,85	,83

Results and Discussion

This study focuses on the characteristics of standard technology development processes. This section defines the standard technology development process, determine the level of its implementation, and assess its impact on process performance. The proposed model evaluates the implementation of necessary activities for standard technology development processes, their level of implementation, and their impact on process performance. This study is built upon the assumption that the top 500 businesses in Türkiye, which spend the most on R&D, have implemented a standard technology development process in some way and that this implemented process has made a positive contribution to process performance. Technology development is a long-term and complex process, consisting of numerous critical decisions and activities. However, previous research has predominantly focused on the ideation phase, organisational attitudes, behaviours, culture and leadership. An approach explaining the relationship between process implementation and performance, and how process performance should be measured, has not been developed. Alongside obtaining results regarding whether the standard technology development process works or not, the study has also provided answers to the questions of why and how. The impact of the technology development process on operational activities and their operational outcomes has been analyzed, and the standard technology development process has been conceptualised and supported using empirical results.

The development of new technology is a discovery process involving technical and commercial research activities that require new knowledge. A successful research phase can pre-

vent interruptions and changes in concepts and outcomes during the process (Harmancioglu et al., 2007, p. 422). There are strong connections between marketing research and both engineering skills and R&D, which affect product outcomes (Sun, 2012, p. 7). Market, business opportunities, and competitive conditions play an important role in facilitating technology management (Sweeney, 1990, p. 9). Market-oriented behaviours facilitate strategy implementation and have a positive impact on performance (Dobni & Luffman, 2003, p. 583). Our findings, which are in line with this perspective, provide evidence supporting the necessity of incorporating factors associated with technical and business research into the technology development process.

The accuracy and reliability of early-stage (research) information shape subsequent technical stages (Frishammar, 2005, p. 16). The process is completed successfully when the required criteria are met at each stage. A process that is successfully completed shows good performance and achieves success (Lusthaus et al., 2002, p. 76). Decisions regarding product content and project scope have strategic importance due to their impacts on project performance. There is a relationship between decisions regarding the scope of the product to be developed, and project scope, and project performance. The transition between fundamental and applied research and product development processes is particularly important. Activities related to the selection, development, and transition of technology have a significant impact on product development performance (Iansiti, 1995, p. 260). The findings of this study support the information presented in previous studies. The evidence obtained from this study shows that the research stage impacts the development stage. Additionally, in the technology development process, the stages of technical research and development play a decisive role in performance. However, it is not possible to mention that business research has an impact on performance. Adequate implementation of activities related to the business and technical research stages leads to a positive impact on the development stage. This situation also contributes to the technology development initiative to achieve the desired level of success from an operational perspective.

From the perspective of the literature, specialisation in technology development processes is important due to the field's ongoing significance and potential to play an even greater role. In this regard, the study will also make a significant contribution to the expansion of the technology development process and its related literature. Moreover, it possesses comprehensive features by examining thirty-two normative models that directly reference technology development and technological innovation, which serve as the basis for the proposed model. Another important finding of this study is the evidence that technology development initiatives can be evaluated in the context of operational activities, and their performance can be measured.

From a practical perspective, the evidence obtained suggests that businesses should adopt a standard technology development process. The developed model will benefit technology

development initiatives conducted by businesses at both national and international levels, across different industries, and of various sizes. Successful completion of the technology development process provides information about the challenges encountered throughout the process. The results obtained from the full implementation of the proposed model will help address the gaps related to the reasons for shortcomings in technology development processes by comparing them with previous practises. In this way, the proposed model can contribute to improving processes by learning from past applications.

In conclusion, structured processes are essential for businesses to shorten the technology development cycle, increase success rates, foster collaboration, and promote knowledge sharing while ensuring proper allocation of resources. By identifying and implementing these structured processes, more successful outcomes can be achieved. However, even if businesses have all the necessary capabilities, achieving perfect implementation of the process may not be possible.

Further Work

Challenges in technology development processes persist. The primary focus of process improvement is the decisions made and the extent to which employees can implement them. Researchers should always consider these factors. Each stage from idea generation to process performance measurement should be approached using different innovative approaches. Performance requirements, especially concerning technology development processes, should be examined using different factors and criteria. Even if a good process exists throughout the organisation, the impact of the relationship between team flexibility and empowerment required (Krishnan, 2013, p. 144) by team members, which is inherent in the nature of technology development, and the role of the leadership approach should be examined in the process.

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RESEARCH ARTICLE

Dynamics of Digital Financial Inclusion in Türkiye

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Abstract
This study examined the dynamics of different levels of digital financial inclusion (DFI) in Türkiye within the framework of individuals' basic financial behaviours and socioeconomic conditions and investigated factors that may affect the utilisation rate of DFI. Accordingly, findings from the 2017–2021 World Bank Global Findex dataset were estimated using the ordered logit model. The concept of DFI, which is becoming increasingly important, underscores that financial systems should have two basic conditions. First, the ability of those who can access financial systems digitally should be as high as possible. Second, these actors with access to financial systems should also have sufficient utilisation rates of the relevant financial instruments. In this respect, by focusing on the determinants of this second condition, the study fills a gap in the literature and provides clues for policy recommendations. These findings provide empirical evidence for our motivation. In this respect, the results clearly show that socioeconomic factors, such as education level and income level, as well as financial behaviours, such as formal savings and borrowing, should be taken into account when expanding DFI.

Keywords: Digital financial inclusion, Financial behaviours, Socioeconomic factors, Ordered logit, Global findex

Introduction

Financial inclusion is a multidimensional concept that affects the accessibility and availability of financial products and services (Ahmad et al., 2021).This concept explicitly refers to a high proportion of both those who have access to the financial system and those who use the services offered by this financial system (WB, 2014; Demirgüç-Kunt et al., 2017; WB, 2019). Building on the same basic structure, digital financial inclusion (DFI) refers to financial systems in which a high proportion of individuals access and use financial services digitally (Lyman & Lauer, 2015). Thus, ever-evolving technologies can create opportunities for those excluded from the financial system and those with limited access (Niu et al., 2022) and help individuals make choices that promote financial stability (Ozili, 2018).

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Over time, innovations in digital technologies play an essential role in increasing the slow penetration of financial inclusion (Tiwari et al., 2019) and in developing and transforming digital financial markets (Heckel and Waldenberger, 2022). With such innovation, digitised financial inclusion can provide financial services to a wide range of households (Akanfe et al., 2020) and increase their likelihood of participating in the financial market (Liao & Zhou 2020; Shen et al., 2022; Zhou & He 2020).DFI is central to reducing economic and social negatives, especially during times of crisis, such as during the current COVID-19 pandemic. Increasing financial access in different segments of society can also contribute to financial repair (Tay et al., 2022).DFI can improve the width and depth of financial services, decrease service costs, and reach more populations (Chen et al., 2022). Apart from all of its benefits, the significant increase in loan supply and recent household debt with digital loan platforms, due to the widespread use of DFI, has drawn the attention of researchers (Feng et al., 2019; Chen et al., 2020; Yue et al., 2022). Studies in this direction have shown that DFI encourages more households to borrow through formal channels (Li et al., 2022; Yue et al., 2022).

Examining the definitions and characteristics of the inclusions mentioned above makes it easier to move towards the main idea of this study. This research also helps the existing literature in several ways. First, it provides a microeconomic perspective, focusing on the individual characteristics of financial actors that may affect their use of DFI. Because, as will be recalled, DFI is by definition a financial system with a high proportion of both those who can access and use digital financial services. As in this study, these actors can include individuals (Chen et al., 2022) and guide their financial choices. In this context, this study examines basic financial behaviours such as savings, debt, and socioeconomic factors, that affect individuals' DFI levels. The existing literature generally focuses on financial inclusion (Sanderson et al., 2018; Sarigul, 2020; Teker et al., 2021; Avcı, 2022; Girón et al., 2022), whereas studies on DFI (Naumenkova, 2019; et al., 2021; Li et al., 2022) are relatively new and limited. In other words, research on the factors that may affect the utilisation rate of DFIs has been ignored, and the focus has been on access.

Second, this study contributes to the existing literature in several ways. First, an index was created using variables (debit cards, credit card ownership, making bill payments online, buying something online, using mobile phones or the internet to access financial institution accounts, and using mobile phones or the internet to check account balances) included in the studies (Akanfe et al., 2020; PAL, 2020; Nandru et al., 2021; Ozili, 2022) as indicators of DFI, each of which also contains different information. Although various studies (Nandru et al., 2021) have analysed and correlated relevant variables, these indicators provide only partial and therefore incomplete information when used individually and separately. Therefore, considering the current deficiencies in the literature, an additional DFI index was created in this study. Using the DFI index created by principal component analysis (PCA) instead of using the variables separately strengthens the measurement capability.

Most importantly, despite the recent global spread of DFI, more research has yet to be conducted in Türkiye. However, Türkiye has the infrastructure to ensure DFI (PAL, 2020; Yıldırım, 2020; CBFO, 2021). Here, one of the important points is decisions that affect the participation rate of individuals in DFI. Moreover, including basic financial behaviours such as savings and debt, in the analysis is important for identifying which financial behaviours will affect the actors covered by DFI and how and in what way. On the other hand, given the increasing use of digital financial services in recent years, determining the impact of financial behaviours on DFI. This is because DFI not only increases household savings and the amount of loans taken from financial institutions, which may increase the likelihood that individuals fall into debt traps. Thus, this study analyzes the impact of financial behaviour on DFI in Türkiye and socioeconomic variables to examine the impact of DFI from a more detailed perspective. For this purpose, the ordered logit model was applied using data obtained from the World Bank's Global Findex database for 2017–2021.

The remainder of this article is organised as follows: Section 2 reviews previous studies on financial inclusion and DFI, Section 3 provides datasets and methodology, Section 4 presents empirical results and discussions, and Section 5 presents concluding remarks.

Literature Review

This section provides an overview of the literature on financial inclusion and DFI. Although the main factors determining financial inclusion have been the focus of many studies, DFI has not been adequately explained, especially in Türkiye. This study contributes to the DFI literature by addressing this gap and expanding the existing literature's scope.

When studies on financial inclusion in the current literature were examined, it was seen that they generally focused on the relationship between financial inclusion and macroeconomic indicators. Lenka and Sharma (2017) used autoregressive distributed lag (ARDL) to examine the impact of financial inclusion on economic growth in India. They emphasised the positive impact of financial inclusion on economic growth. Fernandes et al. (2021) investigated the impact of digital financial services on financial inclusion with ARDL in Mozambique. Gündüz & Özyıldırım (2020) revealed the role of participation banking on financial inclusion in Türkiye. Sarıgül (2021) investigated factors determining financial inclusion in Türkiye using a co-integration test. Chen et al. (2022) examined the relationship between financial inclusion, economic growth, income inequality, and poverty using panel data from China. They found that financial inclusion has a long-term effect on poverty reduction in China, whereas the effect of economic growth is relatively weak. Kouladoum et al. (2022) sought to uncover the relationship between digital technology and financial inclusion in Africa through generalised method of moments (GMM). They emphasised that the rate of financial inclusion in Africa has increased as digital technologies have increased. Demir et al. (2022) sought to

reveal the relationship between quantile regression and financial technologies, financial inclusion, and income inequality in 140 countries. The determinants of financial inclusion and regional inequality in Türkiye were examined by Takmaz et al. (2022) using an ordered logit model. Canatan & İpek (2023) researched factors affecting household financial inclusion in Türkiye. These studies considered macroeconomic variables in various dimensions, such as economic growth, income inequality, poverty, digital technologies, and their financial use. In this context, it is understood that these studies emphasised that financial inclusion supported by digitalisation can positively contribute to income, income inequality, economic growth, and regional inequalities.

Although the literature on DFI is relatively new, international studies have been increasing rapidly, whereas national studies still need to be comprehensive. Ahmad et al. (2021) examined the relationship between FDI and economic growth in China using panel data analysis. Dai (2021) conducted a study on the development and supervision of robo-advisors of complex systems and DFI in China. Keliküm (2021) revealed the relationship between DFI, informal economy, and poverty through GMM in Africa. Kumar (2021) explored the role of DFI on access, use, and quality of digital finance in India. Liu et al. (2021) investigated the relationship between DFI and economic growth. Nandru et al. (2021) reported on the determinants of DFI in India. Chen et al. (2022) used panel data to investigate the impact of DFI on household poverty in China. Li et al. (2022) examined the impact of DFI on household debt in China using panel data. Li et al. (2022) aimed to determine the effect of household consumption on DFI using spatial econometrics in China. Luo et al. (2022) studied the effect of DFI on household consumption in China using a fixed-effect model. Ozturk and Ullah (2022) examined DFI, economic growth, and environmental sustainability in GMM and OBRI economies. Saxena and Thakur (2022) investigated the factors affecting DFI by ANOVA in India. These studies generally recommended expanding DFI participation to achieve higher economic growth and reduce poverty and income inequality.

As a result, there are still some limitations in the relevant literature. More than macroeconomic indicators should be considered for DFI. Therefore, this study identified and evaluated factors affecting DFI by creating a micro-based DFI index to fill Türkiye's research gap. As this study's main contribution emphasises, to say that DFI is fully present, the rate of people using digital financial systems must be high. Only in this way can the DFI rate be fully increased and the above-mentioned macroeconomic developments be achieved. Thus, these findings are expected to help DFI become more efficient and broad.

Data Set

The Global Findex dataset is one of the microdata sets that measures individuals' savings, debt, payment, remittance, and risk management (+15) in the most detailed way (WB, 2018).

In this study, the 2017–2021 Global Findex Data Set (2011–2014 were not included because they did not have variables presenting the DFI index) was used as a pool to determine the impact of socioeconomic conditions and financial behaviours that affect DFI in Türkiye.

In this regard, a composite DFI indicator was created for Türkiye, which included DFI indicators via PCA. The formation of PCA follows the strategy of the World Bank (2022b), data set availability, and the relevant literature (Akanfe et al., 2020; Nandru et al., 2021; Ozili, 2022) and (PAL, 2020). For the DFI index, a triple-categorical dependent variable was formed that included items like debit cards, credit card ownership, making bill payments online via the internet, buying something online using the internet, using mobile phones or the internet to access financial institution accounts, and using mobile phones or the internet to check account balances. In addition, this indicator considered the need to use system contents and access financial systems. Furthermore, debt and savings variables were used to measure the effects of using the financial system for the same purpose. The PCA methodology and DFI construction are described in detail in the next section.

In addition, the choice of the independent variables debt and savings is based on their potential impact on the utilisation rate of DFI. An important point is to use borrowers that are family or friends rather than informal borrowers. One reason for this is that individuals in the sample may be reluctant to report informal borrowing (as Lyons et al. (2022) noted, factors such as legal and regulatory institutions and cultural factors, which are particularly emphasised in this study, are important in Türkiye and similar societies). Another reason is that the effects of borrowing from family or friend networks are well known in Türkiye (Yükseker, 2010), especially for sociological aspects). Finally, choosing socioeconomic variables is important in guiding their financial behaviour and understanding how they can guide their utilisation rates while following relevant literature. The variables included in the dataset and their summary statistics are detailed in Table 1.

Table 1
Summary Statistics

Variable	Description and Summary Statistics
DFI	Digital Financial Inclusion Index, N:1294, Min:1-Max:3 1:Low: 435(%33.62); 2:Med: 465(%35.94); 3:High: 394(%30.45);
Income	Income group, N:1294, Min:1-Max:5 1:Poorest: 146(%11.28), 2:Second: 155(%15.69), 3:Middle: 221(%17.08), 4:Fourth: 297(%22.95), 5:Richest: 475(%36.71)
Education	Education level, N:1294, Min:1-Max:3 1:Completed primary or less: 188(%14.53), 2:Secondary: 766(%59.20), 3:Completed tertiary or more: 340(%26.28)
Gender	Gender, N:1294, Min:1-Max:2 1:Male: 785(%60.66), 2:Female: 509(%39.34),
Workforce	Labour force inclusion status, N:1294, Min:1-Max:2 1:In-workforce: 967(%74.73); 2:Out-of-workforce: 327(%25.27);

Variable	Description and Summary Statistics
Age	Age, N:1294, Min:17-Max:87 Mean: 37.84, standard deviation: 13.86
Saved FI	Saved in past 12 months: Using an account at a financial institution, N:1294, Min:1-Max:2 1:Yes: 345(%26.66), 2:No: 949(%73.34)
Saved IS	Saved in past 12 months: Using an informal savings club, N:1294, Min:1-Max:2 1:Yes: 106(%8.19), 2:No: 1188(%91.81)
Borrowed FI	Borrowed in past 12 months: From a financial institution, N:1294, Min:1-Max:2 1:Yes: 347(%26.82), 2:No: 947(%73.18)
Borrowed FF	Borrowed in the past 12 months: From family or friends, N:1294, Min:1-Max:2 1:Yes: 465(%35.94), 2:No: 829(%64.06)

Finally, remarkable descriptive statistics regarding the variables in the dataset can be observed. In this regard, only 30.45% of the respondents in the DFI index are at a high level. In comparison, the percentage of those at low and medium levels is 69.56%. These rates are preliminary evidence for our research question and emphasise that for a sample like Türkiye, where digital financial infrastructure is available, the usage rate of tools offered by the relevant infrastructure should be high. In addition, the fact that the rate of those who borrowed from a family/friend network was 35.94%, whereas the rate of those who borrowed from a financial institution was 26.82% strengthens the argument that was made before for the variable under consideration. In conclusion, inadequate saving rates and other essential points highlighted in this paragraph emphasise that DFI must consider individual factors.

Methodology

The ordered logit model is widely used when the dependent variable has more than two ordered responses. This approach provides a methodology for finding independent variables that explain ordinal variables, considering the measurement uncertainty of the data (Ballerin et al., 2016). The ordered logit model can be written as in Eq.(1) and represents the dependent variable reflecting the DFI categories (DFI1, DFI2, and DFI3):

$$y_i^* = \beta' x_i + \varepsilon_i \qquad i = 1, \dots, n \tag{1}$$

$$\begin{aligned} y_i = \;& 0 \text{ if } -\infty < y_i^* \leq \mu_0 && \text{(low level of DFI: DFI1)} \\ = \;& 1 \text{ if } \mu_0 < y_i^* \leq \mu_1 && \text{(medium DFI: DFI2)} \\ = \;& 2 \text{ if } \mu_1 < y_i^* \leq \infty && \text{(high DFI: DFI3)} \end{aligned} \tag{2}$$

Here, μ is the threshold points and indicates the bounds of the dependent variable, xi represents the explanatory variable matrix, $\varepsilon i$is the error term, and β is the vector of the parameter to be estimated. In the xi explanatory variables matrix in Eq.(1) and adapted to the

study, there are gender, age, educational status, employment status, income status, and saving and borrowing behaviors of the individual. In the next section, in Table 5, where the ordered logit model estimation results are shown, the odds ratio values are estimated according to the reference group and express the effect of the variables on DFI proportionally. In the logit models, the interpretation is made based on the odds ratio In logit models, interpretation is based on odds ratios and marginal effects (İpek, 2020).

Empirical Results

PCA is a data analysis tool that preserves the information of many interrelated variables and is used to reduce the number of variables. The most significant components (principal components) are determined using the eigenvalues and eigenvectors of the covariance matrix of the data matrix. The index created by PCA is based on projections of the principal components of the data (Abeyasekera, 2003; Vyas and Kumaranayake, 2006). In this study, a DFI index was constructed using a weighted combination. Where $w_i,\ldots,w_n$ are the weights of the components on the index. X_n is the projection of the nth principal component:

$$\text{Index} = w_i X_i + \cdots + w_n X_n \quad (3)$$

$$\text{DFI}=0.45*(\text{PC1})+0.40*(\text{PC2})+0.27*(\text{PC3}) + 0.37*(\text{PC4})+ 0.44*(\text{PC5})+ 0.46*(\text{PC6}) \quad (4)$$

Table 2
The results of Principal Component Analysis

	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	0.3012	0.5514	0.8921	3.1678	0.6445	0.4428
Proportion	0.0502	0.0919	0.1487	0.5280	0.1074	0.0738
Cumulative	1.0000	0.8760	0.6767	0.5280	0.7841	0.9498
Eigenvectors						
Component 1	0.4550	0.4024	0.2738	0.3761	0.4421	0.4681
Component 2	-2.2381	-0.2194	0.8478	0.3314	-0.1211	-0.2277
Component 3	-0.2309	0.5124	0.3364	-0.6796	0.2960	-0.1464
Component 4	-0.4130	0.6196	-0.2563	0.5177	-0.0758	-0.3257
Component 5	0.2756	0.3757	0.1653	-0.1369	-0.8327	0.2097
Component 6	0.6606	0.0537	0.0053	0.0036	0.0553	-0.7467

Eigenvalues are a metric that measures how much each principal component explains the variance in the data set in PCA. Large eigenvalues indicate that the component is significant and reflects the underlying structure in the data set (Demšar et al., 2013). PC4 (first principal component) has a variance of 3.16 and explains 52% of the total variance (3.16/6). PC3 (second principal component) has a variance of 0.89, i.e. 14% of the total variance (0.89/6). As a result, we can also say that the first two principal components explain the sum of the variances of the individual components or about 66% of the total variance.

The suitability of PCA was measured using the Keiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. To test the sample adequacy, the results of the KMO test and Bartlett's test of sphericity were used and are given in Table 3. If the KMO index is 0.80, it is considered meritorious, 0.70 middling, and below 0.50 is unacceptable (Kaiser & Rice, 1974; Wu, 2021). The results supported the use of PCA in this study.

Table 3
KMO and Bartlett's Test Results

Variable			**KMO**
Overall			0.83
PC1: Check account			0.80
PC2: Buying something online			0.88
PC3: Credit card			0.84
PC4: Debit card			0.88
PC5: Making bill payments online			0.86
PC6: Account			0.79
Bartlett's	Chi-square	df	p-value
	2593.308	15	0.000

The findings of the ordered logit model used to study the DFI effect are included in this section. The parallel assumption, which is the most critical assumption in the ordered logit model, was tested with the help of Wolfe Gould and Brant's (1990) tests. The hypothesis that the coefficients of independent variables are the same across all dependent variable categories must be tested. More technically, this means that the odds ratios of a category in all logistic models remain the same against a variable created by collapsing all categories except itself (Williams, 2016). Thus, a more generous interpretation technique can be used. Therefore, parallel assumption tests were applied.

Table 4
Parallel Regression Tests

Test	**Chi2**	**df**	**P> Chi2**
WolfeGould	11.88	13	0.537
Brant	12.48	13	0.489
Score	12.03	13	0.525
Likelihood Ratio	12.24	13	0.508
Wald	12.12	13	0.518
Information Criteria	ologit	gologit	difference
AIC	2477.93	2491.69	-13.76
BIC	2555.41	2636.32	-80.91

Table 4 presents the results of the Wolfe–Gould and Brant tests, in which the parallelism assumption was tested for the model in general. It was concluded that the probability value of the Ho hypothesis was greater than 0.05; therefore, the assumption of parallelism was provided for the overall model. When the model goodness of fit, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) values were compared, it was observed that the ordered logit model (ologit) had lower information criterion values. Lower AIC and BIC information criteria were selected.

