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Research on Digital Transformation Innovation and Adaptive Capability of Manufacturing Enterprises in Afghanistan

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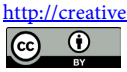

Abstract

During the critical period of promoting the construction of Digital Afghan and high-quality development, manufacturing enterprises have actively engaged in digital transformation, which has deeply integrated into various aspects of technological innovation within the enterprises, providing a favorable driving force and development atmosphere for technological innovation. This article constructs a conceptual model of the impact of digital transformation on the technological innovation capability of manufacturing enterprises. Data was collected through a questionnaire survey; SPSS and AMOS software are used for data analysis and hypothesis testing. The research results indicate that digital strategic transformation, digital organizational transformation, digital business process transformation, and digital technology application transformation have significant promoting effects on the technological innovation capability of manufacturing enterprises. Exploratory learning can positively regulate the relationship between digital transformation and technological innovation capability of manufacturing enterprises. Utilization learning positively regulates the relationship between digital strategic transformation, digital technology application transformation, and technological innovation capability of manufacturing enterprises.

Subject Areas

Human Resource

Keywords

Digital Transformation, Technological Innovation Capability, Organizational Learning, Manufacturing Enterprises, Afghanistan

1. Introduction

The rapid development of new generation digital technologies such as 5G-based

cloud computing, the Internet of Things (IoT), and big data will inevitably have significant impacts on the current human production and lifestyle, economic growth prospects, and international production patterns [1]. In the dynamic environment of global digitization, networking, and intelligence, the manufacturing industry is undoubtedly the cornerstone of modern industry and also reflects the level of a country's productive development. The world is currently at a crucial historical period of transitioning from high-speed economic growth to high-quality development, and the new generation of information technology is providing opportunities for digital transformation and development in manufacturing enterprises through its innovative, penetrative, and driving characteristics [2].

In the digital age, what enterprises need is pioneering innovation rather than sticking to old ways. Innovation enables enterprises to gain a competitive advantage in the fierce market competition. Under the strategic goal of innovation-driven development in Afghanistan, manufacturing enterprises gradually realize the importance of innovation-driven development, with technological innovation being of paramount importance. Afghanistan new government pointed out the need to establish a deep integration of industry, academia, and research in the technological innovation system, with enterprises as the main body of innovation and the market as the driving force of innovation [3]. The 2022 Government Work Report also emphasized the promotion of high-quality development of the real economy by relying on innovation and the cultivation of new growth drivers, aiming to enhance the overall technological innovation capability of Afghan manufacturing enterprises.

Based on this, this study focuses on manufacturing enterprises as the research object, using questionnaire surveys and empirical analysis to explore the relationship between digital transformation and technological innovation capability in manufacturing enterprises. It aims to deepen and expand the theoretical system of digital transformation and technological innovation capability in manufacturing enterprises, providing new paths and theoretical support for research on the influencing factors of technological innovation capability. Additionally, it seeks to increase the attention of manufacturing enterprise personnel, especially decision-makers, to digital transformation, enhance the enthusiasm of enterprises to invest continuously in digital transformation, help enterprises understand their current stage of digital transformation and the gap with industry-leading enterprises, and thus formulate more objective and comprehensive strategic measures to enhance the technological innovation capability of enterprises.

2. Literature Review

2.1. Digital Transformation

Economic globalization is an irreversible historical trend. Due to the rapid iteration and innovation of new generation information technology, afghan manu-

facturing enterprises are facing tremendous pressure for survival and development. In this context, digital transformation is imperative for manufacturing enterprises. Digital transformation in manufacturing enterprises refers to the use of digital technology to change existing business processes, strategic models, and organizational changes, helping enterprises create and acquire more value [2]. Digital transformation requires a deep transformation in thinking, using digital technology as a means to thoroughly optimize key points of enterprise development, such as technological aspects, organizational structure, and business processes, achieving high utilization and sharing of resources and bringing higher efficiency to the enterprise [3]. Digital transformation is a strategic change in manufacturing enterprises that utilizes digital technology to address uncertainties and complexities, achieve business improvements, and enhance operational efficiency and technological innovation capability [4]. In the process of digital transformation, manufacturing enterprises use digital technology to reshape organizational structure, business processes, business models, and strategic thinking, closely connecting with stakeholders to create value and improve competitiveness [5].

