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THE IMPACT OF INDUSTRY 4.0 TECHNOLOGIES, ORGANIZATIONAL CLIMATE AND AGILITY ON FINANCIAL PERFORMANCE: AN EMPIRICAL STUDY ON TURKISH MINING ENTERPRISES

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ABSTRACT

The mining sector, due to high capital requirements, environmental risks, and operational uncertainties, is implementing digital transformation processes more cautiously and gradually compared to other sectors. In this context, it is important to evaluate the effects of Industry 4.0 technologies on financial performance not only through technological investments but also through internal factors such as organizational climate and organizational agility. The aim of this study is to empirically examine the effects of organizational climate and organizational agility on financial firm performance in mining companies operating in Turkey, and the role of Industry 4.0 awareness and technology utilization levels in these relationships.

Data were collected from 538 middle- and upper-level managers working in 28 mining companies using a survey method. The obtained data were analyzed using confirmatory factor analysis (CFA), structural equation modeling (SEM), and reliability analyses. The results show that organizational climate has a positive and significant effect on Industry 4.0 awareness, technology utilization level, and financial performance. Although organizational agility was found to have significant relationships with Industry 4.0 awareness and technology utilization levels, no direct effect on financial performance was detected. Furthermore, the direct effects of Industry 4.0 awareness and technology utilization levels on financial performance were not statistically significant.

The findings indicate that digital transformation investments in the mining sector do not directly translate into financial performance in the short term. Instead, the success of this process is closely related to organizational factors such as organizational climate, cultural structure, and employee awareness. In this respect, the study addresses the financial implications of digital transformation in the mining sector from a holistic perspective and offers valuable contributions to both academic literature and sectoral practices.

Keywords: Organizational Climate; Organizational Agility; Industry 4.0; Technology Utilization; Financial Performance; Mining Sector

INTRODUCTION

The mining sector has a complex structure, both strategically and managerially, due to high capital requirements, dependence on natural resources, environmental risks, and operational uncertainties. (You et al., 2022; Li, 2023). These characteristics require firms not only to possess strong technical capabilities but also to develop robust organizational structures and flexible management approaches that enable adaptation to changing environmental conditions. In an era characterized by rapid digital transformation, examining the role of internal organizational factors—such as organizational climate and organizational agility—on firm performance has become increasingly important.

Digital technologies developed within the scope of Industry 4.0, including automation systems, big data analytics, artificial intelligence, and the Internet of Things, have the potential to fundamentally transform production processes and provide firms with sustainable competitive advantages. However, in capital- and labor-intensive sectors such as mining, the short-term financial impact of these technologies is often limited. High investment costs, long payback periods, infrastructure requirements, and the need for a

qualified workforce are among the main factors causing the financial returns of digital transformation investments to materialize over time.

The literature widely acknowledges that organizational climate has positive effects on employee motivation, innovation tendencies, and technological adaptation (You et al., 2022; Li, 2023) Similarly, organizational agility is associated with firms' abilities to respond rapidly to uncertainty, enhance learning capacity, and reconfigure resources effectively. Nevertheless, empirical findings regarding the impact of organizational agility on financial performance differ across sectors, and studies focusing specifically on the mining industry remain limited (Mrugalska&Ahmed,2021).

Although Industry 4.0 awareness and the level of digital technology utilization are considered critical components of the digital transformation process, the literature does not provide a clear consensus on their direct effects on financial performance. In particular, the relationship between awareness of digital technologies, the actual level of their use, and how these processes are reflected in financial outcomes has not been sufficiently examined in the context of the mining sector. This gap highlights the need for a comprehensive empirical investigation.

Accordingly, this study aims to examine the effects of organizational climate and organizational agility on financial firm performance, together with the mediating roles of Industry 4.0 awareness and the level of digital technology utilization, in mining companies operating in Turkey. A total of fourteen hypotheses were developed to test both direct and mediating relationships among these variables. By adopting a holistic model, the study seeks to explain why digital transformation investments in the mining sector have limited short-term financial effects and to emphasize the importance of organizational preparedness and internal dynamics in this process.

THEORETICAL FRAMEWORK

The theoretical foundation of this study is grounded in the literature on organizational behavior and strategic management. The relationships between organizational climate, organizational agility, Industry 4.0 applications, and financial firm performance are examined to explain how internal organizational factors and digital transformation processes interact in capital-intensive sectors such as mining. This framework provides the basis for the development of the research hypotheses and the construction of the conceptual model.

Organizational Climate

Organizational climate refers to employees' shared perceptions regarding organizational policies, procedures, and practices, which over time shape individual attitudes and behaviors within the workplace(Schneider & Barbera, 2014). It reflects the general atmosphere perceived by employees and can be defined as the cumulative perception of management style, organizational functioning, and internal practices (Litwin & Stringer, 1968).

Empirical studies indicate that a supportive organizational climate positively influences employee commitment, job satisfaction, and voluntary contribution behaviors (Schneider & Barbera, 2014; Christian, Garza, & Slaughter, 2011). Particularly during digital transformation processes, a positive organizational climate facilitates employees' adaptation to technological change by strengthening trust, communication, and psychological safety (Edmondson, 1999).In this regard, organizational climate is considered a key determinant of both individual productivity and overall organizational effectiveness (Christian, Garza, & Slaughter, 2011)..

From a theoretical perspective, organizational climate is grounded in psychological climate theory and organizational behavior approaches (Litwin & Stringer, 1968; Schneider & Barbera, 2014) . A positive climate is expected to enhance employee motivation and engagement, thereby contributing to firm performance. Accordingly, this study posits that organizational climate plays a critical role in shaping both digital transformation outcomes and financial performance.

Organizational Agility

Organizational agility is defined as a firm's ability to sense environmental changes, seize emerging opportunities, and respond effectively to threats in a rapidly changing business environment (Teece,

2007; Doz & Kosonen, 2010). Agile organizations are characterized by flexibility, rapid decision-making, and the capacity to reconfigure resources in response to uncertainty. (Overby, Bharadwaj, & Sambamurthy, 2006).

The literature emphasizes that agility enables organizations not only to react to change but also to proactively anticipate strategic opportunitie. (Sharifi & Zhang, 1999). Organizational structure, leadership style, and openness to innovation are among the key factors influencing the development of agility(Judge & Piccolo, 2004) .In the context of digital transformation, agility provides firms with a competitive advantage by facilitating faster adaptation to technological advancements and market demands (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013).

This concept is theoretically rooted in the Dynamic Capabilities Theory, which suggests that sustainable competitive advantage arises from a firm's ability to integrate, build, and reconfigure internal and external competencies in response to changing environments (Teece, 2007). From this perspective, organizational agility is expected to contribute to firm performance by enhancing responsiveness, efficiency, and strategic flexibility. (Teece, Pisano, & Shuen, 1997).

Industry 4.0

Industry 4.0 represents a paradigm shift in production systems through the integration of digital technologies, automation, and intelligent systems. It refers to a transformative industrial stage in which machines, digital systems, and production processes are interconnected and capable of communicating with one another, enabling more flexible, efficient, and data-driven production environments.

The core components of Industry 4.0 include cyber-physical systems (CPS), the Internet of Things (IoT), big data analytics, artificial intelligence, and cloud computing. These technologies facilitate real-time data exchange, process optimization, and intelligent decision-making across production systems (Kagermann, Wahlster & Helbig, 2013);(Hermann, Pentek & Otto, 2016); (Zheng, Xie & Ma, 2017). As a result, Industry 4.0 enables firms to improve productivity, enhance quality, and increase operational flexibility.

