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THE IMPACT OF DIGITALIZATION AND ARTIFICIAL INTELLIGENCE ON FIRMS' EFFICIENCY: THE MEDIATING ROLE OF DIGITAL INNOVATION

Purpose. This study investigates the impact of digitalization and artificial intelligence (AI) adoption on firms' economic efficiency. In particular, the research examines the role of digital capabilities and attitudes toward AI in stimulating digital innovation and improving organizational economic outcomes.
Design/methodology/approach. Data were collected through a structured questionnaire administered to employees working in organizations undergoing digital transformation, yielding 258 valid responses.
Findings. The empirical analysis was conducted using SmartPLS 4.0 and the partial least squares structural equation modeling (PLS-SEM) technique. The results demonstrate that digital capabilities and favorable attitudes toward AI significantly contribute to the development of digital innovation, which in turn has a positive effect on economic efficiency. The findings confirm the proposed research model and underline the importance of effectively leveraging digital technologies and AI-based solutions to enhance organizational performance.
Originality. This study contributes to the literature review on digital transformation by providing empirical evidence from an emerging economy context. From a practical perspective, the results offer valuable insights for managers and decision-makers seeking to improve economic efficiency through the strategic implementation of digital and AI-driven innovations.
Keywords: Economic Efficiency, Digital Capabilities, Digital Innovation, AI Attitudes.

Introduction

The rapid advancement of digital technologies has fundamentally transformed the way organizations operate and compete in modern markets. In recent years, businesses have increasingly integrated digital tools into their core activities, leading to significant changes in organizational structures, processes, and strategic priorities. Among these technologies, artificial intelligence (AI) has emerged as a particularly important driver of transformation, offering new opportunities to enhance operational efficiency, automate routine tasks, and support more accurate and data-driven decision-making. As companies continue to invest in digital transformation initiatives, the focus is gradually shifting from mere adoption of technologies to understanding their tangible impact on organizational outcomes. In this context, examining how digitalization contributes to economic efficiency has become a critical area of research. Economic efficiency is not only associated with cost reduction but also with the ability of firms to utilize their resources more effectively, improve productivity, and achieve better financial performance in a competitive environment. Economic efficiency (EE) reflects an organization's ability to achieve optimal economic outcomes while minimizing costs and resource inputs. It is commonly interpreted as the extent to which firms approach their optimal production and financial performance levels (Aparicio et al., 2023). Importantly, economic efficiency is not solely dependent on expanding resources but also on improving the quality of their utilization (Geamanu, 2011). In this regard, digital technologies and AI-based solutions may serve as mechanisms that enhance the productive use of organizational assets and capabilities. A central mechanism linking digital transformation to performance outcomes is digital innovation (DI). Digital innovation refers to the creation and implementation of new products,

services, and business models enabled by digital technologies (Nambisan, 2017). It encompasses not only technological upgrades but also the redesign of processes and value-creation logic within firms (Elia et al., 2020). Organizations that successfully leverage digital innovation are often better positioned to improve adaptability, responsiveness, and long-term competitiveness. The development of digital innovation largely depends on digital capabilities (DC). Digital capabilities describe an organization's ability to integrate, deploy, and reconfigure digital resources effectively (Tams et al., 2014). They enable firms to combine diverse knowledge sources and maintain organizational resilience in rapidly changing environments (Chen et al., 2023). Without sufficient digital capabilities, investments in advanced technologies may fail to generate meaningful economic returns. In addition to structural capabilities, individual perceptions toward AI also play a crucial role in digital transformation processes. Attitudes toward artificial intelligence (AIT) represent employees' cognitive and emotional evaluations of AI technologies and their willingness to adopt them (Satici et al., 2025; Abuadas et al., 2025). Positive attitudes toward AI can facilitate smoother implementation and integration into business operations, whereas skepticism or resistance may hinder digital initiatives. Although previous studies have explored digital transformation, digital innovation, and AI adoption separately, limited empirical attention has been given to their combined effect on firms' economic efficiency, particularly in emerging economy contexts. Therefore, this study aims to examine how digital capabilities and attitudes toward AI influence digital innovation and, subsequently, organizational economic efficiency. By empirically testing this framework, the research seeks to provide a clearer understanding of how digitalization and AI implementation translate into measurable economic outcomes for enterprises.

