

The Impact of Digital Leadership on Organizational Digital Transformation: The Mediating Role of Organizational Agility and Digital Resilience, and the Moderating Role of Digital Culture

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Abstract

In recent years, digital transformation has become a strategic necessity for organizations, and its success depends on factors beyond mere technology implementation. This study aimed to clarify the role of digital transformation leadership, organizational agility, digital resilience, and digital culture in shaping organizational digital transformation. The statistical sample included 63 technology-driven startup organizations, and data were collected through a standardized questionnaire and analyzed using structural equation modeling in PLS software. The results showed that digital transformation leadership has a direct and significant impact on both digital transformation and organizational agility. Furthermore, organizational agility not only has a direct effect on digital transformation but also serves as a significant mediator between digital transformation leadership and digital transformation. The findings indicated that organizational agility significantly

enhances digital resilience, which, as a key variable, has a positive and direct effect on digital transformation. The role of digital culture was also highlighted in this study; it had both a direct effect on digital transformation and moderated the relationships between organizational agility and digital transformation leadership with digital transformation, although the strength of this moderating effect was weak but significant. Overall, the study results suggest that digital transformation is the outcome of the systematic interaction of three layers: leadership, dynamic capabilities, and digital culture. For organizations to achieve sustainable digital transformation, these three dimensions must be strengthened synergistically. This study, by presenting an integrated model, provides valuable theoretical and practical insights for managers and researchers in the field of digital transformation.

Keywords: Digital Transformation, Agility, Culture, Resilience, Organization

INTRODUCTION

In the contemporary business environment, characterized by rapid technological advancements and dynamic, volatile market conditions, organizations are compelled to undertake digital transformation in order to maintain competitiveness and ensure long-term sustainability. Digital transformation involves the integration of digital technologies into all aspects of business operations, fundamentally altering how organizations operate and deliver value to customers [1]. Leadership plays a critical role in the success of digital transformation initiatives. Digital transformational leadership is pivotal in guiding organizations through the complexities of digital change and is characterized by a forward-looking mindset, the promotion of innovation, and the creation of an environment that supports agility and resilience [2]. However, despite its recognized importance, the mechanisms through which digital transformational leadership influences organizational outcomes have not yet been fully explored. Digital culture refers to the shared values, beliefs, and practices within an organization that promote the effective use of digital technologies and foster an environment conducive to innovation and adaptability. This culture encompasses elements such as openness to change, collaborative work practices, and a proactive approach to technology adoption. A strong digital culture plays a fundamental role in bridging the gap between digital transformational leadership and organizational outcomes, including agility and resilience. For instance, prior research has shown that digital culture mediates the relationship between transformational leadership and employee performance, highlighting its importance in translating leadership initiatives into tangible organizational benefits [3]. Moreover, a study by Cheng et al. [4] demonstrates that digital culture, together with leadership and digital capabilities, significantly influences innovation and organizational performance, underscoring its critical role in the digital transformation process.

Organizational agility, defined as the ability to rapidly adapt to market changes and environmental disruptions, has emerged as a vital capability in the digital era. Empirical studies indicate that organizational agility plays a mediating role between digital transformation and organizational performance, emphasizing its importance in achieving successful digital outcomes [5]. In addition, digital resilience—the capability to withstand, respond to, and recover from digital disruptions—has been identified as a crucial factor in ensuring the continuity and sustainability of digital transformation efforts [6]. The interplay among digital transformational leadership, organizational agility, and digital resilience highlights the

need for a comprehensive understanding of how leadership shapes these dynamic capabilities.

While the existing literature has examined these concepts individually, relatively few studies have investigated their interrelationships and the mechanisms through which they jointly influence organizational digital transformation. This gap is particularly evident with respect to digital culture, which is argued to moderate the effects of leadership on organizational outcomes [7]. Addressing this gap is essential for both scholarly research and practical application. From a theoretical perspective, advancements can be achieved through the development of integrated models that clarify the pathways through which digital transformational leadership affects digital transformation outcomes. From a practical standpoint, organizations can benefit from insights that inform leadership development programs, strategic planning, and cultural initiatives aimed at enhancing agility and resilience.

Accordingly, the present study seeks to examine the impact of digital transformational leadership on organizational digital transformation, while investigating the mediating roles of organizational agility and digital resilience and the moderating role of digital culture. Exploring these relationships contributes to a more precise understanding of the factors that shape the success of digital transformation in organizations.

Theoretical Foundations of the Study

Digital Transformational Leadership, Organizational Agility, and Digital Transformation

Digital transformational leadership has emerged as a distinct leadership construct that integrates traditional transformational behaviors such as vision creation, motivation, and empowerment with a specific orientation toward digital-based strategies, cultures, and structures. Recent studies conceptualize digital transformational leadership through behaviors such as formulating and articulating a coherent digital vision, developing cross-functional digital capabilities, supporting data-driven decision-making, and fostering a digital culture that is receptive to intelligent risk-taking [8]. Research indicates that digital transformational leadership goes beyond technological competence and instead represents a socio-technical leadership role that shapes legitimacy, resource allocation, and stakeholder expectations throughout digital transformation initiatives [9].