The connotation of digital transformation can be explained not only from the perspectives of changing strategies, technological support, business models, management concepts, and organizational changes, but also from a systemic and comprehensive perspective. Based on existing research, this study defines digital transformation in manufacturing enterprises as follows: Manufacturing enterprises deeply integrate various digital technologies with advanced manufacturing technologies, achieve precise control of the digital world, fully leverage the value-creating role of data as a key element, realize strategic transformation, significant organizational changes, optimization and improvement of business processes, enhance core values and capabilities, drive deep restructuring of enterprises, empower traditional manufacturing enterprises for transformation and upgrading, and ultimately enhance core competitiveness. Therefore, this study divides digital transformation in manufacturing enterprises into four dimensions: digital strategic transformation, digital organizational transformation, digital business process transformation, and digital technology application transformation.

2.2. Technological Innovation Capability

Technological innovation capability is a crucial element for enhancing a firm's competitiveness in the face of increasing global competitive pressures. Scholars have studied it from different perspectives such as resource input and integration, strategic positioning, dynamic processes, and system integration. From the perspective of resource input [6], proposed that technological innovation capability includes technology, products, processes, knowledge, experience, and organization, and it consists of four aspects: new product development, production, application, and response. From the perspective of resource integration, some scholars argue that technological innovation capability refers to the ability of enterprises to use information technology to reorganize relevant knowledge

and information. In this process, enterprises invent relevant technologies and have the ability to summarize and master practical experience [7]. Based on the strategic positioning of the firm [8], it emphasized the improvement of technological innovation capability through the selection of target markets and the implementation of market orientation, enabling the firm to maintain a competitive advantage and engage in disruptive innovation. Some scholars have gradually moved away from a static perspective of technological innovation capability [9]. That static technological innovation capability is no longer sufficient to meet the demands of sustainable development and intensifying inter-firm competition, and instead proposed a dynamic process perspective that consists of three parts: the ability to perceive environmental changes, the ability to adapt to organizational and operational requirements, and the ability to innovate. Yu, *et al.* (2022) explored the combination of product and process innovation and established the core technological innovation capability of enterprises through a strategic, dynamic, and integrated approach [6]. From a comprehensive perspective proposed that technological innovation capability in manufacturing enterprises encompasses various capabilities including the input capability for technological innovation, R&D capability, manufacturing capability, marketing capability, and management capability [10].

Currently, research on technological innovation capability has been approached from various perspectives such as resource input, resource integration, strategic positioning, innovation process, and dynamic views. This study focuses on the technological innovation capability of manufacturing enterprises, which emphasizes understanding customer latent needs and market development trends. It is a prerequisite for manufacturing enterprises to respond to highly turbulent external environments. Technological innovation in manufacturing enterprises is a complex process that requires the full exploration of internal and external resources and their rational allocation to technological innovation activities within the enterprise. It involves the use of original technological processes, maintaining a sustained advantage in innovation and development, and effectively realizing enterprise value through technological innovation outcomes such as new products. It is a dynamic and comprehensive capability.

