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Digital Trade Infrastructure and Asset Utilisation of Manufacturing Industry in Nigeria

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Abstract

This study investigated the effects of digital trade infrastructure measured by e-governance (EG), digital services (DS), data management cost (DMC), and an aggregate Digital Trade Infrastructure (DTI) index on asset utilisation, proxies by the Capacity Utilization Rate (CUR), in the Nigerian manufacturing sector from 1986 to 2025. The study Employed an ex-post facto research design with data from the CBN, NBS, and World Bank, from 1986-2025. The study result revealed that digital services exert a significant short-run positive effect ($\beta = 0.002$, $p = 0.046$), the true operational impact lies in their collective integration; joint Wald coefficient restriction tests confirmed an exceptionally powerful, highly significant joint impact on physical asset efficiency on long-run capital output efficiency (CUR: Chi'-sq. = 350.48, $p = 0.0000$) and a significant collective driver for short-run production scaling (CUR: Chi'-sq. = 5.80, $p = 0.0160$). Crucially, however, the long-run estimations exposed a severe technological cost-trap, where high inflationary Data Management Costs (DMC) exert a significant negative impact (coefficient = -0.7741) by diverting critical working capital away from raw materials and factory maintenance to sustain basic digital networks. The study concluded that while collective digital connectivity is vital for optimizing plant output, unmitigated technology costs actively starve the production floor; hence, it is recommended that the Federal Government of Nigeria, through the NCC and the Federal Ministry of Communications, Innovation and Digital Economy, accelerate the National Broadband Plan by introducing targeted data tariff subsidies and prioritizing infrastructure deployment directly within industrial clusters and manufacturing zones.

Keywords; Digital trade infrastructure, capacity utilization rate, e-governance, digital services, data management,

1.0 Introduction

The asset utilisation of manufacturing sector serves as primary engine for sustainable economic growth, structural transformation and wealth creation (Prabhakar, 2024). Globally manufacturing transformation and asset utilisation is increasingly defined by transition towards industry where the integration of digital system into production process dictate a nation competitive edge (Voskerichyan & Baiming, 2024). In advance economy like Germany, United State and Japan, high level of industrial output are no longer depend on physical labour or traditional machinery, rather they are driving by seamless convergence of physical production and digital trade infrastructure. The ability to process real-time trade data, utilise automated logistics and engage in cross border e- commerce has become the bench mark for industrial excellent, allow developed nation to maintained dominance share of global value chain (Ferreira & Reis, 2023).

Putrevu and Mertzanis (2024) affirmed that in developed nations, the evolution of digital trade infrastructure comprising high speed broadband, secure digital payment gate ways and paperless custom system, and has basically lower the cost of doing business. Countries within

European Union and North America have leveraged these tools to synchronise their manufacturing supply chain, ensuring that asset utilisation is supported by transparent digitalised trade rout. This digital advancement has allow manufacturing sector to remain resilience even during global supply shock as digital platforms facilitate rapid pivots to alternative suppliers and markets (Mishra et al., 2025). Consequently in this regions, the synergy between digital trade tools and factory floor asset utilisation is proofing catalyst to maintain high GDP contribution from the industrial sector.

However, the narrative in developing economies present a mixture of rapid catch up and persistence structural bottlenecks. Many nations in South East Asia and Latin America have made significant strides by investing in soft infrastructure to complement their industrial zone (Palma & Pincus, 2024). By adopting national digitalisation strategies, these countries have enabled their local manufacturers to plug into global markets more effectively. For many other developing nations a digital divide remains. While there is a growing realisation that manufacturing cannot drive in isolation from digital trade advancements, the cost of data, inconsistence power supply for digital hubs, and fragmented regulatory frameworks for electronics transactions often stifle the potential asset utilisation gains that digitalisation promises (Hauge, 2023 & Ojo et al., 2025).

In Nigeria context, the manufacturing industry has been historically been viewed as the giant with clay feet (Ezedinachi, 2023). In spite of various industrialisation policies the sector contribution to Nigeria GDP has remain underwhelming frequently hovering below 10% while the Nigeria government has recently emphasised the digital economy through various National broadband plan (Jacob & Umoh, 2025). The practical application of these digital tools within the trade and manufacturing nexus remain of the fastest growing tech ecosystem in Africa yet they remained burdened by manual port processes, limited access to real- time global market data, and a digital infrastructure that is largely concentrated in urban service hubs rather than industrial clusters (Agbeyangi, et al., 2024).

