

From Digital Transformation to Operational Responsiveness: A Structural Equation Model of Turnaround-Time Efficiency among North Central Nigerian Small and Medium-Sized Enterprises

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Abstract: This study investigates the effect of digital transformation capabilities on operational responsiveness among small and medium-sized enterprises (SMEs) in North-Central Nigeria, using Structural Equation Modelling (SEM). Anchored on a multidimensional perspective, the study examines how data analytics capability, process automation, and employee digital literacy influence the speed of core business processes. A quantitative research design was adopted, with data collected from 373 SME owners and managers across the region. The hypothesized relationships were analyzed using structural equation modeling (SEM). Findings reveal that digital transformation has a significant negative effect on turnaround time, indicating that stronger digital capabilities enhance process speed and operational responsiveness. Process automation and employee digital literacy produced the strongest effects, underscoring their importance in minimizing operational delays. Data analytics capability also significantly improved turnaround efficiency, although with a relatively moderate effect. The study contributes to digital transformation and SME operations literature and offers practical insights for improving competitiveness in emerging economies.

Keywords: Data analytics, Digital transformation, Process automation, Operational responsiveness, Small and Medium Scale Enterprises.

Introduction

Small and medium-sized enterprises (SMEs) are widely recognized as a critical driver of economic growth, employment generation, poverty reduction, innovation, and industrial development across both developed and developing economies. In Nigeria, SMEs constitute the backbone of the productive sector, contributing over 48 percent of the country's Gross Domestic Product (GDP) and approximately 84 percent of total employment (SMEDAN & NBS, 2022). Beyond their contribution to income generation and job creation, SMEs play a significant role in promoting entrepreneurship, enhancing local value chains, supporting rural development, and facilitating economic diversification. Consequently, improving the operational performance and competitiveness of SMEs remains a strategic priority for national economic development..

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Despite their economic significance, many Nigerian SMEs continue to face operational challenges that constrain productivity and long-term sustainability. Such challenges include inefficient business processes, limited access to finance, inadequate infrastructure, weak technological capabilities, and poor managerial systems. These challenges are particularly pronounced in North-Central Nigeria, a region characterized by a large concentration of SMEs operating in agriculture, manufacturing, trade, and service sectors. Although the region possesses substantial economic potential, many enterprises continue to experience operational delays in inventory management, order fulfillment, financial reporting, payment processing, customer service delivery, and internal decision-making processes (Gontur et al., 2023; World Bank, 2024). These bottlenecks often increase operating costs, reduce responsiveness to market opportunities, and weaken competitiveness in increasingly dynamic business environments.

The present study focuses on registered small and medium-sized enterprises operating within North-Central Nigeria, given their strategic role in regional economic development and their growing exposure to digital transformation initiatives. Recent evidence indicates that although digital technology adoption among Nigerian SMEs has increased, many firms remain at an early stage of digital maturity, relying largely on basic digital applications such as mobile payments, social media platforms, and simple electronic record-keeping systems (SMEDAN & NBS, 2022). Advanced digital solutions that could significantly improve operational efficiency remain relatively uncommon, particularly among enterprises operating in agriculture, manufacturing, and informal retail sectors, where process delays and operational inefficiencies persist (World Bank, 2024).

To address these challenges, governments and development institutions have increasingly promoted digital transformation initiatives aimed at improving SME competitiveness and operational performance. Digital transformation refers to the integration of digital technologies into business operations to enhance efficiency, decision-making, customer engagement, and value creation. Technologies such as data analytics, process automation, cloud computing, artificial intelligence, and digital communication platforms are reshaping how organizations coordinate activities, manage resources, and deliver services (Deku et al., 2024). What was once considered a strategic option has become a necessity for organizations seeking to remain competitive in an increasingly digital economy.

In Nigeria, several policy interventions have been introduced to facilitate SME growth and digital adoption. These include financial support programmes such as the Micro, Small, and Medium Enterprises Development Fund, the Anchor Borrowers' Programme, and the National Collateral Registry (CBN, 2024). More recently, the National Digital Economy Policy and Strategy has promoted digital skill acquisition, e-commerce participation, and ICT infrastructure development (Federal Ministry of Communications & Digital Economy, 2020). Similarly, the SMEDAN Digital MSME Programme seeks to expand SMEs' access to digital marketplaces, while innovations such as the eNaira are expected to facilitate faster and more secure business transactions (SMEDAN, 2023; CBN, 2024). Numerous public and private sector training initiatives focused on automation, digital accounting systems, and process optimization further demonstrate the growing emphasis on digital transformation as a pathway to SME development (CBN, 2024).

The relevance of digital transformation to SME operations lies in its potential to improve operational turnaround efficiency. According to Deku et al. (2024), business turnaround time refers to the period required to complete a business activity from initiation to completion and represents a key indicator of operational efficiency and organizational responsiveness. Among SMEs, prolonged turnaround times often emerge from inefficient workflows, manual processing systems, delayed decision-making, and poor information management. Digital transformation capabilities can help address these challenges by enabling firms to collect, process, and utilize information more efficiently, automate repetitive processes, and enhance workforce productivity. Specifically, data analytics capability facilitates evidence-based decision-making through timely access to relevant business information; digital literacy capability equips employees with the knowledge and skills required to effectively utilize digital technologies; while process automation capability reduces human

intervention in repetitive tasks, thereby increasing speed, accuracy, and consistency in business operations (Kahveci, 2025; Benard et al., 2025).

Nevertheless, the realization of these benefits remains constrained by several contextual challenges within Nigeria, including unreliable electricity supply, poor internet connectivity, high technology acquisition costs, low levels of digital competence, cybersecurity concerns, and organizational resistance to change (Usman et al., 2025). Consequently, although many SMEs have adopted basic digital tools, the extent to which digital transformation capabilities contribute to operational turnaround efficiency remains insufficiently understood, particularly within the context of North-Central Nigeria.

