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The Effect of Digital Transformation on Sustainable Innovation Performance Among Manufacturing Smes in Plateau State, Nigeria: The Mediating Role of Organisational Agility

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Abstract: This study examined the relationships among digital transformation, organisational agility, knowledge sharing and sustainable innovation performance among manufacturing small and medium enterprises (SMEs) in Plateau State, Nigeria. Drawing on Dynamic Capabilities Theory and Absorptive Capacity Theory, the study examined organisational agility as a mediator of the relationship between digital transformation and sustainable innovation performance and knowledge sharing as a moderator of the relationship between organisational agility and sustainable innovation performance. A quantitative, cross-sectional survey design was adopted. The target population comprised 21,960 manufacturing SMEs in Plateau State, consisting of 19,980 small and 1,980 medium enterprises. Using the Krejcie and Morgan (1970) sample-size determination approach, 378 SMEs were targeted and 378 questionnaires were administered. Of the 289 questionnaires retrieved, 152 were retained for analysis following data screening. Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS 4. The results showed a positive and statistically significant relationship between digital transformation and sustainable innovation performance ($\beta = 0.150$, $p = 0.047$), although the coefficient was relatively small and sensitive to data treatment. Digital transformation was positively related to organisational agility ($\beta = 0.491$, $p < 0.001$), while organisational agility was positively related to sustainable innovation performance ($\beta = 0.471$, $p < 0.001$). Organisational agility significantly mediated the relationship between digital transformation and sustainable innovation performance (indirect effect $\beta = 0.231$, $p < 0.001$; VAF = 60.6%). The interaction between knowledge sharing and organisational agility was not statistically significant ($\beta = 0.058$, $p = 0.344$). However, the moderation test had low statistical power (0.36), making the result inconclusive rather than evidence that knowledge sharing does not moderate the relationship. The findings indicate that organisational agility is an important mechanism through which digital transformation is associated with sustainable innovation performance among manufacturing SMEs in Plateau State, while the role of knowledge sharing requires further investigation using a larger sample.

Keywords: *Digital Transformation; Organisational Agility; Knowledge Sharing; Sustainable Innovation Performance; Manufacturing SMEs.*

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I. INTRODUCTION

Small and medium enterprises (SMEs) play an important role in employment generation, production, entrepreneurship and local economic development. In Nigeria, manufacturing SMEs operate within an environment characterised by infrastructure constraints, energy challenges, limited technological capabilities and resource pressures. These conditions can constrain firms' ability to improve productivity while responding to changing market, environmental and social requirements. Waste generation and inefficient resource use may further intensify the sustainability challenges associated with manufacturing activities (Chukwuebuka & Wang, 2024).

Digital transformation (DT) has become increasingly relevant to how firms organize production, access information, coordinate activities and respond to changing

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market conditions. In manufacturing SMEs, digital technologies can support automation, information processing, communication, data-driven decision-making and coordination across organisational activities. However, the adoption of digital technologies does not necessarily translate into improved organisational outcomes. The value derived from digital transformation depends, in part, on how digital technologies are integrated into organisational processes and capabilities (Fitzgerald et al., 2014; Verhoef et al., 2021). Thus, beyond access to digital technologies, manufacturing SMEs require organisational capabilities that enable them to translate digital resources into improved and sustainable innovation outcomes.

Organisational agility (OA) represents one capability through which digital transformation may be associated with organisational outcomes. Organisational agility refers to a firm's ability to identify changes in its environment and respond through timely adjustments to processes, resources and organisational arrangements. Digital technologies can increase the availability and speed of information, but the ability to interpret information and respond appropriately remains an important organisational capability. From the perspective of Dynamic Capabilities Theory (DCT), digital resources may therefore contribute to organisational outcomes through capabilities that enable firms to sense changes, seize opportunities and reconfigure resources in response to changing conditions (Teece et al., 1997; Teece, 2007, 2023).

Knowledge sharing (KS) provides a further organisational perspective on the relationship between organisational agility and sustainable innovation performance. An agile organisation may respond rapidly to environmental changes, but the effectiveness of such responses may depend on the extent to which relevant knowledge, expertise and experience are exchanged within the organisation. Knowledge sharing facilitates the movement and application of knowledge among employees and organisational units and may support innovation-related activities. Absorptive Capacity Theory provides a basis for understanding how organisations recognise, assimilate, transform and exploit knowledge to enhance organisational outcomes (Cohen & Levinthal, 1990; Zahra & George, 2002).

Sustainable innovation performance (SIP) extends the assessment of innovation beyond conventional economic outcomes by incorporating environmental and social considerations. For manufacturing firms, this multidimensional perspective is particularly relevant because innovation is increasingly expected to contribute not only to economic performance but also to environmental sustainability and social value. Sustainable innovation performance therefore provides a broader basis for assessing the outcomes of firms' innovation activities (Calik & Bardudeen, 2016).

Despite growing research on digital transformation, organisational agility and knowledge sharing, limited empirical evidence has examined these constructs within an integrated model of sustainable innovation performance among manufacturing SMEs in Plateau State, Nigeria. In particular, there is limited evidence on whether organisational agility provides an intervening mechanism through which digital transformation is associated with sustainable innovation performance and whether knowledge sharing conditions the relationship between organisational agility and sustainable innovation performance. This gap is important because the ability to translate digital resources into sustainable innovation outcomes may depend not only on technology adoption but also on the organisational capabilities through which those resources are mobilised and applied.

The context of manufacturing SMEs in Plateau State provides an important setting for examining these relationships. Firms operating in this environment must respond to changing market conditions and resource constraints while pursuing innovation that can support economic performance and address environmental and social considerations. Understanding how digital transformation, organisational agility and knowledge sharing are related to sustainable innovation performance can therefore provide useful evidence for both scholarship and SME development policy.