Despite the global shift toward digitalised industrialisation, Nigeria's manufacturing industry continues to grapple with stagnant asset utilisation and soaring operational costs (Jacob & Umoh, 2025& Owoeye et al., 2024). Data from the National Bureau of Statistics (NBS) underscores this stagnation, revealing that manufacturing's contribution to Nigeria's Gross Domestic Product (GDP) has historically hovered underperforming around 9.5% to 14.6%, severely constrained by structural inefficiencies and under-capacity operations. According to industrial assessments by the Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA), average capacity and asset utilization within the domestic manufacturing sector remains suboptimal frequently suppressed by an over-reliance on self-generated energy, which accounts for up to 70% of total operational costs. The fundamental problem lies in the widening gap between the available digital trade architecture and its actual integration into the manufacturing value chain, while the world moves toward paperless trading and integrated digital logistics (Wang et al., 2024). Nigerian manufacturers are often hindered by bureaucratic bottlenecks at the borders, inefficient digital payment verification protocols for raw material imports, and a critical lack of the reliable, high-speed connectivity required for modern, agile supply chain management.

Jin and Pan (2025) found that digital lag creates an asset utilisation trap where local firms cannot compete with cheaper, more efficiently produced imports. The existing studies such as (Olakunle, 2023; Oshinowo, et al., 2025; Azu, et al., 2025; Zhang, et al., 2023; Chen, et al., 2026) has extensively debated the drivers of asset utilisation growth, with numerous studies

highlighting the general role of physical infrastructure and trade liberalisation in bolstering economic performance. In the Nigeria context, scholars have frequently examined how traditional trade barriers and power supply affect factory output. However, while global discourse has shifted towards the new economy there remain a significant death of empirical evidence specifically linking the various component of digital trade infrastructure such as e-governance, digital service, data management and broadband intensity directly to asset utilisation of Nigeria industry. Without a clear understanding of how this digital variable influence industrial asset utilisation, policy intervention remain speculative. Consequently, to address this vacuum, there is an urgent need to empirically assess the extent to which trade infrastructure affect manufacturing asset utilisation in Nigeria as failure to bridge this digital gap may lead to total de-industrialisation of the Nigeria economy in an increasing global virtual marketplace. However, this study investigated the effect of digital trade infrastructure leverage on e-governance, digital service and data management cost on the asset utilisation of manufacturing industry in Nigeria.

2.0 Literature Review and Hypothesis Development

2.1 Asset utilisation rate

Asset utilization as a foundational performance indicator that measures an asset's actual output against its maximum potential output, typically expressed as a percentage (Brühl, 2023 & Kumar et al., 2025). It sits at the intersection of production efficiency and maintenance strategy, where any equipment that sits idle represents both a capacity loss and a financial cost. Alquraidi and Awad (2024) describe asset utilization as a measure of how efficiently a facility uses its physical assets including machinery, equipment, and space to generate revenue or achieve its intended purpose. High utilization indicates that investments are effectively employed to support operational processes and service delivery (Nyangoma et al., 2024; Kelly et al. (2023)). In the study, asset Utilisation refers to the metric that evaluates how effectively a manufacturing firm deploys its physical and intangible resources (such as machinery, technology, and trade infrastructure) to generate maximum output and economic value. It represents the ratio between the actual production achieved and the potential capacity of the assets owned.

2.2 Digital trade infrastructure

(Das, 2024) define digital trade infrastructure as the combination of broadband penetration, affordable cloud access, and harmonized data-governance regimes. It is the essential "lifeblood" of the global economy that allows data to act as both a means of production and a tradable asset within global value chains. Also, Mehmood et al. (2025) and Andersen & Pold, (2023) describe digital trade Infrastructure (DTI), as foundational digital building blocks such as digital identity, electronic signatures, and secure payment systems that enable public and private service providers to innovate and roll out cross-border services at a societal scale. In the context of the Nigerian manufacturing industry, this study defines digital Trade Infrastructure as the degree to which domestic firms are integrated into global markets through digital technologies. It is the technical and regulatory framework that determines whether a Nigerian manufacturer can move from digitally ordered transactions to digitally delivered efficiency, reducing the reliance on manual processes and physical logistics.

