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Unlocking SME Growth through Digitalization: An Empirical Study of Technology Adoption, Digital Literacy, and Infrastructure in Pakistan

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ABSTRACT

This study examines the importance of digitalization for small and medium-sized enterprises (SMEs) in Pakistan. It focuses on three key areas: technology adoption, digital literacy and digital infrastructure. Data were gathered with a standardized survey of 300 SME managers in key urban areas, and were analyzed using multiple regression, Pearson correlation, and reliability tests in SPSS. The results show that all three dimensions have a strong and positive impact on business growth. Technology Adoption was the key predictor followed by Digital Literacy and Digital Infrastructure. While not directly measured, the results indicated that the competitiveness of SMEs increased due to digitalization, which can indirectly help SMEs in their internationalization efforts. These alone accounted for 75.0% of the variance in business growth, highlighting the importance of human capital and technological enablers for enhancing the competitiveness of SMEs. The research is theoretically and empirically relevant to the literature on digital transformation in developing countries, using the Technology-Organization-Environment (TOE) framework, the Human Capital Theory and the Resource Based View. The results provide actionable policy recommendations for strengthening digital capability, infrastructure, and digital adoption practices, as well as for digital training providers and SME entrepreneurs. The limitations of the cross-sectional design and the urban biased sample are discussed, and future research is suggested to examine the rural SMEs and to adopt a longitudinal approach to identify dynamic effects over time.

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Introduction

The Fourth Industrial Revolution is an era defined by the intersection of new technologies in the world of physics, digital and biology. These technologies are revolutionizing industry, information and communication technologies (ICTs), business operations and social systems. Technologies like AI, advanced computing and connected digital systems are coming together to open up new opportunities for innovation and change economic activities and organizational processes (World Economic Forum, 2023; Battaglia, 2024).

Digital transformation is the organizational and social consequences that are the result of the integration of digital technologies in the economic, social and business fields. In the business world its usage is reconfiguring business models, enhancing customer experiences, creating a data-driven culture, and optimizing operational performance and value creation. These transformations can lead organizations to be innovative, flexible to international markets, and to establish sustainable competitive advantages (Riedl et al., 2024; Ghafoori et al., 2024; UNCTAD, 2024).

Digital transformation has been well documented in recent research to be a key driver of competitive advantage and corporate performance in today's business environment. The direct connection between better business performance and digital transformation is demonstrated in (Kraus et al., 2022) comprehensive analysis, whereby a company carrying out digital initiatives is likely to produce smoother operational and financial outcomes. Such findings emphasize the need to explore the digitization and business growth relationship in developing countries such as Pakistan.

International business is undergoing a digital revolution as companies overcome the analog limitations as information converts to data in many ways. This is enhancing the way companies and businesses work and creating new value (Gartner, 2024). With young and growing population and internet penetration, the use of technology to make Pakistan competitive, economically strong and internationally integrated is now becoming a reality (World Bank, 2021). Pakistan has already seen the benefits of digital transformation from other nations, which include investments in digital infrastructure, increasing smartphone penetration, and the thriving IT industry, but Pakistan faces certain challenges including a lack of skilled workforces, technology differences, cybersecurity threats, legislative difficulties, and the absence of protective policies and frameworks (Iqbal et al., 2023). To facilitate Pakistan's international business growth, it is crucial to have a thorough understanding of these opportunities and challenges (World Bank, 2021).

The impact of e-commerce on international trade is significant with regard to reducing search costs and increasing transparency. It also enables developing country SMEs to participate in global value chains without the traditional constraints (UNCTAD, 2021). Digital social media marketing and content localization along with foreign Search Engine Optimization are the methods that can be used to reach international audience segments (Kotler & Keller, 2016).

The purpose of this study is to understand the impacts of digitalization on the business outcomes in a developing society in detail. Digital payment systems automate payments, which in turn reduces expenses and makes financial transfers cheaper, quicker, and safer (World Bank, 2021).