Literature Review

Artificial Intelligence Attitudes and Economic Efficiency

Artificial intelligence (AI) has increasingly been recognized as a transformative digital technology capable of enhancing economic efficiency and accelerating innovation across various sectors. Recent studies emphasize that AI-driven solutions contribute to sustainable efficiency by improving information processing quality, optimizing resource allocation, and supporting managerial decision-making (Dejanovic, 2025; Hussain et al., 2023).

Empirical evidence from the European Union indicates that the widespread adoption of AI technologies in priority sectors has led to noticeable improvements in both innovation intensity and economic efficiency. These outcomes are largely attributed to AI's ability to automate routine processes, reduce operational costs, and enhance productivity through data-driven insights (Dejanovic, 2025). Similarly, Hussain et al. (2023) argue that AI serves as a key driver of green economic efficiency by enabling firms to utilize resources more effectively while minimizing waste and inefficiencies.

Beyond technological implementation, organizational attitudes toward AI play a critical role in determining its economic outcomes. Positive perceptions and acceptance of AI facilitate smoother integration into organizational processes, thereby strengthening efficiency gains. Ananyi and Nwosu (2023) demonstrate that in Nigerian public universities, favorable attitudes toward AI adoption significantly improved resource utilization and reduced operational inefficiencies. Organizations that actively support AI implementation tend to achieve higher levels of automation, faster decision-making, and improved financial performance.

Furthermore, Wang, Sun, and Li (2025) highlight that the economic efficiency effects of AI are primarily realized through optimized resource distribution and improved technological processes. Organizations with proactive attitudes toward AI adoption exhibit higher levels of process automation and managerial efficiency, resulting in reduced time costs and enhanced economic outcomes. In addition, Dejanovic (2025) identifies AI as a transformational technology that not only improves economic efficiency but also stimulates digital innovation by increasing organizational readiness for technological change.

Based on these arguments, the following hypothesis is proposed:

H1: AI attitudes positively affects to organizational economic efficiency.

Digital Capabilities and Digital Innovation

Digital capabilities refer to an organization's ability to integrate, reconfigure, and utilize digital technologies and resources to support innovation

and operational transformation. Grounded in dynamic capability theory, digital capability is considered a strategic organizational asset that enables firms to respond effectively to rapidly changing technological environments (Lyytinen, Yoo, & Boland, 2016).

Prior research consistently indicates that organizations with strong digital capabilities are more likely to develop and implement digital innovations. Khin and Ho (2018) argue that enhanced digital capabilities significantly increase a firm's potential to generate digital innovations that improve overall performance. Similarly, Del Giudice et al. (2017) find that firms with advanced digital infrastructure and digitally skilled human capital demonstrate greater readiness to adopt and adapt new digital solutions.

Digital capabilities also foster a culture of experimentation and risk-taking, which further strengthens innovation activities. Organizations with well-developed digital competencies are more inclined to explore new business processes, experiment with emerging technologies, and accelerate innovation cycles.Levallet and Chan (2018) emphasize that digital capabilities function as strategic resources that enable firms to respond rapidly to market changes, thereby transforming digital innovation into a source of competitive advantage.

Accordingly, digital capabilities play a decisive role in shaping the scope and effectiveness of digital innovation within organizations. Firms that successfully mobilize digital technologies and human resources are better positioned to translate technological potential into tangible innovative outcomes.

Based on the above discussion, the following hypothesis is formulated:

H2: Digital capabilities positively affects to digital innovation.

Digital Innovation and Economic Efficiency

Digital innovation is widely acknowledged as a key driver of economic efficiency, particularly in environments characterized by rapid technological change. Innovations based on digital technologies enable organizations to enhance decision-making quality, accelerate data processing, and reduce operational costs, thereby improving overall economic efficiency (Hao et al., 2023).

Empirical studies reveal that digital innovation contributes to economic efficiency by optimizing operational processes and increasing innovation speed. Shah et al. (2023) demonstrate that organizations actively engaging in digital innovation achieve higher levels of automation in administrative and production processes, leading to more efficient resource utilization and improved financial outcomes. Through the integration of advanced digital solutions, firms are able to streamline workflows, minimize redundancies, and enhance productivity.

Moreover, digital innovation supports structural transformation by reshaping business models and industrial processes. As digital technologies become more accessible, organizations can leverage innovative applications to improve operational efficiency and strengthen long-term competitiveness. Consequently, digital innovation serves not only as a technological outcome but also as a strategic mechanism for achieving sustainable economic efficiency.+

Based on these findings, the following hypothesis is proposed:

H3: Digital innovation positively affects to organizational economic efficiency.

