

ASSESSMENT OF THE IMPACTS OF DIGITALIZATION ON THE EFFICIENCY OF SUPPLY CHAIN FUNCTIONS IN THE RETAIL SECTOR OF TANZANIA. A CASE OF AZAM BAKHRESA GROUP

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Abstract

The study evaluates the effects of digitalization on the efficiency of supply chain functions in the retail sector of Tanzania, specifically focusing on the Azam Bakhresa Group. As technology advances, retail supply chains face increasing demands to incorporate innovations like artificial intelligence, blockchain, the Internet of Things (IoT), and electronic procurement systems, such as TANEPS. The research aims to evaluate how these technologies affect supply chain transparency, efficiency, responsiveness, and overall customer satisfaction in the Tanzanian context. Utilizing a descriptive research design and a mixed-methods approach, the study drew data from 80 respondents, including supply chain professionals, IT specialists, procurement officers, and retail managers, through questionnaires and in-depth interviews. The quantitative data were analyzed using descriptive statistics, while qualitative responses were thematically analyzed to provide depth to the numerical findings. Results indicated a strong consensus on the positive impact of digital tools. Over 95% of respondents recognized that emerging technologies enhance supply chain visibility, accountability, and responsiveness. Notable contributions from digital platforms like blockchain and IoT included real-time monitoring, traceability, and fraud prevention. Additionally, digitalization was found to significantly improve customer satisfaction by facilitating better communication, quicker deliveries, and enhanced inventory accuracy. Digital procurement systems like TANEPS have also been praised for streamlining procurement processes, cutting costs, and fostering transparency. By outlining both strategic advantages and practical results of digital integration, the study offers valuable recommendations for retail firms, policymakers, and technology providers. Retailers are advised to invest in scalable digital solutions, enhance employee digital literacy, and pursue partnerships to improve infrastructure.

Keywords: *Digitalization, Supply Chain Efficiency, Retail Industries, Emerging Technologies*

Introduction

The impact of digitalization on supply chain activities has seen a major shift across the globe. The integration of digital technologies such as the Internet of Things (IoT), blockchain, and cloud computing has revolutionized supply chain management in terms of efficiency, transparency, and responsiveness. For instance, cloud computing enables organizations to forecast demand more accurately, streamline inventory management, and reduce operational costs. The pandemic of COVID-19 largely accelerated the adoption of digital technologies as businesses strove to mitigate disruptions and ensure continuity within their supply chains. Real-time monitoring and data analytics have grown in importance as organizations increasingly depend on them, and they have become essential tools for maintaining supply chain visibility and control of activities (Crawford, 2021).

Digitalization has been keeping up and continuing to reshape supply chain dynamics even after the pandemic, in the post-COVID-19 era. Utilization of automated cargo and passenger screening systems, along with sophisticated surveillance technologies, has greatly enhanced supply chain security and efficiency. Organizations are progressively using digital platforms to drive collaboration with suppliers, optimize logistics, and enhance customer service. The convergence of information technologies has also enhanced the development of sustainable supply chains, enabling companies to monitor and minimize their environmental impact (Martínez et al., 2021).

Although with many advantages, digital transformation is beset with challenges. High expense in terms of rollouts, lack of stakeholder buy-in, and threats to security from cybercrime are some issues confronting organizations as they embark on the integration of digital technology. Furthermore, the accelerated pace of innovation in technologies entails a sustained investment in infrastructure spending, training, and policy changes in keeping abreast of future advancements in terms of staying ahead of the competition (Stevenson & Spring, 2020). It is crucial to overcome these challenges for businesses to reap the full advantages of digitalization in supply chain management.

In the context of Africa, digitization of supply chain management is increasingly speeding up as governments recognize digital technologies' ability to promote economic advancement and growth. The 2020-2030 African Union's Digital Transformation Strategy for Africa is focused on building a digital-powered, knowledge economy, prioritizing innovation, competition, and inclusivity. These strategies recognize digital technologies' crucial ability to improve efficiency, accountability, and transparency in such sectors as health, agriculture, and manufacturing. The application of advanced technologies, including artificial intelligence (AI), the Internet of Things (IoT), and blockchain, is being deployed to improve inventory management, logistics, and traceability in real-time (African Union, 2020).

The implementation of digital technologies in African supply chains is diverse. Whereas some countries have made considerable strides in digitalization, their counterparts lag, having insufficient infrastructure, limited access to the internet, and vulnerabilities to cyber-attacks. For example, Kenya and South Africa have made considerable strides in digital technologies in their supply chain systems, compared to states such as Eritrea, whose access to the internet is relatively low. Bridging such disparities is imperative for unlocking digitalization for all states in Africa (GSMA, 2021). Despite these, there are encouraging signs of progress. The growing use of mobile technologies and access to the internet in Africa creates strong foundations for digital supply chain systems to take hold. For instance, cloud computing is both cost-saving and flexible, hence making it an attractive solution for companies seeking to re-energize their business.

In Tanzania, retail is undergoing massive digitalization, and companies are using digital technologies to optimize their supply chain. The focus on digital development in the country is reflected in their developmental plans, where digital structures and innovative technologies is given priority. The application of digital technologies, such as data analytics, cloud computing, and electronic payment systems, is helping Tanzanian businesses optimize their supply chain, improve their operational efficiencies, and promote better

customer interactions. For example, extensive use of mobile technology makes retailers interact better through mobile sites and applications (GSMA, 2021).

Despite these limitations, digitalization offers strong future benefits to the retail industry in Tanzania. Using digital technologies, businesses have the ability to better manage their supply chain, reduce operating expenditure, and strengthen their market position. The intentional incorporation of such technologies also enhances innovations, enhances supply chain transparency, and leads to data-driven decisions. As Tanzania continues to develop in digitalization, the retail sector is expected to realize enhanced efficiency and effectiveness in their supply chain business (Honoriers, 2021).

Literature Review

Digitalization

Digitalization is the incorporation of digital technologies into business operations to increase efficiency, improve data management, and facilitate real-time decision-making. It includes the application of technologies such as artificial intelligence (AI), the Internet of Things (IoT), block-chain, and cloud computing (Ivanov & Dolgui, 2020). This research explores the effects of digitalization on supply chain processes in the retail sector in Dar es Salaam, with a focus on the potential of these technologies to enhance processes and increase performance.

