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Synergy Between Digital Transformation and Innovation Capabilities Towards Firm Performance in Startups

[1]*Shazia Zahir*, [2]*Ambareen BiBi*

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Digital Transformation, Innovation Capabilities, Startup Performance, Technology Adoption, Digital literacy, Digital Infrastructure.

ABSTRACT

In technology firms, particularly in the context of startups, Digital Transformation and Innovation Capabilities are strategic drivers of firm performance. In this study we analyze the effect of Digital transformation and Innovation capabilities on the performance of technology startups in Pakistan's twin cities of Islamabad and Rawalpindi. Data are collected from 418 employees through structured survey questionnaire with the use of convenient sampling techniques and analyzed using regression analysis in SPSS. Findings showed the substantial positive effect of Digital Transformation (measured as technology adoption, digital literacy and digital infrastructure) and innovation capabilities on firm performance. These findings add more value to the importance of having digital infrastructure and innovation to improve the startups performance and competitive advantage. Drawing on the matching of digital transformation and innovation capabilities, this research contributes to literature by facilitating an innovative perspective of how startup performance is influenced by digital transformation.

INTRODUCTION

Digital transformation constitutes the amalgamation of digital technologies in the operations of business with the aim of bringing radical changes in the way processes, customer experiences and competitive advantages are being delivered by a business (Masoud & Basahel, 2023). Firm innovation capabilities (i.e., its capability to develop novel products, services and processes) represents a vital mechanism by which firms maintain their competitiveness and their capacity of adaptation to the market dynamic (Wielgos et al., 2021). They have increasingly been recognized as driving firm performance, especially in startups context. Prior research asserts a lower rate of digital adoption in Pakistani firms than their global counterparts as a result of a lack of digital infrastructure, low digital literacy, and least amounts of

[1] *PhD Scholar, Department of Management Sciences, Islamia College University Peshawar. Email: shazia.zahir90@gmail.com (Corresponding Author)*
[2] *Student, Govt. College of Commerce and Management Science for Women Mardan. Email: ambareen.bibi2004@gmail.com*

investment in technology (Yu et al., 2017). This lag in optimizing business performance through digital transformation has both internal firm impact and external industry (Bouwman et al., 2019; Tarutė & Gatautis, 2014) impact in the Pakistani as well as global context. Siqueira, et al. (2024) defines startups as organizations that produce innovative products and services under conditions of uncertainty. A management approach is needed for startups that tackle uncertain environments, learning how to develop a sustainable business, how to convert ideas in to products, measure customer reactions, and how to make correct decisions for a successful business (Quaiser & Srivastava, 2024; Polidoro & Jacobs, 2023; Nabarreto, 2020).

Despite the research of digital transformation and innovation capabilities, little is known on their integration in explaining startup performance. The extant prior research addresses digital transformation and innovation capabilities individually (Nwankpa & Roumani, 2016). However, little research has been conducted to explore the complex relationship amongst digital literacy, technological adoption, investment, and firm performance in the context of Pakistan (Hongyun et al., 2023; Shah et al., 2023). In addition, we observe that few studies have examined the influence of digital transformation—digital literacy, technology adoption and infrastructure—variables in startups. Integration of these variables in explaining startup performance remains underexplored. Prior research primarily focuses on either digital transformation or innovation capabilities independently (Nwankpa & Roumani, 2016). Moreover, existing studies often lack contextual specificity and fail to address the challenges faced by startups in resource-constrained environments (Li et al., 2024). Also, deprived of proper strategic orientation, unselective implementation of digital technologies coupled with little digital literacy can make the prevailing issues more severe and investing in technology adoption may result in maladministration and underutilization of organizational resources (Mushtaq et al., 2023).

This study addresses these research gaps by empirically investigating the joint influence of digital transformation and innovation capabilities on firm performance in startups within this domain.

Objectives of the study

The primary objective of this research is to assess the influence of digital transformation and innovation capabilities on the performance of startups. Specific objectives are as follows:

1. Evaluate the role of technology adoption, digital literacy, and digital infrastructure in enhancing firm performance in startups.

2. Analyze the contribution of innovation capabilities in enhancing firm performance in startups.
3. Provide actionable insights for managers to leverage digital tools and foster innovation.

Using an inclusive framework of innovation capabilities and digital transformation to enhance startup performance, this research offers invaluable insinuations for policymakers and business managers. It also adds to the theoretical discourse as it bridges two critical constructs and contextualizes them in the technology sector of Pakistan.

