

Healthcare Supply Chain Capabilities and Universal Health Coverage Outcomes in Kenya: An Empirical Structural Equation Modeling Approach

Abuya, Joshua Olang'o

School of Business & Economics, Kibabii University, Kenya

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ABSTRACT

Universal Health Coverage (UHC) has emerged as a central global health priority under Sustainable Development Goal 3, which seeks to ensure equitable access to quality healthcare services without financial hardship. Despite widespread policy commitments, many developing countries continue to face systemic challenges in achieving UHC due to inefficiencies in healthcare delivery systems and supply chains. Healthcare supply chains play a critical role in ensuring the availability, accessibility, and affordability of essential medicines and healthcare commodities required for service delivery. This study examines the influence of healthcare supply chain capabilities on Universal Health Coverage outcomes in Kenya using Structural Equation Modeling (SEM). Specifically, the study investigates the effects of inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing on healthcare supply chain performance and UHC outcomes. A cross-sectional survey design was used to collect primary data from healthcare administrators, procurement officers, pharmacists, and supply chain managers across public hospitals in Kenya. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results reveal that healthcare supply chain capabilities significantly influence supply chain performance, which subsequently impacts Universal Health Coverage outcomes including service availability, healthcare accessibility, and cost efficiency. Supply chain integration and inventory optimization were identified as the strongest predictors of supply chain performance. The findings highlight the importance of strengthening healthcare supply chain systems as a strategic pathway for achieving Universal Health Coverage in Kenya. The study contributes to both supply chain management and health systems literature by providing empirical evidence linking healthcare supply chain capabilities to health system outcomes in developing countries.

Keywords: Universal Health Coverage (UHC); Healthcare Supply Chain Management; Supply Chain Capabilities; Inventory Optimization; Supply Chain Integration; Strategic Purchasing; Supply Chain Performance.

INTRODUCTION

Universal Health Coverage (UHC) has emerged as a central pillar of global health policy and a key target under the Sustainable Development Goals (SDG 3), reflecting a global commitment to ensuring that all individuals have access to needed health services without financial hardship (World Health Organization [WHO], 2021; United Nations, 2023). In response, countries worldwide have implemented wide-ranging health sector reforms aimed at expanding service coverage, strengthening health financing mechanisms, and improving overall health system performance. Contemporary scholarship emphasizes that achieving UHC extends beyond financing reforms and requires strengthening the core building blocks of health systems, including service delivery, access to essential medicines, and system efficiency (Atun et al., 2021; McIntyre & Kutzin, 2021; Barasa, Nguhiu, & McIntyre, 2021; Kruk et al., 2022). This perspective aligns with broader health systems strengthening discourse, which underscores the need for integrated and resilient systems capable of delivering equitable and high-quality healthcare services (Peters & Bloom, 2020).

In recent years, there has also been growing recognition of the role of digital health and system-wide reforms in enhancing healthcare delivery and efficiency. Digital innovations (including health information systems,

electronic procurement platforms, and data-driven decision-making tools) are increasingly viewed as critical enablers of efficient healthcare systems and improved service access (Bloom et al., 2021). However, despite these advancements, the operational effectiveness of healthcare systems remains a key determinant of UHC outcomes, with increasing attention directed toward healthcare supply chain performance as a critical component of system functionality.

Healthcare supply chains play a fundamental role in ensuring the continuous availability of essential medicines, vaccines, and medical supplies required for effective healthcare delivery. Efficient supply chain systems facilitate timely procurement, distribution, and replenishment of health commodities, thereby supporting service continuity and improving patient outcomes. Nevertheless, empirical evidence indicates that healthcare supply chains in many developing countries remain constrained by persistent inefficiencies, including poor demand forecasting, fragmented procurement systems, inadequate logistics infrastructure, and weak coordination among supply chain actors (Yadav, Tata, & Babaley, 2020; USAID, 2022). These systemic challenges frequently result in stock-outs, wastage of medical supplies, delayed service delivery, and increased operational costs, ultimately undermining progress toward UHC.