2.3. Relationship between Digital Transformation and Technological Innovation Capability

Existing research emphasizes the impact of digital transformation on innovation development in enterprises, highlighting the crucial role of digital technology in supporting and facilitating innovation. It leads to changes in the trajectory of innovation within enterprises, improving operational models, establishing innovative mechanisms, and optimizing innovation processes, capabilities, and performance. From the perspective of innovation theory development argue that the application of digital technology will disrupt existing innovation management theories, fundamentally changing the nature and structure of new products and services within enterprises [11]. This prompts continuous restructuring and

reconstruction of innovation outcomes and processes, giving rise to new approaches for value creation and distribution, and providing a broad foundation for reshaping research on innovation management in the digital world. From the perspective of disruptive change brought about by digital transformation, propose that the rapid development of digital technology has led to significant changes in the entire manufacturing value chain and operating models [12]. Through open innovation and involving customers in the development, design, and creation process of products and services, enterprises can significantly enhance their innovation capabilities. From a multidisciplinary perspective, that digital transformation involves comprehensive changes in various aspects such as strategy, organization, supply chain, information technology, and marketing. Enterprises undergoing digital transformation need to aim for innovation to reduce costs and meet customer experiences, thereby enhancing their technological innovation capability and overall performance. Taking into account the overall context of digital transformation research [13], adopt a combination of qualitative and quantitative methods to analyze its evolutionary process. The research findings indicate that in the context of digital transformation, digital technology reconstructs industry strategies and business models by creating new business models, new products, and new services, driving industries to achieve value acquisition and value creation in relation to digital transformation activities.

Existing research highlights the impact of digital transformation on innovation development in enterprises, emphasizing the crucial role of digital technology in supporting and facilitating innovation. This leads to changes in the trajectory of innovation within enterprises, significantly improving operational models, establishing innovative mechanisms, and optimizing innovation processes, capabilities, and performance. The aforementioned literature provides valuable references for selecting influencing factor variables in this study.

3. Research Design

3.1. Hypotheses

The digital revolution has had a profound impact on manufacturing companies, prompting them to embrace digital strategic transformations in order to drive innovation. By analyzing customer behavior and identifying their needs, these enterprises adopt a customer-centric digital mindset, actively improving their products and services. This approach helps them stay ahead of emerging market trends, reduce uncertainty in technological innovation, increase the success rate of new product development, and enhance overall innovation capabilities [14].

Digital strategic transformations empower manufacturing enterprises with disruptive and integrative capabilities, enabling them to align internal operations with the external environment. This alignment allows them to gather valuable information about market trends and future development directions, leading to the development of highly competitive new products and surpassing competitors

in technological innovation outcomes. Ultimately, this enhances their overall innovation capabilities [15].

The digitization of manufacturing enterprises also brings about flexible organizational structures and improves communication, collaboration, and mutual assistance among employees. This fosters enthusiasm for technological innovation and facilitates innovation activities within the organizations. Additionally, digital organizational transformation enables the rapid restructuring of digital and organizational resources, products, and services, reducing the innovation cycle and improving the monetization of technological achievements [16].

Manufacturing enterprises in the digital age embrace emerging digital technologies and digitize their production processes through methods like agile manufacturing and lean production. This automation enhances production efficiency, accelerates the development of new products, and improves technological innovation capabilities. The digital transformation of business processes allows for true interaction between business operations and digital technology, leading to faster and more efficient operations, increased productivity, and improved production efficiency. Furthermore, the application of advanced digital technologies within the product development and production process, such as flexible control technology and virtual simulation technology, enables rapid improvement of products and production processes, enhancing the efficiency and quality of process innovation. This results in the production of highly innovative and precise new products and further improves technological innovation capabilities [17].

Supporting digital technology research and application is crucial for enterprises to fully leverage the data space, enhance operational efficiency, and catalyze diverse innovation outcomes. Digital technology application transformation in manufacturing enterprises involves the use of software technologies like ERP, CRM, and MES, enabling collaborative sharing of information resources among departments. Hardware technologies such as sensors, monitoring devices, computer terminals, and storage devices facilitate data digitization within enterprises. This provides the necessary data and technological support for technological innovation, allowing for the establishment of digital product models in a more accurate, intuitive, convenient, and efficient manner. Consequently, it improves the success rate of new product design and manufacturing, facilitates rapid market entry, and enhances technological innovation capabilities [18].

Based on the points discussed, the following hypotheses are proposed:

H1a: Digital strategic transformation in manufacturing enterprises positively impacts technological innovation capability.