Industry 4.0 Awareness

Industry 4.0 awareness refers to the extent to which individuals and organizations recognize, understand, and evaluate the impact of digital technologies on business processes. Awareness encompasses not only basic knowledge of technologies but also strategic understanding and the ability to assess their potential organizational implications (Ghobakhloo, 2018)

In the literature, Industry 4.0 awareness is defined as the degree to which firms comprehend digital transformation technologies and their effects on production and management processes (Mittal, Khan, Romero, & Wuest, 2018; Bag, Pretorius, Gupta, & Dwivedi, 2021) This awareness develops progressively, ranging from technical familiarity to strategic vision and application capability.

Theoretically, Industry 4.0 awareness is grounded in learning organization theory and information processing perspectives (Senge, 1990). Firms with higher levels of awareness are better positioned to align technological investments with strategic objectives and are more likely to succeed in digital transformation initiatives.

Industry 4.0 Technology Utilization Level

The level of Industry 4.0 technology utilization refers to the extent to which firms effectively integrate digital technologies into their production and business processes (Brettel, Friederichsen, Keller & Rosenberg, 2014).

This includes the practical application of automation, data analytics, intelligent systems, and digital platforms to achieve efficiency, flexibility, and process optimization. Effective utilization depends not only on technological infrastructure but also on employee skills, organizational culture, and managerial support. From a theoretical standpoint, this variable is rooted in sociotechnical systems theory, which emphasizes the joint optimization of technological and social subsystems (Mumford, 2006). Accordingly, effective use of Industry 4.0 technologies is expected to enhance operational efficiency, reduce costs, and improve overall firm performance.

Mining 4.0

The mining sector has evolved in parallel with technological developments, progressing through stages of mechanization, automation, and digitalization. Mining 4.0 refers to the application of Industry 4.0 principles and technologies within mining operations to create safer, more efficient, and more sustainable production systems.

Mining 4.0 integrates digital technologies, automation systems, and advanced data analytics to enable predictive maintenance, real-time monitoring, and process optimization (Li, Li & Li, 2021). These applications contribute to improved safety standards, reduced operational risks, and enhanced environmental performance. From a theoretical perspective, Mining 4.0 can be explained through the Diffusion of Innovations Theory (Rogers, 2003), the Technology Acceptance Model (Davis, 1989), and the Resource-Based View (Barney, 1991). Together, these frameworks explain how technological adoption, organizational capabilities, and strategic resources interact to shape digital transformation outcomes in the mining sector.

Financial Firm Performance

Firm performance is a multidimensional construct reflecting the extent to which an organization achieves its strategic objectives. It is commonly assessed through both financial and non-financial indicators (Neely, Gregory & Platts, 1995). Financial performance, in particular, is measured using indicators such as profitability, revenue growth, market share, and return on investment, which reflect both short- and long-term economic success (Venkatraman & Ramanujam, 1986; Hitt, Ireland & Hoskisson, 2017).

From a theoretical standpoint, financial firm performance is grounded in the Resource-Based View, which emphasizes the effective utilization of firm resources and capabilities to achieve sustainable competitive advantage (Barney, 1991). In this context, the strategic management of technological, human, and organizational resources is considered a key determinant of financial outcomes. In the context of digital transformation and Industry 4.0, the impact of organizational climate and agility on financial performance has become increasingly significant .

HYPOTHESIS DEVELOPMENT

This section presents 14 hypotheses developed within a research model that examines the effects of organizational climate, organizational agility, Industry 4.0 awareness, and technology use on financial performance. Although these variables have been studied in different sectors, their interactions in capital-intensive industries with long investment payback periods have not been thoroughly explored. Therefore, the hypotheses were designed by considering both the theoretical background and the specific conditions of the sector, aiming to provide a clear understanding of how technological and organizational factors affect financial performance in the context of digital transformation.

Organizational Climate and Organizational Agility

Organizational climate directly affects an organization's capacity to adapt to change by shaping employees' perceptions of being supported by the organization, working in a fair environment, and trusting management. Social Change Theory (Blau, 1964) and organizational climate approaches argue that a supportive and innovation-promoting climate strengthens organizational agility by enabling employees to respond quickly and flexibly to uncertainties (Denison & Mishra, 1995;Jung,Chow,&Wu,2003). In the literature, it is widely accepted that a positive organizational climate increases organizational agility and improves organizations' capacity to adapt to environmental changes (Zhao, Huang, Liu, Davison & Liang, 2023).

H1: A positive organizational climate has a positive and significant effect on organizational agility.

Organizational Climate and Industry 4.0 Awareness

Social Cognitive Theory (Bandura, 1986) and Innovation Adoption Theory (Rogers, 2003) indicate that individuals' perceptions and behaviors towards technology are influenced by the organizational context. A climate that supports innovation and is open to learning increases employees' awareness of Industry 4.0

technologies. Research shows that a supportive and innovation-promoting organizational climate strengthens Industry 4.0 awareness (Brettel, Friederichsen, Keller & Rosenberg, 2014; Chauhan,Dwivedi& Rana,2021).

H2: A positive organizational climate has a positive and significant effect on Industry 4.0 awareness.

Organizational Climate and Industry 4.0 Technology Utilization Level

Organizational climate plays a critical role in shaping employees' behavior towards technology. Within the framework of Social Cognitive Theory and Innovation Adoption Theory, a participatory and supportive climate facilitates the translation of awareness into concrete technology use (Rogers, 2003; Bandura, 1986). Literature shows that a positive organizational climate increases the adoption and utilization level of Industry 4.0 technologies (Cai, Liu, Huang & Liang, 2019; Cai,Liu,Huang&Liang,2019;Schumacher,Rol&Sihn,2019).

H3: A positive organizational climate has a positive and significant effect on the utilization level of Industry 4.0 technologies.

Organizational Climate and Financial Firm Performance

Social Change Theory and Resource-Based View (Barney, 1991) argue that a positive organizational climate increases operational efficiency and reduces costs by enhancing employee commitment, motivation, and productivity. Literature findings show that these processes contribute positively to financial performance in the long term (Burton, Lauridsen & Obel, 2004; Zhang & Liu, 2012; Koo Moon & KwonChoi, 2014; Elnagar, Abdelkawi, Elshaer & Salama, 2022).

H4: A positive organizational climate has a positive and significant effect on financial performance.

Organizational Agility and Industry 4.0 Awareness

Dynamic Capabilities Theory (Teece, 2007) states that organizational agility is the capacity of firms to perceive environmental changes, seize opportunities, and restructure resources. Agile organizations can identify and implement Industry 4.0 opportunities early in the digital transformation process (Alamsjah & Yunus, 2022; Mrugalska & Ahmed, 2021). Literature confirms that agility increases Industry 4.0 awareness (Vu et al., 2023; Prashar et al., 2022).

H5: Organizational agility has a positive and significant effect on Industry 4.0 awareness.

Organizational Agility and Industry 4.0 Technology Usege Level

Agile structures support the rapid adoption of technological innovations. Within the framework of Dynamic Capabilities Theory, agile organizations can implement Industry 4.0 technologies more effectively (Teece, 2007; Damanpour, 1991). Research shows that agility increases the level of technology utilization (Zhang, Ding & Xiao, 2023; Ramadan et al., 2023).

H6: Organizational agility has a positive and significant impact on the level of adoption of Industry 4.0 technologies.

Organizational Agility and Financial Firm Performance

Dynamic Capabilities Theory suggests that agility contributes to long-term financial performance by effectively managing risks, efficiently utilizing resources, and increasing operational flexibility (Sağbaş & İnce, 2022). Literature shows that agile firms gain a competitive advantage and improve their financial performance by responding quickly to market changes (Rafi, Shafiq & Baloch, 2022; Panda & Rath, 2021; Bekos, Jaakkola & Chari, 2025).

H7: Organizational agility has a positive and significant effect on financial performance.