Supply Chain Efficiency

Supply chain efficiency entails effective management of resources, processes, and activities with the aim of minimizing costs, lead times, and improving overall performance. It encompasses actions such as inventory turnover, order accuracy, and cost reduction (Sarkis et al., 2020). This study examines the role played by digitalization in improving supply chain efficiency by streamlining operations, managing inventories, and improving responsiveness to market demands.

Retail Industries

The retail industry comprises businesses that sell products and services directly to consumers. This sector includes a wide range of categories, such as food and beverages, apparel, electronics, and household items. The retail industry is known for its dynamic characteristics and the necessity for effective supply chain management to satisfy consumer needs. This study focuses to the Azam Bakhresa Group, highlighting its importance as a sector poised to gain significantly from digital advancements. The research explores the impact of digital technologies on supply chain processes within this industry, aiming to enhance efficiency, performance, and customer satisfaction (KPMG, 2020).

Emerging Technologies

Refers to innovative tools such as artificial intelligence (AI), blockchains and the Internet of Things (IoT) that are designed to modernize and optimize supply chain operations. These technologies offer increased capabilities, such as automating routine tasks, providing transparency, and enabling real-time monitoring and communication (Heizer, Render, & Munson, 2021).

Theoretical Review

This section explores the two core theories relevant to digitalization in the field of supply chain management; the Resource-Based View (RBV) and the Dynamic Capabilities Theory.

Resource-Based View (RBV)

The Resource-Based View (RBV) was developed by Jay Barney in 1991. Under this conceptual theory, it was argued that a firm's competitive advantage resides in its distinctive resources and capabilities, which are characterized as having value, and resources (Barney, 1991). In digitalization, RBV argues that the integration of cutting-edge digital technologies can act as a strategic resource that raises the supply chain capability of a firm to drive greater efficiency and performance. By utilizing digital technologies, including artificial intelligence and the Internet of Things, organizations can achieve a competitive advantage via enhanced data management, instantaneous decision-making, and improved operational efficiencies.

The Resource-Based View (RBV) theory is utilized in this research as it offers a robust framework for analyzing how digitalization can foster and maintain competitive advantages in supply chain operations within the retail sector. The RBV underscores the significance of harnessing distinctive resources and capabilities. In this context, digital technologies like artificial intelligence (AI), blockchain, and the Internet of Things (IoT) are identified as essential strategic assets. These technologies embody the RBV's criteria of being valuable, rare, inimitable, and non-substitutable (VRIN), allowing retailers and supply chain stakeholders to enhance efficiency and performance.

Dynamic Capabilities Theory

The Dynamic Capabilities Theory, which was introduced by David Teece in 1997, emphasizes the importance of a company's ability to merge, create, and reconfigure internal and external skills to successfully deal with changing conditions at an accelerating pace (Teece, 1997). This theory is particularly relevant to the process of digitalization, as it highlights the importance of companies constantly adapting and innovating based on technological advancements. This research uses the Dynamic Capabilities Theory to investigate how retail firms in Dar es Salaam can formulate and utilize digital capabilities to improve their supply chain activities, be more responsive, and attain sustainable long-term sustainability.

The Dynamic Capabilities Theory is applied in this study because it offers a robust framework for understanding how retail firms in Dar es Salaam can effectively adapt to the challenges and opportunities presented by digitalization. In a rapidly evolving technological landscape, the theory emphasizes a firm's ability to merge, create, and reconfigure its resources and competencies to remain competitive. This aligns directly with the aim of this research, which seeks to investigate how digital tools and capabilities are utilized by retail firms to enhance supply chain operations, improve responsiveness, and achieve long-term sustainability.

Empirical Review

Studies from Developed Countries

The effects of digitalization on supply chain operations have been thoroughly examined in developed nations, yielding significant insights into its transformative capabilities. Research from the United States and Europe, for example, illustrates how innovative

technologies like Artificial Intelligence (AI), Blockchain, and the Internet of Things (IoT) have fundamentally changed supply chain management. A study by Wang et al. (2022) revealed that AI-driven predictive analytics greatly improve the accuracy of demand forecasting, which in turn lowers inventory costs and enhances operational efficiency. Likewise, blockchain technology has been proven to foster transparency and trust among supply chain participants by offering secure, tamper-resistant transaction records.

Furthermore, research from developed countries highlights the contribution of digital tools to improving customer satisfaction. A study in Germany by Müller and Schmid (2021) found that real-time inventory management systems and automated order processing solutions enable quicker order fulfillment and reduce stockouts, leading to increased customer retention. These insights underscore the importance of integrating digital technologies into supply chain operations to meet evolving consumer demands.

Automated procurement systems have been a significant subject of empirical research in developed nations. A study conducted by Johnson et al. (2020) in Canada found that these systems enhance procurement processes, lower administrative expenses, and boost supplier compliance. The research indicated that organizations utilizing automated procurement platforms achieved a 30% decrease in procurement cycle times, showcasing the efficiency improvements that digitalization can bring.

However, despite these advancements, challenges in adopting digital technologies within supply chains persist, even in developed countries. For example, Smith and Brown (2019) conducted a study in the United Kingdom that revealed high implementation costs and employee resistance to change as barriers to the adoption of digital solutions. These obstacles underscore the importance of strategic planning and stakeholder involvement to facilitate successful digital transformation.

Studies from Developing Countries

Investigations in developing countries have shown that digitalization can greatly improve supply chain operations, despite the specific challenges these regions encounter. In Kenya, a study focused on the Port of Mombasa revealed that the use of integrated port management systems significantly boosted cargo handling efficiency and minimized delays (Otieno et al., 2022). The application of real-time data analysis and automated scheduling tools resulted in a 15% increase in cargo throughput and a 20% reduction in vessel idle time, showcasing the potential of digital technologies to enhance port operations.

In Nigeria, e-commerce technologies have played a crucial role in streamlining trade processes and increasing transparency. A study found that electronic documentation and online tracking systems considerably shortened the time needed for cargo clearance and improved communication among stakeholders (Adewumi & Ajayi, 2023). The adoption of these digital solutions led to a 30% decrease in average clearance times and a 25% rise in customer satisfaction, underscoring the advantages of digitalization for supply chain efficiency in developing countries.