HYPOTHESIS DEVELOPMENT

Digital Transformation

Digital transformation defines the strategic process of assimilating digital tools and technologies in a company's operation to enhance efficiency as well as stimulate innovation (Wang et al., 2022). According to Wang et al. (2022) for conceptualization of digital transformation construct three major dimensions, technology adoption, digital literacy and digital infrastructure are utilized. Technology adoption represents key components of process efficiency, digital literacy represents a requisite for workforce readiness, and digital infrastructure promotes seamless integration (Puelles & De la Vega, 2024). Since digital transformation enables scalability, agility and innovation, it is of particular significance for startups to remain competitive in turbulent and dynamic environments (Masoud & Basahel, 2023).

Digital Transformation and Startups Firm Performance

Empirical research has evidenced that digital transformation lead to loftier better financial and operational outcomes in startups. Digital transformation and innovation influence firm's performance including financial, operational and market outcomes (Khan et al., 2023; Smith, 2024). Adoption of digital technologies favorably influence firm performance outcomes through enhanced efficiencies, lowers costs, and promotes data-driven decision making (Guo & Xu, 2021). The part of digital transformation in the contemporary business environment has been confirmed by many past studies, which have all shown a robust relationship amongst digital transformation and improved business productivity (Hsieh & Chou, 2018; Li et al. 2021). The available evidence indicates positive direct relationship of digital transformation initiatives with firm performance, mediated by factors like innovation and dynamic capabilities (Liu & Song, 2024). It is further demonstrated through studies that in startups, digital transformation mediates the association amid firm performance and dynamic capabilities as the crucial enabler (Chen, 2023). Therefore, it is hypothesized that:

H1: *Digital transformation positively effects firm performance in startups.*

Technology Adoption and Startups Firm Performance

Technology adoption is largely important to gain innovation in the context of startups. Advancement of technologies employment such as cloud computing, artificial intelligence and data analytics plays a

crucial role in determining a startup's efficiency and consumer contentment (Li et al., 2024). Moreover, Liu et al. (2023) suggest that operating efficiency and adaptable technology rich firms tend to outperform overall. Though, excessive use of technology without a clear strategy might lead to burnout and dilute long term performance (Usai et al. 2021). Therefore, it is hypothesized that:

H2: *Technology adoption positively influence startups performance.*

Digital Literacy and Startups Firm Performance

Digital transformation comprises the use of digital tools, and digital literacy—defined as employees and managers being able to effectively utilize digital tools—lies at the heart of harnessing the full benefit of digital transformation. Liu and Song (2024) find that, firms with higher digital literacy levels perform better in terms of digital strategy implementation and digital productivity. For starters, the act of being literate in digital technologies enforces the ability to react to changes in the marketplace and the needs of customers rapidly through adaptability. Therefore, we hypothesized that:

H3: *Digital literacy favorably affect firm performance in startups context.*

Digital Infrastructure and Startups Firm Performance

Digital infrastructure is the foundation of technology and systems that enable a firm's digital initiatives, including high speed internet, public cloud, cybersecurity. Technological advancements like AI improves employee related practices however holistic potential of such technologies is dependent upon a vigorous climate of innovation (Ahmad et al., 2024). It is found that startups with a strong digital infrastructure achieve higher scalability and operational efficiency (Puelles & De la Vega, 2024). But this infrastructure also allows real time data analysis to further improve decision making.

Therefore, it is hypothesized that:

H4: *Digital infrastructure positively impacts startup firms' performance.*

Innovation Capabilities and Firm Performance in Startups

For startups, innovation capabilities are crucial to provide the competence to bring in novel processes, products and business models. Innovation capabilities are prerequisites for company survival and market responsiveness. Their positive influence on firm performance is researched and stressed to support the part of vibrant competencies in nurturing creativity and implementing new solutions (Chen, 2023). The exploration has revealed that vigorous innovation capabilities are relevant to the innovation performance of technology-based startups. A positive innovation performance is associated with different combinations of these capabilities (Siqueira, et al., 2024). In Ahmad et al. (2022), firm performance is elucidated in relevance to the influence of digital transformation, and the article provides insights for firm to invest in digitalization and develop a culture of innovation in order to succeed in this digital fast changing environment. Competitive advantage obtained through sustained innovation leads to overall superior financial performance of firms (Nwankpa & Roumani, 2016). Innovation capabilities provide tools and processes that are required to continuously innovate. We therefore, hypothesized that:

H5: *Innovation capabilities positively influence startup firm performance.*

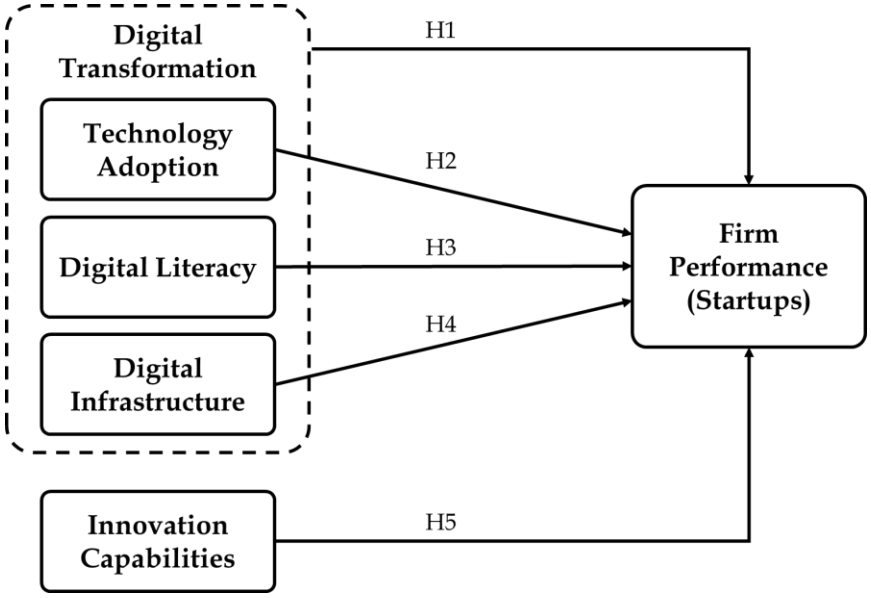

Figure 1: Conceptual Model

METHODOLOGY

Research Design

A quantitative mono method research design was chosen through use of survey strategy for this research. This is a popular and recommended methodology for business and management and social sciences research (Saunders, Lewis, & Thornhill, 2019). In alignment with this methodology survey strategy was employed. The data were collected in cross-sectional manner and analyzed using regression model with SPSS software. The following regression model was used in analysis.

$$SFP = \beta_0 + \beta_1(TA) + \beta_2(DL) + \beta_3(DI) + \beta_4(IC) + \mu$$

Where,

SFP = Startup Firm Performance, TA = Technology Adoption, DL = Digital Literacy, DI = Digital Infrastructure, IC = Innovation Capabilities

Population and Sample

Structured questionnaire was utilized to accumulate data from employees working in startups in Islamabad and Rawalpindi. Therefore, the population was employees working in the technology startups in these cities. As exact size of the population was unknown, sample size for adequate analysis was computed to be 148 utilizing Power Analysis using GPower 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). The effect size, alpha level and power were specified as 0.15, 0.01, 0.99 respectively. However, to ensure sample diversity in role and firm

size, the questionnaires were distributed to 450 respondents selected by using convenient sampling. Out of these 418 usable questionnaires were returned and used for analysis.

Measurement Scales

Digital Transformation (Technology adoption, Digital Literacy, Digital Infrastructure): Items from prior validated scales developed by Zhao et al. (2024) related to technology adoption, digital literacy and digital infrastructure were used to measure Digital Transformation. Responses for all the items were recorded on a five point Likert-type scale.

Innovation capabilities: Established metrics adapted from Chen (2023) such as items based on innovation capabilities of product, process, and organizational were used to assess innovation capabilities. Responses for all the items were recorded on a five point Likert-type scale.

Firm Performance: Items from previous study of Wang et al. (2022) had been used as yardsticks through which Firm Performance was assessed, using financial, operational, and market performance indicators. Responses for all the items were recorded on a five point Likert-type scale.

Table 1
Sample Characteristics

Demographic Variable	Categories	Frequency (%)
Gender	Male	**63**
	Female	37
Role	Manager	34
	Employee	66
Firm Age	<3 years	100
Education	Graduate	77
	Postgraduate	23

N=418

DATA ANALYSIS AND RESULTS

Regression analysis through SPSS software was used to analyze the data. Descriptive statistics and correlations were first computed and then hypotheses were evaluated by regression analysis. Before conducting regression, assumptions underlying the mode, like normality, linearity and multicollinearity were evaluated.