Table 5
Ordered Logit Model Estimation Results

Variable	***Odds Ratio***	***Marginal Effect***		
		Low DFI	*Med DFI*	*High DFI*
Female	*1.017*	*-.003*	*.000*	*.002*
	(.132)	*(.023)*	*(.003)*	*(.019)*
In Workforce	*1.749****	*-.101****	*.016****	*.084****
	(.253)	*(.028)*	*(.008)*	*(.020)*
Age	*.967****	*.005****	*-.000****	*-.004****
	(.004)	*(.000)*	*(.000)*	*(.000)*
Secondary education	*1.521**	*-.084**	*.025**	*.058***
	(.251)	*(.033)*	*(.012)*	*(.022)*
Completed tertiary or more	*4.311****	*-.268****	*.022**	*.245****
	(.892)	*(.037)*	*(.013)*	*(.035)*
Second %20	*1.352*	*-.058*	*.018*	*.039*
	(.300)	*(.042)*	*(.014)*	*(.029)*
Middle %20	*1.740***	*-.106***	*.029**	*.076***
	(.370)	*(.040)*	*(.012)*	*(.028)*
Fourth %20	*2.462****	*-.169****	*.037***	*.132****
	(.516)	*(.039)*	*(.012)*	*(.029)*
Richest %20	*2.231****	*-.152****	*.036***	*.115****
	(.458)	*(.039)*	*(.012)*	*(.028)*
Saved using an account at a financial institution	*2.522****	*-.167****	*.012**	*.154****
	(.369)	*(.025)*	*(.005)*	*(.025)*
Saved using an informal savings club	*.913*	*-.016*	*.002*	*.013*
	(.213)	*(.042)*	*(.008)*	*(.034)*
Borrowed from a financial institution	*2.914****	*-.192****	*.013**	*.179****
	(.417)	*(.024)*	*(.005)*	*(.025)*
Borrowed from a financial institution	*.931*	*-.012*	*.002*	*.010*
	(.121)	*(.023)*	*(.004)*	*(.010)*
Cut1	*.101**			
	(.403)			
Cut2	*1.964**			
	(.407)			

Model Diagnostics		***The Goodness of Fit Tests***	
Number of obs=	*1,294*	*McFadden=*	*0.161*
LR chi2(13)=	*388.99*	*McFadden(adjusted)=*	*0.148*
Prob > chi2=	*0.0000*	*AIC=*	*2060.489*
Pseudo R2=	*0.1608*	*BIC=*	*2137.971*
Log likelihood=	*-1015.2444*	*Hosmer-Lemeshow (25)=*	*49.408 (0.377)*

** p < 0.05, ** p < 0.01, *** p < 0.001and values in parentheses represent standard errors.*

Because there was no violation of the parallelism assumption, the ordered logit model was suitable for this study. Additionally, when the fit tests presented in Table 5 were examined, we found a fit between the dataset and the model. The cut-off point, which expresses the μ threshold values in Eq.(2), is the cut-off point for the latent variable used to distinguish the low-level DFI category from the medium and high categories when the independent variables are 0. Table 5 indicates that the lower and upper threshold values for each statistically signi-

ficant category do not equal one. From this viewpoint, it can be concluded that no categories need to be combined in the model, and the categories established are consistent (İpek, 2022).

According to the statistically significant odds ratio results, individuals in the workforce are 1.74% more likely to participate in DFI than those not in the workforce. Increased workforce participation will create opportunities for DFI. With membership in the workforce, account ownership and access to financial transactions will increase, while expanding DFI will contribute. When the age variable among the continuous variables was analysed, it was seen that the likelihood of participating in the DFI decreased as individuals got older. According to the estimation results, education level is the most influential factor on DFI. More educated individuals are more likely to engage in DFI. This finding highlights the importance of education for providing access to digital financial services and products, in other words, for spreading DFI. Digital financial transactions are structured in a way that literate and educated adults can easily adapt, but illiterate people are excluded (Matthews, 2019). An increase in income level increased the probability of participating in DFI. This finding revealed the importance of providing financial services that meet the wishes and needs of low-income group members (Arnold & Gammage, 2019). It can also provide new tools for low-income households to access digital opportunities and help them better manage their financial behaviours while reducing transaction costs. In addition, opportunities can be offered to increase productivity and efficiency to increase income.

Although not statistically significant, the negative coefficient of the odds ratio indicated that, as expected, informal savers are less likely to participate in DFI. Similarly, although statistically insignificant, women are more likely to participate in DFI than men. It is important to consider these implications. In particular, for the Turkish sample, integrating informal savings into the financial system may be easier when women actively participate in the financial system. This is because women in Türkiye are more likely than men to engage in informal savings, i.e. having more savings under their pillow (Bank ING, 2021; Özbilge, 2022). Borrowers from family and friend networks were 0.93% less likely to engage in DFI. Individuals who borrow from nonfinancial institutions are likely less likely to engage in DFI. Due to the social nature of kinship ties, informal debts may be obtained mostly from a network of family and friends (Li et al., 2022).Another finding is that formal savings are 2.52% times more likely to be involved in DFI. Individuals who borrow from a financial institution are 2.91% more likely to engage in DFI. These findings demonstrate the significant impact of financial behaviours on DFI. This study also highlights the importance of individuals' strategies for digitally making their savings and borrowing behaviours (Niankara, 2023).Note that the household debt-income balance must be maintained while expanding DFI to prevent excessive debt growth (Luo & Li, 2022).

When the other variables were constant and the *marginal effects* showing the effect of the factor affecting DFI according to each DFI level compared to the average were examined, men, individuals with higher education and income levels, those who participate in the work-

force, formal savings, and debt holders were more likely to participate in DFI. Considering the rapid increase in digital financial transactions with technology (Jain et al., 2021) and the interactive relationship between finance and digitalisation (Bunje et al., 2022), it is vital to increase education, workforce participation, and income among the masses to ensure DFI and reach underserved segments. Additionally, the studys results highlight the current level of use of DFI and two marginalised groups: family/friend borrowers and informal savers. In particular, the most significant effects on high levels of DFI are from savings from financial institutions and debt variables with positive coefficients of 0.154 and 0.179, respectively. This provides concrete evidence that DFI may cause imbalances in household debt management.

On the other hand, it provides clues that financial institutions can make saving options more attractive and can also help individuals direct their savings. As a result, it allows us to observe the effects of financial behaviour on DFI. Thus, a framework that can provide a prediction for policy recommendations that can be made on the utilisation rate of DFI can be obtained.

Conclusion and Discussion

This study discusses the factors affecting DFI in Türkiye within the framework of financial behaviours and socioeconomic factors that may affect the usage rate. For this purpose, the effect of these determinants was analysed using the ordered logit method on the 2017–2021 Global Findex Dataset. The results obtained provide a perspective, especially for developing countries such as Türkiye, where digital infrastructure exists in terms of financial systems. However, the rate of DFI use needs to be increased. This perspective contributes to the encouragement of individuals to participate in DFI, especially when the possible effects of financial behaviours are known. The results reveal the importance of decisions made, especially regarding debt and savings, when coordinating the development of DFI.

According to the findings, after education level, the utilisation of financial institutions for saving and borrowing are the most important determinants of DFI. However, given the high borrowing costs, DFI may encourage households to overloan while enabling more convenient and efficient access to financial resources. In this context, policies at the household level should make careful efforts to improve and promote DFI and increase its use. Specific improvements should be made by controlling household debt levels.

Because of the analysis conducted in the study, it was found that 34% of the participants had a low DFI, 36% had a medium DFI, and 30% had a high DFI. Notwithstanding its benefits, DFI for Türkiye shows that it is not sufficiently accessible to vast segments of the population, which points to a gap between availability, accessibility, and use. In particular, informal savings and traditional options, such as borrowing from family/friend networks. Thus, DFI

rates will significantly improve as households move towards formal channels. Moreover, and most importantly, it is anticipated that growing the supply of financial products and services alone will only help expand DFI if holistic efforts are made to improve it. The findings that increased workforce participation, education, and income levels. Furthermore, increase DFI necessitate a holistic perspective. Individuals' compliance with financial systems depends primarily on their ability to meet favourable socioeconomic conditions.

Although this study provides important implications for optimising the impact of DFI in Türkiye and determining the factors on which its use depends, it has some limitations. The effect of heterogeneity across units cannot be explained due to the horizontal cross-sectional structure of the dataset. Only situations specific to COVID-19 can be identified and compared with the findings of this study. Based on these limitations, future research could examine more complex financial behaviours and determine whether other aspects, such as digital financial literacy, could benefit, especially in developing DFI. Additionally, where access to datasets showing cultural and behavioural differences is available, other developing countries can be included in the analysis, and the relevant field can be expanded to compare theory and empirical results.

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RESEARCH ARTICLE

Changes in Capital Structure in Seasoned Equity Offerings: BIST Implementation

Zeynep Kalaycıoğlu[1], Ahmet Kurtaran[2]

Abstract
This study evaluates changes in firms' capital structures after a seasoned equity offering by testing the effects of firm-specific factors on leverage ratios. The relationship between the determined dependent variables and firm-specific factors is associated with the predictions of pecking order and trade-off theory. In 3 different models in which leverage ratios are determined as dependent factors and firm-specific factors as independent variables, 10 basic hypotheses are proposed, and the relationship between the variables is examined using panel data analysis. According to the results obtained in the analyses, as the number of seasoned equity offerings increases, firms' leverage ratios decrease, and firms tend to use more debt because of the corporate tax base discount granted to seasoned equity offerings. In addition, it has been determined that rather than choosing to source resources through equity or borrowing, the view of benefiting from both sources of funds is dominant in the face of the resource requirements of seasoned equity offering firms.

Keywords: Capital structure, Leverage ratios, Firm-specific factors, Seasoned equity offerings, Panel data analysis

Introduction

Modern capital structure theories take into account some benefits and costs and seek an answer to the question, *"Whether debt or equity issuance provides the most benefit with the least cost in the face of resource requirements?"*. These theories are consistent with the view that the issuance of equity capital is the last choice of funding source, despite differences in source preferences. Another common view of both theories is that of turning to sources of funds that provide the greatest benefit at the lowest cost. Many studies have stated that the source of funds that can provide the most appropriate choice as an external fund source among benefits and costs is borrowing. It is emphasized in many studies that interest expenses arising from debt are subject to corporate tax base deductions, making debt advantageous compared to equity capital. Borrowing is the most basic external, cost-effective fund source,

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and some firms turn to equity issuance as an external fund source. Moreover, it is observed that some firms periodically repeat their equity issuance with seasoned public offering (SEO) practices. This situation reveals that some firms prefer the tax advantage provided by the issuance of equity capital rather than borrowing. In this context, the reasons for firms' debt-equity changes in Turkey are considered factors worth investigating.

In this context, the reasons for firms' debt-equity changes in Turkey are considered factors worth investigating.In this study, the capital structure and modern capital structure theories are evaluated in terms of firm-specific factors, and their relationship with SEO is then outlined. By providing a literature review on SEOs; the purpose, importance, and scope of the study, the models and hypotheses created, and the method applied are explained. The findings related to the model were evaluated, and suggestions for future studies were made.

Capital Structure and Related Theories

Capital structure decisions are the first step in determining how a firm's assets are to be financed. The capital structure is how a firm finances its assets through a combination of equity and debt that includes various costs and benefits (Titman and Wessels, 1988: 1). Equity and debt composition indicates firm leverage. This combination works as a balance to minimize resource costs. The main objective is to minimize resource costs as much as possible, in line with the target leverage level.

It should be stated that capital structure decisions will be affected by a wide range of general economic conditions and firm-specific factors, and there cannot be a fixed formula that will show which factors affect the optimal leverage level target and in what direction. Therefore, different views will continue to be proposed in studies on this subject.

Evaluation of Modern Capital Structure Theories

Modern theories of capital structure outline steps towards maximizing firm value and shareholder wealth. Both theories that form a financial resource triangle between the use of a firm's internal funds, equity issuance, and borrowing have been the subject of many studies as rivals to each other. In both theories, the orientation towards the least costly resource is the main means of meeting financing needs. As a matter of fact, trade off theory argues that the optimal balance can be reached with the least cost at the target leverage level; the pecking order theory pushes aside orientation to external financing sources, taking into account the costs of borrowing. According to the theory, internal resources are the safest and least costly. Although trade-off theory directly constructs the target leverage level, the pecking order theory explains the leverage level that changes according to firm managers' financial resource preferences. Although the goal is to create a cheap financing source, the effect of the preferred

method on leverage ratios is undeniable. The firm's selection of financial resources and, thus, resource costs create leverage ratios. The combination of long-term debt and equity is a key component of the target leverage level.

According to both theories, while resource costs are of great importance, the priority order of debt differs depending on the perspective of the theories. According to the trade-off theory, the benefits of borrowing are based on the view that the tax advantage created by the corporate tax base reduction will also reduce the costs of representation between managers and shareholders. The costs of borrowing include costs related to bankruptcy and financial distress, and it is stated that these costs will increase the costs of representation. Tax advantage is the strongest pillar at the target leverage level. The pecking order theory, on the other hand, does not evaluate the benefits and costs of resources. The theory guides capital structure decisions by comparing the benefits and costs of resources. According to this theory, the costs of issuing equity capital create a huge cost pool alongside debt costs. Therefore, firms' last financial resource preference is equity issuance. The priority is internal funding sources, and the second priority is to meet the source requirement based on the tax shield effect of debt. The last option is equity issuance. However, the tax shield effect created by equity capital issuance under certain conditions is ignored.

In their study, Rajan and Zingales (1995) evaluated the question *"Borrowing or financing through equity issuance?"* according to firm-specific factors. Although the importance of firm-specific factors is emphasized for both theories in this study, the approaches of the theories to fundamental factors are also different from each other.

Although the trade-off theory sees market to book (M/B) as the representative of the firm's growth opportunities, the pecking order theory expresses M/B as the determinant of profitability due to differences in growth expectations. While the desire to take advantage of profitable and risky investment opportunities in the future increases debt appetite in some firms, the desire to reduce representation costs in others causes firms to abstain from debt. According to pecking order theory, the point to be considered in this case is the direction of the relationship between the amount of investment to be incurred in the face of growth opportunities and the variability in profitability. Frank and Goyal (2003) stated that leverage ratios increase as growth opportunities increase. However, considering firms that adopt a more conservative borrowing policy according to trade-off theory, while shareholders' profit share expectations increase because of high investment expenditures, agency costs also increase, and the firm becomes more sensitive to resource costs. For this reason, Titman and Wessels (1988) stated that leverage ratios decrease as growth opportunities increase. According to Rajan and Zingales (1995) and Cortez and Susanto (2012), firms with high growth opportunities tend to use less debt, although it is thought that growth opportunities may increase the future debt capacity of the firm.

According to trade-off theory, leverage ratios increase as firm size increases. This prediction is also expressed in Rajan and Zingales (1995) and Fama and French (2002). According to them, these firms can conduct long-term borrowing with much easier and cheaper costs. According to the pecking order theory, as the size of a firm increases, transaction costs and information asymmetry decrease; thus, firms' external financing requirements decrease, and due to increasing growth requirements, the tendency towards equity issuance increases. Frank and Goyal (2008) stated that leverage ratios decrease as firm size increases.

According to trade-off theory, a high ratio of tangible fixed assets is the main collateral indicator of debt supply. As a strong collateral indicator, it minimizes the representation cost of debt, that is, the risk of the lender. Therefore, leverage ratios are expected to increase as the ratio of tangible fixed assets increases. Scott (1979), Harris and Raviv (1990), Rajan and Zingales (1995), Shenoy and Koch (1996), Hirota (1999), Gaud et al. (2005), Huang and Song (2006), Antoniou et al. (2008), Frank and Goyal (2008), and Fan et al. (2012) confirmed these expectations. According to the pecking order theory, firms with high tangible assets already have sufficient internal financing resources and do not require external financing. Marsh (1982) and Harris and Raviv (1990) stated in their studies that leverage ratios decrease as the ratio of tangible fixed assets increases, according to the pecking order theory.

According to trade-off theory, the ability to pay off debt increases as profitability increases because firms with high profitability can obtain debt at a lower cost. Firms can act on their targets of higher leverage ratios because increased profitability also minimizes the costs of bankruptcy and financial distress. Mehrotra et al. (2005) stated that leverage ratios increase as profitability increases. Brealey et al. (2017), however, stated that some firms with high profitability and technology incur relatively less borrowing. Profitable firms' tendency to borrow less can be expressed as their tendency to use internal fund sources. In the pecking order theory, on the other hand, because the priority is always to use internal funding sources, internal funding sources increase as profitability increases. Therefore, as profitability increases, the tendency to borrow decreases, and leverage ratios decrease. Ross (1977), Friend and Lang (1988), Rajan and Zingales (1995), Megginson (1997), Booth et al. (2001), Drobetz and Fix (2003), and Huang and Song (2006) confirmed in their studies that leverage ratios decrease as profitability increases.

According to trade-off theory, firms with higher liquidity ratios are more capable of meeting short-term financial obligations. Therefore, they tend to borrow at higher rates. Bradley et al. (1984) stated that leverage ratios increase as liquidity increases. The pecking order theory, known for its prioritization of orientation to internal funds, argues that leverage ratios decrease as liquidity increases. Deesomsak et al. (2004), Mazur (2007), Sheikh et al. (2011), and Babu et al. (2014) supported these. Because a firm tends to meet its fund needs with existing internal resources. Therefore, according to this theory, firms having higher liquidity use less debt.

Although many studies have examined the effect of ownership structure on capital structure, no clear consensus has been reached. Because of different ownership structures, capital structures are driven by different financial preferences. Friend and Lang (1988) and Berger et al. (1997) stated that borrowing is not preferred to avoid risk. According to Huang and Song's (2006), ownership structure and leverage ratios are not connected. In fact, a framework for the capital structure has been proposed in both theories. However, some firms operate outside this framework. Although theories regarding leverage ratios and firm-specific factors exist, the basic view is that firms interact differently with regard to equity issuance and debt demand.

SEO and Capital Structure Relationship

Although the initial public offering (IPO) causes the ownership structure to open up to the outside environment and the ownership to be dispersed at certain rates, it also offers some sanctions to the firm. These sanctions incur different costs depending on the firm's management practices. These costs will decrease or increase exponentially depending on the success momentum of the firm in its corporate investment and financing policies.

After the IPO, the firms that gained public company status may return to the public offering. One of the most important advantages of public offerings to firms is that they can initiate the public offering process repeatedly. After the IPO, the firm that gains the status of a publicly traded company increases its equity capital by the stipulated amount and offers shares related to the increased amount to the public by limiting all or part of the pre-emptive rights of the existing partners. This transaction is referred to as SEO. SEO is expressed as a long-term and low-cost alternative financing source that can guide firms' capital structure decisions.

The success of the firm's IPO will also affect the direction and success of subsequent SEO decisions. Indeed, Barclay et al. (2021) stated in their studies that SEOs have a wide range of effects, including a number of financial components, such as leverage ratios, dividend distribution decisions, stock repurchases, maturity structures, priority and convertible structures of securities, liquidity policies, and corporate investment decisions. No matter how wide the area of influence is, when considered in terms of capital structure theories, borrowing and fund requirements were preferred to SEOs, and it was stated that SEOs create additional costs and disadvantage for the firm. The need for additional funds for investment projects, debt repayments, a balance instrument to achieve target leverage ratios, firms' acquisitions or provision of R&D expenses, or funds for daily operating expenses, regardless of the purpose of debt financing, is a clear indication that the use of debt should stop at some point.

Jung et al. (1996) stated that the need to create additional funds to implement future investment projects or to repay debt is the basis for firms' SEO decisions. Regardless of the purpose, the target leverage level of a firm is dynamically affected before and after SEO

implementation, and leverage ratios tend to increase or decrease. However, Iqbal et al. (2014) emphasized in their studies that the leverage structure and financial performance of firms that engage in SEOs differ from firms that perform very few SEOs throughout their lifecycle. In addition to these differences, the basic view is that leverage ratios decrease in the short term after SEOs and increase systematically after offers.

Method of Research

In this section, the literature on SEO practices is examined, the purpose, importance, and scope of the study are discussed, the models and hypotheses are explained, the method applied is explained, and the findings of the study are presented.

Literature Review

When the relevant literature is examined, it can be seen that very few studies exist on SEOs in Turkey. It has been observed that these studies highlighted the return performance of IPOs and the changes in financial performance. It can be seen that the international literature on SEOs has been handled very extensively. The main research topics of the studies in the international literature focused on the compatibility of assumptions about reasons for firms to turn to SEOs, the purpose of using funds obtained from SEOs, short and long-term return performance before and after SEO, changes in the financial performance of firms that go to consecutive SEOs and those that do not, and SEO and capital structure theories. In this study, basic studies that highlight the effects of SEOs on the capital structure are included.

Walker et al., (2016); in their studies that deal with the effect of specified uses of SEO revenues on the next SEOs, formed the sampling frame with 670 SEOs conducted by 276 firms operating in the USA between 1995 and 2012. According to the findings of this study, firms that disclose details about the appropriate use of SEO revenues reach higher returns in their next public offering transactions. In addition, it has been stated that firms that use funds collected through SEOs to cover the costs of investment projects have relatively more successful returns in their future public offering announcements.

Walker et al., (2019); in their studies on the provision of funds through equity issuance for firms in financial distress, formed a sampling frame with 3692 SEOs carried out by industrial firms in the United States between 1994 and 2015. According to the findings of this study, it has been stated that after the issuance of equity capital, firms in financial distress have a tendency to grow in their corporate ownership, R&D structures, and market values; they have better abnormal returns; they tend to invest following SEO; and their business performance is on the way to improvement.

Asad et al. (2020), in their studies on measuring market responses to capital structure adjustments through SEOs, formed a sampling frame with 1725 SEOs of 1016 firms operating

in various industries in the United States between 2004 and 2013. According to the findings of this study, cash requirements and growth opportunities have a significant effect on SEO decisions; the desire to reach the optimal leverage ratio, and stocks' valuations have a stronger effect on the orientation to SEO. In addition, it has been stated that firms using excessive debt with SEOs approach the debt rate target and a more optimal capital structure and do not deteriorate the target capital structure for at least 3 years after the offering.

Le et al. (2020), in their studies on the factors affecting SEO decisions, formed a sampling frame with the SEO of 99 firms traded on the Vietnam Stock Exchange between 2014 and 2018. According to the findings of this study, an increase in corporate earnings and growth in the scale of a firm increase the tendency towards SEOs; an increase in dividend payment rates reduces this tendency.

Stamou et al. (2020), in their studies on the changes in the debt structures of firms that go to SEO consecutively and firms that go to SEO once, created a sampling frame with the SEO of 1033 firms operating in the London market between 1999 and 2015. According to the findings of this study, it has been stated that firms that go to consecutive SEOs have a higher debt ratio and do not tend to decrease their existing debt ratios despite obtaining additional funds due to the issuance of equity capital; thus, they maintain a higher debt level, they have a growth trend, and short-term debt levels are very low compared to firms that go the same way.

Li and Wang (2021), in their studies on the role of corporate social responsibility strategies on public offering costs, formed the sampling frame with 1163 SEOs conducted in 38 countries between 2002 and 2018. According to the findings of this study, it has been stated that corporate social responsibility practices reduce equity issuance costs; the higher the corporate social responsibility performance, the less uncertainty in the value of firm assets; thus, solid steps have been taken to strengthen the capital market with a stronger, more stable corporate structure.