In South Africa, the implementation of automated cargo handling systems has significantly improved cargo throughput and minimized turnaround times. Research indicates that automating container handling processes has led to a 20% increase in handling capacity and a 15% decrease in operational costs (Mabasa & Kweyu, 2021). These results highlight the critical need for ongoing investment in digital infrastructure to boost supply chain efficiency and competitiveness in developing nations.

A study conducted at the Port of Lagos in Nigeria explored the effects of advanced security technologies on port efficiency. The findings revealed that the adoption of biometric access control and surveillance systems improved the security of port facilities and decreased incidents of theft and vandalism (Obi & Okeke, 2023). These enhancements in security have fostered a safer and more efficient working environment, illustrating the advantages of integrating digital technologies into supply chain operations.

Local Studies on the Impact of Digitalization on Supply Chain Operations in the Retail Sector in Tanzania

Research conducted within Tanzania has illustrated the beneficial effects of digitalization on supply chain operations. One investigation focused on the influence of AI-driven supply chain software in lowering shipping expenses, revealing that predictive maintenance and dynamic routing contributed to substantial cost reductions by minimizing unplanned downtimes, decreasing fuel usage, and prolonging the lifespan of vehicles (Dayar & Mwendapole, 2024).

Additionally, a study examining the digitalization of procurement processes at the Tanzania Electric Supply Company Limited (TANESCO) uncovered challenges such as insufficient improvements in vendor relationships and a pressing need for greater transparency. The findings suggested that ongoing digitalization initiatives are essential to fully realize benefits and enhance procurement efficiency (Kiula & Kinisa, 2023).

Further research into supply chain practices among Tanzanian small and medium-sized enterprises (SMEs) emphasized the necessity of addressing technical obstacles, improving communication with suppliers, and securing better government support to boost supply chain efficiency (Kumar, 2019). These studies highlight the critical need for focused interventions and investments in digital technologies to optimize supply chain operations within Tanzania's retail industry.

In Tanzania, the retail sector is increasingly adopting digital technologies to enhance supply chain operations; however, there is a scarcity of local empirical studies that evaluate its effects. A significant aspect of this digital transformation is inventory management. Research by Mjema et al. (2020) indicates that retailers in Tanzania are progressively utilizing digital solutions, such as cloud-based inventory management systems, to improve stock control and minimize inefficiencies. These systems allow businesses in Dar es Salaam to optimize inventory turnover, decrease stock-out occurrences, and enhance their responsiveness to market needs. As a result, inventory efficiency has improved, enabling businesses to monitor stock levels more effectively and restock items promptly, which contributes to increased customer satisfaction and better operational performance.

Regarding supplier collaboration, the adoption of digital platforms is crucial for improving communication and streamlining order fulfillment. A study conducted by Lwakatare et al. (2021) explored the effectiveness of digital platforms in fostering collaboration between Tanzanian retailers and their suppliers, particularly through the implementation of Enterprise Resource Planning (ERP) systems. The findings revealed that retailers in Dar es Salaam utilizing these platforms experienced quicker order processing, shorter lead times, and more consistent and accurate communication with suppliers, leading to more efficient order fulfillment. This not only optimized stock availability but also minimized late deliveries, thereby enhancing the overall supply chain performance and strengthening supplier relationships, which is essential for the success of retail businesses in a competitive landscape.

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Research Gap

The adoption of digital technology in supply chain operations within the retail sector has been widely researched around the world, showing benefits like improved efficiency, better customer satisfaction, and lower costs. For instance, studies by Mjema et al. (2020) highlight how new digital tools such as AI, Blockchain, and IoT can enhance supply chain transparency and responsiveness. However, there is limited research specifically targeting the retail sector in Tanzania, especially in Azam Bakhresa Group. Most existing studies tend to generalize findings from other areas and do not consider the specific challenges Tanzania faces, such as poor infrastructure, gaps in technological knowledge, and resistance to change. This study aims to address this gap by examining how these technologies can be applied in the Tanzanian retail context.

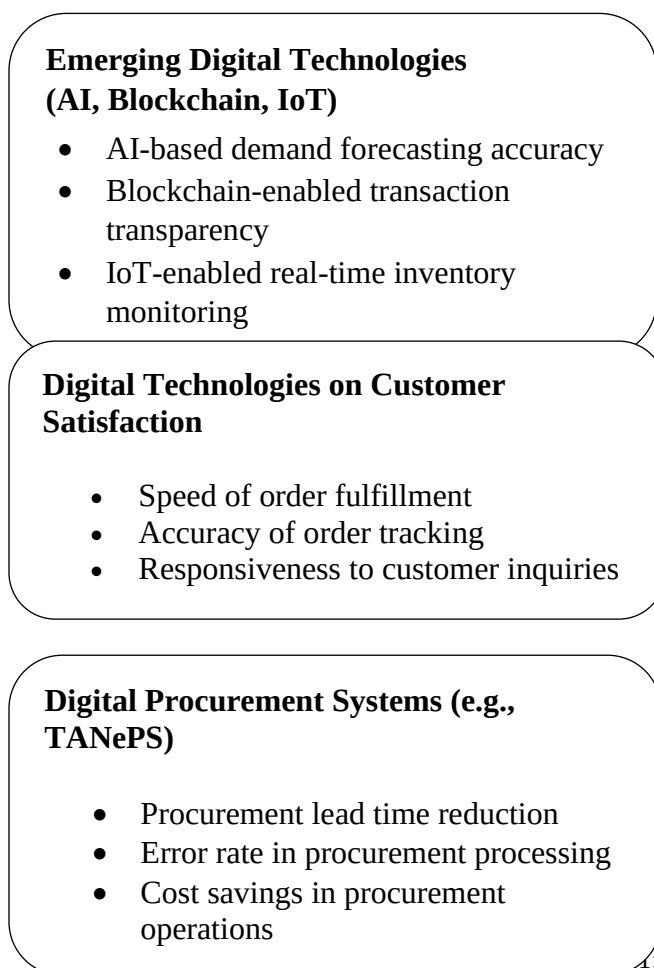
Moreover, while retailers play a crucial role in adopting digital technologies in supply chains, their specific strategies and contributions in Tanzania are not well understood. Research by Lwakatare *et al.* (2021) indicates that tools for real-time inventory management and digital customer engagement can greatly enhance supply chain responsiveness and customer satisfaction. Despite these findings, there is a lack of information on how Tanzanian retailers are using these technologies to meet unique consumer needs and improve operational efficiency. This highlights the need for a thorough investigation of digital initiatives led by retailers, focusing on their impact on supply chain performance and their ability to tackle local challenges.