Recent scholarly discourse conceptualizes healthcare supply chain capabilities as a multidimensional construct encompassing procurement capability, inventory management, distribution efficiency, information systems integration, and supply chain responsiveness (Dubey et al., 2021; Mandal, 2022). These capabilities reflect the ability of healthcare systems to effectively manage the flow of medical commodities from suppliers to end-users. Evidence from recent studies (2020–2025) suggests that strong supply chain capabilities significantly enhance healthcare system performance by improving service availability, reducing lead times, and strengthening system resilience, particularly during public health emergencies such as pandemics (Ivanov & Dolgui, 2021; Choi, Rogers, & Vakil, 2023). Consequently, strengthening these capabilities is increasingly recognized as a strategic priority for achieving sustainable health outcomes and advancing UHC.

In developing countries, including Kenya, healthcare systems continue to face structural and operational challenges that constrain the attainment of UHC. While governments have introduced policy frameworks and financing reforms to expand access to healthcare services, the effectiveness of these initiatives is often limited by weak supply chain systems. Evidence from Sub-Saharan Africa indicates that inefficiencies in procurement processes, limited warehousing capacity, and inadequate last-mile distribution systems significantly affect the availability of essential medicines at healthcare facilities (Mwangi, 2021; Waithaka et al., 2022). These persistent challenges highlight the need to move beyond policy commitments toward strengthening the operational capabilities that underpin healthcare service delivery.

In the Kenyan context, the government has demonstrated strong commitment to achieving UHC through initiatives such as the UHC pilot program, expansion of the National Hospital Insurance Fund (NHIF), and broader reforms under the Kenya Health Policy 2014–2030 (Ministry of Health, 2020). These efforts aim to improve access to quality healthcare services, enhance financial risk protection, and strengthen health system efficiency. However, despite these policy interventions, healthcare facilities continue to experience recurrent stock-outs of essential medicines, delays in procurement processes, and inefficiencies in supply chain coordination (Barasa et al., 2021; Tsofa et al., 2023). This suggests that achieving UHC in Kenya is not solely a policy or financing issue but also a supply chain capability challenge that warrants empirical investigation.

Although prior studies have examined healthcare system performance and UHC outcomes, most have predominantly focused on financing mechanisms, service delivery models, or governance structures, with limited attention to the role of supply chain capabilities. Furthermore, existing studies largely rely on descriptive or regression-based approaches, which may not adequately capture the complex interrelationships among multiple supply chain dimensions and UHC outcomes. Structural Equation Modeling (SEM) offers a robust analytical framework for addressing this limitation by enabling the simultaneous analysis of latent constructs and causal relationships (Hair et al., 2021). The application of SEM in this context provides deeper insights into how various supply chain capabilities interact to influence UHC outcomes.

This study builds on and significantly extends earlier conceptual work (Panya & Abuya, 2023) by incorporating primary empirical data and applying Structural Equation Modeling (SEM) to rigorously examine the relationship

between healthcare supply chain capabilities and Universal Health Coverage (UHC) outcomes in Kenya. Specifically, the study investigates how key supply chain capabilities, such as procurement efficiency, inventory management, distribution systems, and information integration, influence healthcare access, service quality, and financial protection. By providing robust empirical evidence on these relationships, the study contributes to both theory and policy by demonstrating the strategic importance of strengthening healthcare supply chain capabilities as a pathway for improving health system performance and accelerating progress toward UHC in Kenya.

Problem Statement

Despite significant global and national efforts to advance Universal Health Coverage (UHC), many developing countries continue to experience persistent challenges in ensuring equitable access to quality healthcare services. While policy reforms and financing mechanisms have expanded healthcare coverage in many contexts, substantial gaps remain in the availability, accessibility, and affordability of essential health services. In Sub-Saharan Africa, these challenges are particularly pronounced, with healthcare systems often constrained by limited resources, weak infrastructure, and systemic inefficiencies that hinder effective service delivery.

A critical barrier to achieving UHC in developing countries lies in the persistent inefficiencies within healthcare supply chains. Empirical evidence indicates that poor demand forecasting, fragmented procurement systems, inadequate storage facilities, and weak distribution networks continue to undermine the consistent availability of essential medicines and medical supplies (Yadav et al., 2020; USAID, 2022). These inefficiencies contribute to frequent stock-outs, increased wastage, and delays in service delivery, ultimately compromising patient outcomes and weakening health system performance. Furthermore, limited access to essential medicines remains a major concern, particularly among vulnerable populations, reflecting broader structural challenges in pharmaceutical supply systems and market access (Mackintosh et al., 2020).