Organizational agility is a multidimensional construct that describes an organization's ability to sense change, make rapid decisions, and reconfigure resources and processes to capitalize on emerging opportunities or mitigate threats. Conceptually, agility comprises two main dimensions: operational agility, which refers to the rapid reconfiguration of processes and routines, and strategic agility, which involves the swift reassessment of strategies and resource priorities [10]. Organizational agility stems from microfoundations such as sensing routines, inter-unit coordination, and flexible information technology and knowledge infrastructures that enable timely responses. Consequently, agility functions both as a prerequisite for successful digital transformation and as an outcome of leadership, governance, and organizational technological capabilities [11].

Digital transformation itself is a socio-technical, organization-wide process through which digital technologies—such as cloud computing, big data analytics, artificial intelligence, and the Internet of Things—are integrated into products, processes, business models, and organizational practices to create new forms of value [1]. Vial [2] emphasizes that digital transformation is not merely about technology adoption; rather, it is a process in which digital technologies disrupt traditional value creation logics and demand new strategic responses that reconfigure organizational structures, routines, and identities. From this perspective, digital transformation requires changes in governance, skills, and institutional practices, thereby highlighting the critical role of leadership and organizational capabilities in determining its success.

From a theoretical perspective, dynamic capabilities comprise three dimensions: sensing, seizing, and reconfiguring resources. They provide a coherent analytical lens for explaining how digital transformational leadership and organizational agility interact to facilitate digital transformation. Langholf and Wilkens [11] suggest that the microfoundations of dynamic capabilities—including managerial cognition, governance, and reconfiguration routines enable firms to transform technological capacities into competitive advantages. Within this framework, digital transformational leadership provides managerial cognition and legitimacy necessary for prioritizing and allocating resources in sensing and seizing activities, while organizational agility enables rapid reconfiguration and experimentation [9]. Institutional perspectives further complement this discussion by explaining how leaders shape norms and legitimacy essential for institutionalizing digital practices [2].

Empirical studies support a mediating pathway in which digital transformational leadership influences digital transformation outcomes through organizational agility. Ly [9] found in public sector organizations that organizational agility mediates the relationship between digital transformational leadership and digital transformation outcomes, indicating that leadership alone is insufficient without the establishment of agile structures and routines. Zhang et al. [10] provide empirical evidence that organizational agility is a positive predictor of digital transformation performance, with dynamic capabilities serving as critical prerequisites. Accordingly, the following hypotheses are proposed:

H1: Digital transformational leadership has a significant effect on digital transformation.

H2: Digital transformational leadership has a significant effect on organizational agility.

H3: Organizational agility has a significant effect on digital transformation.

H4: Organizational agility significantly mediates the relationship between digital transformational leadership and digital transformation.

Resilience, Organizational Agility, and Digital Transformation

Organizational resilience refers to an organization's ability to anticipate, absorb, adapt to, or rapidly recover from disruptive events while maintaining its core functions and structures. Resilience is typically considered to encompass two fundamental capacities: resistance and recovery. The dynamic capabilities theory, which emphasizes sense-making, resource reconfiguration, and learning, is often used as the primary theoretical framework; accordingly, resilient organizations are those capable of reconfiguring their internal and external resources in response to environmental disruptions [12].

Organizational agility is a related but distinct concept, referring to an organization's ability to change direction, respond quickly to environmental shifts, and adapt processes, decision-making structures, and resource allocations with minimal delay. Gong and Rebier consider agility to comprise two dimensions: a reactive dimension, which involves responding to external changes, and a proactive dimension, which involves anticipating changes. They emphasize the importance of reconfiguring resources and making rapid decisions. Accordingly,

agility is often conceptualized within the framework of dynamic capabilities theory or contingency theory [13].

Digital transformation refers to the adoption, integration, and utilization of digital technologies such as big data analytics, cloud computing, the Internet of Things, and artificial intelligence to transform processes, business models, and organizational culture. The theoretical foundations of this concept include absorptive capacity, theories of technological change, and the socio-technical systems perspective. Digital transformation not only provides tangible technological resources but also requires changes in cognition, leadership, culture, and organizational structure [5].

The theoretical link between agility and resilience is also well established: agility is often considered either a component of resilience or a pathway to achieving it. Agility enhances an organization's speed and effectiveness in resisting and recovering from disruptions. Empirical studies in Chinese manufacturing firms indicate that digital transformation strengthens adaptive capabilities and knowledge absorption, both forms of dynamic capabilities, thereby enhancing resilience in the face of crises [12]. Case studies in media companies further suggest that digital leadership drives agility, innovation, adaptability, and resilience, indicating that facilitative leadership plays a critical role in achieving resilience during the digital transformation process [14]. Accordingly, the following hypotheses are proposed:

H5: Organizational agility has a significant effect on digital resilience.

H6: Digital resilience has a significant effect on digital transformation.

H7: Digital resilience significantly mediates the relationship between organizational agility and digital transformation.

