African Journal Of E-Commerce, Logistics and Transportation Studies (AJELTS)
E-ISSN 3050-2330 (Online); ISSN 3050-2322 (Print)

Indexed by EBSCO and SABINET

Volume 2, Number 2, December, 2025

Pp 25-46

The Influence of Digital Supply Chain Transformation on Patient Care, Inventory Management, and Resource Allocation in Zimbabwe: A Systematic Review

DOI: https://doi.org/10.31920/3050-2330/2025/v2n2a2

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Abstract

This systematic review investigates the impact of digital supply chain transformation on healthcare delivery in Zimbabwe, a context marked by persistent stockouts, inventory inefficiencies, and resource allocation challenges. Analysis of 77 studies reveals notable advancements in patient care, inventory management, and resource allocation, driven by technologies such as blockchain, IoT, artificial intelligence, and predictive analytics. These digital innovations have improved access to medicines, reduced delays, and enabled more personalised treatment, thereby enhancing health outcomes. Inventory management has improved significantly through significantly through the integration of real-time tracking and enhanced demand forecasting, which has successfully reduced both waste and stock shortages. However, overall impact remains constrained by persistent infrastructure limitations. Resource allocation has become more efficient through digital tools that optimise the distribution of medicines and personnel, particularly in underserved areas. Nevertheless, barriers such as inadequate infrastructure, workforce shortages, fragmented implementation, and weak policy frameworks hinder the full realisation of these benefits. The findings underscore the need for comprehensive strategies involving infrastructure investment, capacity building, and regulatory development to support sustainable digital health ecosystems. Successful adoption requires coordinated efforts among government, healthcare providers, and technology partners. Addressing these challenges is critical for Zimbabwe to fully leverage digital supply chain

solutions and improve healthcare delivery and equity in resource-constrained settings.

Keywords: *Digital Transformation, Healthcare, Resource Allocation, Supply Chain Management*

Introduction

The healthcare sector in developing countries, including Zimbabwe, faces significant obstacles in the provision of essential medicines and the achievement of equitable resource distribution (Chiwashira et al., 2025). Challenges such as medication stockouts and inefficient inventory practices adversely affect patient care (Chopo & Mwanza, 2024). Digital supply chain transformation offers potential solutions by leveraging technologies that enhance visibility and accountability (Fritz et al., 2021), such as blockchain for secure transactions and IoT for real-time tracking. The present systematic review is designed to analyse research pertaining to digital supply chain transformation within Zimbabwe, with a scope concentrated on its effects on key operational areas: patient care outcomes, inventory management efficiency, and resource allocation strategies (Rafifing et al., 2025).

Background

The effectiveness of the healthcare sector is intrinsically linked to the quality of care delivered (Detwal et al., 2023). Globally, efforts to enhance supply chain efficiency aim to reduce costs and improve patient outcomes (Fiore et al., 2023). Digital transformation through health technologies offers opportunities to revolutionise healthcare, particularly in resource-limited settings such as Zimbabwe (Limna, 2023). However, Zimbabwe's public health sector faces substantial barriers to technology adoption, including inadequate ICT infrastructure, workforce shortages, and financial constraints (Chilunjika & Uwizeyimana, 2024). Despite these obstacles, integrating digital solutions is essential to address entrenched inefficiencies, such as reliance on outdated paper-based systems that are susceptible to data manipulation (Chilunjika & Uwizeyimana, 2024). The healthcare supply chain comprises organisations collaborating to procure and deliver medical supplies (Arji et al., 2023). Effective supply chain management ensures the timely and appropriate delivery of pharmaceuticals and equipment, particularly during health emergencies

(Wasswa et al., 2023). The necessity of digital capabilities was clearly demonstrated by recent health crises in Zimbabwe, emphasising their role in facilitating robust data collection, accurate outbreak surveillance, and the continuity of essential service delivery (Chidhau et al., 2021; Wasswa et al., 2023).

The integration of advanced technologies, including artificial intelligence, blockchain, big data analytics, and simulation, is essential for enhancing the performance and resilience of healthcare supply chains, particularly during disruptions (Arji et al., 2023). Nevertheless, a research gap exists regarding the practical application of these tools to manage disturbances and ensure supply chain resilience (Arji et al., 2023). The inherent complexities of the healthcare sector necessitate resilient supply chains to ensure timely patient care, a requirement that has become more pronounced amid pandemics and geopolitical challenges (Tiwari et al., 2024).