Fu and Smith (2021) proposed an integrated theory of capital structure that addresses the beneficial aspects of these theories. They created a sampling framework with 8000 SEOs of 7072 industrial firms operating in the United States between 1970 and 2017. In this study, an integrated theory of the capital structure called *"strategic financial management"* has been proposed by considering the beneficial aspects of the theories. According to the proposed theory, it has been stated that strategic financial management theory represents a structure that is reached with the optimal leverage level and that turns to SEO choices to finance the firm's long-term investment opportunities and incentives.

Barclay et al. (2021), within the scope of corporate investment and financing policies, in their studies on the target leverage ratio and management of investment projects in SEOs,

formed the sampling frame with 8608 SEOs carried out by firms operating in the US and the public sector between 1970 and 2015. According to the findings of this study, a strong interaction between firms' future investment projects and capital structure decisions. They stated that the main reason that firms turn to SEOs is to generate large and new investment projects rather than reach the target leverage ratio in capital structure decisions.

Zhu and Li (2022), in their studies in which they investigated how SEOs and firm management affect corporate investment success, formed a sampling frame with SEO firms operating in China between 2009 and 2020. According to the findings of this study, SEOs generally cause a decrease in investment efficiency; it has been stated that the advanced age of management and the fact that they have an overseas background increase the efficiency of investments. Instead of increasing the number of female managers, it was suggested that they should be developed to increase their level of competence.

Chen and Liu (2022) formed a sampling frame with 1061 firms outgoing that examined the effect of increased capital from SEOs and the partial cancellation of issued shares, the effect of reduced capital on the financial structure, and the role of representation costs in this effect. According to these findings, capital decreases due to partial cancelation of issued stocks increase long-term firm performance, whereas SEOs decrease firms' performance regardless of the short and long-term. In addition, they stated that increased free cash flows due to SEOs increase the costs of representation and that representation cost, albeit partially, decrease firm performance.

Hernholm and Wormsen (2023); in their studies, they investigated the prediction that SEOs have a negative impact on firm market value. Between 2010 and 2020, they created the sample frame with 6930 SEO transactions from 630 US firms. Study; It was divided into 3 stages: pre-SEO, SEO year, and post-SEO, and the change in stock returns over time was observed. Although there was an increase in the stock returns of firms before and during the SEO period, there was a decrease in stock returns during the post-SEO period. Firms predicted to have an SEO orientation were evaluated separately, and no meaningful results were obtained. For this reason, it has been suggested that different factors may explain why SEOs reduce their return performance. According to the study, these factors are bankruptcy risk, company size, and debt ratio. For this reason, no convincing evidence has been found regarding the predictions that SEOs have a negative impact on stock returns and reduces market value.

Sanchez et al. (2023) investigated whether firms acting within the scope of corporate social responsibility tend to employ earnings manipulation practices in SEO transactions. A sampling frame was created with 4027 SEO transactions conducted by non-financial firms in France, Germany, Italy, and Spain, representing the largest EU economies between 2011 and 2020. According to the findings, there are differences between countries despite having

the same legal framework and currency. In all countries except Spain, there is cash flow manipulation before SEO. However, it has been stated that firms that attach importance to social responsibility principles are less involved in earnings manipulation.

Ashour and Atik (2024) conducted a comprehensive literature review on the subject, discussing earnings management practices before SEO, which were discussed in 1998. In this context, 846 articles on the subject were scanned between 1998 and 2022, and 38 on earnings management practices were examined. It has been stated that most articles on this subject are published in the United States. For this reason, a recommendation has been made to disseminate studies on the subject in other markets. The common point between the articles is that firms manipulated the pre-SEO earnings management approach as an opportunistic approach. As a matter of fact, pre-SEO earnings were manipulated upwards.

Gad et al. (2024) stated in their study that the ultimate purpose of seasoned equity offerings is to reduce the ratio of financial leverage through the issuance of equity capital and to evaluate new investment opportunities with newly acquired funds and emphasized the importance of the desired effect on financial performance. However, they stated that specific effects will arise along with financial effects. In this context, 903 seasoned equity offering transactions conducted by US non-financial firms between 2002 and 2017 are discussed. They suggested that firms that turn to seasoned equity offerings may cut or increase their workplace health and safety expenses to increase the success of their public offerings. According to the findings, as seasoned equity offerings approach, workplace health and safety expenses are limited, albeit in the short term. The firm-specific effects of this limitation are felt in the medium and long term as a decrease in financial performance and efficiency and failure in the next public offering attempt.

He et al. (2024) opposed the view that banks should focus on increasing equity capital in response to their fund requirements. On the contrary, they stated that banks voluntarily tend to have equity capital that exceeds the legal minimum. In this context, the aim of this study is to reveal banks' motives for acquiring SEOs. In this study, among 2141 US banks between 1985 and 2013, banks that tended to offer SEOs and those that did not were examined comparatively. According to these findings, there was a significant increase in the total assets of banks that opted for SEOs compared to those that did not engage in SEOs. This increase continued to increase 5 years after the start of SEO. It has been stated that banks that turn to SEO make more purchases than those that do not. Accordingly, funds obtained through SEO are invested in loans for sale and other types of loans. This situation shows that banks are turning to SEOs, especially for asset expansion.

Ho et al. (2024) stated that firms exposed to negative environmental and social events tend to decrease their SEO. In this context, a sample frame was created using 1999 SEO transactions of 991 firms from 25 countries between 2009 and 2017. Firm managers calculate the loss

of reputation of the institution and find that investors have higher return expectations in return for the loss of trust. Despite this, it has been stated that firms turning to SEO face restrictions even in obtaining funds through debt.

Purpose and Importance of the Research

Studies on the relationship between SEOs and capital structure in Turkey generally focus on the short and long-term return performance of IPOs and changes in financial performance. It can be seen that the international literature on SEOs has been handled very extensively. The main research topics of the studies in the international literature focused on the reasons for firms to turn to SEOs, the purpose of the use of funds obtained from SEOs, short- and long-term return performance before and after SEO, the difference between the capital structure of firms that perform consecutive SEOs and those that do not, and the compatibility of the assumptions of SEO and capital structure theories. This study is considered an important step in evaluating firms' capital structures after conducting SEOs by testing the effect of firm-specific factors on leverage ratios in SEOs, and it is thought that this study will make a significant contribution to the literature. In this context, the main purpose of this study is to evaluate changes in the capital structure of firms after conducting SEOs by testing the effect of firm-specific factors on leverage ratios.

Scope of the Research

In this study, an unbalanced panel data analysis was used to explain the effect of firm-specific factors on leverage ratios in SEOs, and the Stata/MP 14.0 package program was used for the analysis. In the application part of the study, sports services and financial leasing firms, real estate investment trusts, insurance firms, investment firms, institutions operating in the banking sector, and securities investment trusts; firms that do not go to the SEO despite being traded in the BIST All Index and firms that have zero public offering density, have been transferred, have missing data in their financial statements, and have reduced their capital within the scope of the period covered in the study are not included in the analysis. SEOs of 41 manufacturing firms that were traded in the BIST All Index over the 16-year period between 2005 and 2020 were included in this study. It was determined that the 41 firms included in the analysis made 52 SEOs over a 16-year period. All numerical data obtained are published by the Public Disclosure Platform (KAP), Borsa Istanbul (BIST), and provided by FINNET Electronic Publishing. The calculation methods of the variables used in this study and their abbreviated symbols of the variables are summarized in Table 1. Please refer to the Appendices to Table 1.

Research Hypotheses

Within the framework of the purpose of this study, 10 basic hypotheses and 37 sub-hypotheses were developed. The hypotheses established in this framework are supported by the literature.

Table 1: Variables of the Study

Symbol	Dependent Variables	Calculation Method
D_{ST}/E	Short-Term Debt to Equity Ratio	Short-Term Debt / Total Equity
D_{LT}/E	Long-Term Debt to Equity Ratio	Long-Term Debt / Total Equity
D/E	Debt to Equity Ratio	Total Debt / Total Equity
	Independent Variables	
AGR	Growth Asset Ratio	((Assets at The End of The Period – Assets at The Beginning of The Period)/Assets at The Beginning of The Period)*100
M/B	Market to Book Ratio	(Market Capitalization / Total Book Value
TA	Tangible Asset Ratio	Fixed Assets / Total Assets
NPM	Net Profit Margin	Net Profit / Net Sales
ROE	Return On Equity	Net Profit / Total Equity
QR	Quick Ratio	(Current Assets – Inventories – Other Current Assets) / Short-Term Debts
DPO	Density of Public Offering	Number of SEOs / Age of Firm
PMV_{log}	Public Market Value of Firms	Total Market Value * Free Float Ratio (Included in the Analysis by Taking Natural Logarithm)
FFR	Free Float Rate	Amount of Publicly Held Capital / Total Equity
GRE	Growth Rate of Equity	((Equity at The End of The Period – Equity at The Beginning of The Period)/Equity at The Beginning of The Period)*100
GRNS	Growth Rate of Net Sales	((Net Sales at The End of The Period – Net Sales at The Beginning of The Period) / Net Sales at The Beginning of The Period)*100
	Dummy Variables	
TD	Tax Discount	Firms that have increased their cash capital have been entitled to a discount in their corporate tax returns since July 2015, if they meet certain conditions. Firms are divided into two groups those that receive tax deductions and those that do not.
ICC	Increasing Cash Capital	Firms are divided into two groups as those that increase cash capital and those that do not.

Footnotes to the table: This table contains abbreviated symbols for all variables used in the research article and explanations for their calculation methods.

According to the pecking order theory, as profitability increases, demand for borrowing decreases and leverage ratios decrease. Therefore, as profitability ratio increase, leverage ratios are expected to decrease. Within the scope of profitability ratios, NPM and ROE are included in the analysis as independent variables. In this context, the first hypothesis of the study and the sub-hypotheses are as follows:

H_1: In SEOs, leverage ratios decrease as profitability ratios increase.

- **H_{1a}:** As ROE increases, D_{ST}/E decreases.
- **H_{1b}:** As NPM increases, D_{ST}/E decreases.
- **H_{1c}:** As ROE increases, D_{LT}/E decreases.
- **H_{1d}:** As NPM increases, D_{LT}/E decreases.

- **H_{1e}:** As ROE increases, D/E decreases.
- **H_{1f}:** As NPM increases, D/E decreases.

According to the pecking order theory, leverage ratios are expected to increase as growth opportunities arise. Within the scope of growth opportunities, M/B and PMV are included as independent variables. In this context, the second hypothesis of the study and the sub-hypotheses are as follows:

H_2: In SEOs, leverage ratios increase as growth opportunities increase.

- **H_{2a}:** As PMV increases, D_{ST}/E increases.
- **H_{2b}:** As M/B increases, D_{LT}/E increases.
- **H_{2c}:** As PMV increases, D_{LT}/E increases.
- **H_{2d}:** As PMV increases, D/E increases.

According to trade-off theory, the collateral nature of tangible assets paves the way for low-cost borrowing. Therefore, it is expected that borrowing will increase as tangible assets increase. Alves and Ferreira (2011) evaluated borrowing in two ways: long-term and short-term. According to them, as the ratio of tangible assets increases, the long-term debt ratio increases, whereas the short-term debt ratio decreases.

In this study, expectations overlap with the general assumption of the trade-off theory and the findings of Alves and Ferreira (2011). The TA representing the firm's asset structure is included in the analysis as an independent variable. In this context, the third hypothesis of the study and the sub-hypotheses are as follows:

H_3: In SEOs, leverage ratios increase as tangible asset ratio increases.

- **H_{3a}:** As TA increases, D_{ST}/E decreases.
- **H_{3b}:** As TA increases, D_{LT}/E increases.
- **H_{3c}:** As TA increases, D/E increases.

According to trade-off theory, leverage ratios are expected to increase as firm size increases. Because a firm's assets increase, it can engage in long-term borrowing at easy and cheap costs. According to the pecking order theory, as the size of a firm increases, the tendency to issue equity capital increases; thus leverage ratios are predicted to decrease. In this study, the GAR, GRE and GRNS were included in the analysis, representing the size of the firm. In line with the expectation trade-off theory in the findings of this study, the leverage ratios will increase as the GAR and GRNS increase; in line with the pecking order theory, the leverage

ratios will decrease as the GRE increases. In this context, the sub-hypotheses established by the fourth and fifth hypotheses of this study are as follows:

H_4: In SEOs, leverage ratios increase as growth rates increase.

- **H_{4a}:** As GAR increases, D_{ST}/E increases.
- **H_{4b}:** As GRNS increases, D_{ST}/E increases.
- **H_{4c}:** As GAR increases, D_{LT}/E increases.
- **H_{4d}:** As GRNS increases, D_{LT}/E increases.
- **H_{4e}:** As GAR increases, D/E increases.
- **H_{4f}:** As GRNS increases, D/E increases.

H_5: In SEOs, leverage ratios decrease as GRE increases.

- **H_{5a}:** As GRE increases, D_{ST}/E decreases.
- **H_{5b}:** As GRE increases, D_{LT}/E decreases.
- **H_{5c}:** As GRE increases, D/E decreases.

According to the pecking order theory, leverage ratios are expected to decrease as liquidity ratios increase. The expectation regarding the findings of this study conforms to the pecking order theory. In this context, the sixth hypothesis of this study and the sub-hypotheses are as follows:

H_6: In SEOs, leverage ratios decrease as liquidity ratio increase.

- H_{6a}: As QR increases, D_{ST}/E decreases.
- H_{6b}: As QR increases, D_{LT}/E decreases.
- **H_{6c}:** As QR increases, D/E decreases.

In this study, FFR and DPO were included in the analysis, representing the ownership structure. Although no general conclusion could be drawn regarding the relationship between ownership structure and leverage ratios in academic studies, the expectation regarding the findings in this study is that leverage ratios decrease as FFR increases. This expectation is in line with the findings of Sayılgan and Sayman (2012) that as ownership density decreases, FFR increases, and Stulz (1988) and Mehran (1992) that leverage ratios increase as ownership density increases. Therefore, the expectation is that leverage ratios will decrease as FFR increases. Another expectation is that leverage ratios decrease will decrease as the density

of offer increases. The more the firm raises funds by investing in SEOs, the less its debt orientation will be. In this context, the sub-hypotheses established from the seventh and eighth hypotheses of this study are as follows:

H_7: In SEOs, leverage ratios decrease as FFR increases.

- **H_{7a}:** As FFR increases, D_{ST}/E decreases.
- **H_{7b}:** As FFR increases, D_{LT}/E decreases.
- **H_{7c}:** As FFR increases, D/E decreases.

H_8: In SEOs, leverage ratios decrease as DPO increases.

- **H_{8a}:** As DPO increases, D_{ST}/E decreases.
- **H_{8b}:** As DPO increases, D_{LT}/E decreases.
- **H_{8c}:** As DPO increases, D/E decreases.

According to trade-off theory, leverage ratios increase as the rate of firms benefiting from corporate tax base reductions increase. Since firms benefit from corporate tax base reductions over the funds they obtain from SEOs, firms that receive tax reductions are included in the analysis as a dummy variable, and the leverage ratios of firms that receive tax reductions are expected to increase. However, leverage ratios are expected to decrease due to the funds collected during the SEO period, and the years of the SEO are included in the analysis as a dummy variable. In this context, the sub-hypotheses established with the ninth and tenth hypotheses of this study are as follows:

H_9: SEO practices that receive tax reductions increase firms'leverage ratios.

- **H_{9a}**: SEO practices that receive tax reductions increase firms' D_{ST}/E.
- **H_{9b}:** SEO practices that receive tax reductions increase firms' D_{LT}/E.
- **H_{9c}:** SEO practices that receive tax reductions increase firms' D/E.

H_{10}: Leverage ratios decrease during the year of SEO.

- **H_{10a}:** In the year of SEO, D_{ST}/E decreases.
- **H_{10b}:** In the year of SEO, D_{LT}/E decreases.
- **H_{10c}:** In the year of SEO, D/E decreases.

Econometric Model

Within the scope of the study, three dependent variables were used, and a separate panel data model was established for each. These models are separately analyzed for capital structure ratios, which attempt to express a firm's ability to meet its short and long-term debt obligations and its total debt obligations. In this context, three different models established to explain the relationship between leverage ratios and firm-specific factors in SEOs are statistically expressed as follows:

Model 1: One-Way Random Effects Model

$$D_{ST}/E = \beta_0 + \beta_1 GAR_{it} + \beta_2 TA_{it} + \beta_3 NPM_{it} + \beta_4 ROE_{it} + \beta_5 QR_{it} + \beta_6 DPO_{it} + \beta_7 PMVlog_{it} + \beta_8 FFR_{it} + \beta_9 GRE_{it} + \beta_{10} GRNS_{it} + \beta_{11} TD_{it} + \beta_{12} ICC_{it} + u_{it}$$

Model 2: One-Way Fixed Effect Model

$$D_{LT}/E = \beta_0 + \beta_1 GAR_{it} + \beta_2 M/B_{it} + \beta_3 TA_{it} + \beta_4 NPM_{it} + \beta_5 ROE_{it} + \beta_6 QR_{it} + \beta_7 DPO_{it} + \beta_8 PMVlog_{it} + \beta_9 FFR_{it} + \beta_{10} GRE_{it} + \beta_{11} GRNS_{it} + \beta_{12} TD_{it} + \beta_{13} ICC_{it} + u_{it}$$

Model 3: One-Way Fixed Effect Model

$$D/E_{\square} = \beta_0 + \beta_1 GAR_{it} + \beta_2 TA_{it} + \beta_3 NPM_{it} + \beta_4 ROE_{it} + \beta_5 QR_{it} + \beta_6 DPO_{it} + \beta_7 PMVlog_{it} + \beta_8 FFR_{it} + \beta_9 GRE_{it} + \beta_{10} GRNS_{it} + \beta_{11} TD_{it} + \beta_{12} ICC_{it} + u_{it}$$

Research Findings

Descriptive statistics, which present the information about the variables in tabular form by showing the highest and lowest values, mean value, number of observations, and standard deviation, represent raw data. The descriptive statistics are presented in Table 2. Please refer to the appendices to Table 2.

Table 2: Descriptive Statistics

Variables	Number of Observations	Average	Standard Deviation	Smallest Value	Greatest Value
GAR	656	0.18	0.36	-0.94	4.33
M/B	653	1.77	8.37	-177.54	42.39
TA	656	0.46	0.19	0.01	0.98
D_{ST}/E	656	0.97	10.09	-202.74	42.47
NPM	656	0.00	0.25	-3.63	0.64
ROE	650	-0.01	0.92	-15.72	12.36
QR	656	1.18	1.19	0.02	9.11

Variables	Number of Observations	Average	Standard Deviation	Smallest Value	Greatest Value
DPO	656	0.25	0.14	0.00	0.82
PMV_{log}	656	17.83	1.50	14.91	23.12
FFR	656	0.38	0.21	0.04	0.98
D_{LT}/E	656	0.48	2.26	-46.30	21.38
D/E	656	1.45	11.53	-206.12	63.84
GRE	640	0.19	0.62	-0.81	9.30
GRNS	656	0.15	0.33	-0.79	4.69

Footnotes to the table: This table contains descriptive statistics for the variables used in the analysis.
These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio"*. These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales"*.

Average of the GAR 0.18; M/B 1.77; TA 0.46; the D_{ST}/E 0.97; NPM 0.00; ROE 0.01; QR 1.18; DPO 0.25; the PMV, which was included in the analysis by taking its natural logarithm, was 17.83; FFR 0.38; D_{LT}/E 0.48; D/E 1.45; GRE 0.19; and GRNS 0.15. It can be seen that the standard deviation values of all variables deviate from the mean values. This situation can be interpreted as the values of the variables within a group are not suitable for a homogeneous distribution, and the values are at different points from their mean values. It is necessary to determine appropriate analysis management by testing whether the dataset is homogeneous.

The correlation coefficient, which indicates the direction and strength of the relationship between variables, takes the value between -1 and +1. If the coefficient is positive, it indicates the same direction between the two variables; if it is negative, it indicates the opposite relationship between the two variables. The fact that the correlation coefficient between the two variables is close to 1 in absolute value indicates a strong relationship between them. For a significant correlation coefficient, the coefficient between variables is close to 0. Variables with a correlation coefficient of 0.60 or higher were excluded from the same model in this study. The correlation matrix used in this study is presented in Table 3. Please refer to the appendices to Table 3.

Table 3: Results of Correlation Analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) GAR	1.000													
(2) M/B	0.026	1.000												
(3) TA	-0.030	-0.019	1.000											
(4) D_{ST}/E	0.031	**0.920**	-0.049	1.000										
(5) NPM	0.180	0.093	-0.213	0.042	1.000									
(6) ROE	0.090	0.004	-0.038	-0.041	0.216	1.000								
(7) QR	0.012	0.007	-0.197	-0.023	0.207	0.088	1.000							
(8) DPO	0.039	-0.071	-0.182	-0.063	-0.020	-0.075	-0.004	1.000						
(9) PMV_{log}	0.105	0.102	0.090	-0.006	0.174	0.045	0.129	0.023	1.000					
(10) FFR	-0.038	-0.033	0.073	-0.014	-0.160	-0.042	0.109	-0.068	0.069	1.000				
(11) D_{LT}/E	0.050	0.482	0.110	0.567	-0.004	-0.058	-0.070	-0.020	0.043	-0.059	1.000			

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(12) D/E	0.037	**0.899**	-0.021	**0.987**	0.036	-0.047	-0.034	-0.060	0.003	-0.024	**0.693**	1.000		
(13) GRE	0.311	0.042	0.018	-0.057	0.070	0.056	-0.012	0.066	0.142	0.036	-0.040	-0.060	1.000	
(14) GRNS	0.464	0.040	-0.062	0.029	0.201	0.140	-0.048	0.026	0.120	-0.036	0.061	0.037	0.105	1.000

Footnotes to the table: This table includes the results of the correlation analysis for the variables used in the analysis.
These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio"*. These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales"*.

According to Table 3, a high correlation between the M/B variable and the D_{ST}/E – D/E variables. For this reason, M/B is not included among the independent variables in models 1 and 3. The high correlation between the D_{ST}/E and D/E was not considered because these variables were excluded from the same model.

In the application phase of the study, panel data were used, and all stages required by the panel data model were applied sequentially. The steps taken during the selection phase of the appropriate panel data model are illustrated in Chart 1.

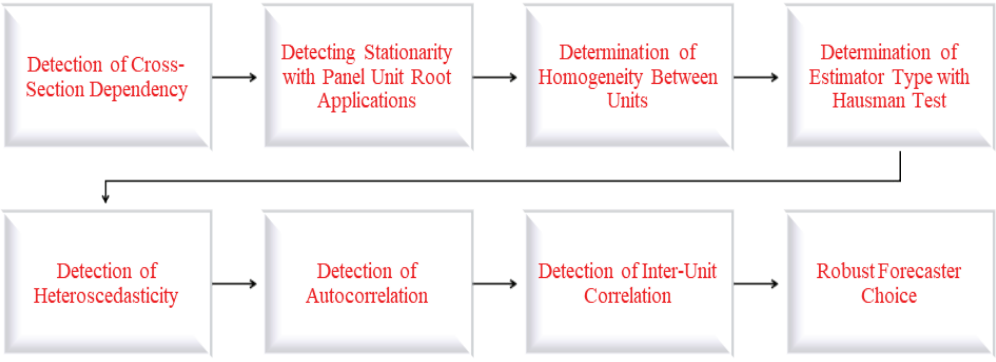

Chart 1: Steps to Apply the Panel Data Model

Cross-section dependence was determined by applying the Pesaran (2004) CD test, which is appropriate for small time dimensions and large unit sizes. The hypotheses for testing cross-sectional dependence are expressed as follows:

- **H_0:** There is no dependence between units.
- **H_1:** There is a dependence between units.