Digital Culture, Organizational Agility, and Digital Transformation

Digital culture can be defined as a set of shared values, norms, practices, and artifacts within an organization that influence how digital technologies are perceived, adopted, and utilized. Scholars emphasize that digital culture is not merely the presence of technological tools but represents a socio-technical orientation—encompassing work patterns, risk tolerance, learning routines, and leadership narratives that allow technology to generate strategic value [15]. From this perspective, digital culture acts both as an

enabler and a filter for innovation, enhancing the organization's ability to identify digital opportunities while reducing frictions that hinder technology adoption [1]. Digital transformation should be viewed not as an IT project but as a strategic and organization-wide reconfiguration. Empirical research and management reports indicate that organizational strategy and governance, rather than technology alone, are the determining factors in the scalability and sustainability of digital initiatives. Digitally mature organizations align a clear strategic purpose, governance mechanisms, and talent development practices to ensure that digital investments support business objectives [6]. Organizational agility serves as a mechanism through which digital culture and strategic intent are transformed into adaptability and superior performance. From a dynamic capabilities perspective, agility reflects an organization's ability to sense environmental opportunities, make timely decisions, and reconfigure resources to create new competitive advantages [16]. Empirical research also supports the relationship between organizational agility and both individual and management level outcomes. Studies conducted under crisis conditions indicate that perceived strategic agility enhances work engagement and improves employee well being [15]. These findings suggest that agility is not merely an organizational attribute but an interactive and behavioral phenomenon. Effective leadership, goal clarity, and organizational learning routines provide the contexts through which digital culture and digital transformation initiatives are truly realized [17].

At the intersection of culture and agility, recent field studies in SMEs indicate that digital organizational culture including learning, experimentation, and readiness for change acts as a mediator of transformation success. When organizations consciously cultivate digital learning routines, allocate resources for change, and embed digital competencies in daily work, both organizational agility and digital transformation outcomes are enhanced. Therefore, digital culture and organizational agility are complementary: culture prepares the organizational mindset to perceive and interpret digital signals, while agility translates this preparedness into timely reconfiguration [18]. Based on this discussion, the following hypotheses are proposed:

H8: Digital culture has a significant effect on digital transformation.

H9: Digital culture moderates the relationship between organizational agility and digital transformation.

H10: Digital culture moderates the relationship between digital transformational leadership and digital transformation.

The conceptual model of the study is illustrated in Figure 1.

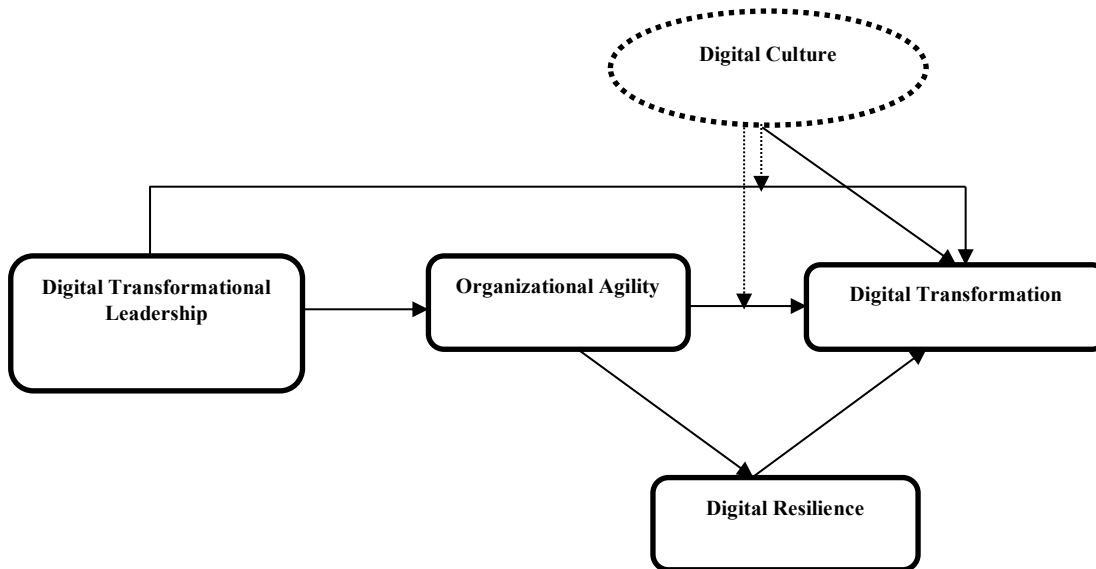


Figure 1: Conceptual Model of the Study

RESEARCH METHODOLOGY

This study is a cross-sectional survey conducted to examine multiple characteristics simultaneously at a single point in time. The statistical population consists of 75 technology-oriented startup organizations identified based on specific criteria, including: being technology-driven, having a strong digital culture, being officially registered and actively operating within the national startup ecosystem, possessing at least three years of operational experience, and operating in industries related to the digital economy such as fintech, e-commerce, digital logistics, digital health, digital education, digital platforms, SaaS, B2B, as well as cloud, data, and digital infrastructure sectors.