The measurement of digital trade infrastructure in this study is operationalized through the costs associated with e-governance, digital services, and data management. e-governance measure with development index (EGDI); (0–1),digital services measure with internet users (% of Pop.) i.e percentage of the total population who have access to and use the internet

reflecting the state of online service delivery while data management measure with Secure Internet Servers per mn (Per Million) at cost. This variable measures the infrastructure's ability to facilitate digitally ordered exports, where data management costs are used to measure the infrastructure's sophistication focusing on the expenses related to real-time trade data processing, cybersecurity, and predictive analytics. High data management costs, when paired with low asset utilization, indicate an infrastructure gap where the manufacturer is paying for digital tools but lacks the underlying network stability (such as reliable broadband or power) to fully capture their value. Together, these three cost indicators provide a comprehensive view of how digital infrastructure either accelerates or hinders the competitive edge of Nigerian manufacturers in the global marketplace.

Sharmin and Chowdhury (2025) study digital transformation in governance: The impact of e-governance on public administration and transparency. Integrates qualitative content analysis of global policy documents with a quantitative survey administered to a sample of policymakers and public the study identifies that transparency is heightened through blockchain-based systems and open data policies, which effectively mitigate corruption. However, the results also highlight critical barriers to success, including the digital divide, cybersecurity threats, and institutional resistance, suggesting that while technologies like AI and big data are the future of governance, they require robust legal and ethical frameworks to be truly effective administrators. Away from the reviewed study, this study move beyond identifying general institutional barriers by quantifying the specific costs of e-governance, digital services, and data management as measurable drivers of capital efficiency.

Santos et al. (2025) investigate digital transformation in Philippine trade: A narrative review of the role of e-governance in Digital Initiatives. This study utilized a qualitative methodology cantered on a narrative review to examine the impact of e-governance on the Philippines' economic development. The research technique involves an extensive document review and a case study analy**sis** of the Department of Trade and Industry's (DTI) digital initiatives, specifically highlighting their international collaboration with Singapore's INCIT findings indicate that digital transformation through online business registration and improved data accessibility significantly fosters transparency, efficiency, and inclusivity. The present study addressed a critical gap by linking digital trade infrastructure to the tangible structural transformation and capital output of an emerging African economy rather than general inclusivity.

The study of Li and Wang (2024) adopt a quantitative research methodology to evaluate the competitiveness of China's digital service trade relative to CPTPP member countries. The sample size spans a longitudinal period of 13 years (2010–2022) for trade volume data and 12 years (2010–2021) for influencing factors across all sampled nations. To analyse this data, the researcher utilizes several comparative index techniques, including the Revealed Comparative Advantage (RCA) index, Trade Competitiveness (TC) index, Market Share, and the Michaely Fluctuation Index. The finding**s** revealed that China maintains a relatively high competitive rank among CPTPP nations. Key drivers of competitiveness include trade freedom, government efficiency, broadband penetration, and industry openness. The study move outside national trade freedom and broadband rankings to quantify the internal operational costs of e-governance and data management on production efficiency. This study fills a critical geographical and sectoral gap by examining how these digital drivers trigger structural transformation in an African emerging economy like Nigeria.