From a theoretical perspective, existing studies have largely examined digital transformation in relation to financial performance, digital inclusion, innovation, marketing performance, customer engagement, and organizational resilience. Comparatively fewer studies have investigated operational turnaround efficiency as a distinct performance outcome, especially among SMEs in developing economies. Moreover, limited attention has been given to the combined influence of data analytics capability, employee digital literacy, and process automation capability on operational efficiency outcomes (Aliuba, Onwuchekwa, & Edokobi, 2025). This represents both a theoretical and practical gap, as SMEs require evidence-based insights into the specific digital capabilities that can accelerate business processes and enhance operational responsiveness.

Accordingly, this study examines the influence of digital adoption on operational responsiveness among registered SMEs in North-Central Nigeria. Specifically, the study investigates how data analytics capability, digital literacy capability, and process automation capability affect operational turnaround efficiency. The study seeks to answer the following questions:

To what extent does data analytics capability influence turnaround time among SMEs in North-Central Nigeria?

How does digital literacy capability affect turnaround time among SMEs in North-Central Nigeria?

What is the effect of process automation capability on turnaround time among SMEs in North-Central Nigeria?

To what extent do digital transformation capabilities jointly explain variations in operational responsiveness among SMEs in North-Central Nigeria?

To address these questions, the study adopts an exploratory sequential mixed-methods approach and employs Structural Equation Modeling (SEM) to validate the proposed relationships. The study contributes theoretically by extending understanding of digital transformation capability within the SME context; methodologically by integrating qualitative insights with SEM-based validation; and practically by providing evidence that can guide policymakers, development agencies, and SME managers in designing targeted digital transformation strategies aimed at reducing operational delays, improving service delivery, and strengthening enterprise competitiveness.

2.0 Literature Review and Theoretical Framework

This study is primarily anchored on the Technology-Organization-Environment (TOE) Framework (Tornatzky & Fleischer, 1990), supplemented by Dynamic Capabilities Theory (DCT) (Teece, Pisano, & Shuen, 1997). The choice of these theories is informed by the study's objective of examining how digital transformation capabilities influence operational turnaround efficiency among SMEs in North-Central Nigeria. Together, the theories provide a coherent explanation of both the factors that facilitate digital technology adoption and the mechanisms through which digital capabilities improve organizational performance.

The TOE Framework serves as the principal theoretical foundation because it explains technology adoption at the firm level and has been widely applied in digital transformation and SME research. The framework posits that organizational adoption of technological innovations is influenced by three interrelated contexts: technological, organizational, and environmental factors (Tornatzky &

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Fleischer, 1990). Within the context of this study, data analytics capability and process automation capability represent the technological dimension because they provide SMEs with digital tools for improving information processing, workflow coordination, and operational speed. Digital literacy capability reflects the organizational dimension, as employees' knowledge and skills determine the extent to which digital technologies can be effectively utilized within the enterprise (Benard et al., 2025; Nnanna & Ohuonu, 2025). The environmental dimension is particularly relevant in the Nigerian SME context, where infrastructure quality, regulatory support, market competition, and customer expectations shape firms' digital transformation efforts (World Bank, 2024).

Although the TOE framework provides a strong basis for understanding digital technology adoption, it offers limited explanation regarding how firms convert adopted technologies into sustained operational benefits. To address this limitation, the study draws on Dynamic Capabilities Theory (DCT) as a complementary perspective. DCT argues that organizations achieve superior performance when they are able to sense opportunities, seize emerging technologies, and reconfigure existing resources in response to changing environmental conditions (Teece, Pisano, & Shuen, 1997; Teece, 2007). In the context of SMEs, digital transformation capabilities are valuable only when firms possess the ability to integrate them into their operational processes and routines. Consequently, SMEs with stronger adaptive capabilities are better positioned to leverage data analytics, digital literacy, and process automation to reduce process delays, improve workflow efficiency, and enhance operational responsiveness (Liu et al., 2018; Otopah et al., 2025; Rahman et al., 2025).

The integration of TOE and DCT provides a suitable framework for understanding digital transformation among SMEs in North-Central Nigeria. While TOE explains the technological, organizational, and environmental conditions that influence the development and adoption of digital transformation capabilities, DCT explains how these capabilities are mobilized and transformed into improved operational turnaround efficiency. The framework is particularly relevant in the Nigerian context, where SMEs operate under infrastructural constraints, resource limitations, and rapidly changing market conditions. Accordingly, the study posits that data analytics capability, digital literacy capability, and process automation capability significantly influence operational turnaround efficiency among SMEs.

2.0.1 Theoretical Contribution

This study contributes to the digital transformation and SME literature in several ways. First, it extends the application of the TOE Framework by demonstrating how specific digital transformation capabilities, namely data analytics capability, digital literacy capability, and process automation capability, influence operational turnaround efficiency among SMEs in a developing economy context. While previous studies have largely applied TOE to explain technology adoption decisions, this study broadens its explanatory scope by linking digital capabilities directly to operational performance outcomes.

Second, the study complements the TOE Framework with Dynamic Capabilities Theory by explaining how SMEs convert digital resources into tangible operational benefits. In doing so, it provides empirical evidence that the value of digital technologies depends not only on adoption but also on the firm's ability to integrate, deploy, and reconfigure those technologies to improve efficiency.

Third, the study contributes context-specific evidence from North-Central Nigeria, where SMEs face unique infrastructural, technological, and organizational challenges. The findings therefore enrich existing theory by demonstrating how established technology adoption and capability-building frameworks operate within resource-constrained environments. Consequently, the study strengthens the theoretical understanding of digital transformation capabilities as strategic drivers of operational turnaround efficiency among SMEs in emerging economies.

2.1 Empirical Review

Recent empirical literature generally supports the view that digital transformation enhances operational efficiency by reducing process delays, accelerating decision-making, and improving

workflow coordination among SMEs. Across developed and emerging economies, technologies such as data analytics, artificial intelligence (AI), process automation, cloud computing, fintech solutions, and digital supply chain systems have been linked to improvements in operational responsiveness and service delivery. However, the existing evidence remains fragmented, particularly regarding the specific mechanisms through which digital transformation capabilities influence operational turnaround efficiency in SMEs.