Given the limited population size and the need for reliable estimation of research parameters, the sample size was determined as 63 companies using the Krejcie and Morgan table. Since the population size is very close to the proposed sample size, a census approach was employed to ensure at least 63 valid responses for final analysis.

Data were collected using a questionnaire with a five-point Likert scale (ranging from “strongly disagree” to

“strongly agree”), developed based on established sources. Items for digital transformational leadership were adapted from Benitez et al. [19], organizational agility from Cegarra-Navarro et al. [20], digital resilience from Tim and Leidner [21], digital transformation from Al Nuaimi et al. [22], and digital culture from Shin et al., [23]. The questionnaire consists of two sections: the first collects organizational demographic information such as year of establishment, number of employees, sector of activity, and ownership type; the second includes specialized items related to the main research variables.

Reliability of the questionnaire was assessed using Cronbach’s alpha, and content validity was confirmed through expert review by university professors and specialists in management and technology, ensuring that the items adequately cover the conceptual dimensions of the variables. Finally, data analysis and evaluation of the conceptual model were conducted using Structural Equation Modeling (SEM) with SmartPLS software—a method particularly suitable for simultaneously analyzing latent variables, handling small sample sizes, and widely applied in management and technology research to examine relationships among study variables.

RESEARCH FINDINGS

The characteristics of the respondents in this study were examined using four demographic variables: year of

establishment, number of employees, field of activity, and ownership type. The results are summarized in Table 1.

Table 1: Frequency and Percentage of Year of Establishment, Number of Employees, Field of Activity, and Ownership Type

Variable	Category	Frequ ency	Percentage (%)
Year of Establishment	Less than 3 years	11	14.7
	3–5 years	15	20.0
	5–10 years	26	34.7
	More than 10 years	23	30.7
Number of Employees	1–10	11	14.7
	11–50	15	20.0
	51–100	26	34.7
	More than 100	23	30.7
Field of Activity	Digital Platforms	44	58.7
	Fintech	8	10.7
	E-commerce	4	5.3
	Digital Health	5	6.7
	Digital Education	4	5.3
	SaaS & B2B	3	4.0
	Cloud & Data	4	5.3
	Others	3	4.0
Ownership Type	Private	59	78.7
	Private–Knowledge-Based	8	10.7
	Subsidiary of Holding	1	1.3
	Independent	7	9.3

Descriptive Findings In the overall descriptive findings, the companies included in the sample show relatively similar patterns in terms of experience, size, field of activity, and type of ownership. Regarding the year of establishment, the highest frequency corresponds to companies with 5 to 10 years of experience, while only a small portion have less than three years of operational experience; both the median and mode fall within the 5 to 10-year range, indicating that the majority of the sample is in the early maturity stage.

A similar pattern is observed concerning the number of employees. The largest group includes companies with 51 to 100 employees, and the smallest number of companies have only 1 to 10 employees. Therefore, both the median and mode fall within the 51 to 100 employee range, representing the predominant medium size of these businesses.

In examining the field of activity, companies operating in digital platforms account for the largest share, while fewer companies are active in areas such as SaaS, B2B, digital education, or e-commerce; hence, both the median and mode also fall within the digital platform group.

Finally, in terms of ownership type, the vast majority of companies are privately owned, with only a small percentage being privately knowledge-based or subsidiaries of a holding company. Therefore, both the median and mode are in the private ownership group.

Taken together, these findings indicate that the dominant profile of the sample consists of private, medium-sized companies with 5 to 10 years of experience, focused primarily on platform-based digital activities.

Measurement Models

To assess the reliability and validity of the constructs in the measurement model, the results of factor loadings, Cronbach's alpha, composite reliability, and average variance extracted (AVE) were recorded (Table 2). Cronbach's alpha values for all constructs exceeded the threshold of 0.7, indicating satisfactory reliability of the measurement instrument. Composite reliability for all constructs was above 0.7, and the average variance extracted exceeded 0.5, indicating adequate convergent validity of the variables.