H1b: Digital organizational transformation in manufacturing enterprises positively impacts technological innovation capability.

H1c: Digital business process transformation in manufacturing enterprises positively impacts technological innovation capability.

H1d: Digital technology application transformation in manufacturing enter-

prises positively impacts technological innovation capability.

In the digital economy era, manufacturing enterprises acknowledge the significance of engaging in exploratory learning to explore new knowledge and technologies. This approach is vital for meeting future market demands and responding to market risks. Knowledge plays a critical role in driving the digital transformation of manufacturing enterprises [19]. Given the rapid pace of technological advancements, digital transformation has become an unavoidable trend for manufacturing enterprises. To adapt to this process and enhance innovation efficiency [19], continuous exploration of new knowledge and technologies is essential. Exploratory learning focuses on enabling manufacturing enterprises to surpass existing "knowledge islands" and "information islands" by acquiring new methods and approaches. With the emergence and advancement of the Internet of Things and big data technology, manufacturing enterprises can construct digital and integrated systems, accelerating the collection and utilization of information resources. This significantly reduces the time required to explore new knowledge and technologies while expanding their learning channels [20]. By doing so, organizations overcome inflexibility, improve production and operational efficiency, facilitate effective digital strategic transformations, and achieve the transformation and upgrading of manufacturing enterprises in the digital context. Consequently, this promotes the smooth progress of technological innovation activities, enhances the speed at which enterprises grasp new markets, processes, and products, and enables the timely introduction of technologically advanced products to maintain enterprise performance. Ultimately, this enhances technological innovation capabilities. Therefore, exploratory learning has a positive impact on the effect of digital transformation on technological innovation capabilities in manufacturing enterprises, creating a favorable environment for technological innovation and the timely development of innovative outcomes that align with customer preferences.

Based on the analysis above, the following research hypotheses are proposed:

H2a: Exploratory learning positively moderates the relationship between digital strategic transformation and technological innovation capability in manufacturing enterprises.

H2b: Exploratory learning positively moderates the relationship between digital organizational transformation and technological innovation capability in manufacturing enterprises.

H2c: Exploratory learning positively moderates the relationship between digital business process transformation and technological innovation capability in manufacturing enterprises.

H2d: Exploratory learning positively moderates the relationship between digital technology application transformation and technological innovation capability in manufacturing enterprises.

Resource-based theory emphasizes that enterprises achieve competitive advantages by leveraging their unique, rare, and non-replicable high-value resources. Exploitative learning plays a crucial role in deepening the understand-

ing of existing resources within an enterprise and exploring their potential value [21]. By enhancing the understanding of enterprise resources and knowledge skills, exploitative learning improves the efficiency of absorbing and utilizing existing resources. In the context of digital transformation, manufacturing enterprises can leverage their unique resource advantages to identify and address issues and deficiencies, optimizing and improving their processes iteratively. This approach mitigates transformation risks and creates opportunities, enabling enterprises to develop reasonable medium- to long-term strategic plans and optimize their organizational structures [22]. Additionally, through the accumulation of existing production technologies, operational methods, and procedures, as well as the digestion and application of newly acquired external resources and technologies, exploitative learning contributes to the expansion of production operations, business processes, and the application of digital technologies within manufacturing enterprises. It enhances the availability of technological innovation resources, strengthening their technological innovation behavior and overall technological innovation activities. Consequently, manufacturing enterprises can introduce new products more rapidly, improve technological innovation efficiency, and enhance their technological innovation capabilities [22].

Based on the analysis above, the following research hypotheses are proposed:

H3a: Exploitative learning positively moderates the relationship between digital strategic transformation and technological innovation capability in manufacturing enterprises.

H3b: Exploitative learning positively moderates the relationship between digital organizational transformation and technological innovation capability in manufacturing enterprises.

H3c: Exploitative learning positively moderates the relationship between digital business process transformation and technological innovation capability in manufacturing enterprises.