A dominant theme in the literature is that digital technologies improve operational speed by reducing reliance on manual processes. Studies conducted in developed and emerging economies show that AI-enabled systems, predictive analytics, and automated customer service applications facilitate real-time information processing and faster decision-making (Oloke et al., 2024). Similarly, Nguyen (2025) found that integrated digital platforms improve workflow synchronization and reduce process bottlenecks. While these findings suggest a positive relationship between digital transformation and process efficiency, they focus primarily on technology adoption outcomes and provide limited insight into the organizational capabilities required to convert digital investments into measurable efficiency gains. This concern is reinforced by Tariq et al. (2024), who argue that the benefits of analytics depend not merely on technology acquisition but on an organization's ability to interpret and act upon digital insights.

Evidence from Asian economies further emphasizes the role of process automation and digital integration in enhancing operational performance. Rahman et al. (2025) reported that digital integration improved technical efficiency among manufacturing SMEs by accelerating both production and administrative processes. Likewise, Ghosh and Manokaran (2025) observed that innovation-driven digital practices reduced workflow duplication and strengthened coordination across organizational units. Although these studies consistently demonstrate positive operational outcomes, they largely focus on manufacturing environments and advanced digital ecosystems. Consequently, the findings may not fully reflect the realities of SMEs operating in resource-constrained environments where infrastructural challenges and limited digital skills often shape technology utilization.

Studies conducted in African economies provide further evidence of the operational benefits of digital transformation but also reveal contextual variations. For example, Opoku et al. (2024) found that digital transformation improved agility and adaptive capacity among Ghanaian SMEs, enabling faster responses to changes in market conditions. However, operational turnaround time was not examined directly. Instead, efficiency gains were inferred through broader indicators such as organizational responsiveness and adaptability. This tendency to treat turnaround efficiency as an indirect outcome is common within the African literature and limits understanding of how specific digital capabilities influence the speed of operational processes.

The Nigerian evidence presents a similar pattern. Existing studies generally report positive associations between digital technologies and organizational performance, yet most focus on financial inclusion, transaction efficiency, or overall firm performance rather than operational turnaround time. For instance, fintech adoption and electronic payment systems have been associated with faster transaction completion and improved cash flow management among SMEs (Mustapha et al., 2025; Adegunju et al., 2024). Likewise, e-banking services improve responsiveness to customers and suppliers through faster financial transactions (Adamu et al., 2024). Although these findings demonstrate the operational potential of digital technologies, they largely examine isolated technologies rather than a broader set of digital transformation capabilities.

Research on digital supply chain systems, cloud computing, and operational technologies provides more direct evidence regarding process efficiency. Digital supply chain management has been associated with reductions in order processing time and improvements in logistics coordination (Ibrahim & Yahaya, 2024), while cloud computing facilitates real-time information sharing and shorter decision cycles (Alabi et al., 2024). Similarly, location-specific and sector-specific studies report improvements in communication, workflow optimization, and service responsiveness following digital adoption (Yerima et al., 2025; Ibrahim et al., 2026). Nevertheless, these studies are often sector-specific and focus primarily on technology usage outcomes, offering limited understanding of how broader digital capabilities collectively influence operational turnaround efficiency.

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Furthermore, studies examining AI, blockchain, enterprise resource planning (ERP) systems, mobile payments, and data analytics generally conclude that digital technologies improve productivity, transparency, coordination, and transaction speed (John & Bala, 2025; Ukoha et al., 2025; Mbakwe & Rose, 2025). While these findings reinforce the strategic value of digital transformation, they also reveal persistent challenges related to inadequate infrastructure, digital literacy deficiencies, and uneven technology utilization across regions. This suggests that the operational benefits of digital technologies are contingent on complementary organizational capabilities, particularly employee digital competence and the capacity to integrate technology into business routines.

Overall, three notable gaps emerge from the reviewed literature. First, most studies conceptualize operational efficiency broadly and rarely examine operational turnaround efficiency as a distinct performance outcome. Second, existing research tends to investigate individual technologies in isolation, with limited attention given to the combined effects of data analytics capability, digital literacy capability, and process automation capability. Third, empirical evidence from North-Central Nigeria remains scarce despite the region's growing SME sector and unique infrastructural constraints. Consequently, there is insufficient understanding of how these digital transformation capabilities jointly contribute to faster operational processes among SMEs. This study addresses these gaps by examining the influence of data analytics capability, digital literacy capability, and process automation capability on operational turnaround efficiency among registered SMEs in North-Central Nigeria.

3.0 Methodology

3.1 Research Design

This study employed a cross-sectional quantitative survey design to investigate the effect of digital transformation on the operational efficiency of Small and Medium Enterprises (SMEs) in North Central Nigeria. The survey approach was considered appropriate because it facilitates the collection of standardized data from a large number of business operators, thereby enabling the statistical examination of relationships among the study variables.

The study was conducted in the North Central geopolitical zone of Nigeria, comprising Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau States, as well as the Federal Capital Territory (FCT), Abuja. The region was selected due to its strategic economic importance, characterized by a substantial concentration of SMEs engaged in agricultural production, manufacturing, trade, and service activities. In addition, the region presents varying levels of digital infrastructure and technology adoption, making it suitable for examining the relationship between digital transformation and operational efficiency within the SME sector.

The target population consisted of registered SMEs operating within the North Central region. Consistent with the classification adopted by the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), SMEs in this study included enterprises categorized as micro, small, and medium-sized businesses. However, only formally registered enterprises with identifiable business premises and active operations at the time of the survey were included in the sampling frame. Unregistered and informal enterprises were excluded because of the absence of reliable records necessary for probability-based sampling. Based on SMEDAN records and state-level business registers, the estimated population of registered SMEs within the study area was approximately 161,515 enterprises.

Data were collected through the administration of structured questionnaires to SME owners, managers, and senior operational staff who possessed adequate knowledge of their firms' digital technology usage and operational activities. The questionnaire contained measures relating to digital technology adoption and indicators of operational efficiency.