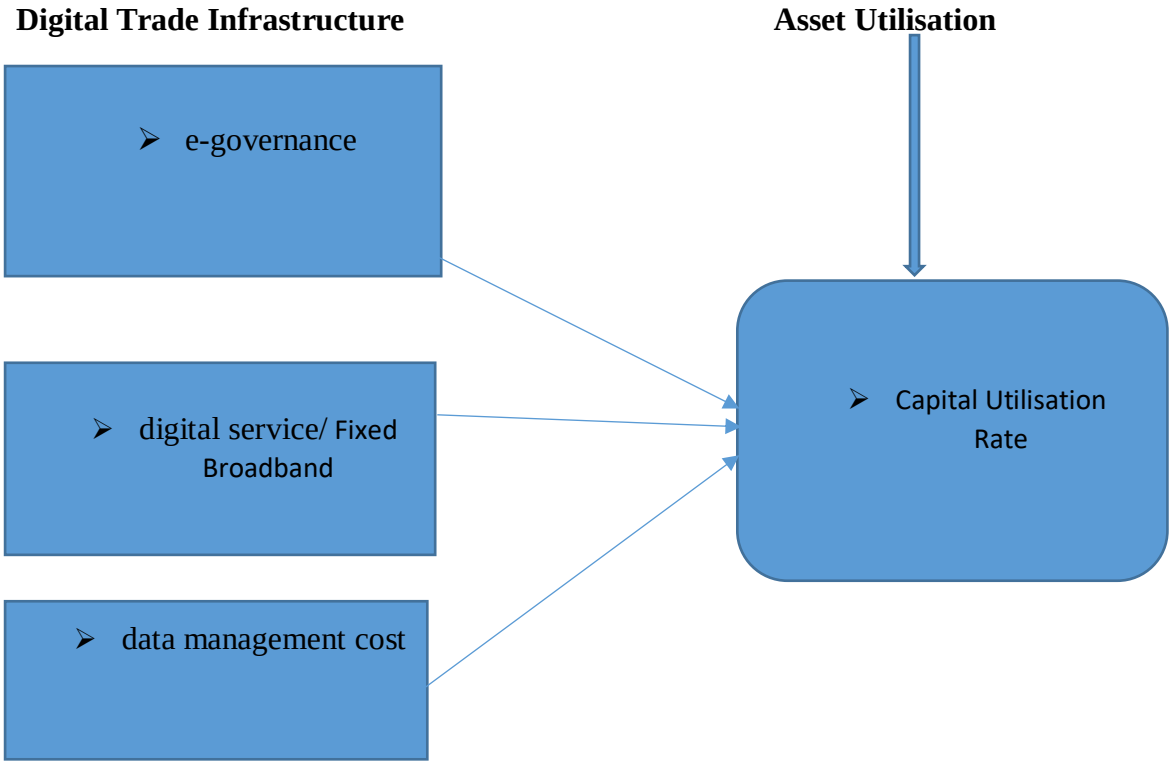
Wang et al. (2025) adopt a quantitative empirical methodology to investigate the relationship between digital infrastructure and trade benefits. The research utilized a trade-in-value-added (TiVA) framework as its primary analytical technique to calculate precise digital trade gains, moving beyond traditional gross trade measures. The study encompassed a bilateral dataset involving China and its global trading partners, focusing on the mechanisms of trade **cost** reduction and innovation enhancement. The findings demonstrated that robust digital infrastructure significantly bolsters China's trade gains, particularly through increased connectivity. This study focus on trade cost reduction to specifically investigate how capital and asset utilisation are affected by the localized costs of e-governance, digital services, and data management.

Mirzaye and Mohiuddin (2025) examined digital transformation in international trade: Opportunities, challenges, and policy implications. Adhering to PRISMA guidelines, the study screened 1,857 records from 2010–2024, ultimately synthesizing 86 high-quality, peer-reviewed studies validated by the Mixed Methods Appraisal Tool (MMAT). The study identifies three core technology clusters e-commerce/cloud services, IoT supply chain solutions, and AI analytics finding that digital maturity can double export intensity for SMEs. However, the findings also highlight a significant digital divide, noting that while AI adoption is surging in East Asia and Northern Europe, firms in lower-income regions struggle with high fixed costs, regulatory fragmentation, and cybersecurity risks. The reviewed study provide a broad systematic review of global digital maturity and export intensity, while this research offers a primary empirical analysis specifically focused on the Nigerian manufacturing sector's internal operations.

Ferracane et al. (2026) examine global trends in digital trade policies and practices: Evidence from the Digital Trade Integration Database. This research introduces the Digital Trade Integration (DTI) database, a comprehensive tool designed to address the critical need for up-to-date regulatory information in the evolving global digital economy. Utilizing a systematic data collection methodology involving a decentralized consortium of partners, the study analysed regulatory policies across 146 countries (based on the 2023 edition). The database organizes these measures into 65 indicators and 12 policy pillars, ranging from ICT goods and online services to data flow and investment regulations. The findings revealed significant global and regional trends, highlighting that while digital trade integration is expanding, it remains hindered by regulatory fragmentation and a widening digital divide between developed and least-developed nations. Here is the hypotheses developed using productivity theory as underlying frameworks;

H_1: *E-governance significantly affect the* asset utilisation *of manufacturing industry in Nigeria.*
H_2: *Digital service significantly and positively affect* asset utilisation *of manufacturing industry in Nigeria.*
H_3: *Data management cost significantly and positively enhance the* asset utilisation *of manufacturing industry in Nigeria.*

2.3 Conceptual Framework



Source: Author's Concept (2026)