In conclusion, this research applies quantitative trend analysis to identify the key enablers and impediments to explore foreign market development by Pakistan and the role of digitalization. While examining the effects of national policies on digital internationalization, it also investigates how firms engage with digital technologies (Lindstrand & Melén Hånell, 2017). Lastly, this study brings a theoretical perspective from internationalization and digital transformation theories to the existing literature on internationalization in developing countries to tackle the digital divide, cybersecurity skills gaps and regulations. The study ultimately seeks to help the Pakistani business community, particularly SMEs, to leverage digital platforms to tap foreign markets, bridge the transnational barriers and enhance Pakistan's reputation in the global business arena (World Bank, 2021).

Literature Review

The terms digitization, digitalization and digital transformation are frequently seen as synonymous in the literature but have different meanings and are applied differently to different degrees, types and contexts of digitalization and transformation of organizations (Gradillas & Thomas, 2025; Riedl et al., 2024).

Digitization is the narrowest i.e. turning analog information into digital form. The term Digitalization however, is a narrower term and describes using digital technologies to change how a business actually runs, its processes, its customer interactions, how it creates value for the businesses (Brennen & Kreiss, 2016). Digital transformation is a broader term that describes a strategic, culture, structure and business model shift at the organization level through the use of digital tools (Westerman et al., 2014; Nambisan et al., 2020). Digitalization, incremental and tool by tool adoption for efficiency and market reach, is more realistic frame for this population as SMEs rarely have the resources to go for wholesale transformation. This is also the level this study is focused upon.

This study is based on three theoretical frameworks. Tornatzky & Fleischer (1990) proposed a framework called the Technology Organization Environment (TOE) that focuses on technological readiness, internal capabilities, and external environment, all of which impact adoption. This seems to be a reasonable approximation of SMEs because owner attitudes and market pressure influence decisions on technology adoption just as much as the technology itself. The study also draws on Rogers' (2003) Diffusion of Innovation theory, which states that the adoption of the innovation can be explained by the relative advantage, complexity, and compatibility of the innovation with current routines. Digital literacy is an investment in the knowledge and skills of the workforce, and is a perfect complement to the organizational-readiness portion of TOE, as noted in Human Capital Theory (Becker, 1993): Technology pays for itself in the knowledge and skill of the workforce, which translates to better decisions and better use of tools. Lastly Barney’s (1991) Resource Based View (RBV) and its dynamic capabilities extension consider infrastructure and digital capability as strategic assets of the organization. They are a competitive edge and can only be useful if the business used them in their processes. Combined, these three views suggest that all three should be important for growth, and that companies that are using and investing in their digital assets, not just holding them, will reap the greatest benefits.

There are many studies that have been done on the connection between technology adoption and business performance. Developed countries' SMEs have CMR systems as well as e-commerce systems, which have increased their operations and enhanced customer satisfaction (Zhu et al., 2006; Ridhwan et al., 2024). For some emerging economies, uptake of digital payment and ecommerce was linked to an increase in sales growth and better shock absorbers like Covid-19 pandemic (Jongwanich & Kohpaiboon, 2025; Khan et al., 2026). In recent years, a study of the entire digital transformation of SMEs suggested that the technologies always have positive effects when they are utilized in the operations of SMEs (Asa et al., 2026). This is supported by the work on organizational drivers of successful digital transformation, which indicates that the intensity of actual use rather than exposure to the technology is the key (Shao et al., 2025). However, evidence from Pakistan in particular suggests slower and less uniform adoption rates than in other emerging economies (Soomro et al., 2024). Expanding this body of work, the first hypothesis of this study is;

H_1: Technology adoption is positively associated with business growth among Pakistani SMEs.