Mediating Role of Digital Innovation between Digital Capabilities and Economic Efficiency

Digital innovation serves as a crucial mediating mechanism that explains how an organization's digital capabilities (DC) translate into economic efficiency (EE). By developing digital capabilities, organizations are better equipped to adopt digital technologies, implement innovative solutions, and enhance business processes. However, the impact of these capabilities on economic efficiency is often realized through the practical application of digital innovation.

Empirical studies support the mediating function of digital innovation. For instance, Khin and Ho (2018) found that digital innovation significantly mediates the relationship between digital capabilities and organizational performance. Their findings suggest that digital capabilities alone do not automatically yield measurable economic benefits; rather, they create the potential that is activated and materialized through digital innovation.

Further evidence indicates that digital capabilities directly foster the development of digital innovation (Liu et al., 2017), while digital innovation itself enhances operational processes and promotes the efficient use of resources, thereby improving economic efficiency (Jahanmir & Cavadas, 2018). Moreover, effective collaboration with external partners combined with strong digital

innovation practices can optimize workflows and resource utilization, further contributing to improved economic outcomes (Pal et al., 2022).

According to affordance theory, the accessibility and usability of digital technologies create new opportunities for organizations. In practice, the availability of digital technologies accelerates digital innovation, increases the speed of implementation, and enhances operational efficiency, ultimately improving the organization's overall economic performance.

Consequently, when digital capabilities are established within an organization, the resulting skills and resources can be applied effectively to real-world business processes through digital innovation. This application enhances operational efficiency and supports overall economic performance. Digital innovation thereby functions as a bridge, linking digital capabilities to economic efficiency. Based on this rationale, considering digital innovation as a mediating variable is both logical and appropriate.

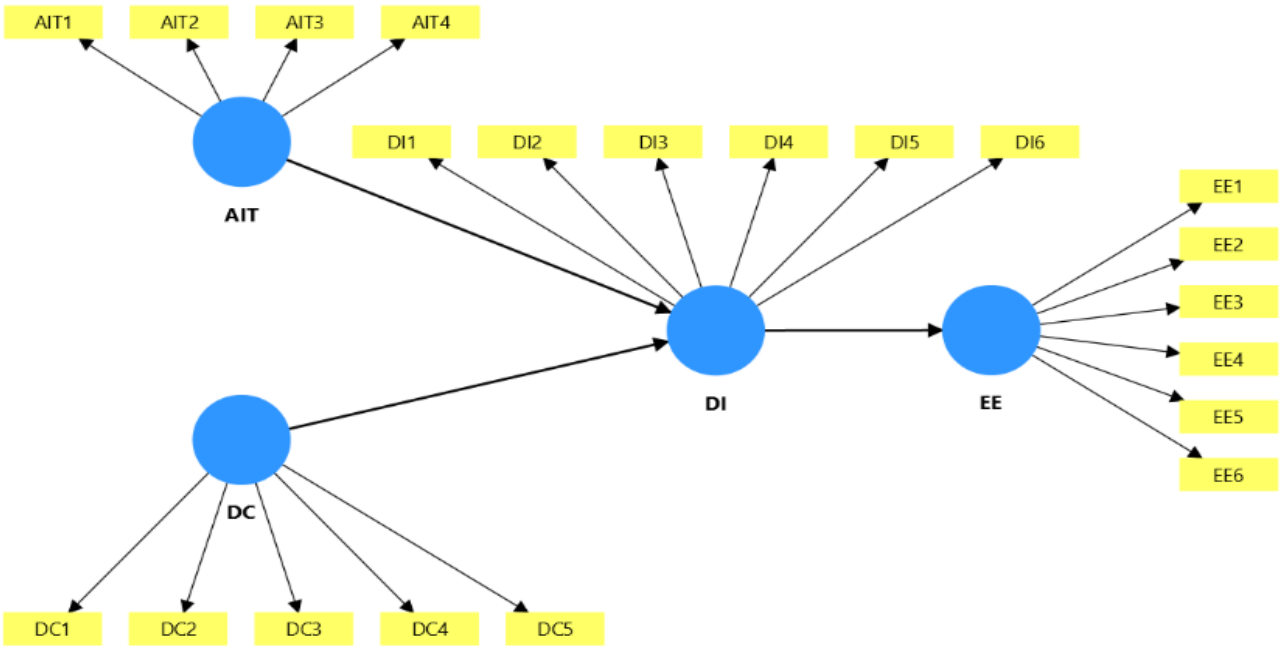
H4: Digital Innovation mediates the relationship between Digital Capabilities and Economic Efficiency.