Therefore, this study examines the relationships among digital transformation, organisational agility, knowledge sharing and sustainable innovation performance among manufacturing SMEs in Plateau State, Nigeria. Specifically, the study examines the relationships between digital transformation and sustainable innovation performance, digital transformation and organisational agility, and organisational agility and sustainable innovation performance; the mediating role of organisational agility; and the moderating role of knowledge sharing. By integrating these relationships within a single empirical model, the study contributes to the understanding of how digital resources and organisational capabilities are associated with sustainable innovation performance among manufacturing SMEs in a developing-country context.

II. LITERATURE REVIEW

➢ *Conceptual Review*

- *Digital Transformation*

Digital transformation refers to the integration and application of digital technologies in organisational processes, operations and decision-making. In manufacturing SMEs, it may involve automation, digital information systems, data-based decision-making, digital communication and the integration of technologies into production and administrative activities.

Digital transformation extends beyond the adoption of individual technologies because it involves changes in how organisations organize resources, processes and activities. The strategic significance of digital transformation therefore lies not only in the technology itself but also in the

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organisational capabilities developed around its use (Fitzgerald et al., 2014; Verhoef et al., 2021).

For resource-constrained SMEs, digital transformation may improve access to information, coordination and operational flexibility. However, the value derived from digital technologies can depend on whether the organisation has the capability to interpret information, adjust its processes and apply new knowledge. This provides a basis for considering organisational agility as a potential mechanism linking digital transformation with sustainable innovation performance.

- *Organisational Agility*

Organisational agility is the ability of a firm to identify changes in its operating environment and respond through timely adjustments to its activities, structures and resources. Agility encompasses responsiveness, flexibility and the capacity to reconfigure organisational resources when conditions change.

For manufacturing SMEs, organisational agility may involve modifying production processes, responding to changing customer requirements, adopting new technologies, reallocating resources or adjusting products and services. Digital technologies can facilitate these activities by improving information availability and communication, but the organisational capacity to act on available information remains important.

Organisational agility is therefore particularly relevant to Dynamic Capabilities Theory, which emphasises firms' capacity to sense opportunities and threats, seize opportunities and transform their resource base in response to environmental change (Teece, 2007, 2023).

- *Knowledge Sharing*

Knowledge sharing refers to the exchange of information, experience, skills and expertise among individuals and organisational units. It enables employees and teams to communicate relevant knowledge and can facilitate the application of existing knowledge to new organisational problems. Reviews of the knowledge-sharing literature link it to a range of individual and organisational outcomes, including innovation (Ahmad & Karim, 2019).

Knowledge sharing is particularly relevant to innovation because innovation frequently involves combining existing knowledge in new ways and applying information obtained from different sources. However, the presence of knowledge-sharing practices does not necessarily guarantee improved outcomes. Their value depends on the firm's ability to recognise, assimilate and apply relevant knowledge, consistent with the logic of Absorptive Capacity Theory (Cohen & Levinthal, 1990; Zahra & George, 2002).

In this study, knowledge sharing is examined as a moderator rather than as a direct predictor. The argument is that the relationship between organisational agility and sustainable innovation performance may differ according to the extent to which relevant knowledge is exchanged within the firm.

- *Sustainable Innovation Performance*

Sustainable innovation performance (SIP) refers to the extent to which an organisation develops and implements innovations that contribute to economic, environmental and social outcomes. Sustainable innovation therefore extends the assessment of innovation beyond financial or market outcomes to include environmental responsibility and social considerations.

Calik and Bardudeen (2016) conceptualised sustainable innovation performance as a multidimensional construct encompassing economic, environmental and social dimensions. This multidimensional perspective is relevant to manufacturing SMEs because innovation may simultaneously concern productivity and competitiveness, resource efficiency and environmental practices, and social outcomes.

In this study, sustainable innovation performance is modelled as a higher-order construct comprising economic, environmental and social dimensions.

➢ *Theoretical Framework*

The study is anchored on Dynamic Capabilities Theory (DCT) and Absorptive Capacity Theory (ACT). The two theories provide complementary explanations for the proposed relationships.

- *Dynamic Capabilities Theory*

Dynamic Capabilities Theory originated in the work of Teece, Pisano and Shuen (1997) and was subsequently developed by Teece (2007). The theory focuses on how firms integrate, build and reconfigure internal and external competences in changing environments.

Teece (2007) identifies three broad activities associated with dynamic capabilities: sensing opportunities and threats, seizing opportunities, and transforming or reconfiguring the organisation. The framework has subsequently been further developed to explain how organisations respond to technological, market and institutional changes (Teece, 2023).

Within the present study, digital transformation represents an important technological resource and organisational development that can improve information availability, communication and coordination. Organisational agility represents an organisational capability through which such digital resources may be translated into timely adaptive responses. This provides the theoretical basis for examining organisational agility as a mediator between digital transformation and sustainable innovation performance.

The theory therefore suggests that digital transformation may be associated with sustainable innovation performance not only through a direct relationship but also through the organisational capabilities

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that enable firms to respond effectively to changing conditions.

- *Absorptive Capacity Theory*

Absorptive Capacity Theory was introduced by Cohen and Levinthal (1990) and later reconceptualised by Zahra and George (2002). The theory emphasises the organisational capacity to recognise the value of new information, assimilate it, transform it and exploit it for organisational purposes.

Knowledge sharing is relevant to this process because knowledge must circulate within organisations before it can be collectively interpreted and applied. However, the benefits of knowledge exchange may depend on the firm's ability to convert shared knowledge into organisational action.

In this study, Absorptive Capacity Theory provides the theoretical basis for examining knowledge sharing as a moderator of the relationship between organisational agility and sustainable innovation performance. An agile organisation may respond quickly to changes, but the effectiveness of its response may depend partly on the availability and exchange of relevant knowledge.

Together, DCT and ACT provide complementary explanations for the proposed model. DCT explains the relationship between digital transformation, organisational agility and sustainable innovation performance, while ACT provides a basis for examining whether knowledge sharing conditions the relationship between organisational agility and sustainable innovation performance.

➢ *Conceptual Framework*

The conceptual framework positions digital transformation as the independent variable, organisational agility as the mediating variable, knowledge sharing as the moderating variable and sustainable innovation performance as the dependent variable.