Industry 4.0 Awareness and Financial Firm Performance

Resource-Based View (Barney, 1991) and Dynamic Capabilities Theory (Teece, 2007) state that digital technologies alone cannot create a sustainable competitive advantage, but contribute to performance when integrated with organizational capabilities. Industry 4.0 awareness enables firms to grasp the strategic importance of digital technologies, while facilitating the effective translation of this awareness into operational outputs (Zhong, Xu, Klotz & Newman, 2017; Michna & Kmieciak, 2019; Chan, 2021). Research shows that firms with high awareness are more successful in digital transformation processes, and this improves financial performance in the long term (Tortorella et al., 2020; Kumar & Singh, 2021).The impact of digital transformation and information management on firm performance has been demonstrated in previous research (Öngel, 2021); in this study, it is examined specifically in the context of Industry 4.0 awareness.

H8: Industry 4.0 awareness has a positive and significant impact on financial performance.

Industry 4.0 Technology Utilization Level and Financial Firm Performance

The Resource-Based View (Barney, 1991) and Productivity Theory (Solow, 1957) emphasize that the effective implementation of technologies reduces costs, optimizes resource utilization, and provides a competitive advantage. The use of Industry 4.0 technologies increases efficiency in firms' production processes and positively contributes to financial outputs through process optimization (Hrbić, 2025). Literature findings show that companies that effectively utilize technology experience increased operational efficiency, which is directly reflected in financial performance (Zhang, Ding & Xiao, 2023; Ramadan et al., 2023). Similarly, businesses that effectively manage their digitalization strategies can contribute to improved financial performance by strengthening operational efficiency and competitive advantage (Mert & Zehir, 2024).

H9: The level of use of Industry 4.0 technologies has a positive and significant impact on financial performance.

Organizational Climate, Industry 4.0 Awareness, and Financial Performance

Dynamic Capabilities Theory (Teece, 2007) and the Technology Acceptance Model (Davis, 1989) suggest that the impact of Industry 4.0 awareness on financial performance can only occur through appropriate organizational conditions and dynamic capabilities. Literature shows that a supportive organizational climate increases awareness, which is reflected in financial performance through cost control, productivity, and process optimization (Lehmann & Beckmann, 2024; Nguyen et al., 2023).

H10: Industry 4.0 awareness plays a mediating role in the relationship between organizational climate and financial performance.

Organizational Climate, Industry 4.0 Technology Use, and Financial Performance (Mediation)

The Technology Acceptance Model and Resource-Based View show that a positive organizational climate can improve financial performance by supporting the effective use of technology (Barney, 1991; Davis, 1989). Research shows that the use of Industry 4.0 technologies strengthens the impact of organizational climate on financial performance (Lehmann & Beckmann, 2024; Elnagar, Abdelkawi, Elshaer & Salama, 2022).

H11: The level of use of Industry 4.0 technologies plays a mediating role in the relationship between organizational climate and financial performance.

Organizational Agility, Industry 4.0 Awareness, and Financial Performance

Dynamic Capabilities Theory (Teece, 2007) and Organizational Learning Theory (Argyris & Schön, 1978) argue that agility indirectly contributes to financial performance by increasing Industry 4.0 awareness. Literature shows that agile organizations identify technological opportunities early, make

strategic decisions, and this translates into long-term financial success (Vu et al., 2023; Prashar et al., 2022).

> **H12:** Industry 4.0 awareness plays a mediating role in the relationship between organizational agility and financial performance.

Organizational Agility, Industry 4.0 Technology Use, and Financial Performance

Dynamic Capabilities Theory and mediation frameworks (Baron & Kenny, 1986; Hayes, 2013) suggest that agility enhances financial performance through the level of technology use. Literature shows that agile firms reduce costs, increase productivity, and strengthen their financial results by effectively using Industry 4.0 technologies (Awwad, Ababneh & Karasneh, 2022; Zhang, Ding & Xiao, 2023).

> **H13:** The level of use of Industry 4.0 technologies plays a mediating role in the relationship between organizational agility and financial performance.

Integrative Mediation: Organizational Climate, Organizational Agility, Industry 4.0 Awareness, and Technology Use

Dynamic Capabilities Theory (Teece, 2007) and Systems Theory (Bertalanffy, 1968) emphasize that the digital transformation process is not only a technological investment but also an organizational transformation process. The literature shows that considering Industry 4.0 awareness and the level of technology use together strengthens the effects of organizational climate and agility on financial performance and provides integrative mediation (Hamel & Prahalad, 1994; Yılmaz Gezgin & Arıcıoğlu, 2025; Lehmann & Beckmann, 2024).

> **H14:** Industry 4.0 awareness and the level of technology use together play an integrative mediating role in the effects of organizational climate and organizational agility on financial performance

MEASUREMENT TOOLS AND DATA COLLECTION

To measure the variables included in the research, scales with previously validated reliability were used. These scales aim to evaluate organizational agility, organizational climate, Industry 4.0 awareness and technology usage level, and financial firm performance.

Organizational agility was measured with the scale developed by Cegarra-Navarro, Soto-Acosta, and Wensley (2016). The scale consists of six items that evaluate the capacity of businesses to respond quickly and flexibly to changing market conditions and customer demands, and was applied using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Organizational climate was measured using the scale developed by Bock et al. (2005) and adapted into Turkish by Korkmaz (2020). The scale consists of ten items that include factors such as collaboration among employees, trust, risk-taking tendency, and an environment that supports innovation. The measurement was performed using a five-point Likert scale.

Industry 4.0 awareness was measured based on the survey form included in the *Digital Transformation Analysis in Industry* report published by the Istanbul Chamber of Industry (2018). The scale consists of nine items that evaluate the knowledge and perception levels of businesses regarding digital transformation and Industry 4.0 technologies and was applied using a five-point Likert scale.

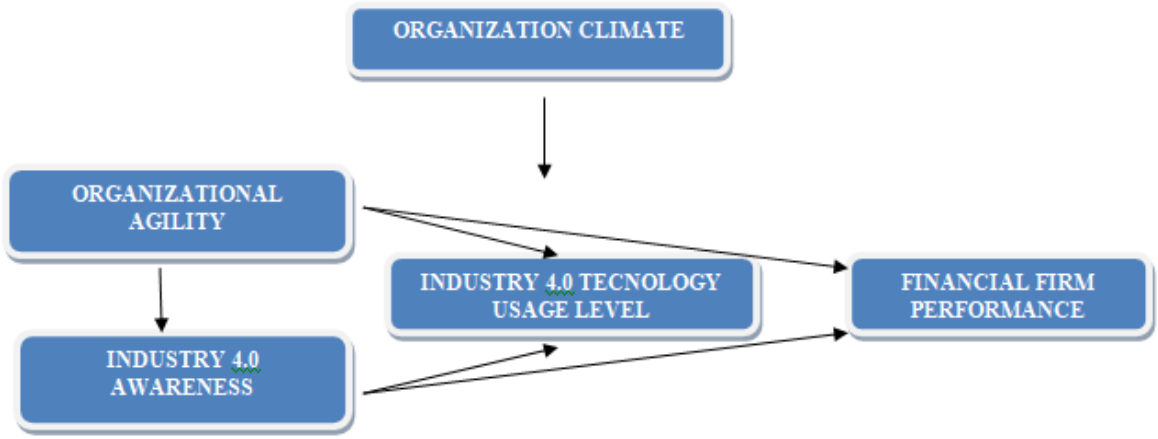
The level of use of Industry 4.0 technologies was evaluated using a 29-item scale developed by Çalış Duman and Akdemir (2021). The scale measures the level of application of technologies such as robotic systems, three-dimensional printers, cloud computing, cybersecurity, augmented reality, the Internet of Things, and big data in businesses. The measurement was conducted using a five-point Likert scale (1 = Not Implemented, 5 = Implemented).

Financial firm performance was measured using a four-item scale based on the criteria proposed by Carton and Hofer (2007), Venkatraman and Ramanujam (1986), and Antoncic and Hisrich (2001). The scale covers key financial indicators such as profitability, sales growth, market share, and return on

investment. The measurement was performed using a five-point Likert scale (1 = Very Low, 5 = Very High).