Table 2
Descriptive Statistics and Correlations

Variable	Min	Max	Mean	Std. Dev.	1	2	3
1. Technology Adoption	2.10	5.00	4.15	0.45			
2. Digital Literacy	2.50	5.00	4.10	0.43	0.62**		
3. Digital Infrastructure	2.20	5.00	4.18	0.46	0.59**	0.57**	
4. Innovation Capabilities	2.80	5.00	4.22	0.44	0.68**	0.65**	0.63**

Relatively strong agreement on the importance of the study constructs is suggested by the means for all variables as they are fairly high (about 4). Response variation was limited and had low standard deviations. All the variables were observed to be positively correlated with each other. Findings showed that Technology Adoption had the strongest correlation with Innovation Capabilities ($r = 0.68$, $p < 0.01$), suggesting critical importance in promoting innovation. In addition, Digital Literacy and Digital Infrastructure were highly correlated with Innovation Capabilities (0.65 and 0.63 respectively), which again corroborate these constructs as enablers for innovation.

Table 3
Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.795	0.632	0.629	0.478

Regression Analysis

To test hypothesized relationships, the Classic Linear Regression Model was used. Before such regression analysis, the underlying assumptions of the model were tested. The Kolmogorov-Smirnow test ($p > 0.05$) was used to verify normality od the data distributions. Scatterplots confirmed linearity among the study variable. We examined the VIF values (VIF < 5) to assess multicollinearity.

Table 4
Regression Coefficients

Variable	Unstandardized Coefficients (β)	Standard Error	Standardized Coefficients (β)	t	p-value
Technology Adoption	0.412	0.045	0.410	9.156	0.000
Digital Literacy	0.353	0.042	0.350	8.405	0.000
Digital Infrastructure	0.382	0.046	0.381	8.304	0.000
Innovation Capabilities	0.441	0.050	0.440	8.820	0.000

Table 3 and Table 4 display the outcomes of data analysis through regression. As is shown in Table 3, the R-square value (0.632) implied that 63.2 percent of the variance in firm performance is explained by exogenous constructs (digital transformation and innovation capability). Table 4 shows that Technology Adoption had a highly significant positive effect ($\beta = 0.410$, $p < 0.001$) and hence is important in firm performance. The findings provided in the table provided evidence to support hypothesis 2 proclaiming that technology adoption has an affirmative influence on the startup's performance. Digital Literacy was also observed to be a strong predictor of startup performance ($\beta = 0.350$, $p < 0.001$). On this basis, hypothesis 3,

digital literacy improves startup performance, is supported. Digital Infrastructure also showed a strong effect ($\beta = 0.381$, $p < 0.001$). This confirmed that hypothesis 4 is also confirmed by empirical results. Results indicated that all three dimensions (technology adoption, digital literacy, digital infrastructure) of digital transformation favorably impact startup performance in startups. Outcomes were found in support of hypothesis 1, which claims the positive effect of digital transformation on the performance of startups. Finally, we found that Innovation Capabilities had the most impact ($\beta = 0.440$, $p < 0.001$), signifying that they are the key drivers of performance. Thus, the results of this study also support hypothesis 5 of the study.

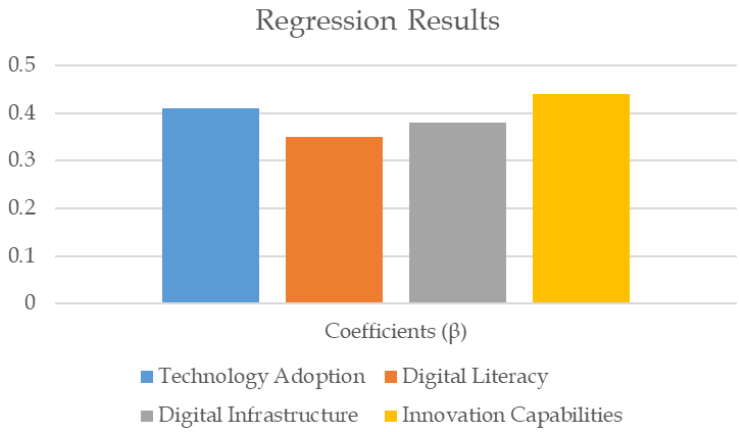

Figure 2: Graphical representation of regression coefficients

DISCUSSION

This paper investigated the influence of technology innovation capabilities and digital transformation on the performance of startups from Islamabad and Rawalpindi. The study analyzed the relationship between particular dimensions of digital transformation: digital adoptions, digital literacies, and digital infrastructure—that influence firms' performance. The results empirically uncovered a promising positive association amid digital transformation, firm innovation capabilities, and performance. These outcomes are in line with existing body of knowledge, and support the possibilities these digital technologies offer to optimize operations, create better customer experience and foster innovation. The study also proved to be true that adoptive use of advanced technologies plays a vital role in reducing operational streamlines and improving customer satisfaction (Li et al., 2024). Consistent with prior studies focusing on the role of technology in facilitating process efficiency and market responsiveness, our results indicated that technology adoption is a major driver of performance. Startups, however, have been able to quickly embrace the advanced tools like data analytics, cloud technologies to deliver custom experiences as well as cut down on the operational bottlenecks (Masoud & Basahel, 2023). Nevertheless, as Usai et al. (2021) point out, excessive reliance on technology without strategic alignment may result in diminishing the organizations' innovation