Table 2: Estimation results of the research measurement model

Construct	I tem	Item Statement	Factor Loading	A VE	Composite Reliability	Cronbach's Alpha
Digital Transformational Leadership	1	Q Our managers articulate a clear vision of the organization's digital future.	0.760	0 .650	0.868	0.865
	2	Q Organizational leaders encourage and reward innovative behaviors.	0.802			
	3	Q Our senior managers encourage employees to continuously learn new technologies.	0.850			
	4	Q Organizational leaders use transparent communication to reduce resistance to digital change.	0.855			
	5	Q Our managers introduce new ways of working using digital technologies.	0.760			
Organizational Agility	6	Q Our organization can quickly respond to changes in customer needs.	0.606	0 .579	0.861	0.852
	7	Q Our organization can adapt processes to new market conditions in a short time.	0.734			
	8	Q We can reuse resources to respond to unexpected changes.	0.835			
	9	Q Decision-making in our organization is fast and data-driven.	0.814			
	10	Q We can respond to environmental changes without compromising service or product quality.	0.803			
Digital Resilience	11	Q Different organizational units collaborate flexibly in response to technological changes.	0.753			
	12	Q Our organization quickly adapts its digital systems in response to unexpected technological changes.	0.786	0 .626	0.851	0.850
	13	Q We have clear contingency plans for maintaining digital operations during system disruptions.	0.782			
	14	Q Our organization can rapidly restore digital services after disruptions or cyber-attacks.	0.816			
	15	Q We always learn from digital crises to strengthen future digital capabilities.	0.784			
Digital Transformation	16	Q Organizational management promotes a proactive approach to prevent and mitigate digital risks.	0.787			
	17	Q The use of digital technologies in our organization has fundamentally changed the business model.	0.761	0 .575	0.817	0.815
	18	Q Our core organizational processes have been improved through digital technologies.	0.766			
	19	Q Digital technologies have increased transparency and accountability in our organization.	0.768			
	20	Q The use of AI and data analytics is institutionalized in managerial decision-making.	0.717			
Digital Culture	21	Q Digital transformation has led to improved customer experience in our organization.	0.778			
	22	Q Sharing valuable digital knowledge and information is considered important in our organization.	0.795	0 .628	0.857	0.852
	23	Q Our employees welcome technological innovations.	0.808			
	24	Q Our organizational culture encourages risk-taking in implementing digital ideas.	0.778			
	25	Q Learning new technologies is considered essential for all employees.	0.811			
	26	Q Digital collaboration among units and employees is common in our organization.	0.770			

The divergent validity assessment using the Fornell and Larcker method showed that the square root of the average variance extracted (AVE) for each construct was

greater than its correlations with other constructs, indicating conceptual distinctiveness among the variables (Table 3).

Table 3: Fornell-Larcker values

Digital Resilience	Digital Transformation	Digital Leadership	Digital Culture	Organizational Agility
Digital Resilience	0.791			
Digital Transformation	0.744	0.758		
Digital Leadership	0.732	0.672	0.806	
Digital Culture	0.745	0.680	0.711	0.793
Organizational Agility	0.732	0.676	0.742	0.697

Based on the values presented in the table, it can be observed that the square root of the average variance extracted (located on the main diagonal of the matrix) is greater than the off-diagonal values in each cell. Therefore, the model demonstrates a relatively acceptable level of discriminant validity.

Structural Model

The results of the structural model evaluation indicate that the research model possesses very good explanatory and predictive power. The R^2 values for the constructs—Digital Resilience (0.692), Digital Transformation (0.715), and Organizational Agility (0.550)—all fall within the desirable range, with the mean R^2 equal to 0.652. According to the criteria proposed by Chin [24], these values indicate the model's strong capability in explaining endogenous constructs and the adequacy of the defined structural relationships among the research variables. Similarly, the predictive relevance (Q^2) values for all endogenous constructs were reported above 0.350, indicating strong predictive power of the model. This

demonstrates that not only are the relationships among constructs appropriately specified, but the indicators are also meaningfully influenced by these relationships. Additionally, the results of the variance explained surplus (with a mean of 0.379) confirm that a substantial portion of the variance of the endogenous constructs' indicators is explained by the exogenous variables, reflecting strong structural model fit.

In the final step, the overall model fit—which integrates both the measurement and structural models—was examined. The global fit index was 0.616, which, considering the threshold of 0.360, indicates very strong overall model fit. Moreover, the root mean square residual (RMSR) was calculated at 0.067, below the reference value of 0.080, indicating minimal discrepancy between observed and estimated data and demonstrating that the model aligns well with the data. Other indices, including the goodness-of-fit and standardized/non-standardized distances, were also within acceptable ranges, confirming the quality of the model. Based on these comprehensive criteria, it can be concluded that the research model exhibits desirable and reliable performance in terms of explanatory power, predictive capability, and overall fit, and it is structurally and metrically sound.

Table 4: Hypothesis Results

Path	Factor Loading	Standard Deviation	t-Statistic	p-Value	Result
Digital Resilience → Digital Transformation	0.184	0.055	3.233	0.010	Accepted
Digital Leadership → Digital Transformation	0.294	0.065	5.164	0.000	Accepted
Digital Leadership → Organizational Agility	0.742	0.028	21.326	0.000	Accepted
Digital Culture → Digital Transformation	0.232	0.079	9.482	0.003	Accepted
Organizational Agility → Digital Resilience	0.832	0.021	25.840	0.000	Accepted
Organizational Agility → Digital Transformation	0.215	0.059	6.453	0.000	Accepted
Digital Culture × Organizational Agility → Digital Transformation	0.160	0.042	7.673	0.000	Accepted
Digital Culture × Digital Leadership → Digital Transformation	0.189	0.046	14.040	0.000	Accepted

structural relationships in the model were statistically supported. In general, t-values greater than 1.961 and p-values less than 0.05 indicate acceptance of the hypotheses and the significance of the relationships among the variables. Specifically, digital transformational leadership has a direct and significant impact on both digital transformation ($t = 5.164$, $\beta = 0.294$) and organizational agility ($t = 21.326$, $\beta = 0.742$), emphasizing that enhancing transformational leadership can