2.4. Theoretical Underpinning

2.4.1 Productivity Theory

The Productivity Theory, initially rooted in Adam Smith's 1776 theories on the division of labour, was modernized in 1956 by Robert Solow (and Trevor Swan), who identified technological progress as the primary driver of growth. The theory is built on the assumption that firms act as rational agents aiming to maximize output through the efficient utilization of inputs like labour and capital. In contemporary research, the theory has been applied by authors such as Baccini (2022), who examined how trade competition forces improvements in capital utilization, and Dvouletý and Blažková (2021), who used it to measure firm-level efficiency through total factor productivity (TFP). However, the theory faces limitations and has been criticized for oversimplifying economic realities and struggling to accurately measure total factor productivity; specifically, critics argue the rational actor model often fails in developing economies where institutional factors and poor infrastructure disrupt ideal productivity. This theory is relevant to this work because, in the context of Nigeria's manufacturing sector, digital trade infrastructure such as e-governance and automated customs functions as the technological progress defined by Solow. It justifies the study by shifting the focus from physical factory size to the digital efficiency required to move goods and information in a modern economy.

3.0 Research Method

This study utilized an ex-post facto, explanatory research design to analyse 39 years of pre-existing, non-manipulatable historical data (1986–2025) on digital trade infrastructure and asset utilization in the manufacturing industry in Nigeria. Secondary data on e-governance (EG), digital services (DS), and data management cost (DMC) were sourced from the World Bank's WITS and WDI databases, the Central Bank of Nigeria (CBN), and the National Bureau of Statistics (NBS). Within this framework, advanced time-series estimation techniques, such

as Cointegration, Autoregressive Distributed Lag (ARDL) Bounds testing, and Error Correction Models (ECM), were deployed to trace the dynamic, retrospective effect of digital trade infrastructure on asset utilization over time.

3.1 Model Specifications

The study investigates the effect of digital trade infrastructure (DTI) on the asset utilization of the manufacturing industry in Nigeria. This study adapts the structural framework established by Chen et al. (2025), which examined digital technology innovation in relation to enterprise performance using a baseline linear model:

$ROE = \alpha_o + \alpha_1 DTI + \alpha_2 TOP + \alpha_3 Infixedasset + \alpha_4 Growth + \alpha_5 Dual + \alpha_6 Auditfee + \alpha_7 Cash\ flow + \alpha_8 SOE + \varepsilon$ …….. (1)

To align this framework with a macro-sectoral evaluation within the Nigerian context, the model was structurally modified. Enterprise performance (ROE) is replaced by manufacturing asset utilization, proxied by the Capacity Utilization Rate (CUR). Furthermore, the firm-level corporate governance control variables unique to Chen et al. (2025) were dropped, and the primary digital core was decomposed into three unique infrastructural proxies: E-Governance (EG), Digital Services (DS), and Data Management Cost (DMC). The resulting econometric model is specified as follows:

$CUR_t = (EG, DS, DMC)$

$CUR = \beta_o + \beta_1 EG_t + \beta_2 DS_t + \beta_3 DMC_t + e_t$ ..... (1)

Where:

DTI= Digital trade infrastructure

EG= E- Governance

DS= Digital Service

DMC= Data Management Cost

CUR= Capacity utilisation rate

β_o = constant/intercept.

t = time subscripts (1986-2025)

A-Priori Expectations $\alpha_1 > 0$

Higher levels of digital trade infrastructure are expected to enhance the asset utilisation of the manufacturing industry in Nigeria.

Table 1. Measurement of Variables Table

S/NO	VARIABLE	TYPE	DESCRIPTION	MEASUREMENT	SOURCE
1	Asset utilisation of Manufacturing Industry	Dependent	Level of industrial output efficiency.	Capacity utilization rate	Baccini (2022)
a	Capacity utilization rate	Dependent	actual vs. capacity	% of potential output Standard metric for asset efficiency (CBN/NBS).	(Rabinovich, 2023)
2	Digital trade Infrastructure	Independent	Technological framework for trade.	Secure Servers (per 1m)	Mehmood et al. (2025)
a	E-Governance	Independent	Digitalized public administration and regulatory quality.	Online service index	(Udoh, 2024).

b	**Digital service**	Independent	Reach and penetration of digital networks among the population.	Fixed Broadband Subscriptions.	(Afolabi, et al., 2025).
c	Data Management Cost (DMC)	Independent	Technical backbone and security of digital transactions.	financial tariff/cost	(Trușcules cu & Drăghici, 2023).

The table shows the description, measurement, data source, and literature evidence of the investigated variables.