Automated digital procurement systems, like TANePS, have demonstrated effective results in improving procurement processes, as shown in studies such as Nchimbi and Ngowi (2020), which report shorter cycle times and better supplier compliance. However, the retail sector in Tanzania has been slow to adopt TANePS, with most research focusing on public-sector procurement. The specific needs of the retail industry, such as quicker order fulfillment and cost efficiency, have not been adequately explored in existing studies. This research aims to fill this gap by assessing how TANePS and similar systems can be tailored for the retail environment, offering practical insights into their potential advantages.

This study tackles these research gaps by examining the impact of new digital technologies, retailers, and automated procurement systems on enhancing supply chain operations in Azam Bakhresa Group. It uses both quantitative and qualitative approaches to provide a detailed understanding of the challenges, opportunities, and strategies for digitalization in Tanzania's retail sector. By situating the findings within the context of Tanzania, the study provides actionable recommendations for stakeholders to address challenges and effectively utilize digital solutions, contributing to both academic knowledge and practical applications.

Conceptual Framework

Independent Variables



Dependent Variables

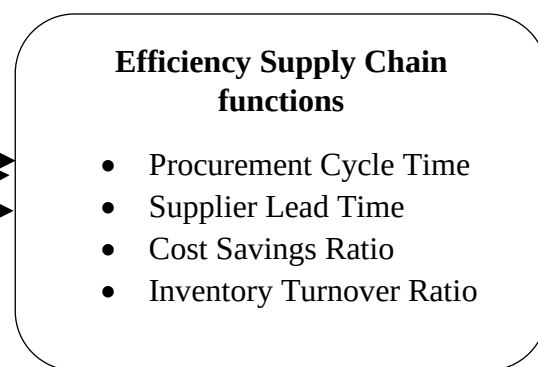


Figure 1: Conceptual Framework

Source: Author illustration (2025)

Methodology

This research employed a mixed-methods approach to assess the impact of digitalization on supply chain operations within the retail sector in Tanzania, specifically focusing on the Azam Bakhresa Group. The methodology integrated quantitative techniques, including structured surveys and secondary data analysis, with qualitative methods such as semi-structured interviews, focus group discussions, and documentary reviews. By incorporating both deductive reasoning to evaluate existing theories and inductive reasoning to formulate new insights, the study effectively captured both measurable outcomes and stakeholder experiences, thereby providing a comprehensive understanding of the effects of digitalization.

A descriptive research design was implemented to examine the integration of digital technologies, including artificial intelligence, blockchain, the Internet of Things, and automated procurement systems, such as TANEPS, within supply chains. The selection of the study area was strategic, given Azam Bakhresa Group's leadership in digital transformation within Tanzania and its significant influence in retail and supply chain activities, rendering it an appropriate case for analyzing both the opportunities and challenges associated with digital adoption. The target population included 100 individuals, comprising retailers, suppliers, IT officials, TANEPS officials, and technology providers. The final sample size of 80 respondents was determined using Yamane's formula, aiming for a 95% confidence level and a 5% margin of error. Stratified and purposive sampling techniques were applied to ensure balanced representation across various stakeholder groups.

Data collection involved a combination of primary and secondary methods. Primary data were obtained through questionnaires and interviews conducted with supply chain managers, ICT staff, logistics officers, and technology providers, while secondary data were sourced from company reports, performance reviews, and policy documents. The questionnaires provided quantitative insights regarding efficiency and satisfaction metrics, whereas the interviews offered in-depth perspectives on challenges encountered and experiences shared. The integration of these methods enhanced the richness of the data and facilitated triangulation, thereby improving the validity of the findings. Data analysis was conducted utilizing SPSS version 28 for both descriptive and regression analysis; qualitative data were examined thematically to identify significant patterns and themes.

Reliability and validity were assured through pilot testing of research instruments, triangulation of multiple data sources, and alignment with established theoretical frameworks. Cronbach's alpha values and factor analysis further confirmed the reliability and appropriateness of the research instruments. Ethical considerations were meticulously observed by obtaining informed consent, ensuring confidentiality and anonymity, and securing approval from relevant authorities. Participants were made aware of their right to withdraw at any point during the study, and data integrity was upheld through precise reporting and proper citation of sources. These methodological choices significantly enhanced the credibility, reliability, and ethical foundation of the research.

Research Results

Table 1: Adoption of AI, Blockchain, and IoT in TANEPS

Statement	SA (%)	A (%)	N (%)	D (%)	SD (%)
AI improves efficiency in customs clearance.	35.0	42.5	10.0	7.5	5.0

Blockchain enhances transparency in procurement transactions.	32.5	40.0	12.5	10.0	5.0
IoT strengthens real-time monitoring of cross-border logistics.	30.0	45.0	10.0	10.0	5.0

Source: Field Data (2025)

Table 1 illustrates how respondents view the integration of new digital technologies such as AI, blockchain, and IoT within TANEPS. A significant number of respondents either strongly agreed or agreed that AI enhances customs clearance efficiency (77.5%), that blockchain improves transparency in procurement transactions (72.5%), and that IoT supports real-time monitoring of cross-border logistics (75%). These findings reflect a strong endorsement of digital technologies from key stakeholders and indicate that these tools are regarded as effective in improving procurement efficiency and operational transparency. The descriptive statistics suggest that AI, blockchain, and IoT have become crucial elements in the modernization of TANEPS. The high levels of agreement indicate that stakeholders acknowledge the concrete advantages of these technologies in optimizing processes, minimizing errors, and boosting the reliability of procurement and logistics functions. This favorable perception creates a foundation for further investment in digital innovations, highlighting that successful implementation relies not only on technical aspects but also on gaining stakeholder trust and engagement with the system.