The sample was obtained using the formula below:

$$n_0 = \frac{Z^2 * p * (1 - P)}{e^2}$$

Then the finite population adjustment is:

$$n = \frac{Z^2 * p * (1 - P)}{1 + \frac{n_0 - 1}{N}}$$

Where:

$Z = 1.96$ (for 95% confidence)

$p = 0.5$ (estimated proportion)

$e = 0.05$ (margin of error)

$N = 161,515$

$$n_0 = \frac{(1.96)^2 * 0.5 * (1 - 0.5)}{(0.05)^2}$$

$$n_0 = \frac{3.8416 * 0.25}{0.0025}$$

$$n_0 = \frac{0.9604}{0.0025} = 384.16$$

Now, apply the finite population correction:

$$n = \frac{384.16}{1 + \frac{384.16}{161,515}} = \frac{384.16}{1 + \frac{384.16}{161,515}} = \frac{384.16}{1 + 0.0024} = \frac{384.16}{1.0024} = 383.24 \approx 383$$

Applying these parameters yielded a minimum sample size of 383 respondents. Given the large population size of 161,515 SMEs, Cochran's formula was considered suitable because it provides a statistically reliable sample estimate for large and geographically dispersed populations. After accounting for questionnaire administration constraints and data cleaning procedures, 383 valid responses were retained for analysis.

A multistage sampling procedure was adopted. In the first stage, the North Central geopolitical zone was purposively selected because of its economic diversity and concentration of SMEs. In the second stage, the seven constituent administrative units (Benue, Kogi, Kwara, Nasarawa, Niger, Plateau States, and the FCT) were included in the study. In the third stage, SMEs were proportionately allocated across the states based on the number of registered enterprises within each state. In the final stage, respondents were selected from available SME registers obtained from relevant government agencies and business associations. Purposive selection was used to identify owners, managers, or senior officers with sufficient knowledge of business operations and technology adoption practices, ensuring that respondents could provide reliable information relevant to the objectives of the study.

The collected data were coded and analysed using Structural Equation Modelling (SEM), which enabled the simultaneous assessment of the relationships between digital transformation dimensions and operational efficiency outcomes. SEM was considered appropriate because it permits the examination of complex relationships among latent constructs while accounting for measurement error, thereby enhancing the robustness of the study findings.

3.2 Method of Data Analysis

Data analysis was conducted using descriptive statistics and Structural Equation Modeling (SEM) to assess both measurement and structural relationships between digital transformation and turnaround time of core business processes among the study variables. The reliability and validity of the research instrument were established through expert review, pilot testing, and internal consistency analysis using Cronbach's alpha, all of which met accepted methodological standards. Model adequacy was further confirmed using multiple goodness-of-fit indices, including RMSEA, CFI, GFI, TLI, and chi-square ratios, ensuring robustness of the measurement and structural models Hair et al. (2010) (see table 3.1). Collectively, these methodological procedures provide a rigorous analytical foundation for examining how data analytics adoption, employee digital literacy, and process automation influence turnaround time and cost efficiency among SMEs in North Central Nigeria.

Table 3.0 Index Table

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S/N	Category	Index Name	Acceptable Threshold
1	Absolute Fit	Chi-square (χ^2)	$p > 0.05$
		Goodness of Fit Index (GFI)	$GFI > 0.90$
2	Incremental Fit	CFI	$CFI > 0.95$
		RMSEA	$RMSEA \leq 0.08$
		TLI	$TLI > 0.90$
3	Parsimonious Fit	χ^2/df	$\chi^2/df < 5.0$

Source: Field survey 2026

3.3 Model Specification

The study aims to investigate the impact of digital transformation on the operational efficiency of small and medium-scale enterprises (SMEs), with a focus on three independent variables: Data Analytics Tools Adoption, Digital Literacy Levels among Employees, Process Automation Levels, which are proxies to digital transformation, and two dependent variables which include: Turnaround Time of Core Business Processes, and Cost Reduction proxied to operational efficiency of small and medium-scale enterprises (SMEs). The measurement and structural models are specified as follows:

3.3.1 Measurement Model

The measurement model defines how the latent variables or hypothetical constructs are measured in terms of the observed variables. To account for digital transformation on the operational efficiency of small and medium-scale enterprises (SMEs). In order to form a measurement model base on both dependent and independent variables for each specific objective, the model will be composed by the following four structural equations as described by Giuffrida et.al., (2005):

$$\text{Data Analytics Tools Adoption (DATA):} \quad L_1 = \pi_L \xi_1 + \varepsilon_1 \quad (1)$$

$$\text{Digital Literacy Levels among Employees (DLLE):} \quad L_2 = \pi_L \xi_2 + \varepsilon_2 \quad (2)$$

$$\text{Process Automation Levels (PRAL):} \quad L_3 = \pi_L \xi_3 + \varepsilon_3 \quad (3)$$

$$\text{Turnaround Time of Core Business Processes (TCBP):} \quad L_4 = \pi_L \gamma_4 + \varepsilon_4 \quad (4)$$

From model 1-4, L_1 , L_2 , and L_3 , and L_4 represents the set of observed indicators that collectively capture the construct related to Data Analytics Tools Adoption, Digital Literacy Levels among Employees, Process Automation Levels, and Turnaround Time of Core Business Processes. ξ_1 , ξ_2 , ξ_3 , and γ_4 are the four (4) latent independent and the dependent variables, π_L are parameters to be estimated. Finally, ε_1 , ε_2 , ε_3 , and ε_4 , are error terms with zero expectation:

3.3.3 Structural Model

The structural model defines the relationships between the latent dependent variables (TCBP) and the independent variable (Data Analytics Tools Adoption DATA, Digital Literacy Levels among Employees DLLE, and Process Automation Levels PRAL).

$$\gamma = \beta\gamma + \Gamma\xi + \zeta \text{-----}(5)$$

γ represent the dependent variables (Turnaround Time of Core Business Processes, TCBP).

ξ = (Data Analytics Tools Adoption DATA, Digital Literacy Levels among Employees DLLE, and

Process Automation Levels PRAL) represent the independent variables (digital transformation), which affect the operational efficiency of small and medium-scale enterprises (SMEs).

β = represents the coefficients for the relationships among the dependent variables.

Γ = represents the coefficient that captures the direct effect of digital transformation (DATA, DLLE, and PRAL) on the operational efficiency of small and medium-scale enterprises (SMEs) (TCBP)

ζ = represents the error term, capturing any unobserved factors affecting the dependent variables.