In addition to supply chain inefficiencies, healthcare access inequalities remain a significant concern in many developing countries, including Kenya. Disparities in healthcare access are often driven by geographical, socioeconomic, and infrastructural factors, with rural and underserved populations experiencing limited access to essential health services. In the Kenyan context, inequalities in service delivery and resource allocation have been shown to significantly affect health outcomes, particularly among low-income and marginalized populations (Mutua et al., 2021). These disparities highlight the need for more efficient and responsive healthcare systems capable of ensuring equitable service delivery across different population groups.

Moreover, broader public service delivery challenges further exacerbate the difficulties in achieving UHC. Weak institutional coordination, bureaucratic inefficiencies, and limited accountability mechanisms often hinder the effective implementation of health policies and programs in developing countries (Rasul et al., 2021). In Kenya, such systemic constraints are reflected in delays in procurement processes, inconsistent supply of essential medicines, and inefficiencies in last-mile distribution systems. These challenges underscore the interconnected nature of healthcare delivery systems, where supply chain performance plays a pivotal role in determining overall system effectiveness.

Although existing studies have examined healthcare system performance and UHC outcomes, much of the literature has focused primarily on financing mechanisms, governance structures, and service delivery models, with limited emphasis on the operational capabilities of healthcare supply chains. This presents a significant research gap, as supply chain capabilities, such as procurement efficiency, inventory management, distribution systems, and information integration, are critical determinants of healthcare service availability and system responsiveness.

Furthermore, previous empirical studies have largely relied on descriptive analyses or traditional regression techniques, which may not adequately capture the complex and interdependent relationships between supply chain capabilities and UHC outcomes. There is therefore a need for more robust analytical approaches that can provide a comprehensive understanding of these relationships.

Against this backdrop, this study addresses this critical gap by examining how healthcare supply chain capabilities influence UHC outcomes in Kenya using a Structural Equation Modeling (SEM) approach. By

focusing on the operational dimensions of healthcare systems, the study seeks to provide empirical evidence on how strengthening supply chain capabilities can enhance healthcare access, improve service delivery, and support the realization of Universal Health Coverage.

LITERATURE REVIEW

Healthcare supply chain management (HSCM) has increasingly been recognized as a critical component of health system performance and a key determinant of progress toward Universal Health Coverage (UHC). Recent scholarly literature (2020–2025) emphasizes that efficient healthcare supply chains ensure the continuous availability of essential medicines, vaccines, and medical technologies, thereby supporting service delivery, improving patient outcomes, and enhancing system efficiency (Yadav et al., 2020; Dubey et al., 2021; WHO, 2021). Beyond operational functions, supply chains are now viewed as strategic enablers of health system resilience and equity, particularly in resource-constrained settings (Yadav, 2021; Sodhi & Tang, 2021). In this context, healthcare supply chain management encompasses a set of interrelated activities including procurement, inventory management, distribution, and last-mile delivery across multiple tiers of the healthcare system. Empirical studies indicate that inefficiencies in any of these components can significantly undermine healthcare access and quality, ultimately constraining the attainment of UHC (Kruk et al., 2022; Choi et al., 2023).

Inventory management capability represents a fundamental dimension of healthcare supply chain performance. Healthcare facilities must maintain optimal stock levels of essential medicines to prevent stock-outs while minimizing wastage, expiries, and holding costs. Recent advancements in inventory management systems, such as demand forecasting models, automated stock monitoring, and real-time tracking technologies, have significantly enhanced the ability of healthcare organizations to maintain appropriate inventory levels (Mandal, 2022; USAID, 2022). Evidence suggests that effective inventory optimization improves service availability, enhances operational efficiency, and reduces supply chain costs (Mwangi, 2021; Chaudhuri & Ray, 2022). Conversely, weak inventory systems often result in overstocking or understocking, both of which negatively affect healthcare delivery, increase inefficiencies, and compromise patient outcomes.