The study that investigates the strategic use of digital capability as human capital of owners and managers has resulted in better quality decision making, greater adoption of digital channels (social media, online marketplaces), and better financial reporting (Hou & Chen, 2026; Andini et.al., 2025; Cahyaningsih, & Rokayah, 2024). Research findings from the South Asian SME contexts have also shown that digital skills are correlated with higher levels of innovation activity, market expansion and operational performance, and there is now evidence showing that digital skills training has measurable impacts on digital skills (UNESCAP, 2025; Cole, Joshi & Schoar, 2024; UNCDF, 2023). The second hypothesis in this study is that;

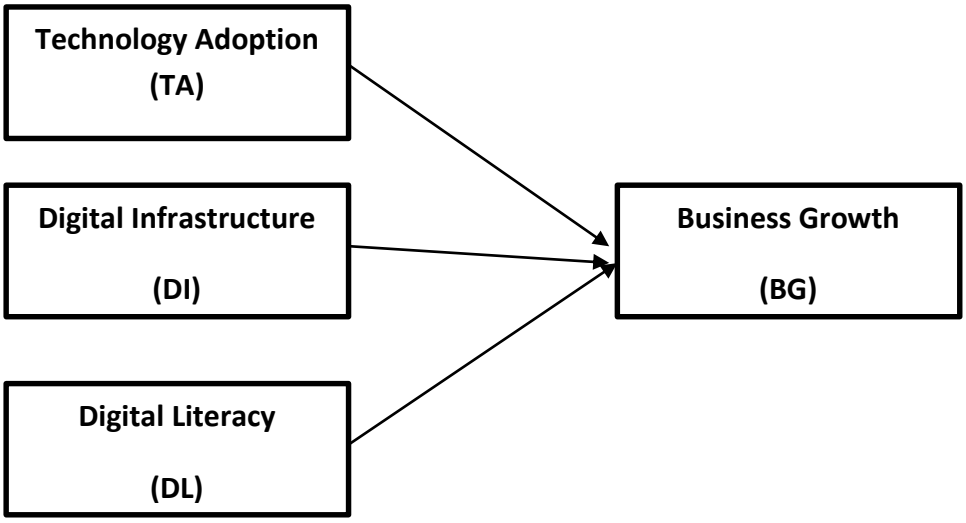
H_2: Digital literacy will have a positive effect on firm performance for SMEs in Pakistan positively.

Reliability of infrastructure, stable connectivity, access to the cloud, secure payment rails is the prerequisite for adoption and literacy to come into play. In a number of emerging-market studies, broadband availability and access to fintech has been correlated with productivity improvements among SMEs (Barba-Sánchez et al., 2024), while in Pakistan, there have been recurring challenges in digital payments, such as slow internet speeds, inconsistent IT policy and thin merchant acceptance of digital payments (Kundi et al., 2008; Information Technology and Innovation Foundation [ITIF], 2025). As infrastructure is frequently a shared or externally provided resource, rather than one that is specific to a particular firm, RBV reasoning would suggest that it is important for growth, but perhaps less so than the capabilities, adoption and literacy that a firm has with respect to the use of that infrastructure (Barney, 1991).

H_3: Digital infrastructure is positively associated with business growth among Pakistani SMEs.

Conceptual Framework: The model tested here treats technology adoption, digital literacy, and digital infrastructure as three correlated predictors of business growth, in keeping with a TOE, Human Capital, and RBV synthesis (Figure 1). Rather than assuming the three dimensions carry equal weight, the study treats their relative importance as an empirical question, which is tested through multiple regression in Section 4.

Figure 1. Conceptual model



Methodology

Design and Philosophy

This study used a quantitative, cross-sectional design as it allows standardized data to be gathered from a large number of respondents (N = 300) and supports multivariate hypothesis testing (Saunders et al., 2019). The work follows a positivist philosophy and a deductive approach i.e. hypotheses were drawn from the TOE framework, Human Capital Theory, and the RBV, and then tested against survey data using multiple linear regression (Bryman & Bell, 2021). As with any cross-sectional design, what is reported here is correlational, not causal; pinning down the direction of these effects would call for a longitudinal design.