The cross-section dependence test is expressed as follows for the unbalanced panel:

$$CD = \sqrt{\frac{2}{N(N-1)}}\left[\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\sqrt{T_{ij}}\,\rho_{ij}\right]$$

According to this formula, "N" refers to the number of units. According to this formula, "N" refers to the number of units. "N(N-1)" calculates the correlation of each unit with all units other than itself. "Tij" correlation coefficient is the calculated number of observations; "Pij" refers to the correlation coefficient of the unit residues. Table 4 presents the cross-sectional dependency test results. Please refer to the Appendices to Table 4.

Table 4: Cross-Section Dependency Test Results for the Variables

Variables	Test Statistics	Probabilty Value	Variables	Test Statistics	Probabilty Value
GAR	7.64	0.00	**QR**	5.93	0.00
GRNS	12.07	0.00	**DPO**	66.8	0.00
M/B	41.30	0.00	**PMV_{log}**	70.34	0.00
TA	**0.95**	**0.34**	**FFR**	23.18	0.00
D_{ST}/E	11.83	0.00	**D/E**	14.89	0.00
NPM	3.23	0.00	**D_{LT}/E**	14.66	0.00
GRE	6.20	0.00	**ROE**	2.64	0.00

Footnotes to the table: This table contains the cross-section dependency test results.
These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio".* These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales".*

According to the results of the cross-section dependency test, the H_0 hypothesis, which is the main hypothesis, was established as *"there is no dependence between units"*. There is cross-sectional dependence in all variables except for the TA variable, and the H_0 hypothesis suggesting inter-unit independence is rejected. For this reason, while the second generation unit root test was applied to all variables with cross-sectional dependence; the first generation unit root test was applied to the TA variable, which has no cross-sectional dependence.

During the unit root tests, the Im–Pesaran and Shin (IPS) Panel Unit Root Test was used. The main feature of the IPS test is that it is based on the average of different unit root statistics. In the IPS test, the hypothesis that there is a unit root in at least one unit is tested against the hypothesis that there is a unit root in all units. The hypotheses established according to the IPS unit root test are expressed as follows:

- **H_0:** All units contain unit roots.
- **H_1:** Some units are stationary.

The IPS panel unit root test is expressed as follows:

$$\bar{t}_{bar} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}$$

According to the formula, $\bar{t}$ represents the arithmetic mean of the t-values, and the unit root is calculated according to the $\bar{t}_{bar}$ statistic. Panel unit root test results are presented in Table 5. Please refer to the Appendices to Table 5.

Table 5: IPS Unit Root Test Results

Second Generation Variables	P Value	IPS Statistics	Second Generation Variables	P Value	IPS Statistics
GAR	0.00	-13.91	**DPO**	0.00	-3.57
GRNS	0.00	-15,16	**PMV_{log}**	0.00	-3.98
M/B	0.00	-11,04	**D/E**	0.00	-30.47
D_{ST}/E	0.00	-34,65	**D_{LT}/E**	0.00	-13,26
NPM	0.00	-5.78	**ROE**	0.00	-10.49
QR	0.00	-5.69	**FFR**	0.01	-2.22
First Generation Variables	**P Value**	**IPS Statistics**			
TA	0.00	0.00			

Footnotes to the table: This table contains the unit root test results.
These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio"*. These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales"*.

According to the IPS unit root test results, the H_0 hypothesis was rejected in all variables, and the series was stationary. After determining stationarity, the Hausman test was applied in accordance with the fixed coefficient panel data model of the models for which homogeneity was determined, and the fixed and random effects models were estimated separately. The heteroscedasticity, autocorrelation, and correlation between units were determined, and the type of resistant estimator suitable for the models was determined.

In Table 6, model 1; in the presence of heteroscedasticity and autocorrelation, the estimation results show that robust standard errors with clustered standard errors are observed in the random-effects model. The F statistic is significant and R^2 is 31.4%. In other words, the independent variables explain 31.4% of the change in D_{ST}/E, which is the dependent variable. The TA, QR, and DPO have a negative relationship with D_{ST}/E, whereas the PMV has a positive relationship. One-unit changes in TA, QR, and DPO decrease by 2.66, 0.23, and 3.43 units, respectively. A 1% increase in PMV increases the D_{ST}/E by 0.34%.

In Table 6, model 2; in the presence of heteroscedasticity, autocorrelation, and inter-unit correlation, resistant standard error estimation results made with clustered standard errors are shown in the fixed-effects model. The F statistic is significant and R^2 is 46.6%. In other words, the independent variables explain 46.6% of the change in D_{LT}/E, the dependent variable. GAR, M/B, TA, GRNS, and tax deduction have a positive relationship with D_{LT}/E, whereas DPO and PMV have a negative relationship. One-unit changes in GAR, M/B, TA, and GRNS lead to increases of 0.18, 0.16, 1.65, and 0.21 units, respectively; A one-unit change in DPO causes a 1.9-unit decrease. A 1% increase in PMV reduced D_{LT}/E by 0.2%. The increase in D_{LT}/E of firms that receive tax deductions is 0.48 units higher than that of firms that do not receive tax deductions.

Table 6: Results of Panel Data Analysis on The Effect of Firm-Specific Factors on Leverage Ratios in SEOs

Estimator Type	**Random Effects**				**Fixed Effects**				**Fixed Effects**			
Resistive Estimator	**Arellano, Froot, and Rogers**				**Driscoll and Kraay**				**Driscoll and Kraay**			
Dependent Variable	**Model 1: D_{ST}/E**				**Model 2: D_{LT}/E**				**Model 3: D/E**			
Independent Variable	**Coef.**	**St. Err.**	**t-value**	**p-value**	**Coef.**	**St.Err.**	**t-value**	**p-value**	**Coef.**	**St.Err.**	**t-value**	**p-value**
GAR	0.29	0.34	0.88	0.38	**0.18**	0.05	**3.27**	**0.00*****	0.29	0.42	0.68	0.498
M/B	-	-	-	-	**0.16**	0.15	**10.70**	**0.00*****	-	-	-	-
TA	**-2.66**	1.27	**-2.07**	**0.038****	**1.65**	0.41	**4.03**	**0.00*****	0.00	1.39	0.00	0.999
NPM	0.76	1.44	0.52	0.6	0.085	0.10	0.84	0.406	0.80	1.11	0.72	0.473
ROE	-3.94	2.23	-1.76	0.078*	-0.12	0.13	-0.95	0.350	**-4.05**	1.82	**-2.22**	**0.033****
QR	**-0.23**	0.93	**-2.48**	**0.013****	0.22	0.01	1.49	0.145	**-0.12**	0.58	**-2.08**	**0.044****
DPO	**-3.43**	1.71	**-2.01**	**0.044****	**-1.91**	0.86	**-2.23**	**0.032****	-7.17	4.06	-1.76	0.085*
PMV_{log}	**0.34**	0.13	**2.66**	**0.008*****	**-0.2**	0.07	**-2.84**	**0.007*****	**0.48**	0.11	**4.23**	**0.000*****
FFR	-1.74	1.02	-1.71	0.088*	0.37	0.39	0.92	0.364	-1.99	1.22	-1.63	0.110*
GRE	-0.29	0.27	-1.07	0.287	-0.08	0.048	-1.77	0.085*	**-0.46**	0.22	**-2.11**	**0.041****
GRNS	0.42	0.23	1.83	0.067*****	**0.21**	0.044	**4.87**	**0.00*****	**0.56**	0.27	**2.05**	**0.047****
ICC_1	-0.15	0.24	-0.06	0.952	-0.10	0.07	-1.37	0.177	0.02	0.21	0.11	0.911
TD_1	-0.11	0.39	-0.28	0.778	**0.48**	0.23	**2.06**	**0.046****	0.19	0.38	0.51	0.612
Fixed	-1.57	1.71	-0.92	0.358	3.19	1.15	2.77	0.008***	-3.88	1.97	-1.96	0.056*
Number of Observations	: 640				: 640				: 640			
Number of Units	: 41				: 41				: 41			
R^2	: %31.4				: 46.6				: 24.3			
P probability value	: 0.00				: 0.00				: 0.00			
Homogeneity Test	Swamy: 0.078, Probability Value: 0.938 Delta: 0.162, Probability Value: 0.872				Swamy: -0.371, Probability Value: 0.711 Delta: -0.907, Probability Value: 0.364				Swamy: 0.845, Probability Value: 0.398 Delta: 1.757, Probability Value: 0.079			
Hausman Test	Test Statistics: 17.42 Probability Value: 0.135				Test Statistics: 22.56 Probability Value: 0.04				Test Statistics: 22.03 Probability Value: 0.04			
Levene, Brown, and Forsythe Test for Heteroskedacity	W0: 8.56 , Probability Value: 0.00 W50: 4.19, Probability Value: 0.00 W10: 5.76, Probability Value: 0.00				Test Statistics: 10053.96 Probability Value: 0.00				Test Statistics: 45045.22 Probability Value: 0.00			
Durbin-Watson and Baltagi-Wu LBI Tests for Autocorrelation	Durbin-Watson: 0.68 Baltagi-Wu: 1.21				Durbin-Watson: 0.92 Baltagi-Wu: 1.29				Durbin-Watson: 0.67 Baltagi-Wu: 1.22			
Inter-Unit Correlation-Pesaran Test	-				Test Statistics: 5.25, Probability Value: 0.00				Test Statistics: 8.99, Probability Value: 0.00			

Footnotes to the table: This table contains results of panel data analysis on the effect of firm-specific factors on leverage ratios in SEOs.

*** p<.01, ** p<.05, * p<.1 refers to statistical significance at the 1%, 5%, and 10% levels, respectively.

These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio"*. These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales"*. These dummy variables are used in the research article: *"TD: Tax Discount, ICC: Increasing Cash Capital"*.

In Table 6, model 3; in the presence of heteroscedasticity, autocorrelation, and inter-unit correlation, resistant standard error estimation results made with clustered standard errors are shown in the fixed-effects model. The F statistic is significant and R^2 is 24.3%. In other words, the independent variables explain 24.3% of the change in D/E, which is the dependent variable. ROE, QR, and GRE have a negative relationship with D/E, whereas PMV and GRNS have a positive relationship. An increase of 1% in the PMV coefficient increases 0.48% in D/E. A one-unit change in GRNS leads to a 0.56' unit increase in D/E; A one-unit change in ROE, QR, and GRE causes a decrease of 4.05, 0.12, and 0.46 units, respectively. Please refer to the appendices to Table 6.

Evaluation of Findings

The expectations regarding the hypotheses put forward in this part of the study and the compliance of the analysis results with these expectations are summarized in Table 7. Please refer to the Appendices to Table 7.

The pecking order theory suggests that as profitability increases, the need for borrowing decreases. The analysis results are consistent with this theory. Ross (1977), Friend and Lang (1988), Rajan and Zingales (1995), Megginson (1997), Booth et al. (2001), Drobetz and Fix (2003), and Huang and Song (2006) support this theory. According to the findings of this study, as firms' ROEs increase, their D/E decreases. H_{1e} hypothesis has been accepted as *"As ROE increases, D/E decreases"*. According to a general opinion, the primary preference

Table 7: Compatibility of Unbalanced Panel Data Analysis Test Results with Hypotheses

Variables	Model 1: D_{ST}/E		Model 2: D_{LT}/E		Model 3: D/E	
	Compliance of Findings with Hypotheses					
	Expectation	**Conclusion**	**Expectation**	**Conclusion**	**Expectation**	**Conclusion**
AGR	Positive	Meaningless	**Positive**	**H_{4c}/Acceptance**	Positive	Meaningless
M/B	-	-	**Positive**	**H_{2b}/Acceptance**	-	-
TA	**Negative**	**H_{3a}/Acceptance**	**Positive**	**H_{3b}/Acceptance**	Positive	Meaningless
NPM	Negative	Meaningless	Negative	Meaningless	Negative	Meaningless
ROE	Negative	Meaningless	Negative	Meaningless	**Negative**	**H_{1e}/Acceptance**
QR	**Negative**	**H_{6a}/Acceptance**	Negative	Meaningless	**Negative**	**H_{6c}/Acceptance**
DPO	**Negative**	**H_{8a}/Acceptance**	**Negative**	**H_{8b}/Acceptance**	Negative	Meaningless
PMV_{log}	**Positive**	**H_{2a}/Acceptance**	**Positive**	**H_{2c}/Rejected**	**Positive**	**H_{2d}/Acceptance**
FFR	Negative	Meaningless	Negative	Meaningless	Negative	Meaningless
GRE	Negative	Meaningless	Negative	Meaningless	**Negative**	**H_{5c}/Acceptance**
GRNS	Positive	Meaningless	**Positive**	**H_{4d}/Acceptance**	**Positive**	**H_{4f}/Acceptance**
ICC_1	Negative	Meaningless	Negative	Meaningless	Negative	Meaningless
TD_1	Positive	Meaningless	**Positive**	**H_{9b}/Acceptance**	Positive	Meaningless

Footnotes to the table: This table summarizes the Compatibility of Unbalanced Panel Data Analysis Test Results with Hypotheses. These variables are the dependent variables used in the research article: *"D_{ST}/E: Short-Term Debt to Equity Ratio, D_{LT}/E: Long-Term Debt to Equity Ratio, D/E: Debt to Equity Ratio"*. These independent variables are used in the research article: *"AGR: Growth Asset Ratio, M/B: Market to Book Ratio, TA: Tangible Asset Ratio, NPM: Net Profit Margin, ROE: Return On Equity, QR: Quick Ratio, DPO: Density of Public Offering, $PMVl_{og}$: Public Market Value of Firms, FFR: Free Float Rate, GRE: Growth Rate of Equity, GRNS: Growth Rate of Net Sales"*. These dummy variables are used in the research article: *"TD: Tax Discount, ICC: Increasing Cash Capital"*.

in SEOs has been internal funds, and debt payments have remained below the accumulated earnings, thus reducing the total debt ratio.

According to the pecking order theory, as firm's PMV increases, growth and investment opportunities also increase, and there will be a greater tendency to borrow. According to the results of the analysis, which is consistent with the theory, as firm's PMV increased, the D_{ST}/E and D/E increased. The hypotheses H_{2a} *"As PMV increases, D_{ST}/E increases"* and H_{2d} *"As PMV increases, D/E increases"* are accepted. According to these findings, the relationship between the D_{LT}/E and PMV is negative, and the hypothesis of H_{2c} *"As PMV increases, D_{LT}/E increases"* can not be confirmed. This finding does not agree with the general opinion proposed by the pecking order theory. Titman and Wessels (1988), Rajan and Zingales (1995), and Cortez and Susanto (2012) stated that firms that adopt conservative leverage policies tend to borrow less despite high growth opportunities. For this reason, it has been suggested that as growth opportunities increase, borrowing requirements decrease. The findings are in line with this prediction. As PMV increases, firms' D_{LT}/E of declines. It is observed that firms prefer short-term borrowing by structuring their long-term debts using funds obtained when the PMV increases after SEOs.

According to these findings, the relationship between the D_{LT}/E and M/B is consistent with pecking order theory. The H_{2b} hypothesis is accepted as *"As M/B increases, D_{LT}/E increases"*. This finding is also expressed in Rajan and Zingales (1995), who suggested that leverage ratios decrease in firms with equity issuance.

These findings are in line with the prediction expressed in the studies of Mıra (2005) and, Alves and Ferreira (2011) that tangible fixed assets that can be shown as collateral increase borrowing capacity and reduce the cost of long-term debt. H_{3a} *"As TA increases, D_{ST}/E decreases"* and H_{3b} *"As TA increases, D_{LT}/E increases"* hypotheses have been accepted. As firms' TA increased, the D_{LT}/E also increased, but D_{ST}/E decreased. These findings show that firms with increasing tangible assets prefer less costly, longer-term borrowing rather than short-term debt.

According to trade-off theory, when firms' growth rates are taken into consideration, growth based on assets and sales also causes trust and collateral factors to come to the fore. For this reason, depending on assets and sales growth rates, it is expected that firm's tendency to borrow money will increase. The analysis results agree with these expectations. As firm's GAR and the GRNS of firms increase, the D_{LT}/E also increases; as the GRNS increases, D/E also increases. For this reason, H_{4c} *"As GAR increases, D_{LT}/E increases."*, H_{4d} *"As GRNS increases, D_{LT}/E increases"*, H_{4f} *"As GRNS increases, D/E increases."* hypotheses are accepted. Frank and Goyal (2003) and Delcoure (2007) stated that as the size of a firm increases, agency costs decrease; accordingly, long-term borrowing with easy and cheap costs is paved. This view is also expressed in Rajan and Zingales (1995), Fama and French (2002).

Rajan and Zingales (1995) stated that the need for borrowing decreased due to firms' growth tendencies due to the capital increases and preferred to turn to equity issuance due to increasing growth requirements. This view is in line with the pecking order theory. According to these findings, H_{5c} hypothesis *"As GRE increases, D/E decreases"* was accepted.

According to the pecking order theory, firms with high solvency tend to borrow less. This prediction was also supported by Deesomsak et al. (2004), Mazur (2007), Sheikh et al. (2011), and Babu et al. (2014). The analysis results are consistent with this prediction. For this reason, H_{6a} *"As QR increases, D_{ST}/E decreases"* and H_{6c} *"As QR increases, D/E decreases"* hypotheses are accepted. In SEOs, it can be stated that firms pay short-term debt with increased liquidity, but this view cannot be generalized for long-term debt. The relationship between the D_{LT}/E and QR could not be confirmed.

The relationship between FFR and leverage ratio could not be confirmed. This finding agrees with Huang and Song (2006) that ownership structure and leverage ratios are not connected.

According to these findings, as the DPO of the firms increased, the D_{ST}/E and D_{LT}/E decline. For this reason, H_{8a} *"As DPO increases, D_{ST}/E decreases"* and H_{8b} *"As DPO increases, D_{LT}/E decreases"* hypotheses are accepted. When firms' fund inflows from SEOs were repeated, their tendency to borrow decreased. Therefore, in SEOs, it can be stated that firms' tendency to default due to equity issuances has decreased. Short and long term funding requirements are met funds obtained from SEOs.

According to the findings of this study, the prediction that firms' leverage ratios decrease during the SEO period is meaningless. However, due to SEO practices, the D_{LT}/E of firms that receive tax deductions has increased. The increase in the D_{LT}/E for these firms is compatible with the trade-off theory. For this reason, H_{9b} *"SEO practices that receive tax reductions increase firms' D_{LT}/E"* hypothesis has been accepted. According to these findings, the D_{LT}/E of firms subject to corporate tax base reduction due to SEOs has increased. The tax factor, which has an important place in the optimal leverage level, can change the direction of firms' financial resource preferences. Although the first advantage that comes to mind is that the interest expenses incurred due to borrowing can be deducted from the corporate tax base when it comes to tax advantages, it is clear that SEOs made through capital increase also create a tax advantage.

Conclusion and Recommendations

Capital structure, which has been the subject of much research with the view that perfect competition conditions cannot always be met under all conditions and the tax factor cannot

be ignored, continues research on capital structure decisions. In the studies carried out, the debt and equity preferences in firms' capital structure decisions and the existence of the optimal leverage level have formed the main point of this research. In many studies, the superior aspects of the theories have been tried to be revealed, and it has been emphasized that both theories are rivals of each other, but there are differences in the fund source preferences of firms due to firm, sector, or country conditions. Although the studies developed under the leadership of modern capital structure theories have not been able to reach a consensus on debt or equity capital preferences against firms' fund requirements, the main view is that both theories contribute significantly to the literature, and these theories should be evaluated as a whole.

When the findings of this study are evaluated, they are found to be generally compatible with modern capital structure theories. While the prediction that firms' long-term borrowing rates will increase according to trade-off theory has been confirmed, as the guarantee nature of a firm's tangible assets paves the way for low-cost and long-term borrowing, according to pecking order theory, the prediction that increased equity profitability ratios due to SEOs will decrease total borrowing rates has also been confirmed in the analysis results. While some analysis results are compatible with the predictions of the trade-off theory, others are compatible with the pecking order theory. It can be stated that the firms that go to SEO do not comply with the financial hierarchical order, and the view of benefiting from both funding sources is dominant rather than choosing between equity capital or financing through borrowing in the face of fund requirements. Therefore, instead of seeing the theories as rivals by focusing on the shortcomings or superiorities of both theories, the view that firms' fund requirement preferences can be changed by taking into account firm-specific factors and evaluating both capital structure theories as a complementary whole comes to the fore.

It can be interpreted that the efforts of firms to meet their fund needs by issuing equity capital are replaced by the corporate tax base reduction advantage provided by SEOs compared with the corporate tax base reduction advantage provided by borrowing. As a matter of fact, subjecting the amount calculated over the cash increase due to SEOs to corporate tax base reductions, SEOs are an important external fund source that provides financing with equity capital. Therefore, it is expected that the probability of repeating SEO at certain intervals in the future will increase considering firms' fund requirements.

According to the results of the analysis, the assets and sales of firms that engage in SEOs in Turkey have increased, and this increase and the benefit of corporate tax base reduction due to SEOs increase their tendency to engage in long-term borrowing. It can be stated that firms with increased SEO density have decreased short and long-term leverage ratios and pay their short-term debts by giving priority to internal fund resources due to the increased liquidity ratio.

In future studies, considering leverage ratios and country-specific factors, not limiting the sector to manufacturing firms only, and comparing firm data from different sectors in SEOs, the time interval, including before and after the SEO evaluation quarterly, and including a longer time period in the research may be important to review the findings more generally.

There are no academic studies in Turkey on the capital structure of SEOs. For this reason, regarding SEO transactions, whether the changes in the capital structures of firms before and after public offering transactions cause a difference when certain maturities are considered and when the purposes of use of the funds obtained through SEOs are considered, it is possible to make a more comprehensive evaluation.

Considering the low number of SEOs in Turkey, it is seen that some firms do not conduct SEOs after the IPO, while some firms conduct SEOs and repeat their SEOs at regular intervals. Changes in the capital structures of firms that did not participate in SEO after the IPO and those that did participate are also seen among the subjects worth researching.