RESEARCH MODEL

Figure 1. Research Model



Source: Created by the author.

RESEARCH METHOD AND POPULATION

The study covers 23 leading mining companies operating across Turkey that have begun to utilize Industry 4.0 technologies at various stages and are striving to adapt to the digital transformation process. Data were collected through an online survey conducted with 538 participants, including general assembly members, general managers, and senior- and mid-level managers working in these companies.

The survey form was prepared using Google Forms, and the data collection process was conducted online. The findings obtained from the survey data are presented and analyzed in the following section.

FINDINGS

The demographic findings ; The majority of the participants were male (91.1%) and aged between 31 and 40 (47%), with the remaining age groups distributed as 41–50 (35.1%), 51 and above (11.7%), and 30 and below (6.2%). Most participants held a university degree (75.8%), followed by a master's degree (24%), while only a very small number had a high school education or less (0.2%). In terms of job position, the sample was predominantly composed of senior managers (81.6%), with middle managers (15%) and business owners (3.4%) making up the rest. Regarding company scope, participants mostly came from nationally operating businesses (71.2%), followed by regional (28.4%) and international (0.4%) companies. Finally, the majority of participants had up to five years of professional experience (53.9%), while those with six to ten years (32.5%) and more than eleven years (13.6%) made up the remainder.

Data Analysis

Data analysis was conducted using normality distribution, Cronbach's Alpha reliability tests, Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). Exploratory Factor Analysis (EFA) was not conducted because the scales used in this study had been previously adapted to Turkish by different researchers and their structural validity and reliability had been tested numerous times in the past. While EFA is not considered necessary for previously used scales in the literature, CFA is considered a necessity (Yaşlıoğlu, 2017). Examining the normality distribution is a necessary step before beginning the analyses. For parametric testing to be applied, a normal distribution is a prerequisite for the sample in data analysis, and the data set must exhibit a normal distribution. Normal distribution is an important indicator that the sample is homogeneously distributed and representative of the population.

Skewness and Kurtosis values are among the most commonly used methods for analyzing normal distribution, and are used in the study (Hair et al., 2014). Information regarding normal distribution is presented in Table 3.

Table 3. Normality Distribution as Related to the Measurements

Measures and low dimensions	Kolmogorov-Smirnov			Central Tendency Measures			
	Statistic	Df	Sig.	Mean	Median	Skewness	Kurtosis
Organizational Agility	0,147	538	0,000	4,352	4,333	0,094	0,024
Organizational Climate	0,112	538	0,000	4,258	4,200	0,477	-0,241
Industry 4.0 Awareness	0,096	538	0,000	4,421	4,444	-0,134	-0,622
Level of Technology Use	0,119	538	0,000	4,046	4,034	-0,160	-0,068
Financial Firm Performance	0,214	538	0,000	3,832	4,000	0,020	0,200

Source: Created by the author.

Skewness and Kurtosis values between +1.96 and -1.96 indicate a normal distribution (Hair et al., 2014). When the values in Table 4 are examined, it can be said that the sample exhibits a normal distribution because the values remain within the limits.

Table 4. Cronbach Alpha Coefficients Related to the Measurements

Measures and low dimensions	Cronbach's Alpha			
		Standardized	Variable Number	Remarks
Organizational Agility	0,808	0,808	6	-
Organizational Climate	0,755	0,801	10	
Industry 4.0 Awareness	0,804	0,804	8	With 9 questions about awareness, the measures became more reliable
Technology Use Level	0,934	0,945	29	-
Financial Firm Performance	0,779	0,787	4	-

Source: Created by the author.

The Cronbach's alpha coefficients of the scales were analyzed, and values were determined for Organizational Agility (α=0.808), Organizational Climate (α=0.755), Industry 4.0 Awareness (α=0.804), Technology Use Level (α=0.934), and Financial Firm Performance (α=0.779). As a result of the measurement, the scales were found to be reliable because their α coefficients were above 0.70 (Hair et al., 2014). Besides normality and reliability, the other important criteria required for the analyses is the multicollinearity problem of the scales (Hair et al., 2014). This measurement is determined using correlation analysis. The values from the correlation analysis are presented in Table 5.

Table 5. Correlation Values

	1	2	3	4	5
Organizational Agility	1				
Organizational Climate	.136**	1			
Industry 4.0 Awareness	.149**	0.075	1		
Technology Use Level	.165**	.178**	0.066	1	
Financial Firm Performance	.124**	.143**	0.050	.158**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Created by the author.

An examination of Table 5 reveals that there is no correlation greater than 0.90 between the variables, indicating that there is no multicollinearity problem. However, it is also observed that the correlation between the variables is low ($r<0.30$) or insignificant ($p>0.05$) (Hair et al., 2014). Harman Single Factor Analysis was conducted to measure common method bias among the scales. This analysis revealed that the explanatory power of all items under a single scale was 21.82%. Since the result was below 50%, it was determined that there was no common method bias.

Confirmatory Factor Analysis

Confirmatory factor analysis is needed to analyze the construct validity of the scales used. Confirmatory factor analysis (CFA) was applied in accordance with the criteria in Table 6.

Table 6. Value Ranges of the Fit Index Values Used in the Research

Fit Criteria	Perfect Fit	Acceptable Fit
$\chi 2/sd$	≤3	≤5
RMSEA	0 <RMSEA<0.05	0.05 ≤ RMSEA ≤ 0.10
SRMR	0 ≤ SRMR<0.05	0.05 ≤ SRMR ≤ 0.10
NFI	0.90 ≤ NFI ≤ 1	0.80 ≤NFI ≤ 0.90
CFI	0.95 ≤ CFI ≤ 1	0.90 ≤CFI ≤ 0.95
GFI	0.90 ≤ GFI ≤ 1	0.85 ≤GFI ≤ 0.90

Source: Schermelleh-Engel, K., Moosbrugger, H., and Müller, H. (2003). "Evaluating the Fit of Structural Equation Models: Tests of Significance and Descriptive Goodness-of-Fit Measures". Methods of Psychological Research Online.

Confirmatory Factor Analysis Values for the Scales

Confirmatory factor analysis (CFA) was conducted to test the validity of the scale structure and establish its reliability. Data were analyzed using the IBM AMOS (Chicago, USA) program.When the confirmatory factor analysis and goodness-of-fit values were examined, it was determined that all goodness-of-fit values, except for AVE, were sufficient. The AVE (Average Variance Explained) value, which indicates validity, should be greater than 0.50, and the Composite Reliability (CR) value should be greater than 0.70. Information regarding these values is provided in Table 7.

Table 7. Goodness-of-Fit Values For the Scales

Variable	X^2(df)	P	RMSEA	GFI	CFI	NFI	SRMR	AVE	CR
Agility	4.002	0.003	0.075	0.990	0.988	0.984	0.024	0.443	0.882
Climate	4.410	0.000	0.008	0.958	0.938	0.922	0.057	0.275	0,773
Awareness	3.293	0.001	0.065	0.988	0.990	0.986	0.046	0.276	0.671
Tech Use	2.536	0.000	0.053	0.901	0.962	0.939	0.042	0.682	0.983
Financial	3.070	0.000	0.076	0.988	0.985	0.984	0.019	0.453	0.753

Source: Created by the author.

Following CFA, the validity of the scales was confirmed, and there were no concerns regarding their use in the study. While the AVE value may appear to be a limitation, the literature suggests that convergent validity is achieved if the AVE value is less than 0.50 and the CR value is greater than 0.60 (Fornell & Larcker, 1981; Karaman, 2023).