Supply chain integration has also emerged as a critical capability influencing healthcare system performance. Integration refers to the extent to which supply chain actors, including suppliers, procurement agencies, distributors, and healthcare providers, are coordinated through information sharing, synchronized processes, and collaborative decision-making (Ivanov & Dolgui, 2021; Dubey et al., 2021). Strong integration fosters trust, enhances coordination, and improves supply chain reliability (Kwon & Suh, 2020), while also enabling better risk management and adaptive coordination in complex supply environments (Lee & Tang, 2021). In contrast, fragmented supply chains, common in many developing countries, lead to duplication of efforts, delayed deliveries, and inefficient resource utilization (Waithaka et al., 2022). Therefore, strengthening integration across supply chain actors is essential for improving responsiveness, transparency, and efficiency in healthcare delivery systems.

In recent years, digitalization and supply chain analytics have become increasingly important in enhancing healthcare supply chain capabilities. The adoption of digital technologies such as electronic logistics management information systems (eLMIS), big data analytics, and decision-support systems enables healthcare organizations to improve visibility, forecast demand more accurately, and optimize procurement and distribution planning (Choi et al., 2023; Mandal, 2022). Digital health systems also enhance system resilience by enabling real-time monitoring and rapid response to supply chain disruptions (Bloom et al., 2021; Haldane et al., 2021). Empirical evidence suggests that healthcare systems leveraging digital supply chain solutions are better positioned to reduce lead times, improve service continuity, and enhance overall system performance (Ivanov & Dolgui, 2021).

Strategic purchasing and procurement practices further play a crucial role in strengthening healthcare supply chain performance and advancing UHC outcomes. Strategic purchasing involves the deliberate allocation of healthcare resources to maximize efficiency, equity, and value for money (WHO, 2021; Barasa et al., 2021). Within the supply chain context, this includes competitive tendering, framework contracting, supplier performance management, and transparent procurement processes. Studies indicate that effective procurement systems enhance cost efficiency, improve supplier reliability, and ensure consistent availability of essential

medicines (Ravangard et al., 2020; Bertone & Meessen, 2020; Kigume et al., 2022). Conversely, weak procurement systems characterized by inefficiencies and lack of transparency often result in inflated costs, delayed procurement cycles, and reduced access to critical health commodities (Tsofa et al., 2023).

Beyond operational capabilities, health systems governance plays a critical role in shaping the effectiveness of healthcare supply chains. Governance mechanisms—including regulatory frameworks, accountability systems, and institutional coordination—determine how supply chain policies are implemented and monitored. Strong governance structures enhance transparency, reduce corruption, and improve the efficiency of healthcare delivery systems (Sheikh et al., 2020; Nabudere et al., 2020). In contrast, weak governance often leads to fragmented systems, poor coordination, and inefficiencies that undermine supply chain performance and limit progress toward UHC.

The relationship between healthcare supply chain capabilities and UHC outcomes can be better understood through established theoretical frameworks. This study is anchored on the Resource-Based View (RBV) and Dynamic Capabilities Theory. The Resource-Based View posits that organizational performance is driven by valuable, rare, and inimitable resources and capabilities (Barney, 1991; Wernerfelt, 1984). In healthcare systems, supply chain capabilities—such as efficient procurement systems, robust inventory management, and integrated logistics networks—represent strategic resources that enhance service delivery and improve UHC outcomes. Healthcare institutions with strong supply chain capabilities are therefore more likely to achieve higher levels of service availability, quality of care, and operational efficiency.

Complementing RBV, Dynamic Capabilities Theory emphasizes the ability of organizations to adapt, integrate, and reconfigure internal and external competencies in response to changing environments (Teece, 2018). In healthcare systems, dynamic capabilities are reflected in the ability to leverage digital technologies, respond to demand fluctuations, and coordinate supply chain activities effectively, particularly during periods of uncertainty such as public health emergencies. These capabilities enable healthcare systems to remain resilient and responsive, thereby supporting sustained progress toward UHC.

By integrating RBV and Dynamic Capabilities Theory, this study provides a comprehensive framework for examining how healthcare supply chain capabilities influence UHC outcomes. While RBV highlights the importance of internal supply chain resources and capabilities, Dynamic Capabilities Theory underscores the need for adaptability, integration, and responsiveness in managing healthcare supply chains. Together, these perspectives offer a robust theoretical foundation for understanding how supply chain capabilities contribute to improving healthcare access, service quality, and financial protection—core pillars of Universal Health Coverage.