4.0 Results and Discussion

4.1. Descriptive Statistics

The descriptive statistics in table 4.1.1 indicate that SME operators generally perceive digital transformation as an important driver of business performance and operational efficiency. The relatively high mean scores across the study variables suggest that firms in North Central Nigeria have embraced various digital technologies and view these tools as contributing positively to their day-to-day operations. In particular, the strong ratings for data analytics adoption imply that many SMEs increasingly rely on digital information to support decision-making, improve resource allocation, and respond more effectively to market demands.

Similarly, the high mean scores for employee digital literacy suggest that workers possess the basic digital competencies required to utilize emerging technologies within their organizations. However, the moderate variation observed across responses indicates that the level of digital capability is not uniform among firms, reflecting differences in access to training, technological infrastructure, and organizational readiness.

The results further reveal broad agreement among respondents that process automation enhances operational efficiency by reducing manual procedures, minimizing delays, and improving turnaround times. The relatively low standard deviations associated with these measures indicate a shared perception that digital technologies contribute to faster and more streamlined business processes.

Furthermore, the highest mean values were recorded for indicators relating to credibility, trust, and reliability, suggesting that digital transformation not only improves internal operations but also strengthens customer confidence and business reputation. From an economic perspective, this finding implies that digital adoption may generate both efficiency gains and intangible benefits that enhance competitiveness and market positioning. Overall, the descriptive statistics provide preliminary evidence that digital transformation is positively associated with improved operational performance among SMEs, thereby justifying further investigation through Structural Equation Modelling (SEM).

Table 4.1.1: Descriptive Statistics

Variables	Obs	Mean	Std.dev	Min	Max
data2	373	4.002681	0.8597907	1	5
data3	373	3.957105	0.7572475	1	5
data5	373	3.949062	0.7760393	1	5
data6	373	3.825737	0.7719423	1	5
dlle1	373	4.061662	0.8353445	1	5
dlle2	373	3.825737	1.018212	1	5
dlle3	373	3.967828	0.8974485	1	5
dlle4	373	3.951613	0.882793	1	5

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pral1	373	3.908847	0.8873375	1	5
pral2	373	3.927614	0.9202699	1	5
pral3	373	3.841823	0.8192371	1	5
pral4	373	3.932976	0.7748125	1	5
pral5	373	3.856757	0.7746109	1	5
pral6	373	3.822581	0.7705676	1	5
tcbp4	373	4.112601	0.5369938	1	5
tcbp5	373	4.147453	0.5700643	1	5
tcbp6	373	3.847185	0.8555473	1	5

Source: Compile by the author, 2026.

Note: data is data analytics, dlle is digital literacy, pral is process automation, and tcbp is turnaround time

4.2 Multicollinearity Analysis

Table 4.2.1 presents the results of the multicollinearity diagnostics to ensure that data analytics, employee digital literacy, and process automation do not exhibit excessive intercorrelations that could bias the analysis. Using tolerance and Variance Inflation Factor (VIF) statistics, the results show that all indicators across the three models fall well within acceptable thresholds, with tolerance values comfortably above 0.10 and VIF values far below the critical value of 10. Specifically, the data analytics, digital literacy, and process automation indicators each demonstrate moderate correlations without undue overlap, indicating that they capture distinct but complementary aspects of digital transformation.

The findings confirm the absence of multicollinearity problems, implying that each independent variable contributes unique explanatory power to the model. This provides confidence that the estimated effects of digital transformation components on operational efficiency are not distorted by redundancy among predictors. Consequently, the study's variables are statistically suitable for subsequent inferential analyses, including regression and Structural Equation Modeling (SEM), thereby strengthening the credibility and robustness of the empirical results.

Table 4.2.1 Multicollinearity

Model 1	Tolerance	VIF
Data Analytics2	0.469	2.133
Data Analytics3	0.323	3.099
Data Analytics5	0.527	1.898
Data Analytics6	0.354	2.826
Model 2	Tolerance	VIF
Digital Literacy Level Among Employment1	0.423	2.365
Digital Literacy Level Among Employment2	0.458	2.183
Digital Literacy Level Among Employment3	0.383	2.613
Digital Literacy Level Among Employment4	0.380	2.629

Model 3	Tolerance	VIF
Process Automation Level1	0.389	2.570
Process Automation Level2	0.437	2.287
Process Automation Level3	0.348	2.871
Process Automation Level4	0.383	2.613
Process Automation Level5	0.366	2.730
Process Automation Level6	0.382	2.618

4.3 Assessment of fit of the Measurement Model

Table 4.3.1 presents the results of the Confirmatory Factor Analysis (CFA) conducted to assess the adequacy of the measurement model for the latent constructs examined in this study, namely data analytics adoption, employee digital literacy, process automation, turnaround time of core business processes, and cost efficiency. The evaluation focused on model fit, reliability, and construct validity using established SEM criteria.

The overall fit statistics indicate that the measurement model provides an acceptable representation of the observed data. Specifically, the Root Mean Square Error of Approximation (RMSEA) values fall within the recommended threshold of less than 0.08, suggesting a reasonable approximation of the model to the population covariance matrix. Similarly, the comparative fit measures, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Normed Fit Index (NFI), exceed the commonly accepted benchmark of 0.90, indicating a satisfactory level of fit between the hypothesized model and the observed data. The Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) also attain acceptable levels, while the Chi-square-to-degrees-of-freedom ratio remains below the recommended maximum threshold, further supporting model adequacy.

The reliability assessment demonstrates strong internal consistency across all constructs. Cronbach's Alpha coefficients exceed the minimum acceptable value of 0.70, indicating that the measurement items consistently capture their respective underlying constructs. Although the turnaround time construct recorded a comparatively lower reliability estimate than the other variables, its coefficient remained above the acceptable threshold and therefore did not pose a threat to measurement reliability.

Furthermore, the results support convergent validity, as the standardized factor loadings are statistically significant and exceed the recommended minimum value of 0.50. Where computed, Composite Reliability (CR) values greater than 0.70 and Average Variance Extracted (AVE) values exceeding 0.50 indicate that the indicators adequately explain the variance of their respective constructs. These results confirm that the measurement items converge sufficiently in measuring the same underlying concept. The values of CR and AVE for all the construct exceed the threshold of 0.70 and 0.50 respectively, implying that the indicators adequately explain the variance of their respective constructs.