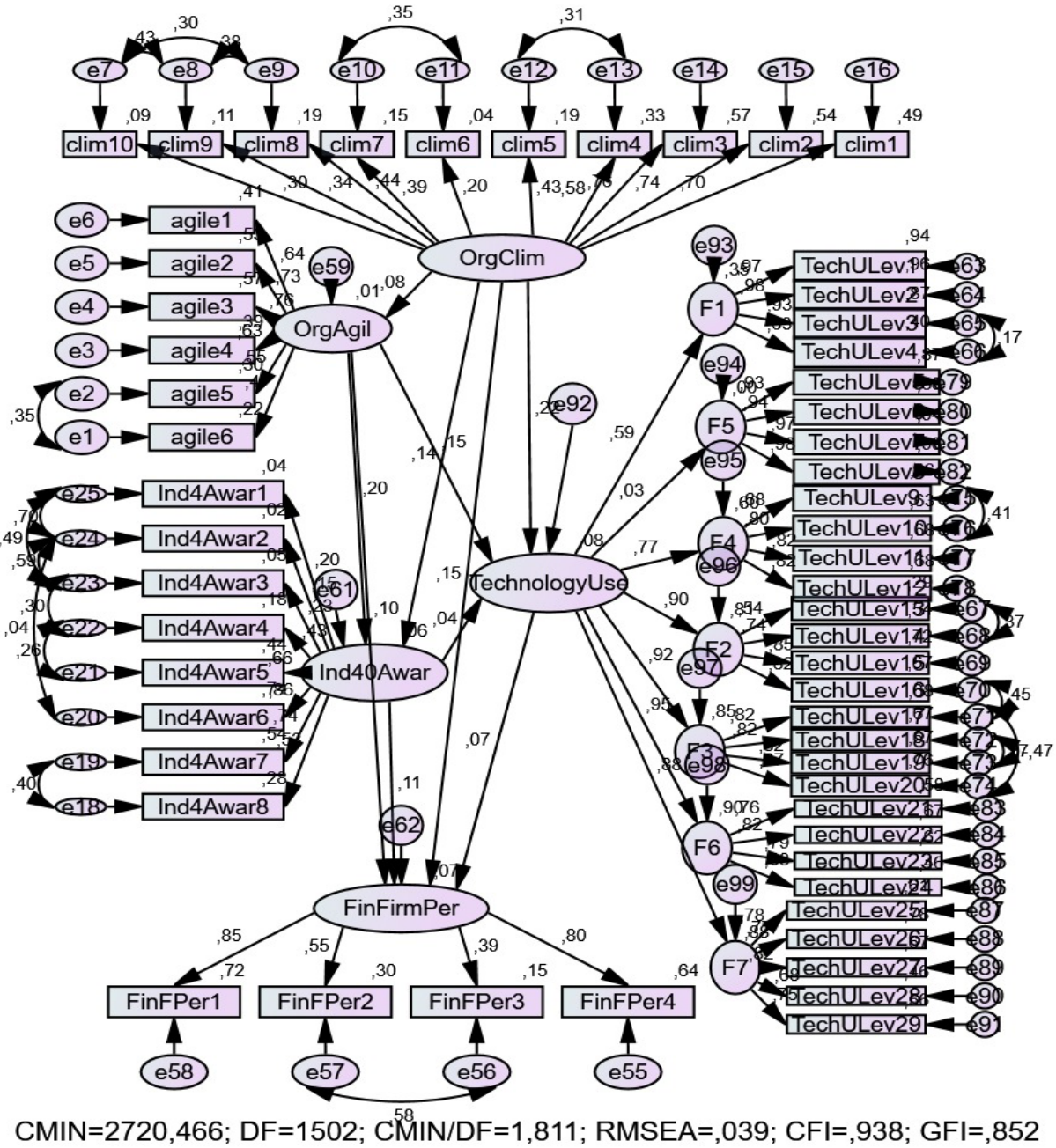
When the results of the confirmatory factor analysis are examined, it is seen that the AVE values of some constructs fall below the recommended threshold of 0.50. However, the fact that the composite reliability (CR) values of the relevant constructs are above the acceptable limits indicates that the measurement model is generally reliable. Fornell and Larcker (1981) state that convergent validity is acceptable when CR values are above 0.60, even if AVE values are below 0.50.

However, it should be considered that multidimensional and perception-based variables such as organizational climate and Industry 4.0 awareness are difficult to measure, especially in heterogeneous and highly uncertain contexts such as the mining sector. Therefore, this limitation of the measurement model should be taken into account when interpreting the obtained findings.

Findings Regarding Hypotheses

Hypotheses formulated in accordance with the literature suggest that organizational agility, Industry 4.0 awareness, and the level of Industry 4.0 technology use mediate the impact of organizational climate on financial firm performance. The path diagram of the analysis results is presented in Figure 1.

Figure 1. Hypotheses Path Diagram



Source: Created by the author.

The hypothesis analysis indicated that Industry 4.0 technology use did not mediate the effect of Industry 4.0 awareness on financial firm performance. Table 8 presents the standardized factor loadings for the constructed measurement model, obtained through confirmatory factor analysis and structural equation modeling. The table also illustrates the relationships and structural paths between latent and observed variables, providing a basis for evaluating the adequacy of the measurement model prior to hypothesis testing.

Table 8. Measurement Model for Hypotheses

			β1	β2	S.E.	C.R.	P
Measurement Model							
F1	<---	Tech Use	0,590	1,000			
F5	<---	Tech Use	0,029	0,060	0,092	0,648	0,517
F4	<---	Tech Use	0,775	0,841	0,076	11,027	<0,001
F2	<---	Tech Use	0,902	1,374	0,135	10,197	<0,001
F3	<---	Tech Use	0,924	1,038	0,076	13,591	<0,001
F6	<---	Tech Use	0,948	1,088	0,083	13,102	<0,001
F7	<---	Tech Use	0,880	0,962	0,074	12,921	<0,001
agility6	<---	Agile	0,468	1,000			
agility 5	<---	Agile	0,545	1,111	0,106	10,459	<0,001
agility4	<---	Agile	0,628	1,276	0,141	9,036	<0,001
agility3	<---	Agile	0,757	1,511	0,156	9,707	<0,001
agility2	<---	Agile	0,728	1,475	0,154	9,588	<0,001
agility1	<---	Agile	0,640	1,257	0,138	9,111	<0,001
climate10	<---	Org. Climate	0,301	1,000			
climate9	<---	Org. Climate	0,337	1,143	0,176	6,511	<0,001
climate8	<---	Org. Climate	0,438	1,372	0,211	6,507	<0,001
climate7	<---	Org. Climate	0,389	1,295	0,246	5,274	<0,001
climate6	<---	Org. Climate	0,198	1,409	0,397	3,552	<0,001
climate5	<---	Org. Climate	0,431	1,443	0,264	5,472	<0,001
climate4	<---	Org. Climate	0,577	1,837	0,307	5,991	<0,001
climate3	<---	Org. Climate	0,755	2,300	0,365	6,305	<0,001
climate2	<---	Org. Climate	0,737	2,333	0,371	6,285	<0,001
climate1	<---	Org. Climate	0,700	2,158	0,346	6,234	<0,001
awareness8	<---	Awareness	0,531	2,678	0,652	4,109	<0,001
awareness7	<---	Awareness	0,737	3,656	0,859	4,256	<0,001
awareness6	<---	Awareness	0,858	4,302	1,007	4,272	<0,001
awareness5	<---	Awareness	0,664	3,303	0,782	4,223	<0,001
awareness4	<---	Awareness	0,427	2,135	0,538	3,971	<0,001
awarness3	<---	Awareness	0,232	1,095	0,240	4,563	<0,001
awareness2	<---	Awareness	0,153	0,765	0,180	4,247	<0,001
awareness1	<---	Awareness	0,201	1,000			
Financial4	<---	Finance	0,801	1,000			
Financial3	<---	Finance	0,390	0,588	0,071	8,239	<0,001
Financial2	<---	Finance	0,545	0,696	0,060	11,628	<0,001
Financial1	<---	Finance	0,851	0,978	0,071	13,784	<0,001
Structural Equality Model							
Agility	<---	Org. Climate	0,083	0,132	0,088	1,511	0,131
Awareness	<---	Org. Climate	0,136	0,086	0,040	2,141	**0,032**
Awareness	<---	Org. Climate	0,204	0,081	0,029	2,832	**0,005**
Tech Use	<---	Org.Climate	0,219	0,505	0,139	3,621	**<0,001**
Tech Use	<---	Awareness	0,037	0,135	0,184	0,736	0,462
Tech Use	<---	Agility	0,152	0,219	0,076	2,892	**0,004**
Finance	<---	Org. Climate	0,155	0,444	0,168	2,637	**0,008**
Finance	<---	Agility	0,105	0,188	0,098	1,914	0,056
Finance	<---	Awareness	0,110	0,498	0,266	1,875	0,061
Finance	<---	Tech Use	0,072	0,090	0,063	1,424	0,155

Source: Created by the author.