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RESEARCH ARTICLE

The Impact of Fintech on Economic Growth: Evidence from Panels of Turkic and Southeast Asian Countries

Aydın Gürbüz[1], Meltem Kılıç[2], Emre Tatlıyer[3]

Abstract

From the beginning of the 21. century, the whole world has witnessed huge changes because of technological improvements and revolutionary inventions. It can be inferred that technological developments affect mankind in terms of many aspects like cultural, psychological, social etc. and these impacts reflect on our lives much more immediately than in past times. One of these impacts can be observed in economic and financial platforms. Financial technology has recently attracted great interest. The cause of this situation may be said to be Fintech becoming a global phenomenon. Therefore, many researchers have tended to investigate the impact of technological improvements on economic growth. This study attempts to evaluate the impact of financial technological improvements on economic growth between 2000 and 2020 for Turkic and selected Asian countries. In obtaining results, panel data analysis has been used. The results indicate that internet usage rates and fixed broadband subscriptions have positive impacts on economic growth. However, mobile cellular subscriptions do not have any impact on economic growth. According to the findings, information-communication technologies and other macroeconomic factors positively affect economic growth.

Keywords

Turkic countries and selected Asian countries, Panel data analysis, Fintech, Economic growth, Communication technologies

Introduction

From the beginning of the millenium era, dazzling developments have been seen in almost every aspect of human life. It does not seem like wrong to claim that these developments have been observed, especially in communication and information technology fields. Because of technological improvements and revolutionary inventions, the whole world has witnessed huge changes and a paradigm shift. Communication and information technologies simplify information circulation and thus have direct effects on humankind in terms of many aspects like cultural, economical, psychological and social etc. (Kurniawati, 2021; Badwan & Awad, 2022).

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If it is described, it can be stated that "*Fintech*" is a branch of service sector that benefits from mobile-based information technology to increase the efficiency of financial systems. Another definition that might be verbalised is "*internet finance*" or "*digital finance*", which comprises all shapes of financial transactions/operations, markets and intermediaries. When we look at the etymological origins, as a term, "*Fintech*" is a composition of "finance" and "technology" words and corresponds to industrial innovation that emerged from the combination of financial services and information technology (Schueffel, 2016). With respect to the contribution of economic growth and value creation; it may be seen that developments in the field of financial technology and communication-information technology, such as electronic banking, e-commerce, mobile devices, wireless networks, Internet of things, artificial intelligence, cloud computing, and blockchain, have enormous and revolutionary impacts recently (Sassi & Goaied, 2013; Song & Appiah-Otoo, 2022; Awais et al., 2023). It was not thought wrong to claim that; Fintech will give shape business processes/models, subvert conventional financial operations/products, and bring a brand new breath by providing a unique business perspective in the millennium (Bu et al., 2022; Awais et al. 2023).

Fintech and communication-information technologies (CIT) augment the accessibility of information, shape new communication methods, and, as a result, increase the efficiency of many distinct financial and economic activities (Kurniawati, 2021). In terms of innovation perspective, CIT can be seen as a broad innovation type of financial service and technological progress, combining technological-product-resource allocation innovations. Through the Fintech, both information transparency and effective distribution of resources have increased however information asymmetry that causes improper market functioning has been mitigated. Fintech may also facilitate turning savings into investment and effective capital use. Therefore, it may be claimed that economic growth of countries or households has effected in an affirmative direction via these technologies (Bu et al., 2022).

Due to rapid developments in communication and information technologies, the number of Internet users continues to grow worldwide. According to data from the International Telecommunication Union, as of 2022, nearly 5.3 billion people - approximately 66% of the world's population - have been using the Internet. This indicates a 24% increase since 2019 and indicates that 1.1 billion people were predicted to have come online during that period, as well (International Telecommunication Union, 2023). According to data of Brimco; market size of global digital transactions was $5.44 trillion in 2020, and by year 2026, it was predicted to be worth $11.29 trillion. It is also predicted that the Fintech industry will reach $ 11.8 billion (by year of 2018) to approximately $306 billion (by year of 2023). In 2021, more than a hundred million people benefited from the opportunity of "*proximity mobile payment*". According to Getapp, proximity mobile payments can be described as a type of payment method for goods or services, which a customer uses (via Near Field Communication-NFC technology) his/her mobile phone or other smart device. According to the same data of Brimco, in

year of 2020, 90% of smartphone users involved in a mobile payment and mobile payment market ran up to a value of more than $1 trillion all over the world. It is projected that mobile transactions will continue to grow, and 60% of customers look to transact or communicate with their financial institutions via a single platform, for example, a mobile application. Additionally, since 2019, the rate of cash usage at all sales points has decreased by 42%.

Nowadays, in which we stand on the edge of 4th industrial revolution, Fintech makes it easier and cheaper for people to access financial services, via computer/Internet technologies and mobile phone applications, in comparison to traditional financial service types. Thanks to these technologies, more people can enter money and capital markets, and consequently economic-financial growth has increased globally (Shkarlet et al., 2018; Shen et al., 2021).

We believe that the Turkic countries of Turkey, Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan, with their common cultural and historical ties, can form a meaningful group to compare the effects of Fintech on economic growth. These similarities allow for a consistent analysis of Fintech's effects on economic growth. In addition, countries such as China and India, which are among the world's largest economies, and Indonesia, Pakistan, Tajikistan, and Russia, which are emerging markets and have a large geographical and economic impact, provide a suitable basis for assessing the role of Fintech in economic growth on a global scale. China, in particular, a leader in mobile payment systems and digital banking, while in regions such as India and Indonesia, Fintech is seen as a critical tool for bringing financial services to the unbanked population through digital platforms. The impact of Fintech on economic growth can be understood through many factors, such as organisational innovations through the development of Information and Communication Technologies (ICT), productivity growth, efficiency of market transactions, new business opportunities, social and cultural changes, and education and knowledge management innovations. These factors allow us to assess Fintech's contribution to economic growth from a broad perspective. For this reason, we selected the Turkic countries and strategically and economically important countries such as China, India, Indonesia, Pakistan, Tajikistan, and Russia. Moreover, studies by Omer (2021) and Razzag (2024) revealed the importance of Fintech in these regions. In short, Fintech is thought to increase economic prosperity in these countries that are endowed with many resources.

In this context, Fintech's worldwide enourmous progress has strengthened our hands. Therefore, we think that in 2000-2020 period, a nexus between Fintech usage of the Turkic World countries and selected some Asian countries and economic growth worths researching on it for our aforementioned study. The rest of our study has been organised as; in the second part, existing literature, in the third part, variables and data set used in the study, and in the fourth part, findings of the research have been mentioned. In the fifth and last part, the results were evaluated and provided some advices.

Literature Review

Although the impact of the Fintech sector, which is named as communication and information technology, on economic growth has been accepted for many years, this impact has been felt much more seriously on a global scale in recent years. It is stated that the important elements that have made Fintech popular late are; technological progresses, changing customer demands and macroeconomic effects. Solow, (1956), In the study, also recognised as the "Solow Theory", Solow indicates that promoting technological developments will enhance income in the current labour market, and with that, innovations created by the real sector due to technological progress will have a significant impact on economic growth. On the other hand, Romer (1990) stated that technological change in the growth model is endogenous, and technological improvements guide investment decisions. Therefore, he asserted that technological improvements will direct economic growth. Bai and Ding (1998), held the view that technological innovations impact financial development in a positive manner and support economic growth. Pohjola (2001) also found that, given the importance of both human and physical capital and similar economic factors, both developing and developed countries will need information technology to promote economic growth. Jorgenson and Vu (2005), examined the influence of investments in information technology on economic growth in the world's 14 largest economies between 1989 and 2003. From that study, they find that technological investments greatly affect economic growth. Additionally, in their study, they determined that this effect was more prominent in the G7 countries and that developing Asian countries followed the G7 countries.

The vast majority of the studies in the literature show that the impacts of financial technologies (Fintech) on economic growth have a positive direction (Madden & Scott, 2000; Torero et al., 2002; Nasab & Aghaei, 2009; Yapraklı & Sağlam, 2010; Anthony & Patrick, 2013; Ishida, 2015; Salahuddin & Gow, 2016; Khan et al., 2020; Cumming & Schwienbacher, 2021). According to the research conducted by Garces and Daim (2012) in the United States, communication and information technology has an affirmative effect on economic growth. In the study of Yılmaz & Kırışkan (2017), conducted in Türkiye, it's claimed that communication and information technology is a crucial element for economic growth. Sadigov et al., (2020) stated that, advances in Fintech support economic growth by increasing real sector financing. According to Kurniawati (2021), communication and information technologies have a significant effect on economic development in high income level and middle income level Asian countries. Kurniawati also stated that improving CIT infrastructure in middle-income Asian countries is necessary to further expedite economic growth. Song and Appiah-Otoo (2022), clearly indicate that Fintech is a basic determinant of China's economic growth. Badwan and Awad (2022) stated that the growing use of financial technology in Palestine contributes to economic growth. Naeruz et al. (2022), also specified that financial technological advances have an affirmative effect on Indonesia's economic growth. Between 1995 and 2008, Türedi

(2013) attempted to determine the effect of information and communication technology on economic progress in 53 countries, 23 developed and 30 developing. The study in which the sample was quite wide, Türedi benefited from the panel data analysis. The result of the empirical analysis indicates that the use of CIT in both developed and developing countries has a positive impact on economic growth. Erumban and Das (2016) targeted to reveal the role of CIT in routing economic growth in India between 1986 and2011. In their studies, they divided the usage areas of CIT into manufacturing and service sectors. According to the results, it can be seen that the use of CIT in India enhances economic efficiency. Another important finding in the aforementioned study is that the weight of CIT used in the service sector is higher than that used in other sectors. Toader et al. (2018) discovered, that the prevalence of CIT in European Union countries between 2000 and 2017 is an important factor in economic growth. Romdhane et al. (2020), between 2001 and 2017, examined the relationship between Fintech usage and economic boost for 21 African countries. Findings demonstrate that financial and technological developments stimulate growth in African countries. Nair et al. (2020) examined the impact of CIT infrastructure on economic growth in OECD countries. According to the empirical findings, the progress of CIT makes a long-term contribution to economic growth. Kirayeva et al. (2021) evaluated the impact of financial technologies on economic growth in the period of 2004-2019. The country groups in their research comprise selected countries from the EU, CIS (Commonwealth of Independent States) and economies in transition. As a consequence of their research, they documented a significantly increased usage of Fintech in the countries examined. In the examined period, additionally, with the transformation in financial technology, researchers determined that there was downsizing in physical (numbers of bank branches) fields by transferring the financial transactions of the countries to the digital environment. As a result, they verified that a strong link exists between financial technologies and economic progress.

Bu et al. (2022) evaluated the effect of Fintech improvements in China on real economic progress using panel data analysis. Due to this study, it has been demonstrated that Fintech usage has crucial and encouraging dimensions to economic growth. Utami (2022) analysed Fintech's impact on economic growth in Indonesia between the years 2020-2022. The empirical results indicate that Fintech has a significant affirmative impact on economic development. In the research carried out by Gomes et al. (2022), the impact of Fintech on economic growth in OECD countries tried to be determined. In this research, 36 OECD countries were divided into groups according to their level of development between 2000 and 2019, and the GMM panel method was applied. The result of that study shows that Fintech usage has a significant effect on economic growth in OECD countries. In this respect, the cruciality of Fintech usage was emphasised to policy makers in terms of economic revival.

Even though it has been confirmed in the literature that the connection between Fintech and economic growth is affirmative, there are some studies that also stated the opposite or that

there is no relationship between them. For example, Li et al. (2009) examined the nexus between fintech and economic growth in the Chinese economy. But, according to the results of their study, they could not identify any connection between Fintech and economic growth. Nabi et al. (2022) aimed to reveal the impact of CIT usage on economic growth for N11 (Next Eleven) countries in the 2000-2018 period. It has been identified that there is a negative correlation between the increasing use of CIT in N11 countries and economic growth in the examined period.

Although our study focuses on the nexus between Fintech and economic growth, we think that the impact of control variables, as well, in the model on economic growth need not be neglected. Studies in the literature claim that economic growth is positively affected by gross fixed capital formation (GFCF) (Ali, 2017; Boamah et al. 2018; Pasara & Garidzirai, 2020), general government final consumption expenditure (GOV) (Gomes et al. 2022; Poku et al. 2022), financial development (FG) (Salahuddin et al. 2016; Gow, Kurniawati, 2022).

This study focuses on the nexus between Fintech usage and economic growth in the Turkic and selected Asian countries. In the literature, it is seen that in most studies examining the linkage between Fintech and economic growth, a single criterion is used as the Fintech indicator. On the other hand, limited number of studies have focused on mobile cellular subscriptions, fixed broadband subscriptions and internet usage rate measurements as Fintech indicators. In addition, existing studies in the literature neglect the causal relationship between Fintech and economic progress. Finally, almost no studies have evaluated the impact of Fintech usage on economic growth from a wide perspective in countries in the Turkic world. Thus, our study not only enrichs the existing literature but also contributes to the literature by investigating the impacts of various Fintech indicators on economic growth for countries in the Turkic world and selected Asian countries.

In his neoclassical growth theory, Solow (1956) argued that information and communication technologies (ICTs) promote economic growth through technological advances and improved labour quality. However, Solow considered these technological developments as exogenous factors. Recent empirical studies, on the other hand, have examined the effects of the internalisation of technological innovations on economic growth, and these findings have been associated with endogenous growth theory (Ehrlich, 1990:9). In this context, the impact of Fintech, which is an important part of ICT, on economic growth can also be explained by endogenous growth theory. Therefore, researchers generally emphasised that ICT has a significant impact on the economic growth of countries (Choi and Yi, 2009; Andrianaivo and Kpodar, 2011; Farhadi, et al. 2012).

In this direction, we aim to test the impact of Fintech on the economies of the Turkic countries and some selected Asian countries in our study, based on the following hypotheses that we have developed inspired by various studies in the literature (Bahrini and Qaffas, 2019; Mayer, et al. 2020) that examined the effects of Fintech on economic growth:

H_1: Mobile cellular subscriptions have an affirmative impact on the economic growth of Turkic and selected Asian countries.

H_2: Fixed broadband subscriptions have an affirmative impact on the economic growth of Turkic and selected Asian countries.

H_3: Internet usage rates have an affirmative impact on the economic growth of Turkic and selected Asian countries.

Data Explanation

Information and communication technologies are expressed using monetary and non-monetary indicators. While monetary indicators comprise information and communication technology investments, non-monetary indicators are measured using numerical information such as mobile cellular subscriptions and fixed broadband subscriptions (Hu et al. 2021; Iqbal et al. 2022).

The aim of this research is to evaluate the effect of Fintech, which refers to information and communication technology, on the economic growth of countries in the Turkic world and some Asian countries between 2000 and 2020. Within the scope of the study, country data from Azerbaijan, China, Indonesia, India, Kazakhstan, Kyrgyzstan, Uzbekistan, Pakistan, Russia, Türkiye and Tajikistan were collected. Because Fintech data of Turkmenistan, a Turkic country, could not be accessed, this country was excluded from the sample. In addition, the reason why the study ended in 2020 is that, Fintech data of the countries within the scope of the study were published until this year. In the context of non-monetary indicators of CIT as a Fintech criterion; mobile cellular subscription (per 100 people) (LMOB), Internet use (% of Population) (LINDI), and fixed broadband subscriptions (per 100 people) (LFBROAD) were used. The dependent variable of the research was the gross domestic product per capita (Fixed 2015 US$) (LGDP). The financial development index (LFG), gross fixed capital formation GDP (LGFCF) and general government final consumption expenditures (% of GDP) (LGOV) are also involved in the model as control variables. Among the data used in this study, the financial development index is provided by the International Monetary Fund's (IMF) database at www.data.imf.org, while other data are provided by the World Bank's database Data Bank's official website www.data.worldbank.org.

Model Specifications

For examining the impact of fintech on economic growth; the below defined econometric model was developed by benefiting the studies of Hafru, 2019; Adeleye & Eboagu, 2019; Kurniawati, 2022; Iqbal et al. 2022; and Gomes et al. 2022:

$$LGDP_{it} = \beta_0 + \beta_1 * LMOB_{it} + \beta_2 * LINDI_{it} + \beta_3 * LFBROAD_{it} + \beta_4 * LGFCF_{it} + \beta_5 * LGOV_{it} + \beta_6 * LFG_{it} + u_{it} \quad (1)$$

In this model, i denotes the country, t denotes the time, β denotes the coefficient, and u_it denotes the error term. Additionally, the symbol L in the model indicates that the variables are logarithmic series.

Methodology

Panel data regression and panel causality analyses were used to examine the connection between information and communication technologies (Fintech) and economic development in the Turkic world and selected Asian countries between 2000 and 2020. In order to perform panel data regression analysis and causality analysis, we first checked whether the series contained cross-sectional dependence and whether they were stationary. Cross-sectional dependence analysis of the series (Pesaran, 2004) was examined using the CD test. Whether there is cross sectional dependance in the CD (*Pesaran, General Diagnostic*) test, is tested with "*H0: There is no cross-sectional dependence (H_0:ρ_ij=0)*" (Tatoğlu, 2018). If the series include cross-sectional dependence, the stationarity of the variables is analysed using the second-generation panel unit root test and the cross-sectionally augmented LM, Pesaran and Shin (CIPS). The CIPS test designed by Pesaran is a simple alternative method expanded by standard augmented Dickey-Fuller (ADF) regressions with cross-sectional means of lagged levels and first differences of individual series (Pesaran, 2007). The CIPS stationarity test is applied as "*H0: Series is not stationary (Contains unit root).*" The cross sectional dependence and panel unit root test results are presented in Tables 3 and 4.

In static panel data regression analysis, pooled ECT, fixed effect and random effect models are frequently used. To select among these estimators; F Test which was developed by Moulton and Randolph, Breush-Pagan Lagrange Multiplier (LM) Test and Hausman Test were performed. The null hypothesis of this test is "*H_0: All unit and time effects are equal to zero (H_0:μ_i=λ_t=0)*." (Tatoğlu, 2020). Using the F Test, a decision is made between the pooled least squares and fixed effects models. The Breush-Pagan LM test is estimated with the hypothesis applied as parametric constraints. Using the LM Test, the regression is calculated by using the residuals of the model estimated by using the least squares test (Breush and Pagan, 1980).

In the Breush-Pagan LM test, hypothesis testing is performed in the form of "*H_0: The variance of unit effects is zero (H_0:σ_μ^2=0).*" (Tatoğlu, 2020). Breush-Pagan LM test is made for deciding between the pooled least squares and random effects models. The Hausman test

is designed under the null hypothesis of misidentification and is developed for model specification. This test is performed to test the instrument variable, time section model and simultaneous equation model (Hausman 1978: 1251). The null hypothesis of this test is "H_0*: Difference between parameters is not systematical.*" (Tatoğlu, 2020). The Hausman test was used to select the appropriate model from the fixed-effects and random-effects models. These three estimator tests are presented in Table 5. After deciding on the regression model according to the results of the Hausman test, F test and Breush-Pagan test, assumption tests are run to determine whether there is a heteroscedasticity, autocorrelation and cross-sectional dependence problem in the model.

The main assumption tests in panel data models are the Levene, Brown and Forsythe Multiplier Test, Durbin-Watson and Baltagi-Wu local best invariant (LBI) tests and the Frees Test. The Levene, Brown and Forsythe tests are derived to test the inequality of variances. In other words, it tests the presence of heteroscedasticity. The null hypothesis of this test is established as "H_0*: The variances of the units are equal.*". The tests applied to the auto-correlation problem are Durbin-Watson and Baltagi-Wu LBI tests. In these tests, a critical value close to 2 indicates that there is no auto-correlation problem. The test hypothesis is established as "H_0*: There is no auto-correlation*." (Tatoğlu, 2020). Frees developed the test that examines the existence of a cross-sectional dependence. The model tests the hypothesis that there is no cross-sectional dependence (Frees,1995). The results of the assumption tests are presented in Table 6.

According to the results of the panel data assumption tests, we found that the model exhibits heteroskedasticity, autocorrelation and cross-sectional dependence problems. Taking these three problems into account, a model estimation was made using the Driscoll-Kraay Robust Estimator. Driscoll-Kraay Test, which is a simple extension of the common non-parametric covariance matrix estimation technique, yields standard error estimates that are robust to all general forms of spatial and temporal dependence as the time dimension grows (Driscoll-Kraay 1998). In this study, the regression created by robust estimation is described in Model (1) and the results are displayed in Table 7.

After determining the impact of Fintech indicators on economic growth, the relation between the dependent variable and independent variables is evaluated with Dumitrescu-Hurlin Panel Causality Test. Dumitrescu-Hurlin's hypothesis testing is established as "H_0*: X is not the cause of Y.*" (Dumitrescu & Hurlin, 2012). The panel causality test results are summarised in Table 8.

Findings

The descriptive statistical analysis of the series used for the sample to determine the impact of Fintech on economic growth in the Turkic and selected Asian countries is displayed in Table 1. The results of the correlation analysis exhibiting the multicollinearity between dependent and independent variables are presented in Table 2.

Table 1
Descriptive Statistics

Variables	Observation	Mean	Standart Deviation	Minimum	Maximum
LGDP	231	7.9219	0.9334	6.0645	9.3986
LMOB	231	3.5620	1.7393	-3.9904	5.1749
LINDI	231	2.5101	1.5589	-3.0241	4.4536
LBROAD	231	0.6851	2.9959	-8.8057	3.5244
LGFCF	231	3.2770	0.3159	2.2123	4.0602
LGOV	231	2.5348	0.2611	1.8767	3.0343
LFD	231	1.3716	0.6429	-2.8739	-0.3977

In this study, there are 231 observations between 2000 and 2020. The variable with the highest average is LGDP at a rate of 7.92%, while the lowest is LBROAD at a rate of 0.68%. On the other hand, LBROAD had the highest standard deviation 2.99%, while LGOV had the lowest standard deviation 0.26%. The variable with the lowest minimum value is LBROAD and the variable with the highest minimum value is LGDP. While LGDP has the highest maximum value, LFD has the lowest maximum value. In addition, when having looked at the Fintech sub-metrics, LMOB variable has the highest average (3.56%) and LBROAD variable has the lowest average (0.68%). After explaining the descriptive statistics of the variables used in the model, the relationships between the variables were tested using Spearman's rank correlation test. Spearman's rank correlation test examines the relationship between two non-uniform heterogeneous series (Spearman, 1904). The results of this test are summarised in Table 2.

Table 2
The Results of the Spearman's Rank Correlation Analysis

	LGDP	LMOB	LINDI	LBROAD	LGFC	LGOV	LFD
LGDP	1.0000						
LMOB	0.7029*	1.0000					
LINDI	0.7502*	0.8873*	1.0000				
LBROAD	0.6832*	0.3431*	0.3933*	1.0000			
LGFCF	0.1724*	0.32483*	0.2259*	0.1231	1.0000		
LGOV	0.1304**	0.1700*	0.2522*	0.4365*	0.0936	1.0000	
LFD	0.6469*	0.2506*	0.3185*	0.3824*	0.2980*	0.1062	1.0000

Note: * and ** indicate significance levels of 1% and 5%, respectively

To the result of the correlation analysis, there was a high correlation between LGDP and LMOB (0.7027 for a p<1%). There was a high correlation between LGDP and LINDI (0.7502 for a p<1%) and between LGDP and LBROAD (0.6832 for a p<1%). There are statistically significant but weak correlations between LGDP, LGFCF and LGOV. There is also a high correlation between LGDP and LFD at 0.6469. There was a very high correlation between LMOB and LINDI (0.8873 for a p<1%). There is a weak correlation between LMOB and LBROAD, LGFCF and LFD, whereas the correlation between LMOB and LGOV is very weak. The correlation coefficients between LINDI and LBROAD, LGFCF, LGOV and

LFD indicate a weak relationship. There was a moderate correlation between LBROAD and LGOV (0.4365 for a p<1%). There was a weak correlation between LBROAD and LGFCF with LFD.