Sample and Sampling Procedure

The population for this research study comprised of Small and Medium Enterprises (SMEs) which were present in Pakistan. According to the data of small and medium enterprise development authority (SMEDA, 2023), about 3.2 million small and medium enterprises (SMEs) are running in Pakistan. The sampling frame for the present study would be the SMEs registered in the major cities of Pakistan which are Karachi, Lahore, Islamabad, Faisalabad and Peshawar or the SMEs who are considered as SMEs in the above-mentioned cities. This was done through a non-probability sampling technique: convenience sampling which is often practical and useful in studies with chronological and budgetary limitations (Saunders et al., 2019). The survey was sent to the owners and senior managers who had implemented at least one digital tool in their company in the last three years via email and SME focused WhatsApp network. Convenience

sampling is a method that may have inherent sampling bias, but is typical when there is no sampling frame involved in large-scale exploratory SME research (Saunders et al., 2019).

Sample size was determined using the rule of thumb in multiple regression from Green (1991): N > 104 + m, where m is the number of predictors, as well as Hair et al.'s (2018) recommended ratio of observations to items of 15:1. In this study, 300 valid responses were successfully gathered, which is well beyond these benchmarks. This sample size is more than sufficient to have the maximum statistical power to support the 75.0% variance explained in the final model.

The study sample consisted of 189 (63.0%) males and 111 (37.0%) females. Data was gathered from personnel of the various SMEs including 20% from manufacturing, about 18.7% from the services industry, 18% from the wholesale/retail sector, 21.3% from technology and 22% of other sectors were included. The majority of these SMEs had been in business for more than 16 years and 27% of these businesses had over 100 employees.

Measures

Constructs of this study were measured by instruments which were adopted from validated instruments and using 5-point likert scales (1 = strongly disagree, 5 = strongly agree). The theory of technology (TOE) and Rogers' Diffusion of Innovation model (2003) were used to judge the adoption of technology (6 items). The Digital literacy was adapted from the UNESCO (2018) Digital Literacy Global Framework (6 items). Digital infrastructure (6 items) adapted OECD (2020) advice and previous SME studies (Ali, 2022). The business growth scale was modified from SME performance scale conducted by Maroufkhani et al. (2022).

Procedure

The study was conducted over a four-week period and followed up periodically to enhance the response rate to the survey. The responses were screened to ensure only complete submissions were submitted and as well as checked for consistency and anomalies. The following statistical measures were used in the study; Cronbach’s alpha was used to check internal-consistency reliability for each scale, descriptive statistics, Pearson correlations was used to check for the correlations among the study variables, and Regression analysis was performed to understand the collective and individual effects of the independent variables (technology adoption, digital literacy, and digital infrastructure) on the dependent variable (business growth). Some diagnostic tests were also performed before the regression model was estimated to test for multicollinearity, normality of the residuals, homoscedasticity, linearity, and independence of the errors.

Results

Reliability

The results in Table 1 indicates that all the four scales are internally consistent and cleared the conventional .70 threshold. Digital literacy showed the highest reliability, and technology adoption the lowest, though even that was still comfortably strong.

Table 1. Scale Reliability

Construct	Items (n)	Cronbach's α
Technology Adoption (TA)	6	.892
Digital Literacy (DL)	6	.916
Digital Infrastructure (DI)	6	.915
Business Growth (BG)	6	.908

n = 300. All values exceed the recommended threshold of .70.

Descriptive Statistics

Table 2 indicates that the mean values for all the study variables are relatively high and similar for the four constructs (i.e. 3.81, 3.72, 3.82 and 3.81 for technology adoption, digital literacy, digital infrastructure and business growth respectively), indicating that the sampled SMEs are, on average, purposefully utilizing digital tools, skills and infrastructure, and that this reflects in their growth. The digital infrastructure had the highest mean and the highest standard deviation of the four, indicating larger infrastructural differences between urban and rural areas, as well as between sectors than what was found for the other constructs, which reflects the known differences in digital access in Pakistan.