Analyses conducted within the scope of the model were obtained using the bootstrapping method using 5,000 sample coefficients. Since the variables had no significant effect on each other, it was determined that there was no mediating role. A mediating role was not determined with the measurement model. However, to validate the determination, it is necessary to examine the adequacy of the model's goodness-of-fit values. In this context, the measurement goodness-of-fit values are presented in Table 9.

Table 9. Goodness-of-Fit Values for the Fourteenth Hypothesis

Fit Criteria	Updated Value	Ideal Value	Status
X^2(df)	1.811	≤ 5 (Preffered ≤3)	Acceptable
P	0.000	≤ 0.05 Acceptable	Acceptable
RMSEA	0.039	≤ 0.08 Acceptable	Acceptable
GFI	0.852	≥ 0.95 Good fit, ≥ 0.90 Acceptable	Acceptable
CFI	0.938	≥ 0.95 Good Fit, ≥ 0.90 Acceptable	Good fit
NFI	0.872	≥ 0.90 Good Fit, ≥ 0.80 Acceptable	Acceptable
SRMR	0.051	≤ 0.08 Acceptable	Acceptable

Source: Created by the author.

When Table 9 is examined, it is seen that the Good Fit values of the performed analysis are within the desired values. In this regard, the state of rejected and accepted values in Table 10 has been shared.

Table10. List Concerning the Hypotheses

Hypothesis	Dependent Variable	Independent Variable	Mediating Variable	Result
H_1	Organizational Agility	Organizational Climate	-	Not supported
H_2	I4 Awareness	Organizational Climate	-	Supported
H_3	ETKD	Organizational Climate		Supported
H_4	Financial Performance	Organizational Climate	-	Supported
H_5	I4 Awareness	Organizational Agility	-	Supported
H_6	ETKD	Organizational Agility	-	Supported
H_7	Financial Performance	Organizational Agility	-	Not supported
H_8	ETKD	I4 Awareness	-	Not supported
H_9	Financial Performance	I4 Awareness	-	Not supported
H_{10}	Financial Performance	ETKD	-	Not supported
H_{11}	Financial Performance	Organizational Agility	ETKD	Not supported
H_{12}	Financial Performance	Organizational Climate	ETKD	Not supported
H_{13}	Financial Performance	I4 Awareness	ETKD	Not supported
H_{14}	Financial Performance	Organizational Agility, Organizational Climate and I4 Awareness	ETKD	Not supported

Source: Created by the author.

DISCUSSION

This study examined the effects of organizational climate, organizational agility, Industry 4.0 awareness, and technology use on financial performance in the digital transformation process of the mining sector. The findings show that while organizational climate and awareness provide positive contributions in some aspects, the direct effects of agility and technology use on financial performance are limited. This situation may stem from the structural characteristics of the mining sector, such as high capital requirements, long investment payback periods, and operational complexity. In the discussion section, the results obtained will be evaluated in relation to both the findings in the literature and the specific conditions of the sector.

The first hypothesis of the research predicted that organizational climate would have a significant and positive effect on organizational agility. However, the findings did not support this hypothesis. This situation can be explained by the structural characteristics of the mining sector. Khutama (2017) states that in sectors such as mining, agility is shaped by external environmental conditions rather than internal climate. In this context, in sectors with high levels of uncertainty and external risks, agility is related more to the ability to adapt to environmental conditions than to organizational climate. The second hypothesis predicted that organizational climate would have a positive impact on Industry 4.0 awareness, and the findings supported this hypothesis. Internal communication, leadership support, and an innovative work environment increase employees' awareness of digital transformation. Similarly, Lööw,

Abrahamsson, and Johansson (2019) emphasize that organizational atmosphere is decisive in attitudes and awareness towards technology.

The third hypothesis predicted that organizational climate would have an impact on the use of Industry 4.0 technologies, and this hypothesis was also supported. Wiese, Lehmann, and Beckmann (2024) showed in their study that companies with an organizational culture focused on development and learning adopt digital technologies more effectively. In the mining sector, organizational climate also plays a decisive role in employees' technological awareness and adaptation processes (Lund, Pekkari, Johansson & Lööw, 2024).

The fourth hypothesis predicted a positive relationship between organizational climate and financial performance, and this hypothesis was supported. A positive organizational atmosphere indirectly contributes to financial results by increasing employee motivation and commitment. Burton, Lauridsen, and Obel (2004) also showed that trust, fairness, and supportive management elements have a positive effect on financial performance.

The fifth and sixth hypotheses examined the impact of organizational agility on Industry 4.0 awareness and technology use, and both hypotheses were supported. Agile businesses have a higher level of awareness in digital transformation processes and can respond more quickly to technological changes (Alamsjah & Yunus, 2022; Mrugalska & Ahmed, 2021).

However, the seventh hypothesis examined the impact of organizational agility on financial performance and was not supported. This indicates that agility affects financial performance indirectly, not directly. Sağbaş and İnce (2022) also state that the impact of agility and information technologies on financial performance is indirect through uncertainty.

The eighth and ninth hypotheses tested the impact of Industry 4.0 awareness on technology use and financial performance; both hypotheses were not supported. This shows that awareness alone is not sufficient to explain technological adaptation or financial success (Tortorella et al., 2020; Tirgil & Fındık, 2023). The tenth hypothesis predicted a positive relationship between the level of adoption of Industry 4.0 technologies and financial performance, and this was not supported. This finding suggests that the short-term financial impact is limited, particularly in SMEs, due to high costs, inadequate infrastructure, and a lack of technical knowledge (Kumar & Singh, 2021; Chen, Zhang & Lee, 2022).

The eleventh, twelfth, and thirteenth hypotheses tested the effects of technology use as a mediating variable and were found to be insignificant. Structural characteristics of the mining sector, low technology awareness, and inadequate employee training limit these relationships (Upstill & Hall, 2021; Litvinenko, 2020).

Finally, the fourteenth hypothesis examined the overarching effect of organizational climate on other variables and was not supported. Mrugalska and Ahmed (2021) also state that the effect of agility on financial performance varies with sector dynamics and organizational structure.

In general, the findings show that organizational climate and agility are important in the digital transformation process, but this effect is not directly reflected in financial performance in the short term. In capital and labor-intensive sectors such as mining, the impact of digital transformation investments manifests itself in the long term through cultural transformation and operational efficiency. In this context, it is critical not only to invest in technology but also to provide an agile culture, a learning-oriented climate, and employee support.

CONCLUSION

This research comprehensively examines the relationships between organizational climate, organizational agility, Industry 4.0 awareness, technology utilization level, and financial performance in mining companies operating in Turkey. Data obtained from 538 middle and senior managers working in 28 mining companies were analyzed. The findings reveal how technological investments and organizational factors interact in the digital transformation process.