capability. Building on these studies, this paper demonstrates that if used properly, technology adoption can complement other dimensions of digital transformation. Another major predictor of firm performance was digital literacy, defined as employees' understanding and usage of digital tools. This also falls in line with the work of Liu and Song (2024) who showed how employee competence was the most important factor when implementing digital transformation strategies. Startup with digitally literate workforce are able to execute digital initiatives more effectively which, in turn, increases productivity and accelerates marketplace readiness (Bouwman et al., 2019). Robust networks, cloud systems and scalable cybersecurity measures are a part of digital infrastructure which enables scalability and leadership. Puelles and De la Vega (2024) also point out that without such infrastructure, even the most innovative companies might not be able to sustain a continuing flow of performance improvement. Our findings here show that having a well-established digital backbone is crucial for startups operating in competitive and dynamic markets. Moreover, the findings emphasize the distinctive role of innovation capabilities as a means to improve competitiveness. This conforms to the finding of Nwankpa and Roumani (2016), that innovation acts as a mediating factor in the association amid firm performance and the digital transformation. Startups create innovation, and they can become leaders in the market space by fostering creation and developing on innovation. In particular, in the service sector, differentiation and customer centric innovation are a driving force of success (Zhao et al. 2024). In contrast to prior research, this study sheds some nuance in that it contextualizes the influence of digital transformation in the technology segment. In Zhao et al. (2024) research digital transformation was found to mediate firm outcomes, this study takes this further by focusing specifically on the relations between the firm and the digital transformation dimensions directly. Moreover, Guo and Xu (2021) particularly stressed the broader advantages of digital transformation in manufacturing, this research however, highlights their equivalent function in strengthening agility and responsibility in the technology-based startups.

In particular, the findings counter Usai et al. (2021) who maintained that excessive digitalization could deplete the capabilities for innovation. We use digital transformation and innovation to present the case that when applied strategically, they also complement one another. It emphasizes how to balance investments across dimensions of digital transformation and innovation capabilities. Chen (2023) concluded that overemphasis of any one dimension without sufficient overseeing can lead to undesirable execution and assets squandering. Finally, the findings point to the significance of integrated view of digital transformation and innovation

capabilities. All of which means that this is something startups must develop a strategic roadmap of technology adoption, workforce readiness and infrastructure development, all while launching a culture of continuous innovation. This holistic approach brings deuce sustainable performance gain and a competitive edge in market places which are evolving.

CONCLUSION AND IMPLICATIONS

This research further the understanding of digital transformation constructs' specific main contributions to firm performance, making a step towards addressing gaps of the existing literature. Study incorporates innovation capabilities into the analysis bridging theoretical silos to provide a holistic framework. The findings suggest to startup managers that investing in digital literacy training programs for employees will be crucial when leveraging technology to its potential through adoption and infrastructure. The results suggest for relevant policymakers that incentives for developing digital infrastructure can strongly support startups' competitive advantage. The findings for industry leaders indicate that enabling collaborative innovation hubs can generate the synergistic benefits of digital transformation and innovation. Therefore, the study results substantiate the exceedingly positive influence of digital technology adoption, digital literacy, digital technology infrastructure on startup performance. The findings offer a blueprint for how strategy plays a role in driving sustainable growth through strategic investments in digital transformation.

Future Research Directions and limitations

The results are limited to startups, and generalizability beyond is constrained. Regional biases may have been introduced because data were collected from a particular geographic region (Islamabad and Rawalpindi). Owing to the cross sectional data collection of the study, the long term trends and causal relationships cannot be examined. To test robustness, future studies should replicate this framework in diverse industries (manufacturing; retail; etc.). The long term effects of digital transformation and innovation capabilities on firm performance can be further investigated. The research could be expanded to several regions or countries in order to achieve generalizability. There could be future research into how environmental factors (e.g., market volatility) affect relationships studied in this paper.

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