Following the correlation and descriptive statistics analyses, a cross-sectional dependence analysis and panel unit root tests used in series are performed. Pesaran CD cross-sectional dependance test results are summarized in Table 3.

Table 3
Results of Cross-Sectional Dependence Test

	CD-Test	**Prob.**
LGDP	32.41*	0.000
LMOB	33.23*	0.000
LINDI	32.19*	0.000
LBROAD	30.53*	0.000
LGFCF	7.19*	0.000
LGOV	3.77*	0.000
LFD	12.55*	0.000

Note: * indicates significance at 1%

According to the result of the Pesaran CD test, it was detected that both dependent and independent variables consist of cross-sectional dependence. In other words, the null hypothesis was rejected and it was concluded that a cross-sectional dependence exists. In order to determine whether the series with cross-sectional dependence are stationary, the cross-sectional augmented panel unit root IPS (CIPS) test developed by Pesaran (2007), taking into account cross-sectional dependence, is used as the second generation panel unit root test.

Table 4
Results of the CIPS (Intercept) Unit Root Test

Variables	**Level**	**Δ**
LGDP	-2.178***	-2.350**
LMOB	-3.175*	-3.484*
LINDI	-2.300**	-3.921*
LBROAD	-3.094*	-2.707*
LGFCF	-2.766*	-3.013*
LGOV	-2.386*	-3.231*
LFD	-2.171***	-3.112*

Note: *, **, and *** indicate significance levels of 1%, 5%, and 10%, respectively.
Critical values at 1%, 5%, 10% significance are as follows: 2.45, 2.25, 2.14 (Pesaran, 2007).

To the results of the CIPS panel unit test, we determined that all of the series were stationary at different levels of significance. That is, it was concluded that all variables used in the study were I(0).

Since the series are stationary a level, it was decided to perform panel regression analysis in the study. The estimator tests are used to decide which panel regression analyses from the

Pooled LS, Fixed-Effect Model and Random-Effect Model tests will be applied. The results of the panel data regression estimator tests are exhibited in Table 5.

Table 5
Results of Panel Regression Estimator Tests

	F Test		Breush-Pagan LM Test		Hausman Test	
	F. Statistical Value	**Probability Value**	**Chibar2**	**Probability Value**	**Chi2**	**Probability Value**
Model	818.35*	0.000	1971.74*	0.000	2.83	0.830

Note: * indicates significance level of 1%

According to the results of the F test, the null hypothesis was rejected and it was determined that all unit and time effects were not equal to zero. This result shows that using the Pooled LS model is not suitable for the established model. According to the results of Breush-Pagan LM test, the hypothesis that the variance of unit effects is equal to zero is rejected. To the result of hypothesis testing using the LM test, it was decided that the Random-Effect Model must be preferred. According to the results of the Hausman test to decide between the Fixed-Effect Model and Random-Effect Model, the null hypothesis was accepted and it was inferred that the difference between the parameters was not equal. Additionally, it was decided that the most suitable test among the regression analyses was the Random-Effect Model estimator. In order to determine whether there is heteroskedasticity, autocorrelation and cross-sectional dependence in the Random-Effect Model assumption tests were performed.

Table 6
Results of Panel Regression Assumption Tests

Heteroskedasticity Test		
	Test Statistics	**Prob. Value**
W0	12.968*	0.000
W50	10.250*	0.000
W10	12.750*	0.000
Cross-Sectional Dependance Test		
Frees	2.442**	
Results of Autocorrelation Test		
Modified from Bhargava et al. Durbin-Watson	0.228	
Baltagi-Wu LBI	0.373	

Note: * indicates significance level of 1%. ** Frees critical value alpha = 0.10:0.1231, 0.05:0.1611, 0.01: 0.2338

According to the consequences of the assumption tests, the null hypothesis for heteroscedasticity and cross-sectional dependence in the model was rejected. Based on the results obtained, it was decided that the variance of the units was not equal to zero and a correlation was observed between the units. Additionally, since Durbin-Watson and Baltagi-Wu LBI test values were far below 2, it was concluded that there was an autocorrelation problem in the model. From the results of the assumption test, we conclude that the model established comprises all three problems. In order to eliminate these problems, the model must be estimated using robust methods. The most suitable estimator, considering the heteroskedasticity,

autocorrelation and cross-sectional dependance problems, is the Driscoll-Kraay Robust Estimator method. The coefficient results of the model established by considering the estimation method are explained in Table 7.

Table 7
Results of the Random Effect Driscoll-Kraay Robust Estimator Test

	Coefficient	Driscoll-Kraay Standard Error	Probability Value
LMOB	-0.0092	0.0179	0.613
LINDI	0.1266*	0.0152	0.000
LBROAD	0.0402*	0.0081	0.000
LGFCF	-0.2925*	0.0493	0.000
LGOV	-0.0579	0.0964	0.555
LFD	0.2679*	0.0899	0.007
CONSTANT	9.1379*	0.2752	0.000
Wald Chi2	5857.77*		
Probability	0.0000		
R2	0.1259		

Note: *indicates significance level of 1%

Obtained Driscoll-Kraay robust estimator results demonstrate that the model is statistically significant. On the other hand, if we examine the impact of Fintech indicators on GDP we found that the impact of the LINDI variable on LGDP is positive and statistically significant at the 1% level. While this result shows that a 1% increase in internet usage rates increases the economic growth of the Turkic and selected Asian countries by 12%, it also confirms the hypothesis H_2 established in the hypothesis development section. Similarly, the effect of LBROAD on LGDP is positive and statistically significant at the 1% level. This result means that fixed broadband subscriptions have an increasing effect on the economic growth of the Turkic and selected Asian countries by approximately 4%, whereas the H_3 hypothesis established in the hypothesis development section will be accepted. On the other hand, unlike the existing studies, we reject the H_1 hypothesis established in the hypothesis development section and observe that mobile cellular subscriptions have no impact on the economic progress of the Turkic and selected Asian countries. Nevertheless, we think that it is not wrong to state that this situation does not undermine the economic consistency of our analysis.

In the model, after examining the nexus between Fintech indicators and economic growth, if we look at the impact of control variables on GDP, it has been revealed that the effect of gross fixed capital formation (LGFCF) on LGDP is negative and statistically significant, and financial development (LFD) has a positive effect on LGDP. Finally, we conclude that general government final consumption expenditures (LGOV) have no effect on LGDP. The discussion of the findings obtained within the scope of the study is presented in the conclusion section.

After examining the impact of Fintech indicators and control variables on economic growth in our study, we applied the Dumitrescu and Hurlin Panel causality test to examine

the causal relationship between the variables. Table 8 presents the Dumitrescu and Hurlin Panel causal relationship results.

Table 8
Results of the Dumitrescu and Hurlin Panel Causality Test

	W-Stat	Zbar-Stat	Olasılık
LMOB <=> LGDP	5.0827	3.3029	0.0010*
	3.9289	1.9168	0.0553**
LINDI <=> LGDP	4.7497	2.9028	0.0037*
	9.9395	9.1374	0.0000*
LGDP => LBROAD	2.8505	0.6213	0.5344
	14.8341	15.0174	0.0000*
LGDP => LGFCF	3.0137	0.8174	0.4137
	6.7756	5.3366	0.0000*
LGDP => LGOV	3.0676	0.8821	0.3777
	7.0112	5.6196	0.0000*
LGDP => LFD	1.2354	1.3189	0.1872
	6.0050	4.4108	0.0000*

Note: *and ** indicate significance levels of 1% and 5% respectively

According to the causality findings, a bidirectional causal relationship between mobile cellular subscriptions (LMOB) and economic growth (LGDP) occurs. Likewise, there exists a bidirectional causal relationship between Internet usage rates (LINDI) and economic progress (LGDP). There is also a one-way causal relationship from economic progress (LGDP) to fixed broadband subscriptions (LBROAD). These results prove that a causal relation between Fintech and economic growth exists. On the other hand, our results show that, there's one-way causality from LGDP to LGFCF, LGDP to LGOV and LGDP to LFD.

Conclusions

This study is conducted in order to reveal the impacts of Fintech indicators, called information and communication technology, on the economic development of the Turkic countries and some selected Asian countries. In this direction, within the scope of the study, first of all the descriptive statistics of the series were evaluated and correlation analysis was performed. Then, the Pesaran CD test was applied to test the cross-sectional dependence of the series, and as a result of the test, it was specified that the series included cross-sectional dependence. The CIPS panel unit root test was then applied to determine the stationarity of the series in the model. To the results of the CIPS unit root test, it was determined that all series were stationary at level. In order to determine the appropriate panel data regression analysis for the stationary series, some estimator and assumption tests were performed. To the result of the estimator tests, it was determined that the most suitable model for the study was the Random Effect model. Due to the heteroskedasticity, autocorrelation and cross-sectional dependance problems arise in the Random Effects Regression Model, our model was tested using the Dris-

coll-Kraay Robust Estimator. According to the robust estimation results, internet usage rates and fixed broadband subscriptions have positive effects on the economies of the Turkic world and certain Asian countries. These findings in line with the results of recent studies indicating that increasing internet usage rates can positively affect economic growth. Salahuddin and Gow (2016) for South African countries, Gomes et al. (2022) for OECD countries Kurniawati (2022) for Asian countries found similar findings. In addition, there are studies suggesting that high levels of fixed broadband subscriptions positively impact economic growth. Toader et al. (2018) for European countries, Nair et al. (2020) for OECD countries, and Badwan and Awad (2022) for Palestine produced parallel results in this regard. In this context, according to the findings of both our study and other studies in the literature, improving the ICT skills of internet users, especially in developing countries, is critical in terms of supporting economic growth and development (Haftu, 2019). On the other hand, it is concluded that financial development, one of the control variables included in the model, has a positive effect on economic growth. This result is consistent with Pasara and Garidzirai (2020) and Nchake and Shuaibu (2022). However, it is observed that the effect of gross fixed capital investments, one of the control variables, on economic growth is negative. There may be several reasons for the negative impact of gross fixed capital investments on economic growth: Low capital formation resulting from slow growth in some countries in the sample of the study, differences in the amount of investment expenditures, inefficient use of investments or low productivity, overcapacity creation, high debt burden, global economic shocks and problems in investment quality may lead to these negative effects. Moreover, Collier and Gunning (1999) argued that one of the main reasons for poor growth performance is low investment.

In this study, causality connections between the variables were also examined with the Dumitrescu and Hurlin Test, and the results of the test showed that there was a bidirectional causality between internet usage rates and economic development. In addition, it was concluded that there's a bidirectional causality between mobile cellular subscriptions and economic development. These results indicate that internet usage rates and mobile cellular subscriptions will affect economic growth, which will affect internet usage rates and mobile cellular subscriptions. Finally, it's been determined that there's a one-way causal relationship from economic growth to fixed broadband subscriptions, financial development indicators, gross fixed capital investments and general government final consumption expenditures.

Recently, both the government and the real sector and scholars have shown great interest in information and communication technologies (Fintech). We believe that we have obtained some important findings by focusing on the Fintech sector in this study. According to these findings, information and communication technologies and other macroeconomic factors positively affect the economic growth of Turkic and selected Asian countries. In this respect, we think that new investments to be made in Fintech infrastructure and improvements to existing investments will be essential factors in guiding the economic development of the Turkic and

selected Asian countries. On the other hand, Internet usage rates, which is one of the CIT indicators, make the biggest contribution to the economies of the Turkic and selected Asian countries, fixed broadband subscriptions make the lowest contribution. Therefore, these results allow policy makers to make important inferences. For example, it seems beneficial for countries to expand their CIT infrastructures and facilitate access to technology for the entire society, especially rural areas. The findings of this study confirm the interpretation that internet usage rates and fixed broadband subscriptions increase economic growth. From this perspective, we believe that improving the CIT infrastructure is of critical importance. Improvement of the CIT infrastructure will also contribute to the progress of the digital economy. Therefore, we believe that it will be beneficial for policymakers, the private sector and academics to act together and accelerate their studies in this field. From this point of view, incentives and projects should be developed by the Turkic and selected Asian countries to facilitate access to technology in rural areas through ICT investment incentive policies, and public awareness should be raised by organising training programmes on the use and benefits of ICT. In addition, cooperation between the public and private sectors should be established, joint projects and funds should be established for Fintech and ICT investments, and tax incentives should be provided to companies investing in these areas. Legal arrangements should be made for the rapid and secure growth of the Fintech sector and innovative projects should be encouraged by increasing R&D support. Finally, high-speed internet access can be expanded through policies to increase fixed broadband subscriptions.

This study examines the impact of CIT on economic growth in the Turkic and selected Asian countries. Given Fintech's global relevance, future research could explore the Fintech-growth nexus among different country groups, especially between developed and developing nations. Sector-specific and city-based analyses, such as Fintech's effects on financial services, retail, health, and education, could reveal differences between metropolitan and rural areas and help to develop regional policies. Additionally, examining the impact of policies and regulations on the Fintech ecosystem can help governments to craft effective strategies. These research directions will provide a more comprehensive understanding of Fintech's impact on economic growth and will contribute significantly to the literature.

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RESEARCH ARTICLE

Lean Management's Effect on Industry 4.0 Regarding Innovation

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Abstract

This study intends to investigate the relationship between lean management, Industry 4.0, and innovation perceptions in employees of companies in Turkey's general tourism sector and to determine whether these perceptions have an impact on how lean management influences perceptions of Industry 4.0. Businesses are compelled to participate in innovation activities due to the fourth industrial revolution, or industry 4.0, which is characterised by the rapid advancement and change of technology. On the other hand, there is a dearth of empirical research on the impact of lean management practises in enterprises on innovation and industry 4.0. Thus, by examining the connection between lean management, industry 4.0, and the innovation process as well as the impact of lean management on these three elements, the study seeks to advance the area.

The sample consists of 527 employees in employment in the tourism sector (hotels, agencies). Surveys were used to gather data, which structural equivalency modelling was used to assess. According to the study's findings, lean management has a favourable impact on innovation and industry 4.0. Another finding is that innovation affects Industry 4.0. The emergence of new and creative ideas in businesses will lead to the creation or development of advanced production technologies. The principal discovery of the study indicates that innovation functions as a mediator in the correlation between industry 4.0 and lean management.

Keywords: Lean Management, Innovation, Industry 4.0, Tourism businesses

Introduction

At the beginning of the twentieth century, scientific management ideas began to emerge in management principles and practices, and a discipline was formed under the name of the scientific management movement. Indeed, all systematic and scientific knowledge on the subject of this discipline has been systematised into theories and has entered the scientific maturation process since the middle of the twentieth century. The most prominent subject here was Frederick W. Taylor.

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Taylor asked three fundamental questions while theorising scientific management thought. The first is where the principles of scientific management differ from other classical understandings. Second is why and how better results will be achieved in scientific management than others. The third question Taylor asked is whether getting the right person to head the company is the most important issue or not. He stated that he developed the Taylor theory to find answers to these questions (Taylor, 1985). The Scientific Management Theory, which started the first studies on business, emerged at this stage.

The supporters of the theory believed that it was possible to conduct business management according to scientific principles, and in this process, under the leadership of Taylor, they suggested that management should be a discipline with clearly defined and unchanging principles instead of relying on vague ideas (Örnek, 1991).

In today's competitive conditions, lean management plays a significant role in establishing a sustainable advantage from the rational outputs of any production tool or technique. It is crucial for businesses that use high-cost production systems and need solutions to the crises in existing markets. Lean management techniques are typically built on eliminating all business endeavours that do not add value to the market for rival competitors' actions.

Meanwhile, the business and related service-production activities are handled holistically. Another issue that should be considered here is that employees' physical and intellectual contributions to service quality must be at the core of lean management.

Like lean management, innovation is one of the basic concepts that should increase service quality. The twenty-first century is still feeling the effects of the industrial revolution. Previously, businesses were conducted with economies of scale and high production volumes, which provided severe competitive advantages. However, today, the situation has begun to change with the emphasis for low cost, high quality, and convenience. Historically, these conceptual changes, encountered in the 1970s and 1980s, first emphasised low cost but later revealed that quality was more important for competition. In addition, the interaction gained momentum with the quick shift in the industries' competitive landscape, the significance of economic-based sustainability, and the prominence of environmentally friendly initiatives and activities.

Therefore, the intensity of the production processes in question, with the impact of changing importance levels of the concepts of low cost, high volume of production and quality, and from another point of view, the approaches such as the contingency approach, total quality management, and learning organisations, has been at the centre of the studies that will contribute to the creation of innovation, along with the novelties and thoughts formed within the extent of Industry 4.0, a significant process of change.

Tourism has continued to increase over the past 60 years, making it one of the biggest and fastest-growing industries in the world; it is expected that there would be more than 1.8 billion foreign visitors worldwide by 2030. (UNWTO, 2017). Numerous development opportunities are available to heterogeneous tourism-related enterprises, such as tour operators, intermediaries, transfer firms, lodging facilities, and dining establishments. However, as technology advances, social, economic, political, and environmental issues will all have a significant impact on their future. One trend that undoubtedly has a big influence and being relevant in the growth of tourism is the advancement of technology. Industry 4.0's adoption of cutting-edge technology is well known for its disruptive power, affecting various industries, including travel and tourism. (Korže, 2019).

With the development of technology, like many other industries, tourism has seen a rise in the use of e-applications. The fourth industrial revolution, or Industry 4.0, is what we are currently experiencing, which has completely transformed numerous industries due to the automation, electrification, computerisation, and digitalisation of tasks (Kagermann et al., 2013). During the fourth industrial revolution, or Industry 4.0, the innovations that create added value in the tourism sector have become more critical than ever (Imanovic et al., 2016). Due to the significant contribution the tourist industry makes to the growth of national economies, the transition to the digitalisation era is essential for the sector to support the economics of the nation. Additionally, regularly monitoring and adjusting to the digitisation processes is how tourism organisations can outperform their rivals in terms of performance (Okatan & Yıldırım, 2021). Again, the effective use of technological opportunities is an important issue regarding giving tourists the possible service. As a result, using digital tools in tourism with the advancement of technology can be quite beneficial for travel agencies (Dülgaroğlu, 2021).

Every sector has some critical strategic factors ensuring its growth and sustainable development. The most important variables in the fiercely competitive tourism industry are innovation and the creation of new services. Companies in the service industry are compelled to innovate by changes and transformations, and innovation is essential to raising the calibre of services, particularly in the travel and tourism sector (Işık et al., 2019). The tourist industry is a large segment within the service sector, which is significantly affected by innovation activities. With the increase in competition, the essential way for a service industry to offer a long-term edge over competitors is to make a difference with innovation in its products or services. Therefore, tourism businesses that perform innovation activities will be able to create customer satisfaction, improve their company's performance and acquire a long-lasting competitive edge. Studies on applying lean management in many industries, including construction and health, occupy a notable place in the literature. However, there is no study focusing on the tourism sector. Therefore, addressing the applicability of lean management in the tourism sector will close a gap in the literature about its effects on production.

This research's objective is to investigate the connection between Industry 4.0, lean management and innovation perceptions in the employees of businesses operating in the tourism sector in Turkey (hotels, agencies) and to reveal whether their innovation perceptions affect the effect of understanding Industry 4.0 through lean management. In this regard, it is intended to make a literary contribution by revealing employees' perceptions or awareness. The staff members were given a questionnaire for this reason. The current economy and production dynamics were considered in the subject selection; the modern methods seen as the requirements of the businesses, and the meaning areas formed for interaction were examined and defined for tourism businesses.

In the article, lean management, innovation and industry 4.0 were discussed conceptually, studies in the literature dealing with the relationship between these concepts were included, research data were collected, and the necessary analyses were made and reported. Then, the results were discussed, and the study was completed with a general evaluation and conclusion, which suggested more comprehensive future studies.

Lean Management

John Krafcik, an MIT researcher, used the concept of "lean" in 1988. He is the first engineer to be employed by the NUMMI automotive company, a partnership between the Japanese auto manufacturer Toyota and the American auto manufacturer GM. "Lean Management" is stated as "Toyota Production System" (TPS). In the beginning, "TPS" and later "Lean Administration" started to attract the attention of academia and the business world as a production and management methodology. TPS was also viewed as the driving force in industrial development in general and the creation of the Japanese miracle specifically in the growth of the automotive sector. This understanding of administration is thus also referred to as the "Japanese Administrative System".

Lean Thinking is an approach established to determine the added value, sequence the actions that will create value to achieve the best result, implement them instantly when requested, and perform the tasks more efficiently and effectively. In short, lean thinking means simplicity. The essence of this simplicity is the minimisation of human labour. On the other hand, lean management achieves the maximum return after this minimisation. This way becomes more effective in meeting customer demands (Womack & Jones, 2003). Lean management is a production theory that focuses on the timely delivery of the best quality product to the consumer and its production at the lowest cost.

Today, many businesses are trying to develop various improvement methods. Many effective techniques have been tried, including six sigma, kaizen, and total quality management. Although these methods are successful when they fit the setup of the businesses, many busi-

nesses cannot benefit from them. Lean management is mentioned worldwide for the first time in Womack and Jones' "The Machine That Changed The World". During promotional trips for the book, they encountered many companies eager to implement lean manufacturing, raising the question, "how do we do lean manufacturing?". The primary rule is to eliminate the waste completely and let the customer make all definitions (Womack & Jones, 2003).

Since the 1990s, the use of lean methods and the literature have been developing. Lean management has been successfully implemented in industries to increase service quality while maximising production and efficiency. Although the concept of lean has become synonymous with large companies, mass production and the automotive industry, it has also started to gain an important place in small and medium-sized businesses, or SMEs and the service sector. Numerous industries apply lean management, including healthcare, instruction, construction, maintenance, insurance and financial services, product development, IT-supported services, airlines, food and beverage services, logistics services, and public services, and continues to grow within the service industry (Cuatrecasas, 2004; Gupta et al., 2016; Perdomo-Verdecia et al., 2022).

"Lean management is a management type established for the realisation of lean manufacturing, where the delegation of authority is increased, everyone is responsible for their work, and zero hierarchy is targeted" (Tikici et al., 2006).

The objectives of lean management are to reduce costs by preventing waste and using the workforce most efficiently. Human resources act as the building block in the operation of processes and are not seen as a cost area. In this context, the way to prevent waste and ensure that processes operate at the highest level is to create cooperation and include human resources in the processes (Engelund et al., 2009).

There is more than one definition for lean manufacturing and lean management. Lean manufacturing is all systems and techniques that adopt the vision of optimising the offered value by eliminating waste and simplifying the product and service creation phase, and eventually increasing the profitability of the company (Sığırcı, 2001).

One method that emerged because of lean thinking is called lean management. Value, excellence, and value streams are all part of lean thinking (Deran & Beller, 2014). Therefore, lean management can be described as a management style that is closely related to the following principles:

1. *Principle of flow:* A simple transformation can be described as a journey involving two large movements. The first of these movements is to create flow, and the second is to create pull. The first focus should be on creating flow, and as with all important journeys, having a checklist is thought to help ensure that the organisation does not stray (Byrne, 2015).