Table 2. Descriptive Statistics

Variable	Mean	SD
Technology Adoption	3.81	0.509
Digital Literacy	3.78	0.572
Digital Infrastructure	3.82	0.580
Business Growth	3.81	0.550

Rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Correlations

Pearson correlations between the four constructs are shown in Table 3. They were all positive and significant at the .01 level. The correlation scores between Technology Adoption (TA) and Digital Literacy (DL) is 0.749, and between Technology Adoption and Digital Infrastructure is 0.757 were fairly high. The correlation value between Digital Literacy and Digital Infrastructure is 0.656 which indicates a moderate relationship between these two independent predictors. The strongest correlation of all predictors was between business growth and technology adoption i.e. 0.813, followed by digital literacy i.e. 0.784, and then digital infrastructure i.e. 0.740. These results are in line with the digitalization as a coherent, albeit differentiated, construct.

Table 3. Pearson Correlations

Variable	TA	DL	DI	BG
TA	1			
DL	.749	1		
DI	.757	.656	1	
BG	.813	.784	.740	1

p < .01 (2-tailed).

Regression Assumptions

All the assumptions of the regression model are generally accepted from regression diagnostic results as illustrated in Table 4 and Table 5. Variance Inflation Factor (VIF) values of the variables ranged from 2.38 to 3.17 indicating that multicollinearity was not a serious concern as values remained below the recommended limit of 5. The Shapiro–Wilk test (W = 0.993, p = 0.287) showed that residuals were not statistically significantly different from normal. Also, the assumption of constant error variance was not rejected by the Breusch–Pagan test ($\chi^2(3) = 4.82$, p = 0.185), and the Ramsey RESET test (F(2, 244) = 1.36, p = 0.259) did not show significant evidence of functional-form misspecification. In addition, the Durbin–Watson statistic value of 2.046 was near the value of 2, suggesting that first-order autocorrelation is not severe. These results indicate that the regression model is adequate for the further study of the key diagnostic assumption and is appropriate for analysis.

Table 4. Variance Inflation Factors

Variable	VIF
Technology Adoption	3.172
Digital Literacy	2.377
Digital Infrastructure	2.447

Table 5. Residual Normality, Homoscedasticity, Linearity and Autocorrelation

Assumption	Test Used	Scores
Residual normality	Shapiro–Wilk	W = 0.993, p = 0.287
Homoscedasticity	Breusch–Pagan	$\chi^2(3) = 4.82$, p = 0.185
Linearity	Ramsey RESET	F(2, 244) = 1.36, p = 0.259
Autocorrelation	Durbin–Watson	2.046

Regression Results

The regression analysis results suggest that the overall model is statistically significant and the model is well suited as it accounts for a significant amount of the variance in business growth. According to Table 6 and Table 7, the model accounts for 75% of the variance ($R^2 = .750$) and is a significant predictor of the outcome, $F(3, 296) = 296.175$, p < .001. Furthermore, the Durbin-Watson value of 2.046 indicates that there is no autocorrelation in the residuals and the model is therefore valid.

Table 8 shows that all three predictor variables, namely Technology Adoption, Digital Literacy and Digital Infrastructure are positive and statistically significant predictors of business growth (all with $p < .001$). Technology Adoption has the highest impact ($\beta = .384$), closely followed by Digital Literacy ($\beta = .354$) and Digital Infrastructure the lowest, though still significant, impact ($\beta = .217$). In particular, a one-unit increase in Technology Adoption results in a 0.415 unit increase in business growth (ceteris paribus).

Table 6. Model Summary

Model	R	R^2	Adj. R^2	SE Estimate	Durbin–Watson
1	.866	.750	.748	.277	2.046

Table 7. ANOVA

Source	SS	df	MS	F-value	p-value
Regression	67.987	3	22.662	296.175	< .001
Residual	22.649	296	.077	–	–
Total	90.637	299	–	–	–

Table 8. Regression Coefficients Predicting Business Growth

Predictor	B (Unstandardized)	SE	β	t	p-value
(Constant)	.156	.125	–	1.254	.211
Technology Adoption	.415	.056	.384	7.451	< .001
Digital Literacy	.340	.043	.354	7.898	< .001
Digital Infrastructure	.206	.043	.217	4.782	< .001

$R^2 = .750$; $F(3, 296) = 296.175$, $p < .001$, $N = 300$.