Table 2: Customer Satisfaction with TANEPS

Statement	SA (%)	A (%)	N (%)	D (%)	SD (%)
TANEPS reduces procurement delays.	33.0	40.0	12.5	10.0	4.5
TANEPS improves transparency in supplier selection.	30.0	42.5	12.5	10.0	5.0
TANEPS increases satisfaction with government procurement processes.	28.0	45.0	15.0	7.0	5.0

Source: Field Data (2025)

Table 2, illustrates how respondents perceive customer satisfaction with TANEPS operations. A majority of respondents either agreed or strongly agreed that TANEPS helps to minimize procurement delays (73%), enhances transparency in the selection of suppliers (72.5%), and boosts overall satisfaction with government procurement processes (73%). These findings suggest that TANEPS has a positive effect on the user experience, leading to quicker procurement cycles, a fairer evaluation of suppliers, and increased trust in government-managed procurement. The results emphasize the connection between the efficiency of digital systems and user satisfaction. By tackling issues related to delays and transparency, TANEPS strengthens stakeholders' trust in procurement processes, promoting broader adoption and more active participation. The findings indicate that when digital technologies are incorporated effectively, they not only elevate operational efficiency but also foster a more favorable perception among users, thus enhancing the system's overall impact on procurement performance.

Inferential Analysis

Regression and ANOVA were conducted to examine relationships between digital technology adoption (AI, Blockchain, IoT), customer satisfaction, and efficiency of TANEPS.

Table 3: Regression Analysis Results

Variable	Coefficient (β)	Std. Error	t-value	Sig. (p)
AI Adoption	0.412	0.085	4.85	0.000
Blockchain Adoption	0.365	0.078	4.68	0.000
IoT Adoption	0.298	0.082	3.63	0.001
Customer Satisfaction	0.441	0.090	4.90	0.000
$R^2 = 0.721$, $F(4,75)=48.62$, $p<0.001$				

Source: Field Data (2025)

Table 3, presents the regression analysis results examining the influence of AI, blockchain, IoT adoption, and customer satisfaction on TANEPS efficiency. All variables have positive and statistically significant coefficients: AI ($\beta=0.412$), blockchain ($\beta=0.365$), IoT ($\beta=0.298$), and customer satisfaction ($\beta=0.441$), with p-values less than 0.05. This indicates that higher adoption of these technologies and improved customer satisfaction significantly enhance the efficiency of TANEPS operations. The model explains 72.1% of the variance ($R^2=0.721$), suggesting that these factors strongly predict system efficiency. These results underscore the critical role of both technological and human-centric factors in digital procurement systems. While AI, blockchain, and IoT enhance operational capabilities, customer satisfaction serves as a complementary factor that drives system effectiveness through better acceptance and usage. The high explanatory power of the model indicates that focusing on technological adoption alongside user experience can significantly improve efficiency in automated procurement systems, reinforcing the study's argument for integrated digital strategies in public sector procurement.

Data Validity

Data validity confirms that the instrument effectively measures its intended target. In this research, construct validity was demonstrated through the clear correspondence between survey questions and the conceptual framework of digital technologies in supply chain management. Each entry, corresponds to a specific dimension of digital performance, including transparency, responsiveness, efficiency, and customer satisfaction, thus reinforcing the internal structure. Moreover, content validity was improved by integrating well-established constructs from recent literature (Sabeti et al., 2020; Kamble et al., 2020; Ivanov et al., 2021). The survey's design was guided by an extensive review of peer-reviewed articles and expert interviews, ensuring that relevant and comprehensive content was evaluated.

Data Reliability

Data reliability refers to the extent to which a measurement instrument remains consistent over time and across various contexts. In this research, the internal consistency reliability was evaluated using Cronbach's Alpha (α). A reliability assessment was conducted across various survey dimensions (technology impact, inventory accuracy, procurement automation, and customer satisfaction), yielding an

average Cronbach's Alpha of $\alpha = 0.87$, which exceeds the acceptable threshold of 0.70 (Nunnally & Bernstein, 2020). This signifies a strong level of reliability in the instrument, indicating that the items assessing the same constructs are closely connected.

Table 4: Internal Consistency of reliability

Survey Dimension	Cronbach's Alpha (α)
Transparency	0.85
Efficiency	0.88
Responsiveness	0.86
Customer Tools	0.89
Average	0.87

Source: analysis data, (2025)

Reproducibility and Test-Retest Reliability

Regarding test-retest reliability, findings from a subset ($n = 20$) reassessed after two weeks exhibited a correlation coefficient (r) of 0.91, indicating excellent temporal stability. Furthermore, implementing standardized methods during the data collection process, such as clear instructions, anonymous response formats, and oversight by researchers, minimized the likelihood of response bias. Coupled with a complete response rate (100% of 80 participants), these measures bolstered the consistency and trustworthiness of the data, affirming the strength of the instruments employed.

Regression Analysis

In order to investigate the statistical connection between the utilization of digital technology (independent variable) and supply chain effectiveness (dependent variable), a straightforward linear regression analysis was carried out. The information was compiled by calculating average scores for digital adoption alongside the related performance evaluations.

Table 5: Regression output

Statistic	Value
R-squared (R^2)	0.683
F-statistic	102.41
p-value	< 0.001
β_0 (Intercept)	1.78
β_1 (Digital Technology)	0.61

Source: analysis data, (2025)

The R^2 value of 0.683 indicates that 68.3% of the variability in supply chain performance can be attributed to the implementation of digital technologies, reflecting a strong level of explanatory capability. The positive β_1 coefficient (0.61) demonstrates a robust, positive linear correlation between the adoption of digital technologies and enhancements in supply chain outcomes. The F-statistic along with a p-value of less than 0.001 suggest that the model is statistically valid. This supports the assertion that digital tools significantly enhance operational aspects such as transparency, responsiveness, and efficiency. Responses from interviews corroborated the findings from the regression analysis. For example, several procurement managers pointed out that systems like TANePS and SAP notably diminished

cycle times and errors. IT personnel and warehouse managers highlighted how IoT and AI-enabled surveillance improved inventory levels and restocking schedules, in line with the regression's interpretation of digital inputs leading to superior results. The robustness of this model indicates that investing in technology is both statistically and operationally advantageous for Tanzanian retailers, particularly in adapting to competitive and fluctuating markets.