H3d: Exploitative learning positively moderates the relationship between digital technology application transformation and technological innovation capability in manufacturing enterprises.

3.2. Data Collection

The main objective of the questionnaire survey was to obtain reliable and unbiased data. This study specifically focused on manufacturing enterprises that were currently undergoing digital transformation. The sample selection was based on the "2022 Afghan Manufacturing Enterprise Directory", and random sampling was conducted to include representative and typical manufacturing enterprises in Kabul, Jalalabad, Qandahar, Herat, and other regions.

To ensure the quality of the research, telephone interviews were initially conducted with the companies. Only those companies that expressed their willingness to cooperate and confirmed their ongoing digital transformation were chosen as research subjects. This process guaranteed the randomness of the sample selection.

Given the complexity of concepts related to digital transformation and the importance of the respondents' familiarity with the subject, the survey targeted middle and senior-level managers in the manufacturing enterprises. This approach aimed to ensure the reliability of the research conclusions. The questionnaire survey was conducted online using survey platforms, and the questionnaires were distributed through interpersonal relationships, such as teachers and classmates. Survey instructions were sent to the participants via email. After completing the survey, the respondents submitted their filled questionnaires to a designated survey retrieval mailbox.

A total of 200 formal questionnaires were distributed in this survey, out of which 180 questionnaires were actually collected, resulting in a response rate of 90%. During the data collection process, 20 invalid questionnaires were excluded. These included surveys that could not clearly be classified as digital transformation enterprises, those with identical responses, and those with extremely short response times. As a result, a total of 150 valid questionnaires were considered, leading to a final effective response rate of 75%.

4. Empirical Results

4.1. Reliability and Validity Analysis

The study utilized SPSS 12.0 and AMOS 24.0 software to perform an analysis on the reliability and validity of the scales used. Reliability testing involved calculating Cronbach's α coefficients for each item in the questionnaire. The coefficients obtained for the items related to digital strategic transformation, digital organizational transformation, digital business process transformation, digital technology application transformation, technological innovation capability, exploratory learning, and exploitative learning were 0.694, 0.673, 0.612, 0.619, 0.703, 0.697, and 0.716, respectively. These coefficients, all exceeding the threshold of 0.6, indicated satisfactory reliability of the scales, as confirmed by the conducted tests. Reliability in this context refers to the consistency and stability of the measurements, suggesting that the questionnaire items consistently measure the intended constructs. Validity testing began with an assessment of the sample adequacy using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity, both of which produced significant results. This indicated that the data obtained from the sample were suitable for factor analysis. Exploratory factor analysis was then conducted, and the factor loadings of all variables were found to exceed 0.6. This indicates that the variables had a strong correlation with their respective underlying factors, suggesting good results in the analysis. Additionally, confirmatory factor analysis (CFA) was performed to examine the model fit, convergent validity, and discriminant validity. The results indicated that all fit indices met the criteria for good fit, implying that the proposed model adequately represented the observed data. The standardized factor loadings, which represent the strength of the relationship between the variables and their factors, were found to be greater than 0.6, further supporting the convergent va-

lidity of the scales. Convergent validity refers to the extent to which different measurements of the same construct are related. Moreover, the average variance extracted (AVE) was determined to be greater than 0.5, indicating that more than half of the variance in the observed variables was accounted for by their respective underlying factors. This finding further supports the convergent validity of the scales. The composite reliability (CR) values, exceeding 0.7, indicate that the scales exhibited good internal consistency and reliability. CR measures the degree to which the observed variables reliably measure their respective underlying constructs.

To assess the discriminant validity of the scales, the square root of the AVE was compared to the inter-factor correlations. It was found that the square root of the AVE was greater than the inter-factor correlations, demonstrating that the scales had good discriminant validity. This suggests that the scales adequately distinguish between different constructs and are not measuring the same underlying construct.