DISCUSSION AND INTERPRETATION OF FINDINGS

Based on the results presented in the tables and figures related to hypothesis testing, all the main and moderating

significantly improve both digital transformation processes and organizational agility. Similarly, organizational agility has a positive and significant effect on digital transformation ($t = 6.453$, $\beta = 0.215$) and digital resilience ($t = 25.840$, $\beta = 0.832$). This suggests that increasing organizational agility strengthens the organization's transformational capabilities and its level of digital resilience. Digital resilience also has a positive and significant impact on digital transformation ($t = 3.233$, $\beta = 0.184$), indicating that organizations with greater resilience to digital disruptions and changing environments can pursue digital transformation more effectively. Furthermore, digital culture has a significant effect on digital transformation ($t = 9.482$, $\beta = 0.232$), highlighting that fostering digital-oriented values, attitudes, and behaviors facilitates organizational transformation.

Regarding moderating relationships, digital culture was found to play an effective moderating role in the structural relationships. Specifically, digital culture

strengthens the relationship between organizational agility and digital transformation ($t = 7.673$, $\beta = 0.160$), indicating that when digital culture is strong, the effect of agility on digital transformation becomes more pronounced. Overall, the findings confirm that digital transformational leadership, organizational agility, digital resilience, and digital culture all play determining roles in the model. Additionally, digital culture, as a moderating variable, enhances the strength of some key relationships. As shown in Table 4 and Figure 2, the t-value for the combined effect of digital culture and digital transformational leadership on digital transformation is 14.040, with a p-value of 0.000. Since the t-value exceeds 1.961 and the p-value is below 0.05, transformational leadership significantly affects digital transformation under the moderating role of digital culture. The corresponding path coefficient is 0.189, which is positive, indicating that digital culture strengthens the relationship between digital transformational leadership and digital transformation.

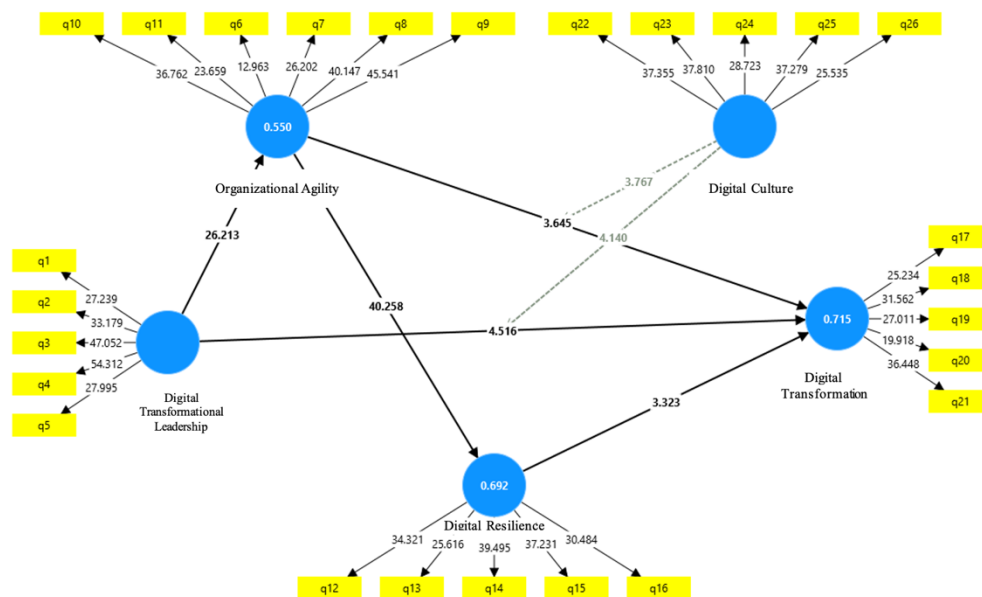


Figure 2: Significance coefficients of the structural model

Determining the Strength of the Moderator Effect

Based on the results, the strength of the moderating effect of digital culture in the model's relationships was assessed using effect size (f^2) values. The effect size for the relationship "Digital Culture $\times$ Organizational Agility $\rightarrow$ Digital Transformation" was 0.035, and for the

relationship "Digital Culture $\times$ Digital Leadership $\rightarrow$ Digital Transformation" it was 0.039. According to Cohen's criteria, where values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively, the obtained values in this study fall within the range of a small effect. Therefore, it can be concluded that although digital culture acts as a moderator and strengthens the

relationships between organizational agility and digital leadership with digital transformation, the magnitude of this enhancement is limited and considered weak. This suggests that, in this model, digital culture primarily serves as a modest facilitator. While its effect is statistically significant, its practical impact is relatively low. Overall, the findings indicate that digital culture can play an important role in supporting digital transformation mechanisms; however, for a stronger impact, the organizational cultural dimensions need to be further developed and institutionalized.