Evidence of discriminant validity is also established where the square root of each construct's AVE exceeds its correlations with other constructs (Fornell-Larcker criterion), indicating that the constructs are empirically distinct and capture different dimensions of digital transformation and operational efficiency. This reduces concerns regarding construct overlap and multicollinearity within the measurement model.

Overall, the CFA results provide strong evidence that the measurement model satisfies the requirements of model fit, reliability, convergent validity, and discriminant validity. Consequently, the latent constructs are considered psychometrically sound, thereby providing a robust foundation for the subsequent Structural Equation Modelling (SEM) analysis and enhancing confidence in the interpretation of the structural relationships among the study variables.

Table 4.3.1: Individual Confirmatory Factor Analysis CFA (Assessment of fit of the Measurement Model)

Variab les	RMSE A	GFI	AG FI	CFI	TLI	NFI	CHISQ/ DF	PV	C R	AV E	Cronbac h α
DATA	0.011	0.912	0.998	0.910	0.956	0.930	2.084	0.000	0.78	0.67	0.868
DLLE	0.072	0.951	0.932	0.995	0.974	0.925	5.902	0.052	0.85	0.75	0.876
PRAL	0.079	0.919	0.933	0.913	0.974	0.914	1.270	0.000	0.82	0.65	0.903
TCBP	0.079	0.930	0.917	0.999	0.971	0.934	1.600	0.004	0.83	0.78	0.705

Source: Source: Field survey 2025

4.4 Factor Loadings of Measurement model

The path diagram results indicate that all retained indicators exhibit strong and acceptable factor loadings, confirming the robustness of the measurement model. The data analytics construct is well represented by four indicators with loadings ranging from 0.70 to 0.88, demonstrating that respondents consistently understood and applied analytics-related practices, with some items providing particularly strong representation of the construct. Similarly, the digital literacy construct shows a high degree of internal consistency, as all four indicators load strongly and closely on the construct, reflecting a clear and shared understanding of employee digital skills among respondents. The process automation construct is also reliably measured, with all six indicators contributing meaningfully and capturing automation from multiple operational perspectives. Finally, the turnaround time construct is particularly well specified, supported by very strong factor loadings, including one exceptionally high indicator that robustly captures process execution speed. Overall, these results confirm that the study's latent constructs are clearly defined, empirically sound, and measured with high reliability, providing a solid foundation for subsequent Structural Equation Modeling (SEM) analysis.

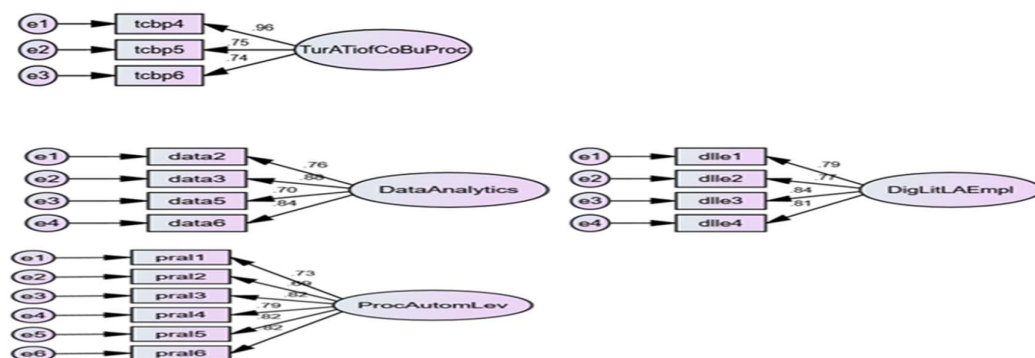


Figure 4.4.1: Measurement model

4.5 Eliminated constructs with low Factor Loadings

Table 4.5.1 highlights the refinement of the measurement model through the removal of questionnaire items with weak factor loadings that did not adequately represent their intended

constructs. In line with confirmatory factor analysis (CFA) standards, items with loadings below the acceptable threshold were excluded to prevent distortion of construct validity. Specifically, two items measuring data analytics, two measuring employee digital literacy, and three assessing turnaround time were removed due to poor alignment with their respective constructs, as evidenced by very low factor loading values (<0.50). These weak relationships suggest possible issues with item clarity, respondent interpretation, or construct relevance. Eliminating these items strengthened the measurement model by ensuring that only indicators with strong and meaningful associations remained. This refinement process enhanced the reliability and construct validity of the model, thereby providing a more robust foundation for the subsequent Structural Equation Modeling (SEM) analysis and improving the overall quality and credibility of the study's empirical findings.

Table 4.5.1 construct with low factor loadings

Construct 1	Factor Loadings
data1	0.03
data4	0.43
Construct 2	
dlle5	0.46
dlle6	0.40
construct 3	
tcbp1	0.08
tcbp2	0.17
tcbp3	0.11

4.6 Structural model

Figure 4.6.1 and Table 4.6.1 present the Structural Equation Modelling (SEM) results examining the influence of key digital transformation dimensions, namely data analytics adoption, process automation, and employee digital literacy, on the turnaround time of core business processes among SMEs in North Central Nigeria. Turnaround time serves as a proxy for operational efficiency, with lower turnaround times indicating improved organizational performance. The structural model provides empirical evidence on how different components of digital transformation contribute to efficiency gains within SMEs.

The findings indicate that data analytics adoption has a statistically significant negative effect on turnaround time ($\beta = -0.247$, $p = 0.011$). This result implies that SMEs that make greater use of analytics tools experience faster processing and decision cycles. The negative relationship suggests that data-driven decision-making enables firms to identify operational bottlenecks, forecast demand more accurately, and allocate resources more efficiently. Although the magnitude of the effect is smaller than those of the other digital transformation dimensions, the result demonstrates that access to timely and relevant information enhances managerial responsiveness and contributes to operational improvements.

Process automation records the strongest effect on turnaround time ($\beta = -0.360$, $p < 0.001$), indicating that increased automation significantly accelerates the execution of business processes. This finding suggests that replacing manual and repetitive activities with automated systems reduces delays, minimizes processing errors, and improves workflow coordination. The result highlights the central role of automation in driving operational efficiency and suggests that SMEs can achieve substantial productivity gains by digitizing routine operational functions.