Theoretical Framework

This study employs three theoretical frameworks to examine the digital transformation of Zimbabwe's healthcare supply chain. The Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) clarify factors influencing user acceptance, perceived usefulness, ease of use, and behavioural intentions regarding digital tools (Tiwari et al., 2024). The Diffusion of Innovations theory describes the processes by which digital technologies are disseminated and adopted among healthcare stakeholders (Tiwari et al., 2024). Organisational Information Processing Theory provides insights into how organisations manage information flows and mitigate uncertainty through digital transformation, particularly in complex environments (Islam et al., 2023). Together, these frameworks offer a comprehensive perspective for analysing technological adoption, organisational dynamics, and environmental factors that affect digital supply chain integration, addressing challenges such as infrastructure limitations and resistance while identifying enablers for successful implementation (Tiwari et al., 2024).

Digital Supply Chain Transformation in Healthcare

Digital supply chain transformation involves strategically integrating digital technologies to optimise the flow of information, materials, and finances

from sourcing to patient care (Asad et al., 2024). The primary objectives are to enhance transparency, interoperability, and real-time data sharing, thereby supporting improved decision-making and patient outcomes (Joshi & Sharma, 2022). Technologies such as big data analytics, artificial intelligence, blockchain, and cloud computing have advanced healthcare supply chains by enabling innovative business models and improving overall performance (Hezam et al., 2024). Particularly, artificial intelligence plays a critical role in diagnostics, chronic disease management, and logistics, facilitating the management of disruptions and enhancing patient care (Kumar et al., 2025).

Patient Care and Digital Transformation

The principal objective of digital supply chain transformation in healthcare is to improve patient care by ensuring the timely availability of medical products and services, reducing errors, enhancing treatment outcomes, and increasing patient satisfaction. This is achieved through the use of real-time data for personalised treatments, predictive analytics for disease outbreak forecasting, and streamlined supply delivery (Kumar et al., 2022). These innovations facilitate more effective resource allocation and minimise delays, ensuring that appropriate medications reach patients promptly (Joshi & Sharma, 2022). Integrating artificial intelligence into the health supply chain has the potential to markedly improve system efficacy and optimise patient management through the deployment of adaptive, real-time interventions (Periáñez et al., 2024). Digital integration also supports navigation of complex supplier networks, promoting efficient delivery of essential medications (Yamoah & Kyeremeh, 2025). Utilising AI enables healthcare organisations to implement predictive supply chain management and quality assurance, thereby improving operational efficiency and decision-making (Periáñez et al., 2024).

Inventory Management and Digital Transformation

Digital transformation improves healthcare inventory management by enabling real-time tracking, demand forecasting, and automated reordering, thereby reducing stockouts and waste (Venkataraman, 2024). Enhanced inventory visibility and data integration facilitate more accurate monitoring and informed decision-making, optimising stock levels in response to fluctuating demand (Holloway, 2024). Advanced analytics empower providers to maintain critical supplies while minimising

overstocking costs (Periáñez et al., 2024). This digital evolution supports the development of a resilient pharmaceutical supply chain, essential for Pharma 4.0, which incorporates AI and IoT technologies for robust manufacturing and rapid responses to shortages (Wong et al., 2023). These innovations increase connectivity and productivity in pharmaceutical production and distribution. AI and machine learning advancements further support demand forecasting and just-in-time inventory management, reducing waste and mitigating supply chain risks (Sinha & Lee, 2024). Adopting a unified systemic approach across healthcare environments strategically balances cost efficiency with the necessary assurance of a reliable supply of essential drugs (Ogbewele et al., 2024).

Resource Allocation and Digital Transformation

Digital transformation has a substantial impact on healthcare resource allocation by providing real-time data and analytics that facilitate efficient and equitable distribution of supplies, personnel, and facilities (Wong et al., 2023). Machine learning models enable accurate drug demand forecasting, reducing stockouts and surplus inventories, and thereby optimising supply chains (Kumar et al., 2023). Digital tools also detect inefficiencies and recommend resource reallocations to ensure critical supplies are available without excessive stockpiling (Sharma et al., 2020). Furthermore, digitalisation enhances system adaptability, allowing healthcare organizations to respond rapidly to crises such as pandemics or natural disasters through improved resource planning and reallocation (Ayati et al., 2020). Advanced IoT devices and AI-based systems support dynamic resource management, enabling providers to adapt to changing patient volumes and allocate staff and equipment where they are most needed, thereby maintaining high-quality care in challenging circumstances (Hameed et al., 2024).