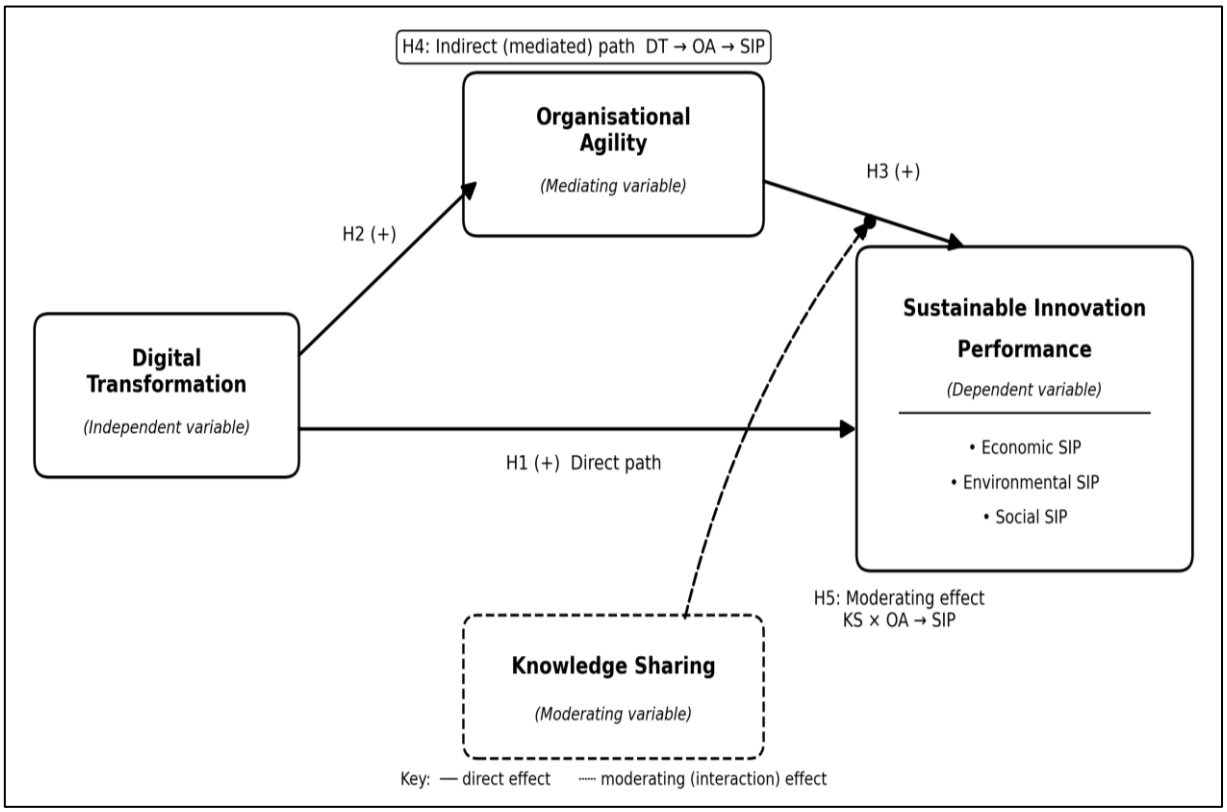

Fig 1 Conceptual Framework of the Study

The framework proposes four structural relationships. Digital transformation is specified as the independent variable. Organisational agility is specified as the mediator because the dynamic-capabilities perspective suggests that technological resources must be translated into organisational capabilities before their potential performance implications can be realised. Knowledge sharing is specified as a moderator on the organisational agility–sustainable innovation performance relationship because knowledge processes may influence the extent to which organisational responsiveness is translated into innovation outcomes. Sustainable innovation performance is specified as a higher-order construct comprising economic, environmental and social dimensions.

➢ *Empirical Review and Hypotheses Development*

- *Digital Transformation and Sustainable Innovation Performance*

Digital transformation can provide firms with improved access to information, enhanced coordination and greater capacity to modify products and processes. These capabilities may support innovation and sustainability-related improvements. However, the relationship is not

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necessarily automatic because digital technologies must be integrated with organisational processes and capabilities.

Khin and Ho (2019) found that digital technology and digital capability were associated with organisational performance, with digital innovation providing an important mechanism. Fitzgerald et al. (2014) similarly emphasised that the organisational consequences of digital technology depend on how firms integrate technology into their broader activities.

For manufacturing SMEs, digital transformation may therefore provide a basis for improving innovation performance, although the strength of the relationship may depend on complementary organisational capabilities. Therefore:

✓ H01: There is no significant relationship between digital transformation and sustainable innovation performance among manufacturing SMEs in Plateau State.

- *Digital Transformation and Organisational Agility*

Digital technologies can improve the speed and availability of organisational information, facilitate communication and support coordination. These characteristics can help firms identify environmental changes and respond more quickly.

From a dynamic capability's perspective, digital technologies can support sensing and seizing activities by improving access to information and facilitating organisational responses. Empirical evidence also suggests a positive association between digital capability and organisational agility among SMEs (Islamuddin et al., 2025). Thus:

✓ H02: There is no significant relationship between digital transformation and organisational agility among manufacturing SMEs in Plateau State.

- *Organisational Agility and Sustainable Innovation Performance*

Organisational agility can facilitate innovation by enabling firms to respond to changing customer preferences, technologies, competitive conditions and sustainability requirements. Agile firms may be better positioned to modify processes, introduce new products and reconfigure resources in response to emerging opportunities.

Previous research has associated organisational agility with innovative performance, although the strength of this relationship may vary according to organisational and environmental conditions. Therefore:

✓ H03: There is no significant relationship between organisational agility and sustainable innovation performance among manufacturing SMEs in Plateau State.

- *Mediating Role of Organisational Agility*

The relationship between digital transformation and sustainable innovation performance may operate partly through organisational agility. Digital transformation can improve access to information and coordination, but these technological capabilities need to be translated into organisational responses.