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Similarly, employee digital literacy exerts a strong and statistically significant negative influence on turnaround time ($\beta = -0.357$, $p < 0.001$). This finding demonstrates that the benefits of digital technologies depend not only on technology acquisition but also on employees' ability to effectively utilize those technologies. SMEs with digitally skilled employees are better positioned to integrate digital systems into their daily operations, resolve technical challenges promptly, and adapt to evolving technological requirements. Consequently, improvements in workforce digital competence translate into faster and more efficient business processes.

Collectively, the results show that all three dimensions of digital transformation contribute significantly to reducing turnaround time and improving operational efficiency. However, the differing magnitudes of the coefficients suggest that not all digital transformation initiatives generate the same level of operational impact. While data analytics primarily enhances decision quality and planning effectiveness, process automation and employee digital literacy exert more direct effects on the speed of operational execution. This finding indicates that information generation alone may not be sufficient to improve efficiency unless supported by appropriate technological systems and workforce capabilities.

From a theoretical standpoint, the findings provide strong support for the study's underlying framework by demonstrating that operational efficiency is shaped by the combined influence of technological resources, organizational processes, and human capabilities. The results are consistent with the Resource-Based View (RBV), which argues that valuable organizational resources and capabilities constitute important sources of competitive advantage. In this context, data analytics capability, automated business processes, and digitally competent employees represent strategic resources that enable SMEs to enhance operational performance. The significant effects observed in the model suggest that firms that develop and integrate these capabilities are better positioned to achieve superior efficiency outcomes.

The findings also reinforce the socio-technical perspective of digital transformation, which emphasizes that organizational performance improvements emerge from the alignment of technology and people rather than from technology deployment alone. The strong effect of employee digital literacy is particularly noteworthy because it highlights the importance of human capital in converting technological investments into tangible operational benefits. This evidence challenges technology-centric perspectives that assume digital tools automatically generate performance gains and instead suggests that workforce capability remains a critical determinant of successful digital transformation.

Furthermore, the results extend existing knowledge by showing that SMEs in a developing economy context can realize measurable efficiency improvements through digital transformation initiatives. The evidence therefore supports the proposition that digital transformation is a multidimensional process involving the interaction of analytical capabilities, technological infrastructure, and human skills. The findings validate the conceptual model underpinning this study and confirm that digital transformation outcomes are stronger when these elements are developed simultaneously rather than in isolation.

Overall, the SEM results provide robust empirical support for rejecting the null hypotheses and affirm that digital transformation significantly enhances SME operational efficiency through reductions in turnaround time. More importantly, the findings underscore the theoretical argument that sustainable performance improvements arise from the effective combination of digital technologies, process innovation, and employee capabilities, thereby strengthening the explanatory power of the study's theoretical framework.

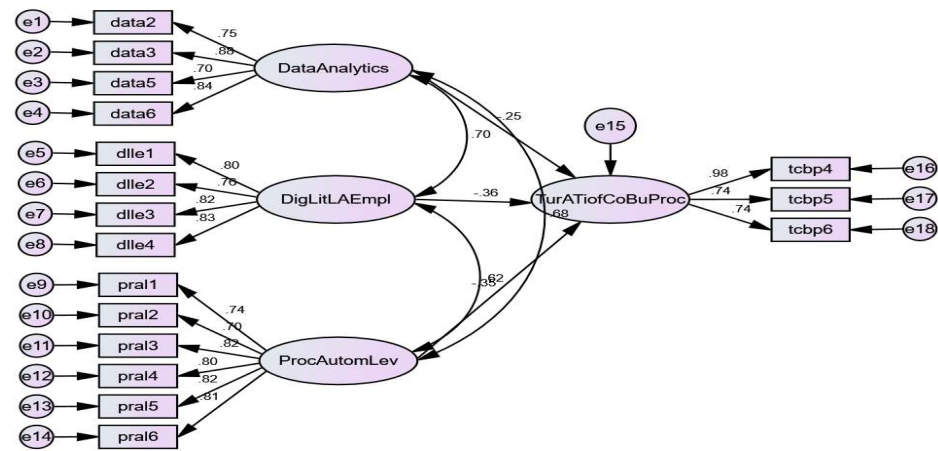


Figure 4.6.1: Structural model

Table 4.6.1: Structural model

Hypothetical Relationship		Path Coefficient	S.E	C.R	p-value
TurATiofCoBuProc DataAnalytics	<--	-0.247	0.078	-2.557	.011**
TurATiofCoBuProc ProcAutomLev	<--	-0.360	0.071	-.433	0.000***
TurATiofCoBuProc DigLitLAEmpl	<--	-0.357	0.064	-4.011	0.000***

Source: Field survey 2026

4.7 Discussion of Major Findings

The findings of this study demonstrate that data analytics adoption, process automation, and employee digital literacy significantly improve operational efficiency among SMEs in North Central Nigeria by reducing the turnaround time of core business processes. These results provide empirical support for the argument that digital transformation is a multidimensional phenomenon in which technology, processes, and human capabilities collectively shape organizational performance. Beyond confirming the statistical significance of these relationships, the findings contribute to the growing body of evidence that SMEs can achieve substantial efficiency gains when digital technologies are effectively integrated into business operations.

The study found that data analytics adoption significantly reduces turnaround time, suggesting that firms that utilize analytics tools are better able to make timely and informed decisions. This finding is consistent with the work of Kannan and Gambetta (2025) and Wang and Zhang (2025), who reported that analytics capabilities enhance organizational agility by improving forecasting accuracy, operational visibility, and resource allocation. Similarly, studies conducted in developing economies by Otopah et al. (2025) and Oloke et al. (2024) found that data-driven decision-making helps firms identify inefficiencies and improve operational performance. The present finding therefore reinforces existing evidence that access to relevant information is a key source of operational advantage.

However, the relatively smaller effect of data analytics compared with process automation and digital literacy suggests that access to information alone may not be sufficient to generate substantial efficiency improvements. This observation supports the argument advanced by Tariq et al. (2024) that analytics capabilities create value only when supported by appropriate organizational routines and implementation mechanisms. In the Nigerian SME environment, where resource constraints, inadequate technological infrastructure, and limited managerial capacity remain common challenges,

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firms may possess analytical insights but lack the systems required to translate those insights into rapid operational outcomes. This may explain why the effect of analytics, although significant, is less pronounced than that of the other digital transformation dimensions.