Healthcare Context in Zimbabwe

Digital transformation offers significant potential to advance healthcare globally; however, low- and middle-income countries such as Zimbabwe face distinct challenges that require contextual analysis (Werner et al., 2023). This process requires evaluating existing infrastructure, technological readiness, and regional healthcare needs (Vats, 2024). **S**trategic implementation necessitates the customisation of digital solutions based on these factors; this is critical for their effectiveness and

long-term sustainability, given that unadapted adoption can result in performance sub-optimisation. Inefficient health information systems impede national planning and resource optimisation (Sylla et al., 2024). In contrast, robust health management information systems streamline reporting and leverage data to monitor service trends, assess policy impacts, and inform decision-making (Omer, 2023). In resource-constrained environments, the use of artificial intelligence and predictive analytics can enhance public health interventions (Moodley & Seebregts, 2023). The COVID-19 pandemic has accelerated the adoption of digital health technologies in LMICs such as Zimbabwe, helping to address healthcare gaps and improve service delivery (Mascarenhas et al., 2024).

Methodology

This methodology outlines a systematic review of digital supply chain transformation in Zimbabwe's healthcare sector, conducted in accordance with the PRISMA guidelines to ensure transparency and reproducibility. The review aimed to identify studies that illustrate the impact of digital interventions on healthcare supply chain management, particularly on inventory and resource allocation. A comprehensive search strategy combined keywords such as "digital transformation," "supply chain," "e-health," and "Zimbabwe," across databases including PubMed, Google Scholar, Web of Science, and SCOPUS. Searches incorporated Boolean operators, targeted grey literature, and reports from organisations like the WHO to ensure broad coverage of relevant interventions in sub-Saharan Africa.

Inclusion criteria prioritised empirical studies, case reports, and systematic reviews published after 2010 that focused on digital supply chain interventions within healthcare, especially those relevant to Zimbabwe or similar contexts. Excluded were purely theoretical articles lacking empirical data or those unrelated to digital interventions or supply chain aspects, with only English-language publications considered. The screening process followed PRISMA protocols, starting with an initial yield of 1,250 articles, which were narrowed through duplicate removal, title/abstract screening, and full-text review, resulting in 77 studies included in the final synthesis.

Data extraction, conducted over 66 days, used a standardised form to capture the study design, digital intervention details, outcomes, and challenges. Quality assessment used the Joanna Briggs Institute and Cochrane Risk of Bias checklists to evaluate methodological rigor and bias.

A thematic analysis organised findings into themes related to patient care, inventory, and resource allocation, guided by an interpretivist and constructivist stance that emphasizes the social and contextual nature of digital transformation. Iterative peer debriefings enhanced trustworthiness and minimised bias, ensuring a comprehensive understanding of the complex socio-technical environment shaping digital health supply chains in Zimbabwe.

Findings

The systematic review initially identified 1,250 articles across multiple databases. Following a rigorous multi-stage screening process, 91 studies were included, offering a comprehensive perspective on digital supply chain transformations and their impact on healthcare systems.

Influence on Patient Care

The review of 77 selected studies underscores significant progress in patient care driven by digital supply chain innovations. These technologies have enhanced access to vital medicines, minimised treatment delays, and provided real-time visibility into stock levels, which collectively improve patient outcomes (Mølgaard et al., 2024). Predictive analytics play a crucial role by forecasting demand and preventing stockouts, especially in resource-limited settings (Maluleke et al., 2021; Miozza et al., 2024). The adoption of this technology strategically contributes to enhanced care quality and advances precision medicine efforts, especially in national contexts such as Zimbabwe, where existing supply chain shortcomings have critically constrained effective healthcare provision (Hiatt et al., 2024). Digital transformation holds considerable promise for fostering equitable healthcare, especially in underserved regions.

However, Maluleke et al. (2021) caution that these benefits are often fragile and constrained. While improvements in access and reductions in delays are evident, they tend to be confined to pilot projects with better resources or specific disease programs. Systemic issues such as inadequate infrastructure, workforce shortages, and fragmented implementation strategies pose significant barriers to scaling these gains. The literature emphasises that technological advances are mainly potential benefits; their realisation depends heavily on a supportive operational environment, which is frequently lacking. Without addressing foundational challenges,

the transformative potential of digital supply chains to enhance patient care remains partially realised.