Sobel Test for Mediation Hypotheses

To evaluate the significance of the mediating role in the research model, the Sobel test was employed. This test calculates a z-value using the path coefficients and their associated standard errors, allowing the assessment of the significance of the indirect effect. If the calculated z-value exceeds 1.961, the mediating effect is considered significant at the 95% confidence level. This analysis helps determine whether the mediation pathway in the model has a genuine and meaningful impact. In addition to statistical significance, the strength of the mediating role was assessed using the effect share index. This index ranges from 0 to 1 and indicates the proportion of the total effect transmitted through the mediator. The closer the value is to 1, the stronger the mediating effect. Generally, values below 0.20 indicate very weak mediation, values between 0.20 and 0.80 indicate partial mediation, and values above 0.80 indicate full mediation. The Sobel test results for both mediation pathways exceeded 1.961, confirming the significance of the mediating roles at the 95% confidence level. In the first pathway, “Digital Leadership → Organizational Agility → Digital Transformation,” the z-value was 6.073, indicating a significant indirect effect. The effect share was 0.352, suggesting that approximately 35% of the total effect is transmitted through organizational agility, representing moderate partial mediation.

In the second pathway, “Organizational Agility → Digital Resilience → Digital Transformation,” the z-value was 3.323, also indicating a significant indirect effect. The effect share was 0.416, meaning that roughly 41% of the total effect is transmitted through the mediator, reflecting moderate-to-strong partial mediation. Overall, the findings demonstrate that both organizational agility and digital resilience serve as significant and impactful mediators in the research model, explaining a substantial portion of the relationships among the main variables. These results underscore the importance of enhancing organizational agility and resilience to achieve successful digital

transformation. Based on the obtained results, the mediating roles of variables in the digital transformation process were examined. For Hypothesis 4, the Sobel test z-value for assessing the mediating role of organizational agility in the relationship between digital transformational leadership and digital transformation was 6.073. Since this value exceeds 1.961, it indicates that organizational agility serves as a significant mediator at the 95% confidence level. The indirect effect through this variable, measured using the effect share index, was 0.352 (or 35.2%), indicating that a portion of the total effect of digital transformational leadership on digital transformation is transmitted indirectly through organizational agility.

Similarly, for Hypothesis 7, the Sobel test z-value for assessing the mediating role of digital resilience in the relationship between organizational agility and digital transformation was 3.323. This value is also greater than 1.961, confirming that digital resilience plays a significant mediating role. The indirect effect through digital resilience, measured by the effect share index, was 0.416 (or 41.6%), indicating that a substantial portion of the total effect of organizational agility on digital transformation is transmitted indirectly through digital resilience. These results demonstrate that organizational agility and digital resilience serve as important mediators, respectively enhancing the effects of digital transformational leadership and organizational agility on digital transformation.

CONCLUSION AND RECOMMENDATIONS

Over the past decade, digital transformation has become one of the most strategic priorities for organizations, fundamentally reshaping the trajectory of businesses. This study aimed to clarify the mechanisms influencing digital transformation and examine the roles of digital transformational leadership, organizational agility, digital resilience, and digital culture, providing a comprehensive view of the interactions among these factors. The findings indicate that digital transformation is not merely a technological phenomenon but a deeply socio-organizational process that requires effective leadership, an enabling digital culture, and dynamic capabilities within the organization. The results of the structural model analysis revealed that digital transformational leadership is one of the most critical drivers of organizational digital transformation. Managers with a clear digital vision, inspirational ability, and innovative approach can translate technological changes into behavioral, cultural, and structural transformations. This finding aligns with previous studies, such as McCarthy et al. [8] and Ly [9], which emphasize that

digital transformational leadership establishes key foundations for transformation, and without such leadership, technological initiatives fail to yield tangible organizational outcomes.

Furthermore, the study demonstrated that organizational agility not only has a direct impact on digital transformation but also plays a significant mediating role in the relationship between digital transformational leadership and digital transformation. This result is consistent with the dynamic capabilities literature and the findings of Zhang et al. [25] suggesting that agility defined as the organization's ability to respond rapidly, reconfigure resources, and make data-driven decisions serves as a vital link between digital leadership and successful digital transformation. The findings indicate that a substantial portion of the effect of digital transformational leadership is transmitted through organizational agility, underscoring the critical importance of agility in the digital era. Furthermore, the role of digital resilience as a new organizational capability was highlighted in this study. The results indicated that organizational agility serves as the primary pathway for enhancing digital resilience, which in turn has a direct positive effect on digital transformation. This finding aligns with the studies of Awad and Martín-Rojas [6] and Zhang et al. [26], who argue that successful digital transformation requires an organization's capacity to withstand, recover from, and rapidly adapt to technological and environmental disruptions. Organizations capable of quickly bouncing back from digital disruptions can implement their digital strategies in a sustainable and continuous manner. In this sense, digital resilience acts as a protective shield for digital transformation.