Dynamic Capabilities Theory provides a basis for viewing organisational agility as the capability through which digital resources can be converted into adaptive organisational action (Teece, 2007, 2023). Digital transformation may therefore be associated with sustainable innovation performance both directly and indirectly through organisational agility. Thus:

✓ H04: Organisational agility does not significantly mediate the relationship between digital transformation and sustainable innovation performance among manufacturing SMEs in Plateau State.

- *Moderating Role of Knowledge Sharing*

Knowledge sharing may influence how effectively organisations convert agility into innovation outcomes. Agility provides the capacity to respond, while knowledge sharing may provide employees and organisational units with information and experience needed to inform those responses.

From an Absorptive Capacity perspective, knowledge becomes valuable when firms are able to recognise, assimilate, transform and apply it (Cohen & Levinthal, 1990; Zahra & George, 2002). Knowledge sharing may therefore strengthen the relationship between organisational agility and sustainable innovation performance.

However, knowledge sharing is not automatically beneficial. Its contribution may depend on organisational structures, employee participation and the firm's ability to use shared knowledge. Therefore**:**

✓ H05: Knowledge sharing does not significantly moderate the relationship between organisational agility and sustainable innovation performance among manufacturing SMEs in Plateau State.

III. METHODOLOGY

➢ *Research Design*

The study adopted a quantitative, cross-sectional survey design. The design was appropriate because data on digital transformation, organisational agility, knowledge sharing and sustainable innovation performance were collected from manufacturing SMEs at a single point in time and analysed statistically to test the hypothesised relationships.

Because the study used cross-sectional data, the findings are interpreted as relationships and associations rather than evidence of temporal or causal effects.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26nov358

➢ *Population and Sample*

The target population comprised 21,960 manufacturing SMEs operating in Plateau State, consisting of 19,980 small enterprises and 1,980 medium enterprises.

Using the Krejcie and Morgan (1970) sample-size determination approach, a sample size of 378 was obtained. Therefore, 378 questionnaires were administered to eligible manufacturing SMEs across Plateau State using a multi-stage stratified sampling procedure, with stratification based on local government area and enterprise size.

A total of 289 questionnaires were retrieved, representing a response rate of 76.5% of the questionnaires administered. Following data screening, 152 questionnaires were retained as valid for analysis. The 152 valid responses represent 52.6% of the questionnaires retrieved and 40.2% of the determined sample size. The 137 questionnaires excluded at screening represent 47.4% of those retrieved. This is substantial attrition and may introduce selection bias if excluded firms differed systematically from retained firms; it is acknowledged as a limitation.

Table 1 Sample Size and Response Rate

Stage	Count	Percentage
Population of manufacturing SMEs in Plateau State	21,960	-
Sample size (Krejcie & Morgan, 1970)	378	-
Questionnaires administered	378	100.0
Questionnaires retrieved	289	76.5 (of administered)
Valid questionnaires used for analysis	152	52.6 (of retrieved); 40.2 (of determined sample)

Source: Field Survey, 2026.

The distinction between retrieved and valid questionnaires is important because the structural model was estimated from the 152 questionnaires retained after screening, rather than from the full 378 questionnaires initially targeted.

➢ *Measurement of Variables*

All constructs were measured on a five-point Likert scale. Digital transformation was measured with a 6-item scale adapted from Chakraborty and Nandi (2024). Organisational agility was measured with a 7-item scale adapted from Islamuddin et al. (2025). Knowledge sharing was measured with an 8-item scale adapted from Obuya Wilfred et al. (2024). Sustainable innovation performance was measured with a 13-item scale adapted from Calik and Bardudeen (2016), comprising economic, environmental and social sub-dimensions.

➢ *Statistical Power*

The Krejcie and Morgan (1970) approach provides a basis for determining sample size in relation to population estimation but does not substitute for a statistical-power assessment of the structural model.

Therefore, a separate power assessment was conducted. Using the inverse-square-root method proposed by Kock and Hadaya (2018), the minimum sample required to detect a path coefficient of approximately 0.197 at the 5% significance level with 80% power was estimated at 160 observations. A separate G*Power 3.1 assessment using linear multiple regression with three predictors, alpha = .05, power = .80 and a medium effect size ($f^2 = 0.15$), produced a minimum sample requirement of 77 observations (Faul et al., 2009).

The achieved sample of 152 exceeds the G*Power threshold under the specified assumptions but falls below the inverse-square-root estimate of 160. More importantly, the moderation analysis had substantially lower power, estimated at approximately 0.36. The results of the interaction test are therefore interpreted cautiously.

➢ *Data Analysis Technique*

Data were analysed using SPSS version 26 for preliminary diagnostics and descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS 4 for measurement and structural model assessment.

PLS-SEM was selected because the model incorporates a higher-order construct, mediation and moderation, and because the study focuses on explaining variance and assessing predictive relationships. PLS-SEM is also suitable where prediction and model development are important considerations (Hair et al., 2019).

Procedural controls, including simplified item wording, concise instructions and assurance of anonymity, were applied to reduce potential common method bias. Statistical assessments included Harman's single-factor test and the full-collinearity assessment proposed by Kock (2015). These assessments provide diagnostic evidence but do not establish that common method bias is completely absent (Podsakoff et al., 2024).

IV. RESULTS

➢ *Common Method Bias*

Harman's single-factor test was conducted by entering all measurement items into an unrotated exploratory factor analysis. The first factor accounted for 37.64% of the total variance, below the 50% criterion.

As a further diagnostic assessment, the full-collinearity test of Kock (2015) was conducted. All inner-model variance inflation factor (VIF) values ranged from 1.000 to 2.246, below the 3.3 threshold commonly used in the full-collinearity approach.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26nov358

Taken together, the results do not indicate an obvious or severe common method bias problem in the data. However, because common method bias is complex and cannot be conclusively ruled out by these tests alone, the results should be interpreted as evidence that common method bias is unlikely to constitute a major threat rather than evidence that it is completely absent (Podsakoff et al., 2024).