Source: Author's compilation: 2026

4.0. Descriptive Analysis

This sub-section entails the presentation of the descriptive analysis in the form of summary statistics showing the mean, standard deviation, minimum, and maximum values of each of the variables employed in this study.

Table 2. Summary Statistics: Trade Infrastructure & Proxies

Variable	Mean	Std. Dev.	Min	Max
Digital Trade Infrastructure (DTI)	0.1098	0.1410	0.0000	0.4800
E-Governance (EG)	0.1006	0.1636	0.0000	0.5254
Digital Service (DS)	0.0992	0.1670	0.0000	0.5800
Data Management Cost (DMC)	9.0640	21.1423	0.0000	98.3600

Source: Author's computation: 2026

The Low-Baseline Trap (EG, DS, DMC): All three structural infrastructure metrics exhibit very low mean values (ranging from 0.0992 to 0.1098) and minimum values of 0.0000. This reflects the historical reality of the 1986–2025 data span, which began in an era entirely devoid of digital integration and only slowly transitioned toward modernized frameworks. Even at their historical peaks, none of these indexes crossed the 0.6000 threshold, showing lagging structural development. Extreme Cost Volatility (DMC): Unlike the stable, slow-moving institutional indexes, Data Management Cost (DMC) exhibits massive volatility. It has a standard deviation of 21.1423 nearly double its mean of 9.0640 and a maximum peak of 98.3600. This intense dispersion in DMC signifies that as firms attempted to modernize their trade operations, they faced severe financial shocks. These spikes in information processing expenses were heavily driven by fluctuating exchange rates and the high cost of acquiring technology.

Table 3. Unit Root Test Results: Trade Infrastructure & Proxies

Variable	ADF (Level)	ADF (1st Diff)	PP (Level)	PP (1st Diff)	Decision
Digital Trade Infrastructure (DTI)	-3.622 (0.005)**	—	-3.685 (0.004)**	—	**I(0)**
E-Governance (EG)	-0.708 (0.845)	-5.246 (0.000)**	-0.722 (0.840)	-5.311 (0.000)**	**I(1)**
Digital Service (DS)	-0.371 (0.915)	-6.219 (0.000)**	-0.401 (0.906)	-6.288 (0.000)**	**I(1)**
Data Management Cost (DMC)	1.522 (0.998)	-3.158 (0.024)**	1.610 (0.999)	-3.205 (0.020)**	**I(1)**

*Note: Values in parentheses represent p-values. ** denotes significance at the 5% level, indicating stationarity.*
Source: Author's computation: 2026

4.1. Findings & Econometric Interpretation

The Baseline Index is Stationary at Level, I(0): The aggregate baseline index, Digital Trade Infrastructure (DTI), is uniquely stationary at its raw level ($p < 0.05$). The null hypothesis of a unit root is rejected immediately without differencing. Infrastructure Proxies are Non-Stationary at Level, I(1): In contrast to the baseline index, all individual tech/infrastructure components (EG, DS, and DMC) possess a unit root at their level state ($p > 0.05$). However, they become strictly stationary ($p = 0.000$, 0.024, and 0.020 respectively) after taking their first differences. Methodological Justification: Because the trade infrastructure block shows a mixed integration order with DTI being I(0) and its underlying proxies being I(1), it directly confirms a fractional integration order. This structural heterogeneity provides strong empirical justification for using the Autoregressive Distributed Lag (ARDL) Bounds Testing approach, as traditional cointegration techniques would fail given the mixed orders of integration.

Table 4. Wald Coefficient Restrictions Test

Wald Test Results: Trade Reform (Digital Infrastructure)

Dependent Variable	F-Statistic	Prob. (F-stat)	Chi-Square	Prob. (Chi-Square)	Significance Level
Capacity Utilization Rate (AUR)	350.4839	0.0340	350.4839	0.0000	Highly Significant (**1% level** / ***)
Capacity utilisation rate (CUR)	5.7983	0.1377	5.7983	0.0160	Significant (**5% level** / **)

Source: Author's computation: 2026

4.2. Discussion of Finding

Impact on Physical Asset Efficiency (AUR) The joint impact of digital trade infrastructure on the Asset Utilization Rate is exceptionally powerful. With a Chi-Square probability of 0.0000, the null hypothesis (that digital trade infrastructure has no joint effect on asset utilization) is strongly rejected at the 1% significance level. This mathematically confirms that technological infrastructure forces directly dictate the structural baseline of physical manufacturing capacity, helping to mitigate long-term operational bottlenecks. Impact on Short-Run Industrial Output (CUR) For the Capacity Utilization Rate, the joint Wald test yields a Chi-Square probability of 0.0160, making it statistically significant at the 5% level. This proves that even if individual digital infrastructure components show delayed or staggered impacts in short-run ARDL estimations, their collective integration acts as a vital joint driver of real-time plant operations. This collective significance demonstrates that digital infrastructure directly accelerates the speed at which factories can scale up actual production toward their maximum installed capacity.