Process automation emerged as the strongest predictor of operational efficiency, indicating that automation has the most direct impact on reducing business process delays. This finding is consistent with previous studies that identified automation as a critical driver of productivity and process improvement. For instance, Jabbour Al Maalouf et al. (2025) and Rahman et al. (2025) found that automated workflows significantly reduce processing time, eliminate repetitive manual tasks, and improve service quality. Similar evidence has been reported by Usman et al. (2025) and Mustapha et al. (2025) within the Nigerian SME sector, where digital process integration was associated with higher productivity and faster service delivery.

The strong influence of automation may reflect the operational realities of many SMEs in Nigeria, where a considerable proportion of business activities are still conducted manually. Under such conditions, even modest automation initiatives can yield substantial efficiency gains by reducing human error, minimizing duplication of effort, and accelerating transaction processing. This finding therefore extends existing literature by showing that automation remains one of the most effective digital transformation strategies for improving operational performance in resource-constrained business environments.

The results further reveal that employee digital literacy has a strong and significant influence on turnaround time. This finding supports earlier studies by Nnanna et al. (2025), Ndaba and Nnenna (2025), Nguyen (2025), and John and Bala (2025), all of which identified digital skills as a critical determinant of technology utilization and organizational performance. Likewise, studies focusing on African SMEs, including those of Aliuba et al. (2025) and Ukoha et al. (2025), concluded that firms are more likely to realize the benefits of digital transformation when employees possess the capabilities required to operate and adapt digital technologies effectively.

The prominence of digital literacy in this study highlights an important aspect that is often overlooked in technology-focused discussions of digital transformation. While investments in digital infrastructure are important, their effectiveness ultimately depends on the ability of employees to utilize these tools productively. The finding therefore challenges perspectives that view technology adoption as an end in itself and instead emphasizes the complementary role of human capital. In contexts where digital skill gaps remain prevalent, investments in workforce training may be as important as investments in technological infrastructure.

From a theoretical perspective, the findings support the Resource-Based View (RBV), which posits that sustainable performance advantages arise from the effective deployment of valuable and difficult-to-imitate organizational resources. Data analytics capability, automated processes, and digitally skilled employees can be viewed as strategic resources that collectively enhance operational performance. The results further suggest that no single capability is sufficient on its own; rather, efficiency gains emerge from the interaction of technological resources, process innovations, and human competencies. This finding strengthens the theoretical proposition that digital transformation outcomes depend on the complementarity of organizational capabilities rather than isolated technological investments.

Practically, the results imply that SME owners and managers seeking to improve operational efficiency should adopt a balanced digital transformation strategy. While investments in analytics tools can improve decision quality, greater efficiency gains are likely to be achieved when analytics is complemented by process automation and continuous employee digital-skills development. Policymakers and SME support agencies should therefore prioritize programmes that promote not only technology adoption but also workforce digital training and business process modernization. Such an integrated approach is more likely to generate sustainable improvements in productivity and competitiveness within the SME sector.

Overall, the findings support the broader literature on digital transformation while extending

empirical evidence within the Nigerian SME context. They demonstrate that the operational benefits of digital transformation are strongest when information capabilities, process technologies, and human competencies are developed simultaneously, highlighting the need for a holistic rather than technology-centred approach to digital transformation.

5.0 Conclusion and Recommendations

This study investigated the effect of digital transformation on the operational efficiency of registered SMEs in North Central Nigeria. The findings revealed that data analytics adoption, process automation, and employee digital literacy significantly reduce the turnaround time of core business processes, leading to improved operational efficiency. Accordingly, the study rejects the null hypotheses and confirms that digital transformation capabilities are important drivers of SME performance.

Among the dimensions examined, process automation exerted the strongest influence on operational efficiency, followed by employee digital literacy, while data analytics demonstrated a significant but relatively smaller effect. These findings suggest that the gains from digital transformation are maximized when technological investments are complemented by capable human resources and efficient business processes. The study contributes to the digital transformation literature by providing evidence from the Nigerian SME context and supports the view that digital capabilities constitute strategic resources for enhancing organizational performance, competitiveness, and long-term business growth.

To enhance SME operational efficiency and competitiveness, SME owners should prioritize the automation of routine business processes, strengthen employee digital skills through continuous training, and adopt data-driven decision-making practices. Digital transformation initiatives should be implemented as integrated strategies that combine technology, process improvement, and workforce development.

At the policy level, federal, state, and local governments should develop a comprehensive SME Digital Transformation Policy focused on expanding access to digital infrastructure, affordable technology solutions, and digital financing schemes. Government agencies should promote AI-enabled business support platforms, establish digital innovation hubs, and implement large-scale digital capability development programmes to improve technology adoption among SMEs. Furthermore, support for cloud-based enterprise systems and digital entrepreneurship initiatives will strengthen SME productivity, stimulate employment creation, enhance business growth, and contribute to sustainable regional and national economic development.

This study empirically demonstrates that digital transformation significantly enhances operational efficiency among SMEs in North Central Nigeria, with particularly strong effects on turnaround time. Using Structural Equation Modeling, the findings show that process automation is the most influential driver of faster business process execution, confirming that automating routine activities reduces delays, errors, and coordination inefficiencies. Digital literacy also plays a critical role, indicating that the speed benefits of digital technologies depend on employees' capacity to effectively use and adapt digital tools. While data analytics contributes to reducing turnaround time, its cost efficiency effects appear less immediate, suggesting that its primary value lies in medium- to long-term process optimization and strategic decision support.

Taken together, the results reveal that automation, digital literacy, and data analytics operate as complementary mechanisms rather than isolated drivers of performance. For SME managers, this underscores the need for an integrated digital strategy that combines process automation with sustained investments in workforce digital skills. For policymakers, the findings highlight the importance of providing affordable automation technologies, structured digital training programmes, and enabling infrastructure to accelerate SME digital adoption. Such coordinated interventions are essential for achieving sustained improvements in operational speed and competitiveness in emerging-economy SME contexts..

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