Methodology

The empirical data for this study were collected using a structured questionnaire survey. A total of 350 questionnaires were distributed among employees of a large industrial enterprise operating in Kazakhstan. In total, 258 completed questionnaires were returned and deemed suitable for further analysis, yielding an adequate response rate.

With respect to the demographic characteristics of the respondents, 48.1% were female and 51.9% were male. The age distribution showed that 46.5% of participants were between 18 and 25 years old, 20.9% were aged 26–35, 15.9% fell within the 36–45 age group, and 16.7% were aged 46 and above. The respondents' work experience ranged from one to twenty-five years, reflecting a heterogeneous sample in terms of professional tenure.

Figure 1
Conceptual Research Model



Measures

The measurement items for all constructs were adapted from previously validated scales in the existing literature. To ensure clarity and consistency, different response formats were applied depending on the nature of each construct.

Economic efficiency was measured using a perceptual scale ranging from "very poor" to "very good", capturing respondents' overall assessment of the economic outcomes and performance of their organizations. Digital capabilities were measured on a scale from "very low" to "very high", reflecting the organization's ability to develop, integrate, and effectively utilize digital technologies.

AI attitudes and digital innovation were treated as two distinct constructs and measured independently using Likert-type scales ranging from "strongly disagree" to "strongly agree." The AI attitudes construct captures respondents' perceptions, acceptance, and overall stance toward the adoption and use of artificial intelligence within the organization, while digital innovation reflects the extent to which organizations implement and develop new digital solutions, processes, and practices.

Economic Efficiency. Following Aparicio, Zofío, and Pastor (2023), economic efficiency refers to the extent to which an organization approaches its optimal economic performance by effectively minimizing costs and maximizing outputs or profits given available resources. The measurement items for economic efficiency (EE) were adapted from Yang, Dong, and Chen (2021) and consisted of six items. All items were measured using a five-point Likert scale. An example item is: *"How would you evaluate the overall economic condition of your company at present?"* The reliability analysis showed that the scale had good internal consistency, with a Cronbach's alpha coefficient of 0,870.

AI Attitudes. Following Satici, Okur, Yilmaz, and Grassini (2025), AI attitudes refer to individuals' perceptions, acceptance, and emotional responses toward artificial intelligence technologies, reflecting how people evaluate and engage with AI in everyday contexts. The measurement items for AI attitudes (AIT) were adapted from Kukanja (2024) and consisted of four items. All items were measured using a five-point Likert scale. An example item is: *"I am interested in using artificial intelligence in my daily life."* The reliability analysis showed that the scale had good internal consistency, with a Cronbach's alpha coefficient of 0,870.

Digital Capabilities. Following Chen, Pan, Liu, and Feng (2023), digital capabilities (DC) are defined as an organization's ability to integrate diverse knowledge and serve as a key source of knowledge resources necessary for sustaining organizational stability. The measurement items for digital capabilities (DC) were adapted from Khin and Ho (2019) and consisted of five items. All items were measured using a five-point Likert scale. An example item is: *"How would you evaluate your company's level of adoption of critical digital technologies?"* The reliability analysis showed that the scale had good internal consistency, with a Cronbach's alpha coefficient of 0,899.

Digital Innovation. Following Nowicka (2019), digital innovation (DI) is defined as the process of developing and implementing new market offerings and business models that emerge through the use of digital technologies. The measurement items for digital innovation (DI) were adapted from Khin and Ho (2019) and consisted of six items. All items were measured using a five-point Likert scale. An example item is: *"To what extent do you consider the quality of your company's digital solutions to be superior to that of competitors?"* The reliability analysis showed that the scale had good internal consistency, with a Cronbach's alpha coefficient of 0,925.

For the purpose of data analysis, SmartPLS 4.0 was employed along with the PLS-SEM approach. This software was selected due to its popularity and proven effectiveness for conducting structural equation modeling. Consequently, the analysis produced the following research model.

The mean scores, Cronbach's alpha, and standard deviation were computed for each measurement item. The Cronbach's alpha coefficients, used to assess the reliability of the scales, all exceeded the recommended threshold of 0.7. Moreover, the mean values for the items were above 0.6, indicating satisfactory central tendencies.