➢ *Demographic Profile of Respondents*

Table 2 Demographic Profile of Respondents (N = 152)

Variable	Category	Frequency	Percent (%)
Gender	Male	93	61.2
	Female	59	38.8
Age	18-29	20	13.2
	30-39	30	19.7
	40-49	45	29.6
	50-59	38	25.0
	60 and above	19	12.5
Education	SSCE	14	9.2
	ND/NCE	24	15.8
	HND	11	7.2
	Bachelor's Degree	64	42.1
	Master's Degree	36	23.7
	PhD	3	2.0

Source: Field Survey, 2026.

The respondents comprised 61.2% males and 38.8% females. The largest age group was 40–49 years (29.6%), followed by 50–59 years (25.0%). In terms of educational attainment, 42.1% held bachelor's degrees and 23.7% held master's degrees.

The respondent profile above describes the respondents only; the small-versus-medium enterprise composition of the 152 valid responses is not reported, so the results cannot be weighted or compared by firm size.

➢ *Measurement Model Assessment*

The measurement model was assessed in terms of indicator reliability, internal consistency reliability, convergent validity and discriminant validity.

Most indicator loadings were approximately 0.70 or higher. One indicator, SOSIP2, recorded a low outer loading and was removed. Composite reliability values ranged from 0.848 to 0.922, while AVE values ranged from 0.550 to 0.668.

These results indicate satisfactory internal consistency and convergent validity. The two indicators with loadings below 0.70 for organisational agility and knowledge sharing were retained because the corresponding constructs retained satisfactory composite reliability and AVE, in line with the guidance that indicators with loadings between 0.40 and 0.70 should be removed only when doing so raises reliability or validity above the threshold (Hair et al., 2021).

Table 3 Internal Consistency and Convergent Validity

Construct	Items	Loading Range	CR	AVE
Digital Transformation	6	0.762-0.861	0.922	0.662
Organisational Agility	7	0.683-0.797	0.895	0.551
Knowledge Sharing	8	0.657-0.824	0.907	0.550
Economic SIP	4	0.724-0.835	0.870	0.627
Environmental SIP	4	0.768-0.885	0.889	0.668
Social SIP	3	0.753-0.836	0.848	0.650

Note. CR = Composite Reliability; AVE = Average Variance Extracted. SOSIP2 was Dropped Due to a Low Factor Loading. Criteria: Loadings ≥ 0.70, AVE ≥ 0.50, CR Between 0.60 and 0.95 (Hair et al., 2021).

Table 4 Discriminant Validity - Fornell-Larcker Criterion

Construct	1	2	3	4	5	6
1. Digital Transformation	0.814					
2. Economic SIP	0.471	0.792				
3. Environmental SIP	0.465	0.696	0.817			
4. Knowledge Sharing	0.673	0.553	0.566	0.742		
5. Organisational Agility	0.491	0.638	0.598	0.608	0.742	
6. Social SIP	0.471	0.508	0.596	0.495	0.544	0.806

Note. Diagonal Values are the Square Roots of AVE for Each Construct.

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The Fornell–Larcker criterion was satisfied because the square root of AVE for each construct exceeded its correlations with the other constructs.

Discriminant validity was further assessed using the Heterotrait–Monotrait ratio (HTMT), which provides a more sensitive assessment than the Fornell–Larcker criterion in variance-based structural equation modelling (Henseler et al., 2015).

Table 5 Discriminant Validity - Heterotrait-Monotrait (HTMT) Ratio

Construct	1	2	3	4	5	6
1. Digital Transformation	-					
2. Economic SIP	0.555	-				
3. Environmental SIP	0.535	0.849	-			
4. Knowledge Sharing	0.752	0.654	0.656	-		
5. Organisational Agility	0.551	0.760	0.702	0.689	-	
6. Social SIP	0.577	0.654	0.758	0.606	0.684	-

All HTMT values were below 0.90. The highest value was 0.849 between economic and environmental sustainable innovation performance, which is marginally below the more conservative 0.85 threshold. The results therefore provide acceptable evidence of discriminant validity, although the relatively high HTMT value between the economic and environmental dimensions warrants cautious interpretation. Because the three first-order dimensions of sustainable innovation performance are closely related, the higher-order specification should be regarded as provisional pending a fuller higher-order validity assessment.