2. *Value principle:* The starting points of lean thinking are values. Manufacturers create these values and customers can define them. The producer who created the values cannot always define them correctly. For example, they think that American firms create value in the short run through competition tactics and profit transfers from the supplier at the head of the chain. German companies with strong technical equipment define values in relation to the technical complexity of their products and technologies. In Japan, the issue of where values are created is important. Value is being able to reconsider from the standpoint of the client. For value to have meaning, it must be expressed regarding a good or service that can fulfil the requirements of clients in a certain time and at a certain price (Warnecke & Hüser, 1995).

3. *Value stream principle*: The next stage of lean thinking is to ensure that the value-creating stages are in flux. To be more precise, it involves redefining the roles of functions, departments and firms in a manner that favourably influences the development of value for businesses. Although this idea contradicts the departmentalised accumulation mentality, which is generally accepted as true in our minds, it states that by working on a workpiece from raw material to final product, tasks can be performed much more accurately and efficiently. In short, it can be seen that things get a lot better when the focus is on the product and what the product requires, instead of the organisation or equipment, so that the activities required for the design, order and manufacturing stages take place in a continuous flow (Sığırcı, 2001).

4. *Pull principle:* Another principle of lean thinking is the concept of "pull". In its most general definition, pulling means that no product or service is produced in the previous processes without the request of the customer in the next processes. The best way to grasp the basic logic of pull thinking is to start with the customer's demand for a particular product and look back through the entire process from the product to the customer's arrival (Düren, 2002).

5. *Principle of excellence:* It becomes increasingly entrenched in the minds of those involved in the business that there is no end to the time, effort, place, error reduction and cost reduction process at the stage of offering a product that is very close to their customers' demands. Perhaps the best promoter of excellence is transparency. The first step in this lean method is the fact that suppliers, subcontractors, system integrators, distributors, employees and customers, in short, everyone can see everything. For this reason, it becomes easier to find healthier ways to create value, and there is very positive and instant feedback for the employees who make the improvement. As stated in this section, lean is the key point of the business and a strong supporter of efforts to improve (Çanakçıoğlu, 2019).

Additionally, even if Lean Management is best for standardised processes, businesses are increasingly being forced to adopt more adaptable strategies to fulfil the expectations of the clients (Handscomb et al., 2020). Thus, agile management should also be considered in addition to lean administration. In addition, whether or not the industry determines how much money can be saved by applying lean concepts. An analysis of a case study that appeared in the International Journal of Production & Operations Management (Lewis, 2000) specifically shed light on this issue.

Innovation

The concept of innovation has recently become a concept that attract the attention of researchers in various fields. In general, innovation is a progressive act of distinctive goods and services that add value to companies in an intensely competitive environment by developing new ideas. With the developing new conditions in the changing competitive environment, consumers tend to turn to new style products and services that are beyond the ordinary, that are developed formally, that bring constant added value, and that are revealed with their visuals.

Consumers show these needs and orientations in a fast and rapid transformation line. In such a challenging and extremely competitive environment, all companies, whether large or small, can maintain their competitiveness by innovating in their products or services and thus survive. For this reason, companies today can only meet the rapidly developing needs of consumers through innovation and manage the conditions of competition in their own direction. Accordingly, the innovation referred to as "innovation" not only does something new, advanced, harmonious and different, but also opens a new way that can create economic value for the benefit of the company (Işık & Keskin, 2013).

According to Schumpeter (1961), innovation means novelty in the basic sense. In this period, innovation was generally expressed as "the series of works that offer practical solutions to the needs and that can be used commercially and accepted as a novelty". Schumpeter described innovation as inventing a new production technique, producing a new product, or enhancing the quality of an already-existing one.

According to Myers & Marquis (1969), innovation is more than just a method, a fresh concept, an invention, tool, or result; it is the whole process consisting of many sub-processes.

In its broadest sense, innovation is the combination of creativity and practice (Lyons et al., 2007). Therefore, innovation is the use of a creative idea commercially. In this sense, it starts from the first stage and reaches the consumer at the end.

According to Kucmarski (1996), most today's managers see innovation as an essential tool for increasing incomes. On the other hand, the managers' tendency to consider innova-

tion as a fundamental business strategy has not increased. All managers must see innovation as a powerful determinant that increases competitiveness in building their strategy. Freeman and Soete (1997) suggest that businesses can draw a path by using the opportunities and alternatives specific to their companies while determining their strategies. For example, short, medium, and long-term strategies can be set; these companies can merge with other companies or switch to different markets with different products and methods. Because of all these different actions, they may encounter significant risks and dangers, especially in technology, materials, and chemistry. The majority of those who fail to manage these processes will not survive. They will face the necessity of re-entering the innovation cycle and have to manage it. This is because their competitors will lower product costs using the innovation cycle and will seize the market earlier. Therefore, they will realise they cannot move forward without implementing an agile, defensive or imitative innovation strategy.

According to the Oslo Manual, one of the first documents that come to mind for inventiveness, "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practises, workplace organisation or external relations" (Oslo Manual, 2005).

The Innovation Support Guide prepared by the Turkish Chamber of Commerce and Exchanges (TOBB) defines innovation as "transforming an idea into a sellable product or service, a new or improved manufacturing or distribution management, or a new social service method".

In addition, Çavuş and Akgemci (2008) draw attention to establishing a team and ensuring the participation of employees with a system that will make it easier to understand technological, social, and local changes to turn innovation into a fundamental skill.

Lean management and innovation approaches intersect within the body of businesses and organisations desiring to perform high-quality activities in the institutional sense. Employee-centred innovation management emphasises employees and their functional power and places considerable value on them; it agrees with the lean management approach. Accordingly, the strategy of creating a working environment that appeals to employees' physical and mental health in lean management is a significant management move towards more qualified activities. The steps realised to improve the operational performance and psychological state of the employees in line with the idea of innovation bring the two management approaches closer.

Industry 4.0

In the past decade, information and communication technologies (ICT) have become more prevalent, and a radical transformation has been witnessed in daily life. The size of computers

is decreasing and they are disappearing into almost all technical devices. Primarily, items converse via the Internet or World Wide Web. This tendency has spread to the industrial sector as well, which stands to gain more from the developments in computer science and ICT.

This movement is known as the "4th Industrial Revolution," or Industry 4.0, in Germany (Kagermann et al., 2013). Shorter product life cycles are closely linked to highly personalised goods and the development of modern factories into "smart factories," which aim to solve and defeat the difficulties posed by the current intense global competition (Weyer et al., 2015).

Industry 4.0 refers to the Fourth Industrial Revolution. It is acknowledged as the next development after the outsourcing boom of the 1990s and the lean revolution of the 1970s, and the digitisation of the manufacturing industry with mechanisation systems in the early 2000s (Uy & Rabo, 2019). The concept of "Industrie 4.0" originates from Germany's digitalisation programme aimed at boosting the manufacturing sector's competitiveness (Ghobakhloo et al., 2021). The idea of Industry 4.0 first surfaced in 2011 at a trade show in Hannover, Germany and brought a wave of development to the industry (Nascimento et al., 2021). It has received tremendous attention in academia since its publication in 2011. Many scientific advances have greatly enhanced our knowledge and comprehension of the Industry 4.0 phenomenon (Ghobakhloo et al., 2021. The goal of Industry 4.0 in Germany was to develop these systems through collaboration between universities and commercial businesses, with funding for research and development coming from the government (Zengin et al., 2021).

The Industrial Revolution is described as the transformation that took place between the end of the eighteenth century and the mid-1800s, in which small-scale workshops were transformed into industrial workshops carrying out large-scale production. It is also expressed as the technological change that allowed the workforce to turn into machines (Frederick, 2016). It is believed that Industry 4.0 marks the start of the fourth industrial revolution and displays the most recent automation technology trend that is becoming increasingly common in the manufacturing sectors (Sony, 2018). Every unit involved in manufacturing, whether directly or indirectly, is planned to work together, and information technologies and digital data software operate together in a cohesive way. (Schuh et al., 2014). Industry 4.0 designates the industrial sectors as having entered the fourth industrial revolution. This new revolution shows itself as an increase in digitisation and diversification and the association between the products, value chains, and business models (Banger, 2017).

As Industry 4.0 provides information about the developments related to future factories, it is seen as an intelligent technological system with a dramatic impact on the industrial sector; and it is the subject of much research (Pereira & Romero, 2017). Industry 4.0 has become a really interesting technology to achieve efficient, accurate, and precise business outcomes (Rajput & Singh, 2019). Meanwhile, Industry 4.0 technologies have created advantages such as higher flexibility, shortening delivery times, and adaptation to customer demands with

small batch sizes (Wang & Wang, 2016). The fundamental feature of Industry 4.0 is that it includes automatically self-configuring and self-optimising systems that allow more agile and low-cost operations in production (Asdecker & Felch, 2018).

In summary, the fourth industrial revolution idea, or Industry 4.0, significantly affects the country's economy, business world, society, and environment. The effects of Industry 4.0 and advancements in technology on companies operating in various sectors are increasing day after day. Industry 4.0 is a new process with many components, including cyber-physical systems, artificial intelligence, analytics, cloud technology, the objects with internet, and intelligent factory. It is predicated on the cooperation of humans with machines, thus aiming to bring customer-specific products to the market faster and more flexibly. In other words, companies are increasingly moving with the idea of Industry 4.0 as a crucial tactic for surviving in a cutthroat market.

Literature Research

Lean Management and Tourism

Today, lean management continues to evolve and is implemented in numerous service industries, including food, finance, and transportation, and mostly occurs within public services (Hadid & Mansouri, 2014; Leite & Vierira, 2015; Gupta et al., 2016; Narayanamurthy & Gurumurthy, 2016). Lean management (Vlachos & Bogdanovic, 2013; Farrington et al., 2018; Perdomo-Verdecia et al., 2022) practices have become priority issues in the tourism sector literature, and the number of studies needed is increasing. Below is a summary of a few few studies that have been done on the topic in the literature:

Vlachos and Bogdanovic (2013) looked into how lean thinking could be used in European hotel companies. With the dearth of lean practice literature in the hotel business, this study might be regarded as a crucial resource. The study claims that one can use the "Five Step Model" as a management tool to reduce waste and boost customer value. The underlying premise of the model is that there are five sequential sequences of actions from Value to Excellence.

Al-Aomar and Hussain (2019) developed a methodology for recognising, classifying, and prioritising lean approaches applied in a hotel supply chain. In order to characterise the lean techniques used in the United Arab Emirates' four- and five-star hotels, they gathered information using a questionnaire. Six primary lean application categories and 19 particular lean methods pertaining to a hotel supply chain were identified by the study. JIT, Kaizen, Quality, Inventory, Maintenance, and Standardisation are examples of the defined categories. The study's findings indicate that, of the lean application categories that were found, JIT and Kaizen have the highest priority. In addition, prompt customer service, an efficient enhancement

framework, and supplier delivery on schedule are the three lean approaches that are most appropriate for a hotel supply chain.

In their study on hotel lean management, "Where we are and where can we go?" Perdomo-Verdecia et al. (2022) attempted to provide answers to these queries. There were only 36 references retrieved, indicating the dearth of studies conducted in this field. With the popularity of VSM and 5S applications, the adoption of lean management solutions in hotels appears to be quite limited. The reference study unequivocally demonstrated the necessity for considerably more research on specific practices—some of which are underreported—in many hotel operations.

Innovation and Tourism

Innovation is a means to competitiveness, environmental sustainability, and economic success. Therefore, tourism-related firms should always be innovating. Furthermore, given how quickly rivals imitate winning concepts, innovation in the tourist industry is crucial to giving destinations a long-term competitive edge over rivals. As a result, competitors should find it difficult to embrace advances (Giotis & Papadionysiou, 2022).

The innovation theory of Schumpeter provides a basis for the literature on tourism and innovation (Alsos et al., 2014). The study, finding, creation, promotion, approval, and commercialisation of novel goods, systems, organisational configurations, and practices are all considered forms of innovation, according to the notion. This strategy is recognised as a widely acknowledged strategy for all other service sectors and the tourism industry (Hjalager, 2002; Nordin, 2003). Below is a summary of a few studies that address innovation in tourism and the connection between innovation and tourism in the literature:

Topsakal et al. (2018) used a questionnaire to gather information on how small and medium-sized tourism enterprises are embracing innovation ideas in Antalya (Kaleiçi), Turkey. The investigation's findings indicate that although small and medium-sized tourism enterprises want innovation to improve service quality, cost is the primary barrier to innovation.

Mendoza-Moheno et al.'s study from 2021 sought to pinpoint the social and technological frameworks that community-based tourism organisations use to sustain their socio-technical innovation system. The results of the study add to the discourse on stakeholder cooperation and offer an effective model of an organisation that satisfies social, environmental, and economic demands. The study's demonstration of the interaction between technical and social systems is one of its key contributions.

Giotis and Papadionysiou (2022) analyzed the empirical research to assess the influence that managerial and technological advances play in the tourism business. Within the context

of the fundamental role that tourism benefits from advances in technology and management, this paper tries to offer a thorough summary of the empirical studies conducted to look into these topics. The findings of a few studies showed that a company's ability to foster innovation is increased when it has a pleasant workplace with suitable personnel, a management style that is appropriate, and managers and employees who work together. Additionally, several management implications have been put up to help managers create effective strategies for companies operating in the tourism sector.

Industry 4.0 and Tourism

Every day, industry 4.0 developments have an increasing impact on the economy, finance, and commercial sectors. The industrial revolution has sped up the growth of the tourism industry. Consequently, the tourism industry is among those where Industry 4.0 technologies have a bigger pragmatic effect. Given the service-oriented nature of the tourist industry, it can be argued that Industry 4.0 advancements will significantly alter how people perceive travel.

There is not much research in the literature on the connection between Industry 4.0 and the travel and tourist industry. A few of these studies are outlined below:

To better understand the present circumstances and future prospects of service automation and robot adoption by travel, tourism, and hospitality-related businesses, Ivanov et al. (2017) carried out a study that included a description of the difficulties that these businesses will have while implementing these technologies to assist visitors.

Osei et al. (2020) planned to thoroughly evaluate the expectations of business 4.0 for the lodging and tourism business by conducting a scientific projection to uncover the expectations of the fourth industrial revolution for the hotel industry. Remarks about the expectations (good and bad) for the lodging industry were included in the study. The discussion concludes with the practical and societal ramifications.

In his research, Şengel (2021) outlined the historical progression of the relationship between contemporary tourism trends and the industrial revolution. The goal of this study was to ascertain how the industrial revolution affected contemporary tourist movements from the outset to the present. The research findings indicate that the industrialisation initiatives that sparked the industrial revolution have had a major influence on the development of contemporary tourism movements.

Chang et al. (2022) conducted a study on the adoption of the blockchain technology for tourism based on UTAUT and the connectivity theory. Their work highlights the potential of using social media (YouTube) to increase user knowledge and potential interest in the domestic travel industry, as well as providing an actual implementation of blockchain technology.

Method

In this section, we used SPSS and AMOS to analyse the data collected through the survey technique. In this context, the statistical methods and techniques used have been explained.

Purpose of the Study

This study aims to reveal the role of the innovation perceptions of employees in businesses operating in the tourism sector in Turkey (hotels, agencies and restaurants) on the effect of lean management perceptions on Industry 4.0 perceptions.

Method of the Study

This study is a quantitative research in which measurements can be repeated and objective, and various statistical methods are used (Elitaş, 2011).

Universe and Sample of the Study

The universe of the study consists of employees employed in the tourism sector in Turkey (hotels, agencies). According to TUIK data, around 34.334.000 people are in the workforce in Turkey (TUİK, 2022). If the size of the universe is 250,000 or more, the minimum sample size should be 384 (Gürbüz & Şahin, 2017). Therefore, the participation of 527 employees in the study provides a sufficient sample size.

Assumptions and Limitations of the Research

The scales used in the study have been qualified to explain the factors (lean management, innovation, industry 4.0) that are the subject of the analysis. Reliability and validity analyses were also performed in this study for scales that showed high reliability and validity in previous studies; the reliability of the measurement tools used was determined to be high. Therefore, it is assumed that the questionnaire reflects the current situation regarding the perceptions of lean management, industry 4.0, and innovation within the organisation.

The human element is the basis of the study, and the data includes evaluations of the employees. Therefore, the general limitations of social sciences research are also valid for this study. The reliability of the findings is limited to employees' evaluations and the characteristics of the survey technique used in data collection.

Data Collection Tools

As the adopted research and measurement method was based on numerical (quantitative) data, the survey technique was used for data collection. The questionnaire starts with 5 qu-

estions prepared to collect the employees' demographic information (gender, age, education level, marital status, and working time). In the first part of the questionnaire, the 24-item Lean Management Scale developed by Derin (2008) was used to measure the lean management perceptions of the employees. The second part of the questionnaire consists of an 8-item scale used by Arpacı (2019) to determine the innovation process. The third part includes a 6-item scale used by Zengin et al. (2021) to measure Industry 4.0. The scales used are of the Likert type.

Research Hypotheses and the Model

Because of the literature review above, the following hypotheses were developed (5.1., 5.2, 5.3.).

The hypotheses of the study are as follows:

H1: Lean management has a positive impact on industry 4.0.

H2: Lean management positively affects innovation.

H3: Innovation has a positive impact on industry 4.0.

H4: Innovation plays a mediating role in the effect of lean management on industry 4.0.

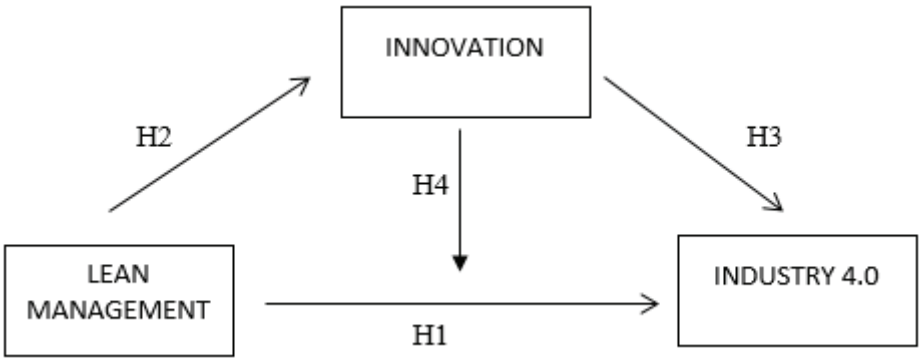

Figure 1. Research Model

Data Analysis

In this study, statistical package programmes were used to analyse the data. The significance level was taken as p = 0.05. First, the reliability and validity of the scales were tested. The reliability of the scales was calculated through internal consistency using Cronbach's alpha coefficients. Exploratory and confirmatory factor analyses were used to test the reliability and validity of the questionnaires. First, correlation analysis was employed to test the

hypotheses that form this study's basis and determine the relationship between lean management, industry 4.0, and innovation. In the study, the structural equation model was used to determine whether the variables were statistically significant. In this direction, the structural model was tested with the AMOS programme. The relationships between the variables were examined using goodness-of-fit statistics and hypotheses to test the model's validity. The bootstrap method was used to test the mediating roles between variables, and the 5-point Likert scale was used in this research. In the selection of the sample, a simple random method was used, which makes the chance of entering the sample equal for every employee in the phase.

Findings

The findings regarding the demographic information of the employees participating in the study are shown in Table 1.

Table 1
Demographic Information

Variable	Category	f	(%)
Gender	Female	156	29.6
	Male	371	70.4
Age	21-30-year-old	110	20.9
	31-40-year-old	206	39.1
	41-50-year-old	158	30.0
	51-year-old and more	53	10.1
Marital Status	Single	150	28.5
	Married	377	71.5
Education	Elementary-High School	33	6.3
	Associate's degree	89	16.9
	Bachelor's degree	252	47.8
	Postgraduate	153	29.0
Working Time in the Tourism Sector	1-5 years	223	42.3
	6-10 years	113	21.4
	11-15 years	80	15.2
	16-20 years	39	7.4
	20 years and more	72	13.7
Annual Income	4,000-6,000-TL	95	18.0
	6,001-8,000 TL	79	15.0
	8,001-10,000	117	22.2
	10,001 TL and more	236	44.8
Managerial Position	Yes	261	49.5
	No	266	50.5

First, an item analysis was conducted to test the reliability of the scales. The item-total correlation of all items was above 30, which is the cut-off point. Therefore, there was no need to remove any item from the scale in the first step (Çanakçı et al., 2019).

The second stage of the reliability and validity analysis was conducted to test the reliability and validity of the lean management, innovation, and industry 4.0 scales separately. For this purpose, exploratory factor analysis with Varimax rotation was performed using the principal component method.

Regarding the exploratory factor analysis results, the factor load of the Lean1, Lean6, Lean7, and Lean19 items in the lean management scale was below 0.40, and they were excluded from the analysis. KMO, which confirms the applicability of the descriptive factor analysis to the data, and the degree of sphericity (Barlett's Test of Sphericity), which show that significant factors can be obtained from the research data. The Cronbach alpha coefficients are displayed in the table below.

Table 2
Exploratory Factor Analysis Results

Variables	Dimensions	Scale Item	Factor Loads	Cronbach's Alpha		KMO	Barlett Test of Sphericity (p)
LEAN MANAGEMENT	Lean 1	Lean5	.791	.880	.963	.969	8341.357; p=0.000
		Lean4	.782				
		Lean9	.714				
		Lean3	.665				
		Lean2	.656				
		Lean8	.604				
	Lean 2	Lean20	.758	.956			
		Lean16	.733				
		Lean12	.731				
		Lean13	.715				
		Lean22	.708				
		Lean24	.706				
		Lean23	.704				
		Lean11	.703				
		Lean17	.686				
		Lean14	.671				
		Lean21	.667				
		Lean10	.661				
		Lean15	.655				
		Lean18	.574				
Eigenvalue: 7.492; Total Variance: 64.434							

Variables	Dimensions	Scale Item	Factor Loads	Cronbach's Alpha		KMO	Barlett Test of Sphericity (p)
INNOVATION	Innovation	Inno3	.879	.931	.931	0.922	3162.631; p=0.000
		Inno2	.862				
		Inno1	.858				
		Inno6	.826				
		Inno8	.818				
		Inno4	.815				
		Inno7	.771				
		Inno5	.741				
		Eigenvalue: 5.409; Total Variance: 67.612					
INDUSTRY 4.0	Industry 4.0	Ind_4_6	.902	.894	.894	.870	1896.388; p=0.000
		Ind_4_5	.864				
		Ind_4_4	.833				
		Ind_4_2	.784				
		Ind_4_3	.778				
		Ind_4_1	.697				
		Eigenvalue: 3.961; Total Variance: 66.018					

Confirmatory Factor Analysis for the Lean Management Scale

After the exploratory factor analysis, confirmatory factor analysis was performed using the AMOS package programme on the lean management scale. Regarding the item loads obtained from the regression model, all the regression items' loads were higher than 0.50. The analysis showed that the modifications between Lean4-Lean5, Lean10-Lean18, Lean11-Lean12, and Lean20-Lean21 would increase the chi-square and fit values.