4.2. Correlation Analysis

The study utilized a valid sample of 180 data points, and SPSS 12.0 software was employed to perform correlation analysis in order to investigate the relationships between the variables. The results of this analysis are presented in **Table 1**. Upon examining **Table 2**, it becomes apparent that significant positive correlations exist among the variables. This finding further validates the practicality and viability of the research model and hypotheses. The significant positive correlations suggest that there are meaningful associations between the variables, supporting the potential for conducting a more in-depth analysis.

Specifically, the variables of digital transformation, organizational learning, and technological innovation capability demonstrate significant positive correlations. This indicates that as digital transformation increases, there is a tendency for organizational learning and technological innovation capability to also increase. The positive correlations suggest that these variables are interrelated and influence one another, which aligns with the research model and hypotheses.

4.3. Regression Analysis

4.3.1. Regression Analysis of the Impact of Digital Transformation on Technological Innovation Capability in Manufacturing Enterprises

To investigate the relationship between digital transformation and technological innovation capability in manufacturing enterprises, regression analysis was performed using SPSS 12.0. The analysis involved testing Models one to five, and the results are presented in **Table 3**.

In order to examine the relationship between digital transformation and technological innovation capability in manufacturing enterprises, a series of regression models were analyzed. Model 1 focused on the association between control variables and technological innovation capability. The results from

Table 1. Reliability test.

Dimension			KMO	Approximate Afg-square	Significant	Normalized factor loadings	AVG	CR
	C11					0.557		
C1						0.534		
	C12	0.694	0.586	473.855	0.000		0.748	0.648
	C13					0.526		
	C14					0.573		
	C21					0.537		
C2						0.554		
	C22	0.673	0.568	375.654	0.000		0.685	0.636
	C23					0.574		
	C24					0.485		
	C31					0.484		
C3						0.557		
	C32	0.612	0.506	515.685	0.000		0.685	0.637
	C33					0.491		
	C34					0.595		
C4	C41					0.534		
						0.582		
	C42	0.619	0.509	496.765	0.000		0.747	0.589
	C43					0.481		
	C44					0.557		
	P1					0.594		
P						0.594		
	P2	0.703	0.574	473.686	0.000		0.747	0.734
	P3					0.583		
	P4					0.481		
	E1					0.471		
E						0.494		
	E2	0.697	0.502	386.686	0.000		0.696	0.636
	E3					0.593		
	E4					0.524		
	Q1					0.572		
Q						0.596		
	Q2	0.716	0.484	445.745	0.000		0.694	0.683
	Q3					0.596		
	Q4					0.549		

Table 2. Correlation coefficient of variables.

Variable	Mean	St. Dev	1	2	3	4	5	6
Age of business	1.643	0.324						
Enterprise size	1.223	0.572	0.321**					
C1	2.434	0.824	0.082* (0.432)					
C2	2.387	0.887	0.084**	0.382** (0.422)				
C3	2.533	0.917	0.062**	0.443**	0.367** (0.373)			
C4	2.376	0.865	0.072*	0.536	0.535**	0.554** (0.375)		
p	2.376	0.865	0.054*	0.072*	0.536**	0.535**	0.554 (0.375)	
E	2.545	0.846	0.033*	0.053*	0.565**	0.554**	0.585** (0.333)	
Q	1.839	0.612	0.075*	0.034*	0.854**	0.467**	0.595**	0.554** (0.533)

Table 3. Exploratory learning regression analysis.

Variable		T				
		Model 1	Model 2	Model 3	Model 4	Model 5
Control variable	Age of business	0.024	0.031	0.021	0.43	0.41
	Enterprise size	−0.089	−0.097	−0.034	−0.021	−0.019
Explanatory variable	C1	0.107**	0.112**	0.176**	0.154**	0.149**
	C2	0.141**	0.154**	0.139**	0.143**	0.129**
	C3	0.098**	0.114**	0.128**	0.112**	0.131**
	C4	0.198**	0.199**	0.136**	0.141**	0.166**
Adjusting variable	E		−0.097*	0.032	0.031	0.101**
0.135**	Interaction item	C1*E				
		C2*E		0.134**		0.155**
		C3*E		0.121**		0.142**
		C4*E		0.141**		0.098*
R2		0.316	0.319	0.491	0.378	0.512
Adjustment R2		0.307	0.317	0.49	0.371	0.511
F		11.966	9.756	21.775	13.754	19.776
DW		0.986	0.982	1.576	0.996	1.435

Note: **, * indicate significant at the 1% and 5% confidence levels, respectively.