➢ *Structural Model Assessment*

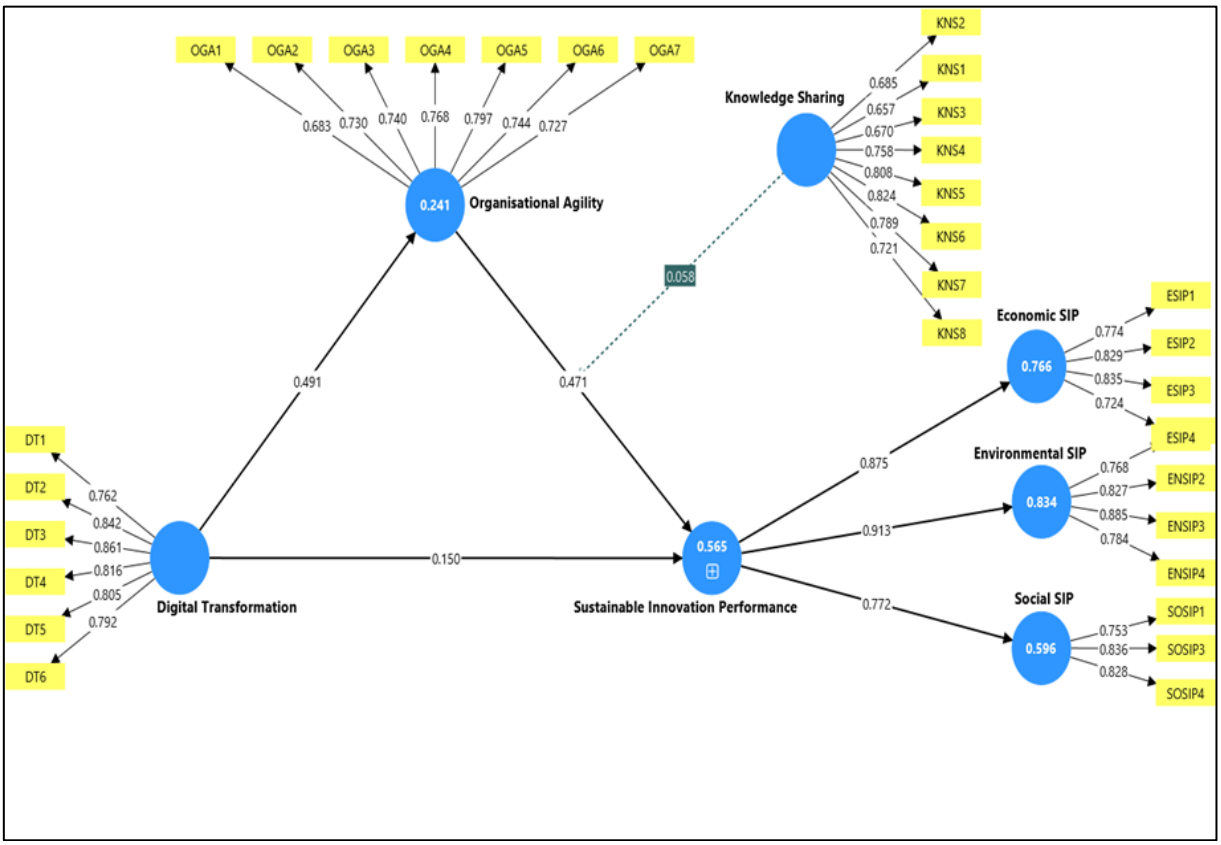

Fig 2 Structural Model Showing Path Coefficients and Indicator Loadings

The structural model was assessed using the coefficient of determination (R^2), effect sizes (f^2), predictive relevance and path coefficients.

Digital transformation explained 24.1% of the variance in organisational agility ($R^2 = 0.241$). Digital transformation and organisational agility jointly explained 56.6% of the variance in sustainable innovation performance ($R^2 = 0.566$).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26nov358

Table 6 R-Square and Effect Size (f^2) Results

Relationship / Construct	R^2	f^2	Magnitude
Organisational Agility	0.241	-	Moderate
Sustainable Innovation Performance	0.566	-	Substantial
Digital Transformation -> Organisational Agility	-	0.318	Moderate
Digital Transformation -> Sustainable Innovation Performance	-	0.028	Small
Knowledge Sharing -> Sustainable Innovation Performance	-	0.058	Small
Organisational Agility -> Sustainable Innovation Performance	-	0.314	Moderate

The effect-size results indicate a moderate contribution of digital transformation to organisational agility and of organisational agility to sustainable innovation performance. The direct contribution of digital transformation to sustainable innovation performance was comparatively small.

The predictive assessment using PLSpredict (Shmueli et al., 2019) produced positive Q^2predict values for the 18 endogenous indicators, ranging from 0.064 to 0.268. PLS-SEM produced lower prediction errors than the linear-model benchmark for 13 of the 18 indicators. Because the majority, but not all, of the indicators showed lower prediction error, the model can be regarded as having medium predictive power (Shmueli et al., 2019). The model also produced an SRMR of 0.067.

➢ *Hypothesis Testing*

Table 7 Direct Path Coefficients

Hyp.	Path	β	SE	t-value	p-value	Decision
H01	DT -> SIP	0.150	0.075	1.984	0.047	Reject H01
H02	DT -> OA	0.491	0.064	7.623	0.000	Reject H02
H03	OA -> SIP	0.471	0.070	6.709	0.000	Reject H03

The results indicate a positive and statistically significant relationship between digital transformation and sustainable innovation performance ($\beta = 0.150$, $p = 0.047$). However, the coefficient is comparatively small and the p-value is close to the conventional 5% significance threshold.

Digital transformation was also positively and significantly related to organisational agility ($\beta = 0.491$, $p < 0.001$). Organisational agility was positively and significantly related to sustainable innovation performance ($\beta = 0.471$, $p < 0.001$).

A sensitivity analysis using the unwinsorised data produced $\beta = 0.143$ and $p = 0.061$ for the digital transformation–sustainable innovation performance relationship. The direct relationship should therefore be interpreted cautiously and replicated with a larger sample.

Table 8 Test for Mediation

Hyp.	Indirect Path	β	SE	t-value	p-value	95% CI	Effect / Decision
H04	DT -> OA -> SIP	0.231	0.049	4.711	0.000	0.142, 0.329	Partial (complementary) mediation, VAF = 60.6%; reject H04

The indirect relationship between digital transformation and sustainable innovation performance through organisational agility was positive and statistically significant ($\beta = 0.231$, $p < 0.001$). The confidence interval did not include zero.

Because both the direct relationship between digital transformation and sustainable innovation performance and the indirect relationship through organisational agility were statistically significant and operated in the same direction, the results indicate complementary partial mediation. The variance accounted for (VAF) was 60.6%.

Table 9 Test for Moderation

Hyp.	Interaction	β	SE	t-value	p-value	95% CI	Decision
H05	KS x OA -> SIP	0.058	0.061	0.946	0.344	-0.052, 0.151	Not rejected (underpowered; power = 0.36)

The interaction between knowledge sharing and organisational agility was positive but not statistically significant ($\beta = 0.058$, $p = 0.344$). The confidence interval included zero.

However, the statistical power of the interaction test was estimated at 0.36. The analysis therefore had limited ability to detect a small interaction effect.

Consequently, the non-significant interaction should be interpreted as inconclusive rather than as evidence that knowledge sharing does not moderate the relationship between organisational agility and sustainable innovation performance.

A post hoc G*Power assessment indicates that approximately 395 observations would be required to detect

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an interaction effect of $f^2 = 0.02$ at 80% power under the specified assumptions.

V. DISCUSSION OF FINDINGS

- *Digital Transformation and Sustainable Innovation Performance*

The study found a positive and statistically significant relationship between digital transformation and sustainable innovation performance ($\beta = 0.150$, $p = 0.047$). Although the coefficient was comparatively small and close to the conventional significance threshold, the finding suggests that greater digital transformation was associated with higher sustainable innovation performance among the sampled manufacturing SMEs.