Influence on Inventory Management

Digital innovations have notably improved inventory management in healthcare. Blockchain technology, for instance, enhances traceability and cybersecurity, ensuring integrity across pharmaceutical supply chains (Miozza et al., 2024). These advancements lead to better stock visibility, fewer stockouts, and streamlined procurement processes (Agarwal et al., 2020). Moreover, predictive analytics facilitate more accurate demand forecasting, enabling facilities to optimise inventory levels and reduce wastage of critical supplies (Miozza et al., 2024). Improved inventory management supports operational efficiencies, enabling data-driven decisions that enhance supply chain responsiveness (Dixit & Shivhare, 2025). Real-time data allows proactive replenishment, reducing delays and shortages that threaten patient care.

Despite these benefits, practical challenges hinder widespread impact. Agarwal et al. (2020) highlight that unreliable data inputs—due to inadequate data collection systems—compromise the quality of analytics. Additionally, shortages of skilled personnel to manage advanced digital tools limit effective implementation. High costs of deploying and maintaining these systems, coupled with fragmentation from legacy infrastructure, further impede seamless integration. Consequently, digital solutions often yield localised improvements rather than systemic overhauls, restricting their overall transformative potential in inventory management.

Influence on Resource Allocation

Digital health technologies such as telepharmacy and electronic prescribing have improved the efficiency of resource allocation (Alsoweih et al., 2024). These tools enhance medication safety by reducing errors and streamlining pharmacy workflows, allowing pharmacists to focus more on direct patient care (Mantel Teeuwisse et al., 2021). Digital resource management systems also help distribute medical equipment and personnel more equitably, which is vital in regions with limited healthcare infrastructure, such as Zimbabwe (Limna, 2023).

However, significant hurdles remain. Alsoweih et al. (2024) note that fragmented implementation and infrastructural deficits hinder digital tools

from providing comprehensive and accurate data needed for optimal resource deployment. Without reliable connectivity, interoperable systems, and standardised data formats, insights are often incomplete or inaccurate. Workforce shortages and limited digital literacy further restrict the effective use of these tools. As a result, despite their high potential, operational limitations frequently prevent digital solutions from fully transforming resource allocation processes at scale.

Challenges and Enablers of Digital Transformation

Key barriers include inadequate infrastructure, workforce shortages, and fragmented implementation strategies (Alsoweih et al., 2024), which limit the full potential of digital health initiatives. Overcoming these obstacles requires strong leadership, collaboration, and effective change management (Hundal et al., 2025). Addressing these challenges involves substantial investment in policies, infrastructure, and training at the national level, along with fostering partnerships among government, healthcare providers, and technology companies (Huaytan et al., 2024). Establishing clear regulatory frameworks for data governance and cybersecurity is vital, as these frameworks are foundational to building trust and enabling secure data exchange (Ebo et al., 2025). However, it is critical to note that enablers such as leadership, investment, professional training, and interoperability frameworks facilitate smoother adoption, helping healthcare systems embed digital solutions into routine practice and maximise benefits.

Discussion

The integration of digital technologies into healthcare systems has significantly improved patient outcomes and service efficiency (Alawiye, 2024). Key benefits include using real-time data and enhanced resource management, particularly in inventory control, thereby ensuring improved allocation of supplies and personnel (Arji et al., 2023). Despite these advancements, the success of digital health initiatives hinges on strong infrastructure, skilled human resources, and supportive regulatory frameworks (Feibert, 2017). Many projects face delays owing to regulatory hurdles, cultural resistance, and shortages of IT-skilled healthcare workers (Hundal et al., 2025). This underscores the need for an all-inclusive approach that combines technological innovation with foundational policy

development, workforce training, and infrastructure improvements (Alotaibi et al., 2024; Beaulieu & Bentahar, 2021).

To unlock the full potential of digital health, strategies should focus on developing comprehensive digital skills, integrating digital health into medical education, and providing continuous learning opportunities for healthcare workers (Ferreira et al., 2025). These measures are crucial for addressing cyber threats and safeguarding patient data privacy, thereby maintaining service integrity and building trust (Charalambous, 2024; Limna, 2023). Technologies such as blockchain are vital in ensuring data security, integrity, and privacy, facilitating healthcare transformation (Wu et al., 2023). However, resource-limited settings like Zimbabwe face distinct challenges that impede digital health adoption, including inadequate ICT infrastructure, significant digital literacy gaps, and severe financial constraints (Chilunjika & Uwizeyimana, 2024; Alsoweih et al., 2024). Fragmented initiatives and the absence of cohesive policies further impede scalability and sustainability, underscoring the need for integrated, well-governed digital strategies tailored to sub-Saharan Africa's socio-economic contexts (Karamagi et al., 2022; S et al., 2024).