According to the research findings, no direct and significant effect of organizational agility, Industry 4.0 awareness, and technology utilization level on financial performance was observed in the short term. Similarly, the mediating role of Industry 4.0 awareness and technology utilization on financial

performance was not supported. This situation shows that the financial outcomes of digital transformation investments emerge over time, especially in capital-intensive sectors with long investment payback periods and high infrastructure requirements, such as mining.

In contrast, it was found that organizational climate plays a decisive role in the digital transformation process. A supportive organizational climate increases awareness of Industry 4.0, encourages the use of technology, and directly contributes to financial performance. Furthermore, increased awareness of digital technologies has been shown to strengthen organizational agility and increase willingness to use technology. These findings demonstrate that digital transformation is not limited to technical infrastructure investments; organizational structures and the human factor are also critical to the success of the process.

The research reveals that digital transformation applications in the Turkish mining sector are still in the development phase. The sector's high-cost infrastructure requirements, long payback periods, and operational complexity limit the direct impact of Industry 4.0 technologies on financial performance in the short term. Therefore, for digital transformation to be effective, not only technological investments but also management support, employee awareness, and corporate alignment are necessary. Additionally, the limited level of digital maturity in the sector can be considered one of the main reasons why financial gains are not yet fully observable.

Theoretically, the research makes significant contributions to the literature. The findings show that the relationship between Industry 4.0 applications and financial performance is neither direct nor linear. The inclusion of organizational climate, agility, awareness, and technology use within the same model reveals that the digital transformation process, especially in capital-intensive sectors, has a multi-dimensional and dynamic structure. These results emphasize that digital transformation investments should be planned not only as a technological investment but also as an organizational transformation. In terms of application, a holistic and strategic approach is needed to achieve financial success through digital transformation in the mining sector. It is important for managers to prioritize creating a supportive organizational climate, increasing employees' digital awareness, and strengthening organizational agility, rather than focusing solely on technological investments. Such an integrated approach will contribute to the creation of sustainable value from digital transformation investments in the long term.

In conclusion, this study shows that the effects of the digital transformation process on financial performance may be limited in the short term, but when appropriate organizational conditions are provided and technological awareness and use are supported, it can create significant value in the long term. The findings are guiding for both the academic literature and practitioners in the mining sector.This study comprehensively examined the effects of organizational climate and organizational agility on financial performance, as well as the role of Industry 4.0 awareness and technology use in these relationships. In the research conducted with 538 managers working in 28 mining companies in Turkey, while some of the 14 hypotheses yielded significant results, the effects on financial performance were not observed at the expected level.

The findings show that the effect of organizational agility on financial performance (H7) and the direct effect of Industry 4.0 awareness and technology use (H9-H10) on financial results are limited. In contrast, it was determined that organizational climate positively contributes to Industry 4.0 awareness (H2), technology use (H3), and direct financial performance (H4). Furthermore, it was observed that Industry 4.0 awareness increased organizational agility (H5) and supported technology use (H6).

These results reveal that digital transformation in the mining sector is still in its early stages and that technological investments do not directly reflect on financial performance in the short term. In addition to infrastructure, employee awareness, managerial support, and organizational alignment are critical for the effectiveness of digital transformation. The fact that organizational climate contributes to financial performance by supporting both awareness and technology use highlights the importance of human and cultural factors.The research provides empirical evidence that digital transformation should be considered not only as a technological investment but also as an organizational transformation process. Although financial impacts are limited in the short term, it was concluded that these impacts will strengthen in the long term if the right organizational conditions are provided.

A Statement of Ethics

The article was produced from the doctoral dissertation prepared by the first author under the supervision of the second author. The doctoral dissertation titled *"The Effect of Organizational Agility and Climate on Financial Firm Performance Through Industry 4.0 Technologies: A Study on Mining Enterprises"* was **approved by the Istanbul Beykent University Social and Human Sciences Scientific Research and Publication Ethics Board on 08.11.2024.**

REFERENCES

Alamsjah, N., & Yunus, M. (2022). Organizational agility and digital transformation: Evidence from manufacturing firms. *Journal of Business Research, 140*, 50–61.

Antoncic, B., & Hisrich, R. D. (2001). Intrapreneurship: Construct refinement and cross-cultural validation. *Journal of Business Venturing, 16*(5), 495–527.

Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective*. Addison-Wesley.

Bag, S., Pretorius, J. H. C., Gupta, S., & Dwivedi, Y. K. (2021). Industry 4.0 and supply chain management: A systematic literature review and future research directions. *Benchmarking: An International Journal, 28*(10), 3001–3033. https://doi.org/10.1108/BIJ-08-2020-0375

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice Hall.

Barney, J. (1991). *Firm resources and sustained competitive advantage.* Journal of Management, 17(1), 99–120. https://doi.org/10.1177/014920639101700108

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182.

Bertalanffy, L. von. (1968). *General system theory: Foundations, development, applications*. George Braziller.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly*, 37(2), 471–482. https://doi.org/10.25300/MISQ/2013/37.2.06

Blau, P. M. (1964). *Exchange and power in social life*. Wiley.

Bock, G.-W., Zmud, R. W., Kim, Y.-G., & Lee, J.-N. (2005). Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic motivators, social-psychological forces, and organizational climate. *MIS Quarterly, 29*(1), 87–111.

Brettel, M., Friederichsen, N., Keller, M., & Rosenberg, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 perspective. *International Journal of Mechanical, Industrial Science and Engineering*, 8(1), 37–44.

Cai, S., Liu, J., Huang, X., & Liang, H. (2019). Technological innovation and organizational climate: Impacts on technology adoption. *Journal of Engineering and Technology Management, 53*, 1–14.

Carton, R. B., & Hofer, C. W. (2007). Measuring organizational performance: Metrics for entrepreneurship and strategic management research. *Edward Elgar Publishing*.

Castellani, D., Lamperti, F., & Lavoratori, K. (2022). Industry 4.0 adoption and performance outcomes: Evidence from manufacturing firms. *Technological Forecasting and Social Change, 178*, 121569.

Cegarra-Navarro, J. G., Soto-Acosta, P., & Wensley, A. K. (2016). Organizational agility and innovation: Empirical evidence from Spanish SMEs. *Management Decision, 54*(2), 331–351.

Chen, Y., Zhang, Z., & Lee, C. (2022). Industry 4.0 implementation challenges and solutions: A review. *International Journal of Advanced Manufacturing Technology, 119*, 1121–1134.

Çalış, O., Duman, T., & Akdemir, Ö. (2021). Industry 4.0 technology adoption in manufacturing firms. *Procedia Computer Science, 180*, 103–112.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal, 34*(3), 555–590.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.

Denison, D. R., & Mishra, A. K. (1995). Toward a theory of organizational culture and effectiveness. *Organization Science, 6*(2), 204–223.

Doz, Y. L., & Kosonen, M. (2010). Embedding strategic agility: A leadership agenda for accelerating business model renewal. *Long Range Planning*, 43(2–3), 370–382. https://doi.org/10.1016/j.lrp.2009.07.006

Elnagar, A. R., Abdelkawi, M. A., Elshaer, I. A., & Salama, R. (2022). Organizational climate, technology adoption and performance outcomes. *Technological Forecasting and Social Change, 180*, 121679.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.

Ghobakhloo, M. (2018). The future of manufacturing industry: A strategic roadmap toward Industry 4.0. *Journal of Manufacturing Technology Management, 29*(6), 910–936. https://doi.org/10.1108/JMTM-02-2018-0057

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Pearson.

Hamel, G., & Prahalad, C. K. (1994). *Competing for the future*. Harvard Business School Press.

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for Industrie 4.0 scenarios: A literature review. *Technische Universität Dortmund, Working Paper*.

Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management: Concepts and cases: Competitiveness and globalization* (12th ed.). Cengage Learning.

Hrbić, M. (2025). Industry 4.0 technologies and firm performance: Evidence from manufacturing. *Journal of Manufacturing Systems, 67*, 102–115.