The result is consistent with the view that digital technologies can support innovation by improving information access, communication, coordination and the ability to modify organisational processes (Fitzgerald et al., 2014; Khin & Ho, 2019). However, the relatively small coefficient indicates that digital transformation alone accounts for only a limited portion of the variation in sustainable innovation performance.

This finding is also consistent with the dynamic-capabilities perspective, which distinguishes between the possession of resources and the organisational capabilities required to deploy and reconfigure those resources effectively (Teece, 2007). Digital technologies may therefore create opportunities for innovation without automatically producing corresponding performance outcomes.

The sensitivity analysis reinforces the need for caution. When the model was re-estimated using unwinsorised data, the relationship was no longer statistically significant ($\beta = 0.143$, $p = 0.061$). The direct relationship should therefore be described as preliminary evidence of a positive association rather than conclusive evidence of a strong relationship.

- *Digital Transformation and Organisational Agility*

Digital transformation had a positive and statistically significant relationship with organisational agility ($\beta = 0.491$, $p < 0.001$). This was the strongest direct relationship in the structural model.

The finding suggests that manufacturing SMEs reporting greater levels of digital transformation also tended to report greater organisational agility. Digital technologies can improve access to information, facilitate communication and support faster coordination, thereby creating conditions that enable firms to respond more readily to changing circumstances.

The finding is consistent with Dynamic Capabilities Theory because digital resources can support sensing and seizing activities, while organisational agility represents a capability through which firms respond to environmental changes (Teece, 2007, 2023). It also aligns with evidence from SMEs in emerging economies showing that organisational agility can connect firm capabilities with performance outcomes (Adomako et al., 2022).

For manufacturing SMEs operating in environments characterised by infrastructure and resource constraints, the relationship between digital transformation and agility is particularly relevant. Digitalisation may provide firms with improved information and coordination mechanisms that support faster organisational responses.

- *Organisational Agility and Sustainable Innovation Performance*

Organisational agility was positively and significantly related to sustainable innovation performance ($\beta = 0.471$, $p < 0.001$). The relationship represents one of the largest direct paths in the model.

The finding indicates that firms reporting greater organisational agility also tended to report higher levels of sustainable innovation performance. Agile firms may be better positioned to modify products and processes, respond to changing customer and market requirements and adjust resource allocation when sustainability-related demands arise.

The finding supports the dynamic-capabilities perspective that organisational adaptation requires more than the possession of resources. Firms also require capabilities that enable them to respond to changing environments. Organisational agility provides one such capability through responsiveness and resource reconfiguration.

The finding also complements the digital transformation result. While digital transformation was strongly associated with organisational agility, organisational agility was itself strongly associated with sustainable innovation performance. This pattern suggests that organisational capability is an important part of the relationship between digital transformation and sustainable innovation outcomes.

- *Mediating Role of Organisational Agility*

Organisational agility significantly mediated the relationship between digital transformation and sustainable innovation performance. The indirect relationship was positive and significant ($\beta = 0.231$, $p < 0.001$), while the VAF of 60.6% indicated complementary partial mediation.

This finding provides support for the proposition that the relationship between digital transformation and sustainable innovation performance is partly transmitted through organisational agility. Digital transformation may provide firms with technological resources and information capabilities, but these resources become more closely associated with innovation performance when the organisation is capable of responding and reconfiguring its activities.

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The result provides empirical support for the application of Dynamic Capabilities Theory to the digital transformation–performance relationship. Rather than treating digital transformation as an isolated technological input, the findings highlight the organisational capability through which digital resources may be translated into adaptive action.

The partial rather than full mediation is also important. Organisational agility does not account for the entire relationship between digital transformation and sustainable innovation performance. Other mechanisms, including digital innovation, organisational learning, technological capability and resource integration, may also help explain the relationship.

- *Moderating Role of Knowledge Sharing*

The interaction between knowledge sharing and organisational agility was not statistically significant ($\beta = 0.058$, $p = 0.344$). On its own, this result would not support the proposed moderating relationship.

However, the interaction test had statistical power of only 0.36. The analysis therefore had limited capacity to detect a small interaction effect. The appropriate interpretation is consequently that the study did not obtain sufficient evidence to establish the moderating role of knowledge sharing, rather than that knowledge sharing has no moderating role.

Two interpretations remain possible.

The first is substantive. Knowledge sharing may not strengthen the relationship between agility and sustainable innovation performance to a meaningful extent in the sampled firms. The existence of knowledge-sharing practices does not necessarily mean that knowledge is systematically recognised, assimilated and applied to organisational problems. This interpretation is consistent with Absorptive Capacity Theory, which distinguishes knowledge acquisition from the capacity to assimilate and exploit knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002).

The second interpretation is methodological. A small interaction effect may exist but remain undetected because of the limited sample size and statistical power. Moderating effects in field studies are typically small and tests of them are frequently underpowered (Aguinis et al., 2005). The reported power assessment indicates that the study had limited capacity to detect a small interaction effect. Therefore, the result should be interpreted as a non-significant moderation effect, rather than as evidence that knowledge sharing cannot moderate the relationship between organisational agility and sustainable innovation performance.

VI. CONCLUSION, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

- *Conclusion*

This study examined the relationships among digital transformation, organisational agility, knowledge sharing and sustainable innovation performance among manufacturing SMEs in Plateau State, Nigeria.

The findings indicate three principal relationships. First, digital transformation was positively and significantly related to organisational agility. Second, organisational agility was positively and significantly related to sustainable innovation performance. Third, organisational agility significantly mediated the relationship between digital transformation and sustainable innovation performance.

The direct relationship between digital transformation and sustainable innovation performance was positive and statistically significant, although relatively small and sensitive to the treatment of the data. This suggests that digital transformation may be associated with sustainable innovation performance, but its relationship with performance is better understood alongside the organisational capabilities through which digital resources are translated into action.

The proposed moderating relationship involving knowledge sharing was not statistically significant. However, the moderation test had relatively low statistical power, which limits the ability to detect a small interaction effect. Accordingly, the finding should not be interpreted as evidence that knowledge sharing cannot condition the relationship between organisational agility and sustainable innovation performance. Further research using a larger and adequately powered sample is warranted to examine this relationship more conclusively.