Model 1 indicate that the coefficient for enterprise age is significantly positive (β = 0.142, p < 0.04). This suggests that as the age of the enterprise increases, there is a promotion of technological innovation capability. On the other hand, the significance level (p value) for enterprise size in relation to technological innovation capability is greater than 0.04. This implies that enterprise size does not have a significant impact on the technological innovation capability within manufacturing enterprises.

Moving on to Models 2 to 5, each model examined the relationship between one of the four dimensions of digital transformation in manufacturing enterprises (digital strategic transformation, digital organizational transformation, digital business process transformation, and digital technology application transformation) and technological innovation capability. The results from Models 2 to 5 indicate that the coefficients for each dimension of digital transformation (digital strategic transformation, digital organizational transformation, digital business process transformation, and digital technology application transformation) are all significantly positive (β = 0.307, 0.317, 0.49, 0.371, p < 0.01). These findings suggest that improvements in these dimensions of digital transformation contribute to the enhancement of technological innovation capability. Consequently, hypotheses H1a, H1b, H1c, and H1d, which propose positive relationships between these dimensions of digital transformation and technological innovation capability, are supported by the analysis.

4.3.2. The Moderating Effect of Exploitative Learning on the Relationship between Digital Transformation and Technological Innovation Capability in Manufacturing Enterprises

The regression analysis results of the moderating effect of exploratory learning on the relationship between digital transformation and technological innovation capability in manufacturing enterprises are presented in **Table 4**. To examine the moderation effect, the four dimensions of digital transformation and exploratory learning were centered. The product of the two variables was calculated to obtain the interaction term, which was then included in the regression equation to test the hypotheses.

In testing the moderation effect, the variables were introduced into the regression equation in the following order: Model 6 included the control variables and explanatory variables, Model 7 included the control variables, explanatory variables, and moderating variable, and Model 8 introduced the interaction terms into the regression equation. The results showed that the adjusted R-squared increased in Models 6 and 7 The interaction effects between digital strategic transformation, digital organizational transformation, digital business process transformation, digital technology application transformation, and exploratory learning were all significantly positive (β = 0.107, 0.112, 0.176, 0.154, p < 0.01). This indicates that exploratory learning enhances the positive effect of digital transformation on technological innovation capability in manufacturing enterprises, supporting hypotheses H2a, H2b, H2c, and H2d.

Table 4. The regression analysis of exploratory learning.

Variable		T				
		Model 6	Model 7	Model 8	Model 9	Model 10
Control variable	Age of business	0.024	0.031	0.021	0.43	0.41
	Enterprise size	−0.089	−0.097	−0.034	−0.021	−0.019
Explanatory variable	C1	0.107**	0.112**	0.176**	0.154**	0.149**
	C2	0.141**	0.154**	0.139**	0.143**	0.129**
	C3	0.098**	0.114**	0.128**	0.112**	0.131**
	C4	0.198**	0.199**	0.136**	0.141**	0.166**
Adjusting variable	E		−0.097*	0.032	0.031	0.101**
0.135**	Interaction item	C1*E				
	C2*E			0.134**		0.155**
	C3*E			0.121**		0.142**
	C4*E			0.141**		0.098*
R2		0.316	0.319	0.491	0.378	0.512
Adjustment R2		0.307	0.317	0.49	0.371	0.511
F		11.966	9.756	21.775	13.754	19.776
DW		0.986	0.982	1.576	0.996	1.435

Note: **, * indicate significant at the 1% and 5% confidence levels, respectively.