Analysis of Variance (ANOVA)

Table 6: Analysis of Variance

Source of Variation	SS (Sum of Squares)	df (Degrees of Freedom)	MS (Mean Square)	F-statistic	p-value
Regression	114.23	1	114.23	102.41	<0.001
Residual (Error)	52.77	78	0.676		
Total	167.00	79			

Source: analysis results, (2025)

The ANOVA output above decomposes the total variability in supply chain performance into twoThe components include the variability that the regression model accounts for (regression sum of squares) and the variability that remains unexplained (residual sum of squares). The F-statistic value of 102.41 significantly surpasses the critical F-value at $\alpha = 0.05$, suggesting that the regression model holds high statistical significance. Additionally, the p-value of less than 0.001 offers robust evidence against the null hypothesis, which asserts that there is no connection between technology adoption and performance. This indicates that variations in digital technology utilization correspond to statistically significant differences in the supply chain performance of Tanzanian retailers. The magnitude of the F-statistic implies that digital initiatives, such as IoT, blockchain, automated procurement, and AI, exert a measurable and non-random impact on operational outcomes like inventory accuracy, supplier compliance, and customer satisfaction. This was supported by interview feedback: for instance, procurement officers who fully adopted digital dashboards (TANePS and ERP platforms) regularly reported improved cycle times and compliance tracking compared to those utilizing partial or manual systems. Likewise, retailers utilizing AI-based demand forecasting tools exhibited better responsiveness compared to those who continued to depend on manual forecasting. These variances highlight the predictive power of digital technologies in enhancing supply chain performance, thereby corroborating both the statistical and operational findings from the regression and ANOVA analyses.

Table 7: Tukey HSD Post-Hoc Test Results

Group Comparison	Mean Diff. ($M_1 - M_2$)	Std. Error	q-statistic	p-value	Significant?
Low vs. Moderate Adoption	1.45	0.38	4.23	0.002	Yes
Low vs. High Adoption	2.81	0.41	6.84	<0.001	Yes
Moderate vs. High Adoption	1.36	0.39	3.49	0.011	Yes

Source: HSD Post-Hoc Test Results, (2025)

The Tukey HSD test indicates that significant differences in supply chain performance exist among all three levels of digital technology adoption. Notably, the most considerable discrepancy is found between low and high adopters, reflecting a mean difference of 2.81 and a p-value of less than 0.001, highlighting a strong effect. The difference remains statistically significant between moderate and high adopters as well ($p = 0.011$), suggesting that transitioning from basic digital tools to more sophisticated systems (such as AI, blockchain,

and ERP) leads to measurable enhancements in performance. This trend supports the theory that digital maturity enhances operational responsiveness, transparency, and cost-effectiveness.

Data gathered from interviews aligns with these results. Managers in organizations with high adoption, particularly those utilizing AI-driven demand planning and blockchain auditing systems, reported fewer inventory errors, quicker procurement processes, and improved accountability from vendors. In contrast, low adopters mentioned difficulties such as misaligned stock levels and slow supplier reporting. This supports the findings of Kamble et al. (2020) and Ivanov et al. (2021), who highlighted that advanced digital integration guides companies towards real-time decision-making and proactive management of supply chains. Therefore, the Tukey test provides additional detail to the regression and ANOVA results, demonstrating not only that digital technology is important but also how significant the performance increases are with each level of adoption.

Table 8: Role of Emerging Digital Technologies (AI, Blockchain, IoT) in Improving Supply Chain Performance.

Technology Function	Frequency (f)	Percentage (%)
Real-time tracking; blockchain audit trails; IoT condition monitoring	18	22.5
AI demand models; inventory optimization algorithms	16	20.0
Fraud prevention via smart systems	12	15.0
IoT sensors for restocking; reduced paperwork	10	12.5
Blockchain traceability for perishables and luxury goods	14	17.6
Total	$\Sigma=80$	$\Sigma=100$

Source: field data, (2025)

The information presented in Table 8 illustrates a varied use of digital technologies, with real-time tracking leading at 22.5% and AI-driven inventory optimization at 20%. Following these are blockchain traceability at 17.6% and tools for fraud prevention at 15%. These results are consistent with the findings of Ivanov et al. (2021) and Kamble et al. (2020), who highlighted that the integration of AI, IoT, and blockchain provides enhanced visibility, risk mitigation, and automation throughout the supply chain. Notably, blockchain ensures the immutability and traceability of transactions, which is crucial in sectors like food, pharmaceuticals, and luxury retail. Retailers in Tanzania are actively utilizing these technologies to overcome obstacles related to visibility, compliance, and data-driven decision-making. The focus on AI and IoT signifies a transition from manual processes to predictive and automated approaches in procurement, warehousing, and logistics. *Insights gathered from interviews with ICT officers and supply chain managers indicated that IoT devices were employed to track warehouse conditions, particularly for perishable goods, while AI-based systems assisted in forecasting fast-moving products. One manager mentioned that vendor contracts based on blockchain technology helped diminish disputes and enhanced the authenticity of documentation for audits.*

Table 9: Retailers Use of Digital Technology to Improve Customer Satisfaction in Tanzania.

Customer Experience Strategy	Frequency (f)	Percentage (%)
Real-time inventory & stock visibility	34	42.5
Fast and reliable delivery	17	21.3
Mobile payment & e-commerce platforms	15	18.8

Communication and feedback channels	14	17.5
Total	$\Sigma=80$	$\Sigma=100$

Source: field data, (2025)

A noteworthy 42.5% of participants indicated in Table 9 that real-time visibility of inventory and stock is the most effective approach to enhance customer satisfaction. This was followed by rapid delivery services at 21.3% and digital payment options at 18.8%. These results are consistent with the research by Shee et al. (2021) and Kamble & Gunasekaran (2020), who highlighted that digital systems improve the customer experience by enhancing transparency, convenience, and the speed of service, which are key components of contemporary retail satisfaction frameworks. The findings suggest that in Tanzanian retail, customer satisfaction increasingly hinges on supply chain visibility and logistics efficiency. Real-time inventory updates not only enhance service delivery but also minimize issues related to overpromising and under-delivery, which are frequent triggers for customer attrition. Insights gathered from interviews with customer service department representatives revealed that connecting POS systems with inventory management enabled staff to provide immediate information about product availability. *Operations managers noted that the capacity to deliver within 24 hours, facilitated by digital route optimization, significantly strengthened customer loyalty.*