Overall, the findings highlight organisational agility as an important mechanism connecting digital transformation with sustainable innovation performance among manufacturing SMEs in Plateau State.

- *Theoretical Implications*

The study contributes to the application of Dynamic Capabilities Theory by positioning organisational agility as an organisational capability through which digital transformation is associated with sustainable innovation performance. The significant indirect relationship provides empirical support for the proposition that technological resources alone do not fully explain organisational outcomes.

The study also extends the application of Absorptive Capacity Theory by considering knowledge sharing as a potential boundary condition in the relationship between organisational agility and sustainable innovation performance. Although the proposed moderation was not statistically established, the low power of the test means that the theoretical proposition remains open for further examination.

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The combined use of DCT and ACT therefore provides a framework for examining both the organisational capability associated with digital transformation and the knowledge processes that may shape the translation of agility into innovation outcomes.

➢ *Practical Implications*

For manufacturing SME managers in Plateau State, the findings suggest that investment in digital technologies should be accompanied by deliberate development of organisational agility. The significant relationship between digital transformation and organisational agility indicates that digital tools may be most valuable when firms establish processes that enable information to be accessed, interpreted and translated into timely organisational responses.

Managers should therefore complement digital investment with flexible decision-making structures, employee digital-skills development, responsive operational processes and mechanisms for reallocating resources when market, technological or customer conditions change. Particular attention should be given to ensuring that digital information is not merely collected but is used to support timely decisions and operational adjustments.

The significant relationship between organisational agility and sustainable innovation performance further suggests that firms should treat adaptability as an organisational capability rather than simply as a consequence of technology adoption. Manufacturing SMEs can strengthen this capability by encouraging rapid problem-solving, cross-functional collaboration, experimentation and periodic review of production and business processes.

The findings also suggest that knowledge-sharing practices should be viewed in terms of their quality and application rather than their mere existence. Managers may therefore benefit from mechanisms through which employees can share operational experience, technical knowledge and information about emerging customer or market requirements. However, because the present study did not establish a statistically significant moderating effect of knowledge sharing, these measures should be regarded as managerial recommendations rather than as evidence of a confirmed moderation mechanism.

➢ *Policy Implications*

The findings have implications for policies aimed at strengthening the digitalisation, organisational capability and sustainable competitiveness of manufacturing SMEs in Plateau State.

First, SME digitalisation programmes should extend beyond the provision or subsidisation of digital technologies to include organisational-capability development. Training and support interventions should incorporate digital skills, data-driven decision-making, process improvement, organisational responsiveness and change-management capabilities. This is particularly relevant given the positive relationship observed between digital transformation and organisational agility, and between organisational agility and sustainable innovation performance.

Second, SME support institutions and policymakers should promote interventions that enable firms to translate digital resources into improved operational coordination, responsiveness and innovation. Rather than treating technology acquisition as an end in itself, policy support should encourage firms to develop the managerial and organisational capabilities required to integrate digital technologies into business processes and decision-making. This could include digital advisory services, capability-building programmes, technology adoption support and practical assistance for process digitalisation.

Third, policies aimed at promoting sustainable innovation should encourage manufacturing SMEs to pursue innovation outcomes that extend beyond short-term economic performance to include environmental and social considerations. Such support could include technical assistance, sustainability-oriented innovation programmes, resource-efficiency initiatives, and access to information on appropriate technologies and sustainable production practices. This would help align digital and innovation policies with broader sustainable development objectives.

Finally, although the moderation test for knowledge sharing was inconclusive, the presence of knowledge-sharing mechanisms should not, by itself, be assumed to strengthen the relationship between organisational agility and sustainable innovation performance. Policy interventions should therefore place greater emphasis on the quality, relevance, accessibility and practical application of knowledge. SME support programmes may benefit from peer-learning platforms, industry networks, technical communities and other mechanisms that facilitate the transfer, adaptation and application of knowledge to firm-level innovation challenges.

➢ *Limitations and Future Research*

This study has several principal limitations.

First, although 378 questionnaires were targeted, only 289 were retrieved and 152 were retained as valid for analysis. The analytical sample was therefore smaller than the determined sample and slightly below the 160 observations indicated by the inverse-square-root power assessment. More importantly, the moderation analysis had an estimated statistical power of approximately 0.36. Although the interaction between knowledge sharing and organisational agility was not statistically significant, the relatively low power limits the ability to detect a small interaction effect. Future studies should therefore employ a larger and adequately powered sample, potentially extending data collection beyond Plateau State to the wider North Central Nigeria region, to improve the detection of interaction effects and assess the generalisability of the findings. In addition, 137 of the 289 retrieved questionnaires (47.4%) were excluded at screening, which may introduce selection bias, and the direct path from digital transformation to sustainable innovation performance was

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sensitive to data treatment (p = 0.047 with winsorised data and p = 0.061 without), so it should be regarded as preliminary.

Second, the study employed a single-source, cross-sectional survey design. Although procedural controls and statistical assessments were used to examine potential common method bias, the design does not establish temporal ordering or causal relationships. Future research could employ longitudinal or time-lagged designs, with digital transformation measured at an earlier point and organisational agility, knowledge sharing and sustainable innovation performance measured subsequently. Multi-source data could also be incorporated to strengthen the robustness of the findings and reduce reliance on single-source self-reported measures.

Future studies could further examine whether other organisational capabilities, such as digital innovation capability, organisational learning, absorptive capacity and technological capability, explain additional variation in the relationship between digital transformation and sustainable innovation performance. Multi-group analyses could also compare small and medium-sized enterprises or firms across geographical contexts to determine whether the structural relationships vary by firm size or location. With a sufficiently larger sample, future research could additionally re-estimate the structural model using covariance-based SEM (CB-SEM) alongside PLS-SEM as a complementary confirmatory robustness assessment, provided that the assumptions and sample requirements of the alternative approach are adequately satisfied.

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