When examining the moderating effects, the order in which variables were introduced into the regression equation was as follows: Model8 introduced control variables, explanatory variables, and moderating variables simultaneously, while Model 10 introduced the interaction terms into the regression equation. The results showed that the interaction effects between digital strategic transformation, digital technological application transformation, and exploitative learning were significantly positive ($\beta = 0.107, 0.112$, $p < 0.01$), while the interaction effects between digital organizational transformation, digital business process transformation, and exploitative learning were not significant ($\beta = 0.024$, 0.031, $p > 0.05$). Therefore, exploitative learning can enhance the positive effects of digital strategic transformation and digital technological application transformation on manufacturing firms' technological innovation capabilities, supporting the hypotheses H3a and H3d, while hypotheses H3b and H3c are not supported.

5. Conclusions

The four dimensions of digital transformation in manufacturing firms: digital strategic transformation, digital organizational transformation, digital business process transformation, and digital technological application transformation significantly promote the improvement of manufacturing firms' technological innovation capabilities in Afghanistan. Manufacturing firms that focus on value

positioning, establish clear directions, visions, and holistic strategic planning for digital transformation, and grasp market dynamics can reduce risk factors in technological innovation activities, improve the efficiency of technological innovation output, and quickly seize the market. Digital technology acts as a catalyst for organizational transformation in manufacturing firms, and digital organizational transformation can profoundly change organizational structure, enhance interdepartmental communication and collaboration, increase members' innovation motivation, quickly match and restructure digital resources, effectively shorten the innovation cycle, and thereby enable manufacturing firms to rapidly launch technological innovation outcomes and enhance technological innovation capabilities. Digital business process transformation in manufacturing firms can improve business accuracy and efficiency, make the operational model faster and more efficient, thereby enhancing productivity, production efficiency, and production quality, and strengthening technological innovation capabilities. The development and application of digital technology in manufacturing firms can improve the accuracy of product and process design, enhance the success rate of technological innovation, and catalyze diverse technological innovation outcomes, thereby enhancing manufacturing firms' technological innovation capabilities.

Exploratory learning has a significant positive moderating effect between digital transformation and manufacturing firms' technological innovation capabilities. Manufacturing firms that adopt an exploratory learning mindset can effectively break existing models, strengthen the driving force for digital transformation, enhance organizational flexibility, and improve the adaptability and agility of the enterprise. This leads to the realization of various forms of technological innovation and the generation of more technological innovation outcomes, thereby enhancing manufacturing firms' technological innovation capabilities.

Exploitative learning has a positive moderating effect between digital transformation and manufacturing firms' technological innovation capabilities, enhancing technological innovation capabilities. Manufacturing firms that engage in exploitative learning can effectively adjust and improve existing knowledge and skills in the digital domain, apply and deepen existing knowledge resources in business operations, and help optimize the process of digital transformation in manufacturing firms, formulate medium and long-term strategic planning, accelerate the digestion and application of digital technology, and improve the efficiency of technological innovation. Exploitative learning does not have a moderating effect on the impact of digital organizational transformation on manufacturing firms' technological innovation capabilities. This may be because the existing resource base accumulated by manufacturing firms has uniqueness and irreplaceability, limiting the transferability of organizational transformation models to other firms, resulting in a lack of relevant experience in digital organizational transformation and insufficient decision-making and execution at the departmental level, which is not conducive to the generation of technological innovation behaviors. Additionally, exploitative learning does not have a mod-

erating effect on the impact of digital business process transformation on manufacturing firms' technological innovation capabilities. This may be due to the limited ability of manufacturing firms to acquire external knowledge in existing domains and transform it into their own tacit resources, as well as the over-reliance on internal experience, which hinders the process of digital business process transformation in manufacturing firms, weakens the motivation for process optimization, and fails to fully enhance the amount of technological innovation resources and technological innovation capabilities in manufacturing firms.

Conflicts of Interest

The authors declare no conflicts of interest.

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