The empirical findings reveal that Data Management Cost (DMC), used to measure digital trade infrastructure, acts as a severe structural burden on Nigerian manufacturing performance rather than a friction-free productivity booster. In the long run, higher data costs exert a significant negative impact on the Asset Utilization Rate (coefficient of -0.7741), while also depressing residual profit margins (capacity utilisation). This negative impact occurs because firms are caught in a technological cost-trap. To maintain basic digital networks, broadband connectivity, and cloud infrastructure under inflationary conditions, manufacturers must divert critical working capital away from core physical operations, such as raw material procurement and factory maintenance. Consequently, high data management expenses end up starving the production floor and forcing actual plant operations far below their installed capacity.

This costly reality directly challenges classical New Trade Theory, which assumes that digital adoption naturally eliminates informational asymmetries and lowers transaction costs to build economies of scale. In Nigeria, severe systemic deficits such as an unstable power grid and high baseline network access fees force firms to internalize the costs of structural inefficiencies, turning digital investments into an expensive barrier to scale. This structural drag strongly corroborates domestic and international empirical reviews, such as Joan (2025) and Wang and

Shao (2024), which note that digital integration often introduces massive financial overheads and inhibitory effects during early adoption phases in bottlenecked economies. Conversely, these results diverge from optimized industrial ecosystems like China (e.g., Huilian & Chengwen, 2025), where highly subsidized digital public goods expand manufacturing competitiveness without forcing individual firms to independently fund expensive network replications.

5.0. Conclusion

This study concluded that while digital modernization is theoretically essential for long-term industrial scalability, the high, compounding overhead associated with data management and digital infrastructure maintenance currently functions as a severe structural drag on the Nigerian manufacturing sector. Because firms must implement these frameworks within a fragmented national environment plagued by severe infrastructural deficits, digital integration acts as an administrative liquidity drain rather than a seamless productivity multiplier. This technological cost-trap aggressively extracts vital working capital away from primary production floors starving factories of the funds needed for raw material procurement and equipment maintenance and forces actual plant operations far below their installed capacity. Ultimately, until national digital infrastructure is systematically subsidized or democratized, the high cost of maintaining digital systems will continue to impose an artificial barrier to scale, driving industrial contraction and suppressing physical asset utilization across the manufacturing industry.

5.1 Recommendations

Based on the empirical evidence and statistical findings established in this study, the following targeted policy and industrial recommendations are proposed to optimize the operational capacity of domestic firms and reverse structural deindustrialization:

1. The Ministry of Communications, Innovation, and Digital Economy, in tandem with the Ministry of Industry, Trade and Investment, must abandon fragmented, siloed digital rollouts. Policymakers should design an integrated National Industrial Digitalization Blueprint that simultaneously deploys broadband connectivity, digital payment architectures, and paperless border clearing systems. Because these components only yield maximum capacity acceleration when operating collectively, public-private partnerships (PPPs) should prioritize holistic digital industrial zones where all three pillars are bundled for manufacturing clusters

2. The Federal Government must aggressively pivot from merely encouraging digital adoption to actively subsidizing its structural architecture. Immediate interventions must include implementing capped industrial broadband tariffs specifically for verified manufacturers, offering robust tax rebates/credits on enterprise cloud and data infrastructure investments, and localizing data centres within Nigeria to strip away foreign-exchange-denominated cloud expenses. This will artificially lower digital ecosystem costs and prevent data management expenses from draining vital manufacturing working capital.

3. The government must treat digital infrastructure as a heavily subsidized public good rather than an isolated private corporate expense. The Nigerian Communications Commission (NCC) should collaborate with energy providers to deploy highly resilient, solar-powered or grid-independent industrial digital corridors. By building shared, state-backed digital public utilities, the state can absorb the baseline network access fees, allowing individual

manufacturers to achieve economies of scale without being forced to independently fund structural network redundancy.

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