Another significant and valuable finding of the study is the role of digital culture. Moderation analysis revealed that digital culture strengthens the relationship between digital transformational leadership and organizational agility with digital transformation, although the effect size is modest yet significant. These results are consistent with the digital culture-oriented literature on digital transformation, such as Kane et al. [7], which emphasize that digital mindsets, values, and attitudes create the conditions necessary for successful technology implementation. Digital culture provides a socio-psychological environment that reduces employee resistance while fostering learning, knowledge sharing, and digital collaboration. In such an environment, the impact of leadership and organizational agility on digital transformation is enhanced. Overall, the findings of this study indicate that digital transformation is a multilayered and intertwined process whose success is only possible

when its three core dimensions are simultaneously strengthened and interactively aligned. First, the leadership layer provides direction and guidance by articulating a digital vision, motivating employees, and legitimizing change. Second, the dynamic capabilities layer, including agility and resilience, enables effective execution of transformation, rapid adaptation to environmental and technological changes, and ensures continuity and sustainability of change. Third, the digital culture layer creates a foundation of trust, continuous learning, and technology acceptance, reducing soft resistance and embedding digital change into employee behaviors, attitudes, and values. The coordinated combination of these three layers makes digital transformation meaningful, sustainable, and effective, enabling organizations to remain competitive in today's turbulent environment. These layers systematically guide, reinforce, and institutionalize digital transformation, demonstrating that its success depends on their simultaneous strengthening and alignment. In other words, digital transformation succeeds only when organizations move beyond a one-dimensional approach and view it as an integrated socio-technical process—a process whose success depends on a balanced combination of leadership, structure, culture, and organizational capabilities. Accordingly, organizations must simultaneously strengthen digital transformational leadership at managerial levels to provide clear direction and the necessary motivation for change. At the same time, organizational agility and rapid-response mechanisms should be developed so that the organization can reconfigure its resources and processes in line with environmental and technological changes.

Moreover, fostering digital resilience and strengthening business continuity support systems are essential to ensure the organization remains stable amid technological and environmental disruptions and can recover quickly. Finally, digital culture must be elevated to the level of shared organizational values so that technology adoption, continuous learning, innovation, and digital collaboration become embedded in collective behavior. Together, these dimensions form a coherent system that enhances the organization's capacity to achieve sustainable and effective digital transformation. From a theoretical perspective, this study integrates the literature on digital leadership, dynamic capabilities, and digital culture to provide a comprehensive framework explaining how digital transformation occurs and through which pathways. By confirming the mediating and moderating roles, the study clarifies the precise mechanisms of influence, addressing key theoretical questions. Ultimately, it can be concluded that the success of digital transformation is not merely the result of

investing in technology but the product of the intelligent synergy among leadership, culture, and organizational capabilities. This research demonstrates that digitally oriented organizations are those capable of creating dynamic alignment between technology and people, structure and culture, strategy and operations. Such alignment is what guides organizations toward sustainable, competitive, and forward-looking digitalization.

Based on the research findings, the following practical recommendations are proposed for managers and technology-based startup organizations. First, developing digital leadership training programs is essential. Managers can organize specialized courses to enhance digital transformation leadership skills, such as envisioning a digital roadmap and fostering innovation. Collaborating with external consultants or leveraging online learning platforms, such as Coursera, can be beneficial in this regard. Second, strengthening organizational agility through flexible processes is recommended. For example, employing agile methodologies, such as Scrum, in project management can facilitate a rapid response to market changes. Additionally, investing in digital tools, such as resource management software, can help quickly reconfigure resources. Third, building digital resilience systems is crucial. Organizations can ensure rapid recovery from disruptions by implementing data backup programs, providing cybersecurity training, and creating digital crisis teams, while leveraging tools such as cloud computing to enhance resilience. Fourth, nurturing a digital culture is important. Conducting digital knowledge-sharing workshops, rewarding innovative ideas, and promoting digital collaboration through tools such as Microsoft Teams can strengthen organizational culture. Cultural indicators, such as periodic surveys to assess technology adoption, can assist managers in monitoring progress. Finally, integrating the layers of digital transformation is recommended. Forming a

committee composed of leaders, IT specialists, and cultural representatives can ensure alignment between leadership, dynamic capabilities, and digital culture. These actions can help organizations implement digital transformation practically and sustainably, thereby enhancing their competitiveness.

However, this study has several limitations. The sample size was limited to 75 technology-based startups, and although 63 organizations were selected using a census method, the generalizability of the results to larger organizations or non-technology industries may be limited. The use of self-reported questionnaires may introduce response biases, such as social desirability, potentially affecting data accuracy. The cross-sectional research design does not allow for examining causal relationships over time, and the geographic limitation of sampling to Iran, influenced by specific cultural, economic, and regulatory factors, restricts the generalizability of the results to other contexts. Furthermore, control variables such as organizational size or digital maturity were not fully considered, which may affect the observed relationships. For future research, conducting longitudinal studies to examine variable changes over time and to confirm causal relationships is suggested. Expanding the population to include larger organizations, diverse industries, or other countries can increase the generalizability of findings. Using mixed-method approaches, such as in-depth interviews alongside questionnaires, can provide a deeper understanding of cultural and leadership mechanisms. Moreover, investigating new variables, such as artificial intelligence, environmental sustainability, or the role of government, and conducting comparative analyses between traditional organizations and startups or between developed and developing countries, can offer a more comprehensive analysis and novel insights in the field of digital transformation.

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