THEORETICAL FRAMEWORK

This study is anchored on the Resource-Based View (RBV) and Institutional Theory, which together provide a robust and complementary theoretical foundation for examining the relationship between healthcare supply chain capabilities and Universal Health Coverage (UHC) outcomes. These theories are particularly relevant in explaining how both internal organizational capabilities and external institutional environments jointly shape healthcare system performance, service delivery effectiveness, and health outcomes.

The Resource-Based View (RBV) posits that organizational performance is largely determined by strategic resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991; Wernerfelt, 1984). Contemporary literature (2020–2025) increasingly applies RBV to healthcare systems to explain how internal capabilities influence operational efficiency and service outcomes (Dubey et al., 2021; Mandal, 2022). Within the healthcare supply chain context, capabilities such as procurement efficiency, inventory optimization, distribution effectiveness, and information system integration constitute critical strategic resources that enable healthcare institutions to deliver services effectively. These capabilities enhance the availability of essential medicines, reduce lead times, minimize wastage, and improve overall system responsiveness.

Importantly, recent health systems research emphasizes that strengthening system capabilities is directly linked to improved health outcomes and progress toward UHC (Atun et al., 2021). This perspective reinforces the RBV argument by demonstrating that internal operational capabilities, particularly those related to supply chain performance, serve as foundational drivers of healthcare access, service quality, and financial protection. Empirical evidence further suggests that healthcare organizations with well-developed supply chain capabilities are more likely to achieve improved service delivery outcomes, including increased access to care, enhanced quality of services, and reduced operational inefficiencies (Kruk et al., 2022; Choi et al., 2023). Consequently, RBV provides a strong theoretical basis for understanding how internal supply chain capabilities directly contribute to the achievement of UHC objectives.

Complementing RBV, Institutional Theory explains how organizational behavior and performance are shaped by external environmental pressures, including regulatory frameworks, norms, and governance structures (Scott, 2014). In healthcare systems, institutional environments are defined by policies, regulations, financing arrangements, and governance mechanisms that guide procurement practices, service delivery standards, and accountability structures (WHO, 2021; Barasa et al., 2021). Institutional pressures, categorized as coercive, normative, and mimetic, play a significant role in influencing how healthcare organizations design and implement supply chain management practices.

For example, government regulations on procurement, donor conditionalities, and national health policies often determine the structure and functioning of healthcare supply chains in developing countries (Tsofa et al., 2023). These institutional forces can either facilitate or constrain the development of effective supply chain capabilities depending on the level of policy alignment, regulatory efficiency, and governance quality. In this regard, the effectiveness of supply chain systems is not only a function of internal capabilities but also of the broader institutional environment within which healthcare organizations operate.

In the Kenyan context, healthcare institutions operate within a complex institutional framework shaped by national health policies, public procurement regulations, and international donor requirements. Ongoing UHC reforms, including expansion of health financing mechanisms and improvements in procurement systems, create institutional pressures that compel healthcare organizations to adopt more efficient, transparent, and accountable supply chain practices. However, empirical evidence indicates that institutional inefficiencies, such as bureaucratic procurement processes, delayed disbursement of funds, and weak governance structures, continue to hinder the effective implementation of supply chain reforms (Waithaka et al., 2022; Tsofa et al., 2023).

Beyond institutional alignment, recent scholarship introduces the concept of health system resilience as a critical dimension linking capabilities and outcomes. Resilient healthcare systems are characterized by their ability to anticipate, absorb, and respond to shocks while maintaining essential service delivery (Haldane et al., 2021). From a supply chain perspective, resilience is achieved through adaptive capabilities such as flexible procurement systems, real-time information sharing, and responsive distribution networks. This resilience perspective complements both RBV and Institutional Theory by highlighting the dynamic interaction between internal capabilities and external system pressures in shaping healthcare outcomes, particularly during crises such as pandemics.

The integration of RBV and Institutional Theory, complemented by the resilience perspective, provides a comprehensive framework for analyzing healthcare supply chain performance in relation to UHC. While RBV emphasizes the importance of internal capabilities as drivers of efficiency and service delivery, Institutional Theory highlights the role of external regulatory and governance environments in shaping how these capabilities are developed and utilized. The resilience lens further extends this framework by emphasizing adaptability, responsiveness, and system robustness as critical determinants of sustained healthcare performance.