Comparison with Existing Literature

This review aligns with broader global insights regarding digital health transformation, especially in developing regions (Charalambous, 2024). A notable concern is the duplication of digital health initiatives and an overemphasis on data mining rather than direct service provision, which limits the capacity to strengthen health systems effectively (Karamagi et al., 2022). Furthermore, the lack of robust training and digital literacy among healthcare workers hampers effective technology integration, leading to suboptimal outcomes despite well-designed systems (Ferreira et al., 2025). These issues call for coordinated efforts, standardised approaches, and strategic investments to reduce fragmentation and improve efficiency, particularly in low-income countries like Zimbabwe (Sylla et al., 2024; Karamagi et al., 2022).

The existing literature also underscores common implementation barriers, such as the digital divide, infrastructural limitations, and weak data governance frameworks—issues that are especially pronounced in low- and middle-income countries (Ahmed et al., 2025). Overcoming these hurdles requires systematic planning and targeted resource allocation to ensure that digital health initiatives are both sustainable and scalable.

Implications for Policy and Practice

To address these challenges, comprehensive national digital health strategies are essential. Such policies should emphasise interoperability, scalability, and sustainability while fostering local innovation and capacity building (Karamagi et al., 2022). Strategies should aim to create integrated platforms that reduce fragmentation, as many current solutions remain limited to pilot phases and have not yet achieved widespread adoption (Sylla et al., 2024). Donor organisations and international partners must align their investments with national strategies, supporting scalable and sustainable solutions rather than fragmented, short-term pilots (Karamagi et al., 2022; Sylla et al., 2024).

Limitations of the Review

A notable limitation of this review is the rapid evolution of digital health technologies, which can render findings outdated quickly, particularly given the innovations accelerated during the COVID-19 pandemic (Fagherazzi et al., 2020). Reliance on published literature may also introduce publication bias, favouring studies with positive outcomes and potentially skewing perceptions of effectiveness (Swartz et al., 2021). The heterogeneity of digital health interventions across different settings complicates direct comparisons and generalisations. Additionally, there are few comprehensive evaluations, particularly regarding long-term sustainability and cost-effectiveness in low-resource environments, which constrain definitive conclusions about the broad applicability of various solutions (Fee et al., 2023; Wilson et al., 2021). This highlights the need for more rigorous, longitudinal research to systematically assess the impacts of digital health across diverse socio-economic and geographical contexts.

Conclusion

This review underscores affirms the strategic importance and transformative capacity of digital supply chain interventions for Zimbabwe's healthcare sector, yet also identifies key impediments to effective implementation. Overcoming these obstacles requires a multifaceted approach, including the development of robust policy frameworks, infrastructure enhancements, and targeted capacity-building efforts (Fritz et al., 2021; Ahmed et al., 2025). Sustained investment in ICT infrastructure and comprehensive training programs for healthcare

workers is vital to bridging the digital divide and promoting equitable access to digital health innovations (Rashid, 2024). Despite ongoing efforts, challenges such as limited electronic health records and interoperability issues persist, impeding widespread digital transformation (Sylla et al., 2024).

Recommendations

Future initiatives should focus on developing integrated digital platforms to enable seamless data exchange and interoperability across healthcare systems (Selvanesan & Satanarachchi, 2023). This requires substantial investment in infrastructure, such as reliable internet and accessible hardware, especially in rural and underserved areas (Lugada et al., 2022). To effectively assess the quantifiable impact of digital health technologies, particularly in mitigating stockouts and minimising medical commodity waste, the deployment of robust measurement frameworks is a methodological requirement (Konduri et al., 2018). National digital health strategies must be formulated to coordinate efforts, ensuring sustainability and scalability beyond pilot projects (Elkins et al., 2023). A comprehensive approach should promote collaboration among manufacturers, distributors, and pharmacies to build a resilient drug-sharing network through real-time inventory tracking and predictive analytics, thereby mitigating supply shortages (Wong et al., 2023). A secure digital system with clear quality management protocols would enhance supply chain visibility, enabling data-driven decision-making for better management (Onyango et al., 2023).

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