To further examine our research model, the bootstrapping technique was applied to test the hypotheses related to mediated moderation, utilizing 5,000 bootstrap resamples.

Results

Reliability and Validity Assessment

The measurement model was evaluated using SmartPLS 4 by examining internal consistency

reliability, convergent validity, and discriminant validity.

Internal consistency was assessed through Cronbach's alpha and composite reliability (rho_a). The Cronbach's alpha coefficients ranged from 0.87 to 0.93, indicating strong internal consistency across all constructs. Similarly, composite reliability values varied between 0.88 and 0.93, exceeding the recommended threshold of 0.70 and confirming the stability of the measurement scales. (See table 1).

Table 1
Reliability and convergent validity of the constructs

Construct	Cronbach's alpha	Composite reliability (rho_C)	AVE
AIT	0.870	0.881	0.615
DC	0.899	0.896	0.653
DI	0.925	0.911	0.730
EE	0.870	0.931	0.694

Note: Compiled by the author based on SmartPLS 4 output.

Convergent validity was examined using the average variance extracted (AVE). The AVE values ranged from 0.60 to 0.73, which are above the minimum acceptable level of 0.50. These results suggest that the constructs explain a substantial proportion of the variance in their respective indicators. Furthermore, all outer loadings were above 0.70, providing additional support for convergent validity.

Discriminant validity was assessed using both the Fornell–Larcker criterion and the heterotrait–monotrait ratio (HTMT). The square root of AVE for each construct exceeded the inter-construct correlations, satisfying the Fornell–Larcker requirement. In addition, HTMT values ranged from 0.52 to 0.80, remaining below the conservative threshold of 0.85. These findings confirm that the constructs are empirically distinct from one another.

Overall, the measurement model demonstrates satisfactory reliability and validity, supporting the adequacy of the data for subsequent structural model analysis.

The structural model was evaluated using SmartPLS 4.0 along with a bootstrapping procedure of 5,000 resamples. The analysis revealed that all hypothesized relationships were statistically significant. In particular, the effect of AI attitudes (AIT) on digital innovation (DI) was positive and significant ($\beta = 0.218$, $t = 2.298$, $p = 0.022$), providing support for H1. Similarly, digital capabilities (DC) exerted a strong and significant influence on digital innovation ($\beta = 0.598$, $t = 6.541$, $p < 0.001$), confirming H2. Furthermore, digital innovation positively impacted economic efficiency (EE) ($\beta = 0.522$, $t = 9.049$, $p < 0.001$), supporting H3. (See table 2).

Table 2
Structural paths and hypothesis testing

Path	β	t	p	Decision
AIT → DI	0. 218	2.298	0.022	Supported
DC → DI	0. 598	6.541	<0.001	Supported
DI → EE	0. 522	9.049	<0.001	Supported

Note: Compiled by the author based on SmartPLS 4 bootstrapping output (5,000 resamples).

The mediating role of digital innovation was also examined, and the results confirmed that DI significantly mediates the relationship between digital capabilities and economic efficiency, validating H4. This indicates that the positive effect of digital capabilities on economic efficiency primarily occurs through the development and implementation of digital innovation within the organization.

Regarding the explanatory power of the model, R^2 values indicated satisfactory fit. Digital innovation displayed an R^2 of 0.563, suggesting that approximately 56.3% of its variance is explained by AI attitudes and digital capabilities. Economic efficiency exhibited an R^2 of 0.272, meaning that 27.2% of its variance is accounted for by the model via digital innovation.

Overall, these findings support the theoretical framework and underscore the critical role of both digital capabilities and AI attitudes in fostering digital innovation, which in turn enhances organizational economic efficiency. The results align with previous studies emphasizing that digital resources and innovation serve as key drivers of improved organizational performance.

Discussion and Conclusion

This study provides a comprehensive understanding of how AI attitudes, digital capabilities, and digital innovation interact to influence economic efficiency in organizational

settings. The results highlight the critical role of technological readiness, employee perceptions, and innovative practices in driving organizational performance.

First, our findings indicate that positive attitudes toward AI significantly enhance economic efficiency. Employees' acceptance and favorable perception of AI technologies facilitate smoother integration, better decision-making, and more efficient resource utilization. These outcomes align with previous research demonstrating that AI adoption supports operational optimization and sustainable economic performance (Ananyi & Nwosu, 2023; Dejanovic, 2025).