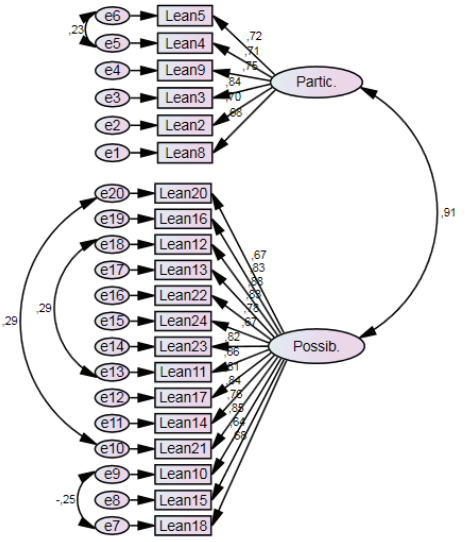

Figure 2. Modified Confirmatory Factor Analysis of the Lean Management Scale

Confirmatory Factor Analysis for the Innovation Scale

After the exploratory factor analysis, confirmatory factor analysis was performed on the innovation scale. Regarding the item loads obtained from the regression model, all the regression items' loads were higher than 0.50. The analysis showed that modifying Inno1-Inno2 would increase the chi-square and fit values. In addition, Inno6 and Inno7 were excluded from the analysis because they highly overlapped with other factors.

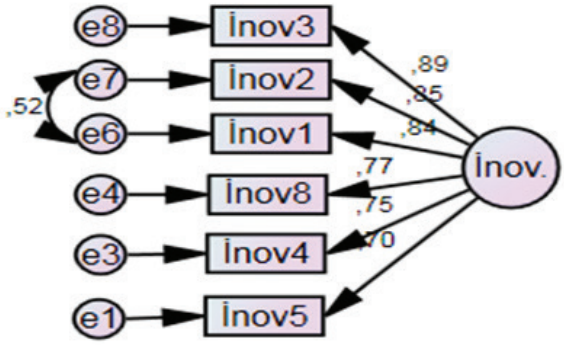

Figure 3. Modified Confirmatory Factor Analysis of the Innovation Scale

Confirmatory Factor Analysis for the Industry 4.0 Scale

After the exploratory factor analysis, confirmatory factor analysis was performed on the Industry 4.0 scale. Regarding the item loads obtained from the regression model, all the regression items' loads were higher than 0.50. The analysis showed that the modifications between Ind401-Ind405 and Ind403-Ind406 would increase the chi-square and fit values.

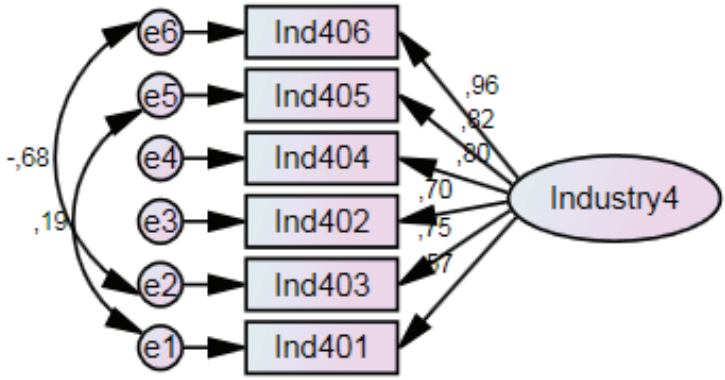

Figure 4. Modified Confirmatory Factor Analysis of the Industry 4.0 Scale

Table 3
Reference Values for the Goodness of Fit

Index	Reference Value	
	Good Fit	**Acceptable Fit**
CMIN/DF	0< χ2/sd ≤ 3	3< χ2/sd ≤ 5
CFI	.95< CFI≤ 1	.90 < CFI≤ .94
TLI	.95< TLI≤ 1	.90 < TLI≤ .94
IFI	.95< IFI≤ 1	.90 < IFI≤ .94
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08
RMR	<0.05	<0.08

Source: Tasgin and Korucuk, 2018

Table 4
Goodness of Fit Indices of the Models for Confirmatory Factor Analysis

Variables	CMIN/DF	CFI	TLI	IFI	RMSEA	RMR
Lean Management	3.3585	.948	.941	.949	.070	.047
Innovation	4.078	.989	.980	.989	.076	.032
Industry 4.0	2.807	.993	.985	.993	.021	.059

CR (Composite Reliability) is a value that measures the internal performance of a factor. It is desirable for the value to be greater than 0.70. The CR value is constructed based on Cronbach's Alpha being considered as a better alternative. The AVE (Average Variance Extracted) value is a value that measures the similarity between the items of a factor. It is desirable for the value to be greater than 0.50.

The table below shows the CR composite reliability values of the lean management, innovation process and industry 4.0 scales. According to the table, the CR value is over 0.70, which shows that the scale is reliable. For the convergent validity of the scale, the mean self-variability is expected to be higher than 0.5 and the composite reliability ratio is expected to be greater than the mean self-variability (CR > (AVE) / AVE > 0.5).

It is evident from the figures in the table that AVE (self-variability) is greater than 0.5 and CR composite reliability) is greater than 0.7. These are the values at which there is enough convergence in the model (Hair et al., 2009).

Table 5
Validity-Reliability Matrix

Factors	**CR**	**AVE**	**CR>0,70**	**AVE>0,50**	**CR>AVE**
Lean Management	0,94	0,51	0,94>0,70	0,51>0,50	0,94>0,51
Innovation	0,95	0,68	0,95>0,70	0,68>0,50	0,95>0,68
Industry 4.0	0,92	0,66	0,92>0,70	0,66>0,50	0,92>0,66

Hypothesis Testing

First, correlation analysis was used to test the hypotheses that formed the research's basis

and determine the relationship between lean management, innovation, and industry 4.0. The results of the correlation analysis are shown in Table 5. The table shows a positive and significant relationship between the organisation's lean management approach and innovation (.795**). At the same time, there is a positive and significant relationship between the lean management approach and industry 4.0 (.440**).

Table 6
Relationship Between Variables

Factors	1	2	3
1-Lean Management	1		
2-Innovation	.795**	1	
3-Industry 4.0	.440**	.498**	1

*p<.05, **p<.01

Analysis of the Structural Equivalence Model

A structural equivalence model was used to determine the statistically significant relationships between the variables. For this purpose, the previously determined structural model of the research was analysed with the AMOS programme. The relationships between variables were examined using goodness-of-fit statistics and hypotheses to confirm the model's validity.

To test the effect of the mediating variables, the mediator was removed from the model, and the prediction power of the independent variable on the dependent variable was calculated. As a result, lean management has a 42.4% effect on industry 4.0. Accordingly, H1 is accepted. The estimations of the tested model are shown in Figure 5.

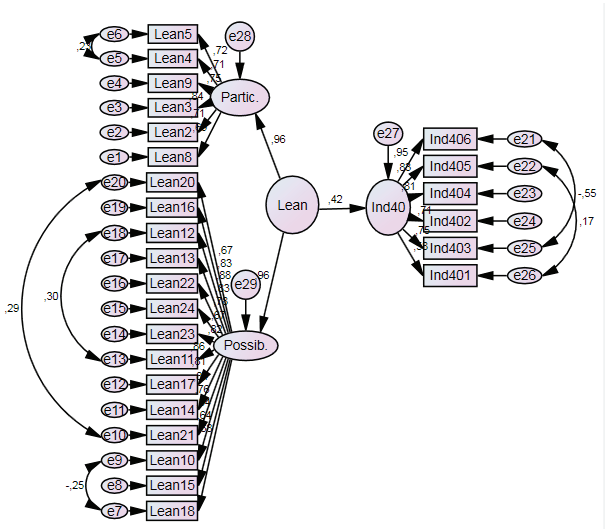

Figure 5. Standardised Estimation Results Showing the Effect of Lean Management on Industry 4.0

The fit indices of the model and the reference values specified in the literature are given in Table 6.

Table 7
The Goodness of Fit Indices of the Models Showing the Effect of Lean Management on Industry 4.0

Index	Reference Value		Measurement	Result
	Good Fit	Acceptable Fit		
CMIN/DF	0< χ2/sd ≤ 3	3< χ2/sd ≤ 5	3.089	Acceptable Fit
CFI	.95< CFI≤ 1	.90 < CFI≤ .94	.942	Acceptable Fit
TLI	.95< TLI≤ 1	.90 < TLI≤ .94	.935	Acceptable Fit
IFI	.95< IFI≤ 1	.90 < IFI≤ .94	.942	Acceptable Fit
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	.063	Acceptable Fit
RMR	<0.05	<0.08	.056	Acceptable Fit

The effect of lean management on innovation is shown in Figure 6. Accordingly, lean management's effect on innovation is 87.8%. Thus, H2 is accepted. The estimations of the tested model are shown in Figure 6.

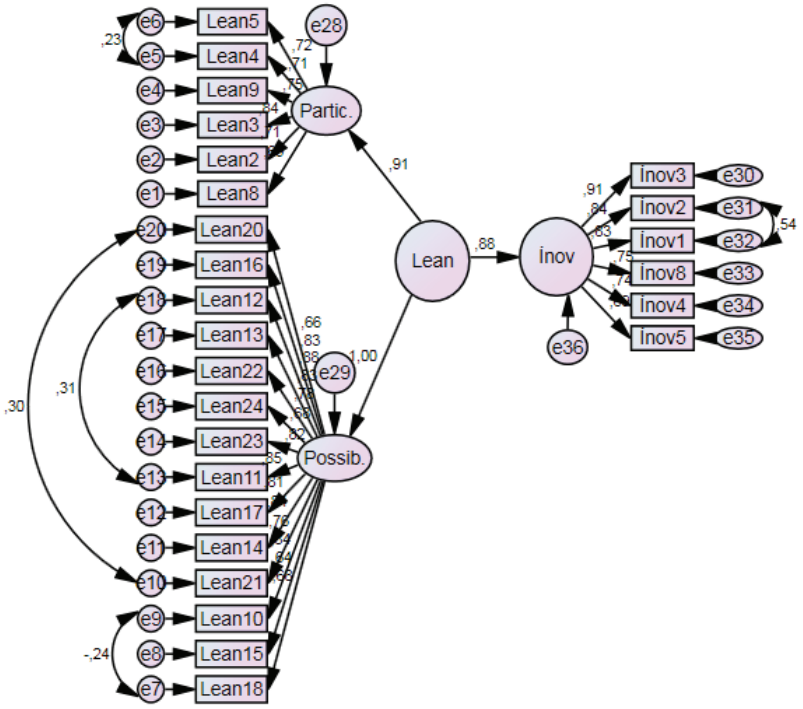

Figure 6. Standardised Estimation Results Showing the Effect of Lean Management on Innovation

Table 8
The Goodness of Fit Indices of the Models Showing the Effect of Lean Management on Innovation

Index	Reference Value		Measurement	Result
	Good Fit	Acceptable Fit		
CMIN/DF	0< χ2/sd ≤ 3	3< χ2/sd ≤ 5	3.360	Acceptable Fit
CFI	.95< CFI≤ 1	.90 < CFI≤ .94	.940	Acceptable Fit
TLI	.95< TLI≤ 1	.90 < TLI≤ .94	.933	Acceptable Fit
IFI	.95< IFI≤ 1	.90 < IFI≤ .94	.940	Acceptable Fit
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	.067	Acceptable Fit
RMR	<0.05	<0.08	.050	Acceptable Fit

The effect of innovation on Industry 4.0 is shown in Figure 7. Accordingly, the effect of innovation on Industry 4.0 is 51.4%. Thus, H3 is accepted. The estimations of the tested model are shown in Figure 7.

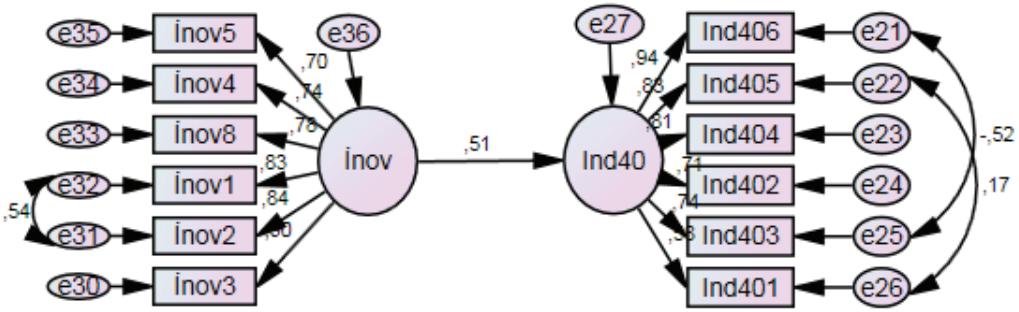

Figure 7. Standardised Estimation Results Showing the Effect of Innovation on Industry 4.0

Table 9
The goodness of Fit Indices of the Models Showing the Effect of Innovation on Industry 4.0

Index	Reference Value		Measurement	Result
	Good Fit	Acceptable Fit		
CMIN/DF	0< χ2/sd ≤ 3	3< χ2/sd ≤ 5	3.984	Acceptable Fit
CFI	.95< CFI≤ 1	.90 < CFI≤ .94	.966	Acceptable Fit
TLI	.95< TLI≤ 1	.90 < TLI≤ .94	.955	Acceptable Fit
IFI	.95< IFI≤ 1	.90 < IFI≤ .94	.966	Acceptable Fit
RMSEA	0 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .08	.075	Acceptable Fit
RMR	<0.05	<0.08	.063	Acceptable Fit

In the research model, lean management was considered an exogenous variable, and implicit variables such as innovation and industry 4.0 were considered endogenous variables. The innovation was added to the model as a mediating variable. The Bootstrap method was

also used to reveal the validity of the mediating role while testing the relationships between the variables. In the Bootstrap method, the sample was increased by 1000, and the Bootfactor was set as1. The maximum likelihood estimation method, which is accepted to be suitable for cases where the data show a normal distribution, was applied in this study. Figure 8 shows the estimation results of the model tested in the AMOS programme using the Bootstrapping method.

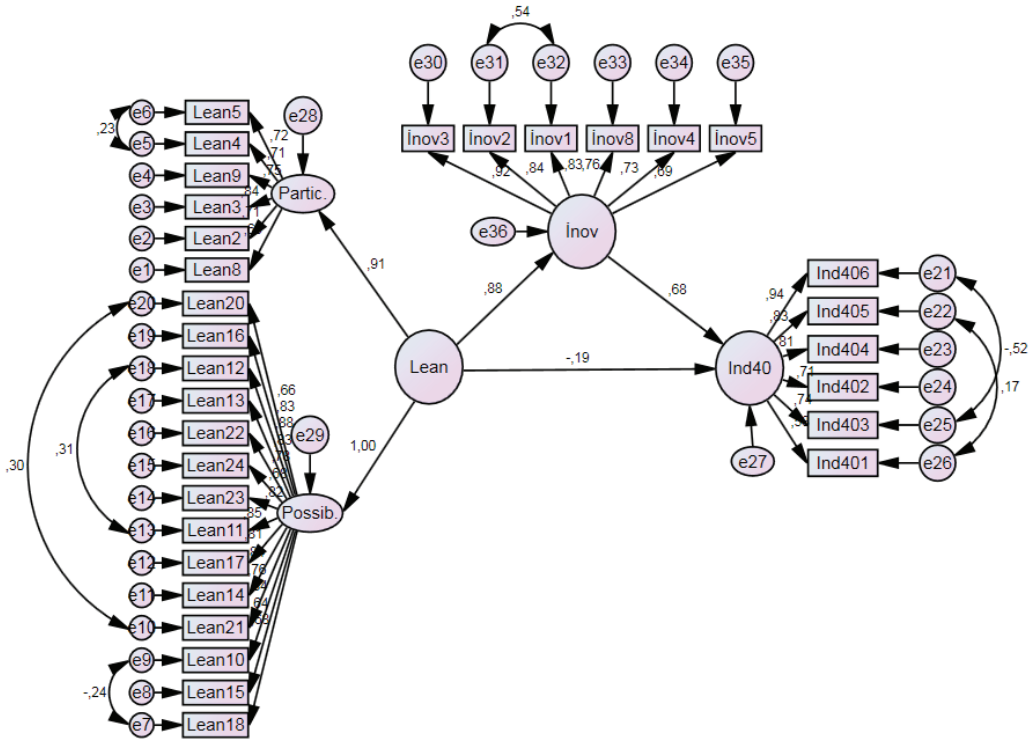

Figure 8. Displaying Standardised Estimation Results on the Model

Regarding the effect of lean management on industry 4.0 in the context of innovation, the innovation (mediator) was removed from the model first, and lean management's direct effect on industry 4.0 was examined. This effect was significant (.424 and p=000). Data related to this model are shown in Figure 2. Then, the innovation process, the mediating variable, was added to the model, and the analysis was repeated. In this case, the effect of lean management on industry 4.0 was significant (.186 and p=.001). As can be seen, the direct effect of lean management on industry 4.0 is significant without a mediator. On the other hand, when the mediator variable innovation is added to the model, the effect of lean management on Industry 4.0 decreased. Regarding the Bootstrap test results, the mediator variable's effect was significant. When the mediator variable was added to the model, the effect of lean management on industry 4.0 did not

disappear and decreased, which shows that innovation plays a mediating role in the interaction between lean management and industry 4.0. It is also possible to interpret this situation as lean management affecting industry 4.0 both directly and through innovation because the mediation effect was also significant according to the results of the Bootstrap test.

Regarding the goodness of fit indices of the model in Table 9, they indicate an acceptable fit.

Table 10
Reference Values for the Goodness of Fit

Index	Reference Value		Measurement	Result
	Good Fit	Acceptable Fit		
CMIN/DF	$0 < \chi 2/sd \leq 3$	$3 < \chi 2/sd \leq 5$	3.086	Acceptable Fit
CFI	$.95 < CFI \leq 1$	$.90 < CFI \leq .94$	.931	Acceptable Fit
TLI	$.95 < TLI \leq 1$	$.90 < TLI \leq .94$	.924	Acceptable Fit
IFI	$.95 < IFI \leq 1$	$.90 < IFI \leq .94$	.931	Acceptable Fit
RMSEA	$0 \leq RMSEA \leq .05$	$.05 \leq RMSEA \leq .08$	.063	Acceptable Fit
RMR	<0.05	<0.08	.059	Acceptable Fit

Discussion and Conclusion

Due to the intense competition brought by globalisation, businesses face some difficulties in terms of cost, quality, and time. The increasing number of competitors increases the customers' decision-making options and causes harsh competitive conditions. To survive in this competitive environment, businesses want to determine efficient methods and processes the entire value chain. The lean management approach focuses on producing more with less time, efforts, and equipment and meeting customers' expectations. Uncertainty is a factor that makes management difficult in businesses; its presence complicates the management. Management eliminates this uncertainty and complexity by simplifying the processes and making them lean and elementary. Consequently, the decision-making processes of the business gain momentum as uncertainty and complexity decrease. From this perspective, lean management is an approach that focuses on creating more efficient working conditions by reducing non-value-adding activities and significantly increasing business performance. The lean management approach eliminates waste by continuously improving the production process. Businesses should adopt the lean management approach to improve their innovation processes and keep up with changing competitive conditions because developing new products and processes plays a vital role in gaining competitive power. Therefore, lean management can significantly contribute to the improvement of a business' innovation capacity. In addition, the concept of Industry 4.0, called the fourth industrial revolution, has emerged recently in the production sector. After a detailed review, it can be said that lean manufacturing methods and Industry 4.0 technologies are intertwined and act on each other.

The tourism sector is at a very different point today, with the development of technology. Industry 4.0, which includes many industries in the world, and the innovation process have also affected the tourism industry.

Among these innovative movements in the tourism sector, there are issues such as businesses designing beautiful websites, developing mobile applications, providing search and research opportunities and conveniences to their customers with social networks, web, agencies.

In addition, one of the most effective methods of providing quality service at low cost for businesses is to adopt the principles of "Lean Management". Like many businesses that consider themselves "Lean", tourism businesses are in a better position than their competitors in the current economy. Lean management practices in tourism businesses differ from lean practices in the production environment because they are service businesses. The intangibility of services, the difficulty of measuring service outputs, and the creation of value for the customer can complicate the applicability of lean management practices in tourism businesses.

This study addressed the simultaneous relationship between lean management, Industry 4.0, and innovation for the businesses operating in the tourism sector (hotels, agencies) in Turkey. The findings showed that lean management is effective in Industry 4.0. According to this result, it can be argued that lean management forms the basis for Industry 4.0 and, at the same time, is supplemented by Industry 4.0. Therefore, it is thought that integrating Industry 4.0 technologies into lean management processes will increase tourism businesses' productivity (Figure 8). Kolberg and Züehlke (2015) stated that Industry 4.0 applications support lean manufacturing approaches and can be a tool in realising lean manufacturing. Their results support the results obtained in this study.

Regarding another finding obtained in the study, lean management was found to be effective in innovation. According to this result, tourism businesses should implement a lean management approach to improve their innovation capacities. Therefore, it can be stated that lean management will improve the innovation processes of tourism businesses and provide high flexibility in offering new products or services to businesses. Abdallah et al. (2019) stated that innovation-oriented companies tend to benefit from lean management to improve their innovation capacity, which supports the results of this study.

Another finding is that innovation affects Industry 4.0. The emergence of new and creative ideas in businesses will lead to the creation or development of advanced production technologies. Industry 4.0 is an industrial revolution that includes high technological development and transformation; therefore, it is closely related to innovation (TÜSİAD, 2016). Tourism businesses should attach importance to innovation activities for adapting to the age of Industry 4.0. In addition, tourism businesses that want to increase their innovation level and adapt to

the Industry 4.0 age are thought to survive in a competitive environment and reach a better position than their competitors.

The study's main finding is that innovation is a mediator in the relationship between lean management and industry 4.0. In cases where lean management positively affects industry 4.0, the inclusion of innovation in the process will further increase the performance of industry 4.0. Especially in today's global world, the rapid change and development of technological activities have accelerated the efforts towards industry 4.0. In this direction, businesses will gain momentum in the transition to industry 4.0 by focusing on innovation and adopting lean management.

The deepening of global competition has expanded its sphere of influence. Industry 4.0, innovation, and especially lean management concepts in planning and implementing cost, activity, high production, new product development, market creation, generating new ideas, and R&D processes of the businesses and making them sustainable have an essential and critical place in the current dimension of the discussions. Businesses operating in the tourism sector are rapidly developing and changing. This development becomes more critical with the effect of lean management, innovation, and industry 4.0 practices. However, tourism businesses should focus more on lean management than on industry 4.0 and innovation, and lean methods should be adapted to the industry's specific needs.

As a result, this quantitative study in the professional and business sectors addressed the relations between lean management, industry 4.0, and innovation regarding the businesses operating in the tourism sector. Future studies can make comparative studies, including tourism and other sectors or the countries where the research will be conducted can be extended.

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Turner, S. J. (2010). Website statistics 2.0: Using Google Analytics to measure library website effectiveness. *Technical Services Quarterly, 27,* 261–278. http://dx.doi.org/10.1080/07317131003765910

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Smith, J. A. (2010). Citing advance online publication: A review. *Journal of Psychology.* Advance online publication. http://dx.doi.org/10.1037/a45d7867

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Henry, W. A., III. (1990, April 9). Making the grade in today's schools. *Time, 135,* 28–31.

Doctoral Dissertation, Master's Thesis, Presentation, Proceeding

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