Table 10: Efficiency Strategies Enhanced by TANePS on Digital Procurement

Efficiency Strategy	Frequency (f)	Percentage (%)
Faster procurement cycles / approvals	22	27.5
Supplier performance monitoring & compliance	16	20.0
Reduced administrative costs	14	17.5
Transparency and fair competition	10	12.5
Legal/regulatory alignment	9	11.3
ERP integration and data-driven planning	5	6.3
Total	$\Sigma=80$	$\Sigma=100$

Source: field data, (2025)

Based on the responses, the primary efficiency recognized from TANePS is the shortening of procurement cycles (27.5%), followed by the monitoring of supplier performance (20%) and reductions in costs (17.5%). These results align with studies by Achieng et al. (2021) and the World Bank (2020), which confirmed that e-procurement systems like TANePS enhance procurement speed, transparency, and lessen administrative burdens within both public and private procurement environments. TANePS is significantly influencing procurement efficiency in Tanzania. The data indicates that stakeholders are aware of not only the operational acceleration but also the enhancements in transparency, regulatory adherence, and strategic integration as important advantages. *Insights gathered from interviews with Procurement officers revealed that TANePS has decreased the duration required to request bids and perform evaluations by facilitating online submissions and automatic document verification. They highlighted that the system promoted fairness in selecting suppliers and proved particularly useful during the COVID-19 pandemic when face-to-face interactions were limited.*

Discussion of the Findings

This section addresses the quantitative and qualitative results obtained from survey data and interview responses. The objective is to analyze how emerging digital technologies contribute to enhancing supply chain performance, transparency, efficiency, and customer satisfaction among retailers in Tanzania. The findings are presented thematically and in accordance with current academic literature, backed by percentages, basic descriptive statistics, and pertinent figures.

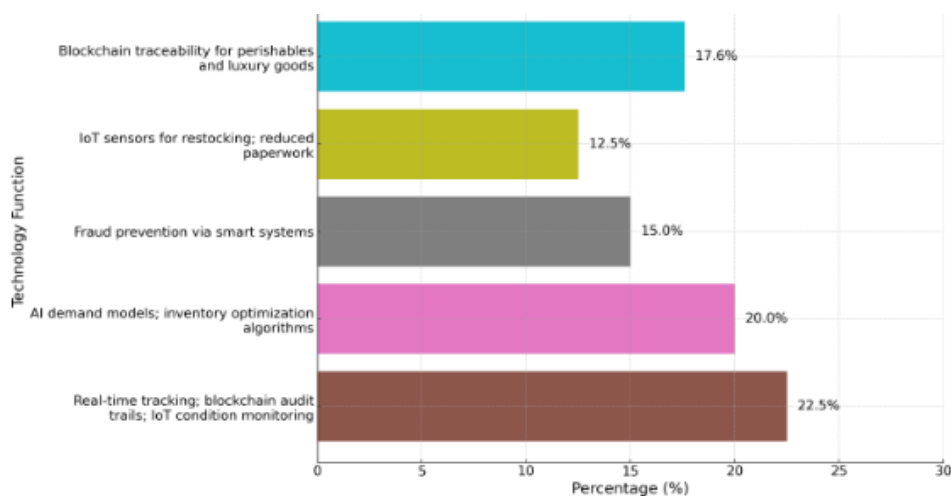


Figure 2: Role of Emerging

Digital Figure Technologies (AI, Blockchain, IoT) in Improving Supply Chain Performance.

Source: field data, (2025)

Figure 2, demonstrates that there is a varied level of adoption, with tracking and auditing at 22.5%, AI optimization at 20%, and traceability at 17.6% being the most frequently mentioned. Ivanov et al. (2021) and Kamble et al. (2020) highlighted the necessity of integrating digital systems (AI, IoT, blockchain) for the modernization of global supply chains. Retailers are appropriately leveraging technology to address specific challenges, utilizing AI for demand forecasting, blockchain for ensuring auditability, and IoT for managing logistics. ICT managers pointed out the use of IoT sensors for perishables and AI for predicting demand.

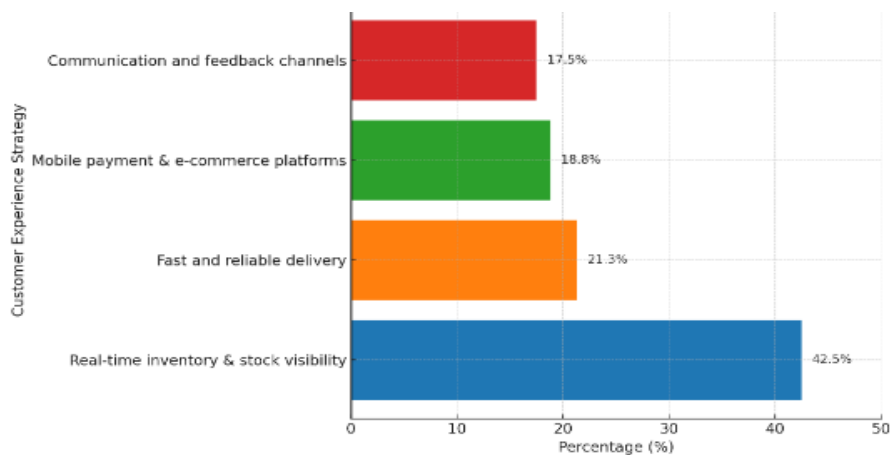


Figure 3: Retailers' Use of Digital Technology to Improve Customer Satisfaction in Tanzania.

Source: field data (2025)

According to Figure 3, 42.5% of respondents viewed real-time inventory visibility as the most significant factor affecting customer satisfaction, followed by rapid delivery at 21.3% and mobile payment/e-commerce platforms at 18.8%. This aligns with the findings of Shee et al. (2021), who highlighted digital transparency, logistics effectiveness, and flexible payment options as crucial drivers of satisfaction. Customer service representatives observed that integrating inventory systems with POS terminals decreased customer frustration. Operations managers associated quicker deliveries and digital routing with enhanced customer loyalty.