Second, digital capabilities were confirmed as a key antecedent of digital innovation. Organizations with well-developed digital skills and infrastructure are better able to adopt innovative solutions, experiment with new processes, and adapt to dynamic market conditions. This is consistent with prior studies emphasizing that investment in digital competencies strengthens an organization's capacity to transform technological potential into practical innovations (Pan, Liu & Feng, 2023; Khin & Ho, 2019).

Third, digital innovation mediates the relationship between digital capabilities and economic efficiency. The results show that the benefits of digital capabilities are realized when organizations translate these capabilities into innovative solutions that improve operational processes, resource utilization, and overall economic outcomes. Digital innovation, therefore, acts as a bridge, converting technological potential into measurable efficiency gains and sustainable advantages (Nowicka, 2019; Pal et al., 2022).

Importantly, our findings are supported by affordance theory, which posits that the availability and accessibility of digital technologies create actionable opportunities for organizations. Organizations with strong digital capabilities are able to leverage these affordances to develop new solutions, enhance operational efficiency, and increase economic performance. Similarly, employees' positive attitudes toward AI enable organizations to capitalize on the potential of AI technologies, turning theoretical affordances into tangible organizational and economic benefits.

Overall, the study underscores the interconnected nature of AI attitudes, digital capabilities, and digital innovation in driving organizational efficiency. Organizations that actively cultivate positive AI perceptions, strengthen digital skills, and foster innovative practices are better positioned to achieve operational improvements, enhance economic outcomes, and sustain competitive advantages.

In conclusion, this research makes both theoretical and practical contributions. Theoretically, it extends the literature review on digital transformation by demonstrating how digital capabilities and AI attitudes translate into economic efficiency through digital innovation. Practically, the results suggest that organizations should focus on fostering favorable AI attitudes, developing robust digital capabilities, and encouraging the implementation of innovative digital solutions. By doing so, firms can effectively convert technological opportunities into sustained economic performance and long-term competitive benefits.

Practical Implications

This study highlights the practical significance of fostering digital capabilities, promoting positive AI attitudes, and implementing digital innovation to enhance economic efficiency within organizations. By developing employees' skills and building strong digital capabilities, organizations can leverage digital technologies more effectively, enabling the creation and implementation of innovative solutions that improve operational processes and resource utilization.

Digital innovation, as a mediating factor, facilitates the translation of digital capabilities into tangible economic outcomes, allowing firms to optimize workflows, automate routine tasks, and focus on higher-value activities. Moreover, positive attitudes toward AI accelerate the adoption and integration of AI-driven solutions, ensuring that organizations can fully capitalize on technological affordances.

In practice, organizations aiming for sustainable economic performance should invest in digital skill development programs, encourage experimentation and innovation, and foster a culture of openness toward AI technologies. These strategies can improve decision-making, enhance productivity, and strengthen long-term competitive advantages, while simultaneously preparing employees to adapt to evolving digital environments.

Limitations and Future Research

This research has several limitations that should be addressed in future studies. First, the study relied on data collected from a single context, which may limit the generalizability of the findings. Future research could expand the sample to include multiple organizations across different sectors and regions to strengthen external validity.

Second, all measurements were based on self-reported survey items, which may introduce subjective or methodological biases. Future studies could complement survey data with objective performance metrics or longitudinal observations to obtain a more robust understanding of the relationships between digital capabilities, digital innovation, AI attitudes, and economic efficiency.

Third, while this study focused on AI attitudes, digital capabilities, digital innovation, and economic efficiency, other variables such as organizational culture, leadership style, and employee engagement may also influence these relationships. Future research could explore additional mediators or moderators to provide a more comprehensive model of digital transformation in organizations.

Acknowledgements and Conflict of Interest

The author declares no conflicts of interest related to this study. No acknowledgements are applicable.

Author Contributions

Conceptualization, B.R.; Methodology, B.R.; Software, B.R.; Validation, B.R. and Y.S.; Formal Analysis, B.R. and Y.S.; Investigation, B.R.; Resources, B.R.; Data Curation, B.R.; Writing – Original Draft Preparation, B.R., Y.S. and D.Y.; Writing – Review & Editing, B.R., Y.S. and D.Y.; Visualization, B.R.; Supervision, Y.S.; Project Administration, B.R. and Y.S.

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