Ittner, C. D., & Larcker, D. F. (1998). Innovations in performance measurement: Trends and research implications. *Journal of Management Accounting Research, 10*, 205–238.

Judge, T. A., & Piccolo, R. F. (2004). Transformational and transactional leadership: A meta-analytic test of their relative validity. *Journal of Applied Psychology*, 89(5), 755–768. https://doi.org/10.1037/0021-9010.89.5.755

Kagermann, H., Wahlster, W., & Helbig, J. (2013). *Recommendations for implementing the strategic initiative INDUSTRIE 4.0: Securing the future of German manufacturing industry*. Final report of the Industrie 4.0 Working Group. Forschungsunion.

Kamber, E., & Sonmeztürk Bolatan, G. İ. (2020). *Industry 4.0 concept and applications on different sectors*. Journal of Global Strategic Management, 14(1), 31–44.

Kaplan, R. S., & Norton, D. P. (1996). *The balanced scorecard: Translating strategy into action*. Harvard Business School Press.

Khutuma, R. (2017). Environmental uncertainty and organizational agility in mining firms. *Journal of Business Strategy, 38*(3), 10–20.

Koo Moon, J., & KwonChoi, J. (2014). Organizational climate and performance: Evidence from Korean firms. *Asian Business & Management, 13*(1), 45–68.

Kowal, M., Włodarz, J., Brzychczy, K., & Klepka, J. (2022). Industry 4.0 technologies: Adoption, usage and organizational outcomes. *Computers in Industry, 139*, 103635.

Kumar, R., & Singh, H. (2021). Industry 4.0 awareness and firm performance: Evidence from Indian manufacturing. *Journal of Manufacturing Technology Management, 32*(7), 1433–1455.

Lehmann, S., & Beckmann, M. (2024). Organizational climate, technology adoption, and firm performance: Evidence from Europe. *Technological Forecasting and Social Change, 190*, 122812.

Li, W. (2023). *Literature review on the impact of organizational climate on individual innovation.* Frontiers in Economics and Management, 4(9), 37–41.

Li, Y., Li, J., & Li, W. (2021). Mining 4.0: Digital transformation and intelligent mining technologies. *Journal of Cleaner Production*, 284, 124786. https://doi.org/10.1016/j.jclepro.2020.124786

Litvinenko, A. (2020). Technology adoption barriers and firm performance: A mining sector perspective. *International Journal of Technology Management & Sustainable Development, 19*(4), 249–264.

Litwin, G. H., & Stringer, R. A. (1968). *Motivation and organizational climate*. Harvard University Press.

Liu, X., Li, Y., & Zhang, Z. (2024). Supportive organizational climate and innovation performance: Evidence from emerging economies. *Journal of Business Research, 176*, 114–127.

Lööw, L., Abrahamsson, M., & Johansson, M. (2019). The impact of organizational atmosphere on digitalization attitudes. *International Journal of Information Management, 45*, 101–112.

Mert, G., & Zehir, H. F. (2024). *Relationships between digitalization and competitive advantage: An application in medium and large-sized enterprises*. Journal of Global Strategic Management, 18(2), 23–32.

Michna, A., & Kmieciak, R. (2019). Industry 4.0 adoption and performance in European firms. *Journal of Business Research, 98*, 199–211.

Mittal, S., Khan, M. A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems, 49*, 194–214. https://doi.org/10.1016/j.jmsy.2018.10.005

Mrugalska, B., & Ahmed, A. (2021). Organizational agility and Industry 4.0 adoption. *Journal of Manufacturing Technology Management, 32*(8), 1521–1540.

Mrugalska, B., & Ahmed, J. (2021). *Organizational agility in Industry 4.0: A systematic literature review.* Sustainability, 13(15), 8272. https://doi.org/10.3390/su13158272

Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures and potential. *Information Systems Journal*, 16(4), 317–342. https://doi.org/10.1111/j.1365-2575.2006.00221.x

Overby, E., Bharadwaj, A., & Sambamurthy, V. (2006). Enterprise agility and the enabling role of information technology. *European Journal of Information Systems*, 15(2), 120–131. https://doi.org/10.1057/palgrave.ejis.3000625

Öngel, V. (2021). *Information management, organizational intelligence, and innovation performance triangle: Empirical research on Turkish IT firms*. Journal of Knowledge Management, 25(8), 1890–1908. https://doi.org/10.1108/JKM-03-2021-0201

Panda, B., & Rath, S. (2021). Organizational agility and firm performance: Evidence from India. *Benchmarking: An International Journal, 28*(8), 2460–2479.

Prashar, A., Verma, S., & Sharma, R. (2022). Dynamic capabilities, organizational agility and technology adoption. *Technological Forecasting and Social Change, 178*, 121556..

Ramadan, Z., Ahmad, M., & Saleh, H. (2023). Industry 4.0 technologies and operational performance: Empirical evidence. *Computers & Industrial Engineering, 177*, 109365.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Sambung, R., & Giovanni, F. (2023). Technology adoption and organizational climate: Evidence from Industry 4.0. *Journal of Engineering and Technology Management, 66*, 101–119.

Sarı, M., Güleş, M., & Yiğitol, M. (2020). Industry 4.0 awareness and its effect on manufacturing performance. *Procedia Computer Science, 170*, 895–902.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8*, 23–74.

Schneider, B., & Barbera, K. M. (2014). *The Oxford handbook of organizational climate and culture*. Oxford University Press.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. Doubleday/Currency.

Sharifi, H., & Zhang, Z. (1999). A methodology for achieving agility in manufacturing organizations: An introduction. *International Journal of Production Economics*, 62(1–2), 7–22. https://doi.org/10.1016/S0925-5273(98)00201-5

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics, 39*(3), 312–320..

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Tortorella, G., Giglio, R., & Fogliatto, F. (2020). Industry 4.0 readiness and firm performance. *International Journal of Production Economics, 227*, 107690.

Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal-getting. *Human Relations, 4*(1), 3–38.

Upstill, G., & Hall, M. (2021). Organizational learning and technology adoption challenges in mining. *Journal of Mining & Innovation Studies, 15*(2), 112–128.

Venkatraman, N., & Ramanujam, V. (1986). Measurement of business performance in strategy research: A comparison of approaches. *Academy of Management Review, 11*(4), 801–814.

Vu, H., Nguyen, T., & Tran, L. (2023). Organizational agility and digital transformation: Evidence from Asian firms. *Journal of Business Research, 157*, 113465.

You, Y., Hu, Z., Li, J., Wang, Y., & Xu, M. (2022). *The effect of organizational innovation climate on employee innovative behavior: The role of psychological ownership and task interdependence.* Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.856407

Zhang, Y., Ding, X., & Xiao, Y. (2023). Organizational agility and Industry 4.0 technology usage: Impacts on firm performance. *Management Decision, 61*(7), 1545–1564.

Zhao, W., Huang, X., Liu, X., Davison, R. M., & Liang, H. (2023). Organizational climate and agility: Evidence from high-tech firms. *Journal of Organizational Behavior, 44*(3), 389–408.

Zheng, P., Xie, X., & Ma, Y. (2017). Smart manufacturing and Industry 4.0: A review of the research literature. *Journal of Manufacturing Systems, 45*, 1–13. https://doi.org/10.1016/j.jmsy.2017.06.001

Zhironkin, V., Gasanov, D., & Suslova, A. (2022). Mining 4.0: Digital transformation in modern mining operations. *Resources Policy, 76*, 102591.

Zhong, R. Y., Xu, C., Klotz, E., & Newman, S. T. (2017). Intelligent manufacturing in the context of Industry 4.0: A review. *Engineering, 3*(5), 616–630.

Zuckerman, A.M. (2002). Improve Your Competitive Strategy A Guide for the Healthcare Executive. Health Administration Pres, Chicago