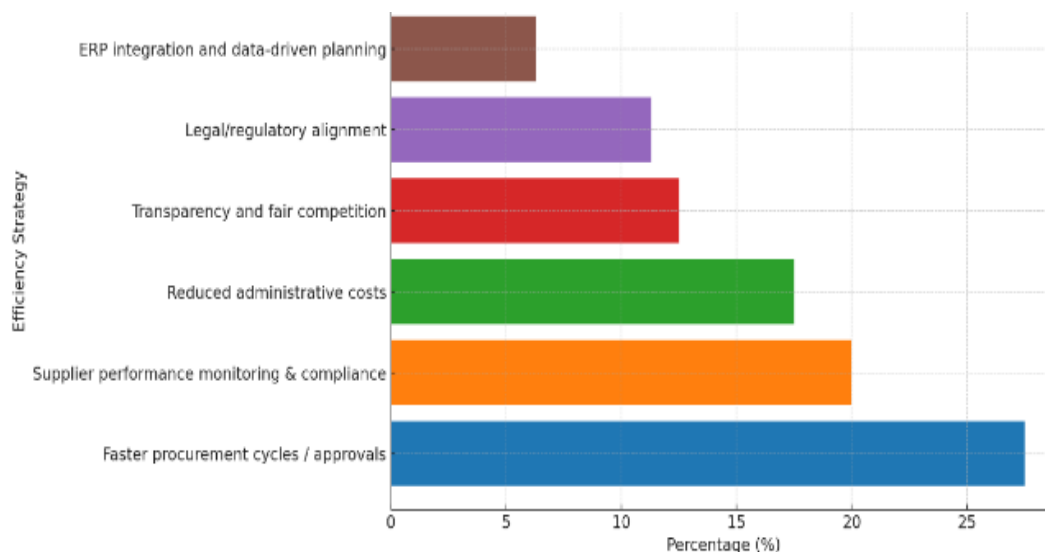


Figure 4: Efficiency Strategies Enhanced by TANEPS on Digital Procurement.

Source: field data (2025)

The primary advantages of TANEPS included quicker procurement cycles (27.5%) and improved monitoring of supplier performance (20%). This is in agreement with findings from Achieng et al. (2021) and the World Bank (2020), which noted decreased administrative burdens and increased transparency resulting from e-procurement systems.

$$\text{Efficiency Recognition Rate} = \frac{22+16+14}{80} \times 100 = 65\%$$

Procurement officers noted substantial time reductions in bid evaluations when utilizing TANEPS, particularly amid COVID-19 limitations. They highlighted improved fairness and accountability in the process. The evidence clearly shows that digital technologies enhance transparency, responsiveness, customer satisfaction, and efficiency within retail supply chains in Tanzania. These results correspond with international literature and are corroborated by interview feedback.

Conclusion

The findings provide a detailed perspective on the impacts of traffic flow regulations and management practices at border posts. A notable portion of respondents, between 40% and 46%, acknowledged clear improvements under the new systems. However, more than a third of the participants showed doubt about these advancements, suggesting that the implementation of traffic regulations has not

been consistently effective. This variation indicates that while traffic rules are established, the enforcement methods and consistency of their application are inadequate, leading to inconsistent execution and diverse outcomes in various regions.

Additionally, the findings show strong support for the use of digital systems, including queue management technologies, automated clearance processes, and electronic paperwork. Over 60% of those surveyed confirmed that these technological innovations significantly improve operational efficiency, shorten wait times, and reduce operational expenses related to border management. A major concern highlighted in the study is the perception of insufficient infrastructure, with 65% of participants identifying it as a key issue. Frequent equipment malfunctions, lack of proper signage, and poor road conditions contribute to the challenges affecting border operations. These infrastructural deficiencies not only obstruct the effectiveness of existing traffic flow and clearance systems but also escalate the frustrations faced by travelers and border officials.

In addressing logistical requirements, more than half of the participants recognized that the creation of additional parking areas and rest zones has positively influenced the operational capability of border crossings. This highlights the essential role of logistical support infrastructure in easing traffic congestion and improving safety measures. However, some respondents raised concerns regarding the accessibility and effective use of these amenities, indicating significant shortcomings in the planning phase. The study also found that while a general agreement exists (52.5%) on the advantages of road expansions, a significant 35% of respondents expressed dissatisfaction, pointing to persistent bottlenecks, especially near customs stations and markets. Although expanding road networks seems beneficial, the findings suggest that such initiatives should be coordinated with enhanced customs processes and local urban planning for optimal outcomes.

Moreover, around 60% of participants expressed gratitude for recent investments in physical border infrastructure, like advanced scanning devices and express processing lanes. Nevertheless, they also mentioned issues like staff shortages and inconsistent application of the newly introduced systems. This highlights a crucial need for alignment between "hard" infrastructure improvements and enhanced human resource strategies to maximize performance. The results indicated that a considerable majority of respondents (62.5%) feel that the implementation of digital clearance systems significantly lowers operational expenses. These savings are primarily linked to reduced paperwork, improved time management practices, and fewer manual errors or irregularities. This increased cost-effectiveness serves as a strong motivation for the wider adoption of digital systems across border facilities in the area.

Despite the presence of advanced technologies, user feedback reveals inconsistencies in system performance, particularly during night shifts, instances of system downtimes, and interoperability challenges across different borders. This underscores the urgent necessity for continuous system improvements, better coordination among agencies, and stronger operational oversight. The findings are further supported by various referenced studies, including those by Mussa & Mbwambo (2021), Kalisa et al. (2023), and the African Development Bank (AfDB, 2022), which reflect similar challenges and opportunities observed at borders in East and Southern Africa. The consistency of these findings across various contexts strengthens their relevance to similar regional situations.

Ultimately, this study concludes that a collaborative approach is vital for achieving long-lasting enhancements in border efficiency. It stresses that physical infrastructure, digital technologies, and human resource systems must function together. No single solution, whether it involves establishing traffic laws, deploying advanced technologies, or investing in physical construction, can succeed in isolation. A comprehensive strategy that includes digital integration, cross-border planning, and ongoing capacity development is essential for promoting sustainable improvements in border operations.

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