As summarized in Table 9, the results indicate that all three predictors have a statistically significant positive relationship with business growth ($p < .001$), leading to the support of all three proposed hypotheses.

Table 9. Summary of Hypothesis Testing

Hypothesis	β	p-value	Result
H1: TA → BG	.384	< .001	Supported
H2: DL → BG	.354	< .001	Supported
H3: DI → BG	.217	< .001	Supported

Discussion

Technology Adoption is actually the most important factor that influences business growth among Pakistani SMEs. In other words, the actual implementation and utilization of technology - such as ERP systems, e-commerce sites, and electronic money transfer services - appear to make the greatest contribution to actual business growth. This is consistent with the Technology Organization Environment (TOE) theory that posits that when SMEs are able to successfully move beyond mere access to technology and actually utilize technology in their day-to-day operations, they experience actual gains in terms of efficiency and competitiveness.

Although Technology Adoption is by far the driving factor with the highest influence, Digital Literacy (beta = 0.354, $p < .001$) is an essential and very close second factor in driving growth. Again, this supports the notion that the capacity for humans to understand and utilize technology is just as important as technology itself. In showing that employee capabilities lead to an improvement in organizational performance, this model provides strong evidence for Human Capital Theory (Becker, 1964). It supports the idea that for SMEs in Pakistan, it is not enough to simply focus on tools; growth is achieved by balancing tools with an employee base able to understand the digital world.

The relatively lower but still high coefficient of digital infrastructure corresponds to a reading of RBV that resources shared or provided externally create a ceiling on what is possible, but without capability on their own they do not create a competitive advantage (Barney, 1991). But none of that is to say that infrastructure isn't important. Broadband speeds, IT-policy consistency and merchant acceptance of digital payments have so far been identified as real constraints in Pakistan (Kundi et al., 2008; ITIF, 2025), and the wide differences observed in this study's infrastructure scores suggest urban–rural and sectoral differences that would likely be even stronger once a nationally representative sample is collected.

These findings are only a sample of how the national policy gap is that literacy and adoption make a huge contribution to growth, yet there is a clear need for a lot more digital upskilling programs to be developed. Not only is a large proportion of the Pakistani population not yet online or digitally skilled (Kemp, 2024), but this "digital divide" represents a significant threat to economic equality. To ensure that SMEs are able to reach the potential growth rate of 75.0% identified in this model, improvements to national infrastructure must be complemented with initiatives to address the skills gap.

Conclusion, Limitations, and Future Research

The aim of this study was to identify the three dimensions of “digitalization” with theoretical and empirical foundation and to examine the impact of each dimension on SME growth in Pakistan. Technology adoption, digital literacy and digital infrastructure were all positively and significantly related to growth, accounting for 75% of the variance in growth, with technology adoption alone being the most predictive factor. The findings open up a new perspective for TOE-, Human Capital-, and RBV-based approaches on digitalization in the context of developing economy SMEs and provide a more granular basis for decisions as digitalization is not one single thing.

There are a few restrictions which should be mentioned here. The cross section design is used for associations not causal inference, and to observe the impact of adoption, literacy, infrastructure investments into growth over time a longitudinal design is needed (Sindhuja, 2025). The analyses were also restricted to five large cities and likely under-represented rural SMEs, as well as firms for which infrastructure and skill shortages are more pronounced than among those sampled here, meaning that the 75% variance explained may not be applicable to these firms. Non-probability sampling has reduced external validity in general and future studies would benefit from stratified random sampling when available (Zhu et al., 2006). Lastly, responses were always self-reported by just one member of the firm, posing the ever-present questions about common method bias, which was minimized by using anonymous, voluntary participation (Podsakoff et al., 2003).

Future research could combine the three dimensions examined in this study with a longitudinal design, incorporate objective measures of performance in addition to self-reported growth, and include additional measures that are likely to interact with the three dimensions such as cybersecurity readiness measures, digital marketing capability measures, and measures of government support.

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