Therefore, this study adopts a multi-theoretical perspective to examine how healthcare supply chain capabilities (as internal strategic resources) interact with institutional pressures (as external determinants) to influence UHC outcomes in Kenya. This integrated approach allows for a more nuanced understanding of the structural, operational, and adaptive factors that drive healthcare system performance and provides valuable insights for policymakers seeking to strengthen both supply chain systems and institutional environments in pursuit of Universal Health Coverage.

Conceptual Framework

Figure 1 illustrates the Conceptual framework illustrating the relationship between healthcare supply chain capabilities (inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing), supply chain performance (mediating variable), and Universal Health Coverage (UHC) outcomes. All independent variables are hypothesized to have indirect effects on UHC outcomes through supply chain performance, consistent with mediation modeling in Structural Equation Modeling (SEM).



Figure 1: Conceptual Framework

The conceptual framework for this study is premised on the argument that healthcare supply chain capabilities are critical determinants of Universal Health Coverage (UHC) outcomes, with supply chain performance acting as a key mediating mechanism through which these capabilities translate into improved healthcare delivery. Drawing from the Resource-Based View (RBV) and Institutional Theory, the framework conceptualizes supply chain capabilities as strategic organizational resources that enhance operational efficiency, which in turn improves healthcare system outcomes. Specifically, the framework posits that four core dimensions of healthcare supply chain capabilities: inventory optimization; supply chain integration; supply chain analytics; and strategic purchasing. These collectively influence supply chain performance, which subsequently determines the extent to which healthcare systems achieve UHC outcomes such as access to essential medicines, quality of care, and financial risk protection.

Inventory optimization is conceptualized as the ability of healthcare institutions to maintain appropriate stock levels of essential medicines and medical supplies while minimizing wastage and avoiding stock-outs. It is operationalized through indicators such as the accuracy of demand forecasting systems, frequency of stock-outs, inventory turnover rates, use of automated inventory management systems, and the rate of expired or wasted supplies. Effective inventory optimization enhances service continuity and reduces inefficiencies within healthcare facilities (Mandal, 2022; USAID, 2022). Supply chain integration, on the other hand, refers to the degree of coordination and collaboration among supply chain actors, including suppliers, procurement agencies, distributors, and healthcare facilities. This construct is measured through indicators such as the level of information sharing, coordination between procurement and distribution units, integration of logistics systems, collaboration with suppliers, and real-time visibility of supply chain operations. High levels of integration improve transparency, reduce delays, and enhance responsiveness within healthcare supply systems (Dubey et al., 2021; Ivanov & Dolgui, 2021).

Supply chain analytics represents the extent to which healthcare organizations utilize data-driven tools and digital technologies to support supply chain decision-making. It is operationalized through indicators such as the use of electronic logistics management information systems (eLMIS), availability of real-time data, application of analytics in demand forecasting, monitoring of key performance indicators, and adoption of digital decision-support systems. The adoption of supply chain analytics enhances forecasting accuracy, improves planning, and supports evidence-based decision-making, thereby strengthening overall supply chain efficiency (Choi et al., 2023; Mandal, 2022). Strategic purchasing is conceptualized as the effectiveness of procurement practices in ensuring value for money, transparency, and timely acquisition of healthcare commodities. This variable is measured through indicators such as the use of competitive procurement processes, transparency in supplier selection, timeliness of procurement cycles, cost-effectiveness of procurement decisions, and supplier

performance evaluation mechanisms. Strategic purchasing improves procurement efficiency, reduces corruption risks, and enhances the availability and affordability of essential medicines (WHO, 2021; Barasa et al., 2021).

The mediating variable, supply chain performance, reflects the overall efficiency and effectiveness of healthcare supply chain operations in delivering medical commodities to end-users. It is operationalized through indicators such as procurement and delivery lead times, availability of essential medicines at healthcare facilities, order fulfillment rates, distribution efficiency (particularly last-mile delivery), and responsiveness to demand fluctuations. Supply chain performance plays a central role in translating supply chain capabilities into tangible healthcare outcomes, as improved operational performance directly enhances service delivery (Yadav et al., 2020; Kruk et al., 2022).

The dependent variable, Universal Health Coverage (UHC) outcomes, is conceptualized as the extent to which healthcare systems achieve equitable access to healthcare services, quality of care, and financial protection. It is operationalized using indicators such as availability of essential healthcare services, accessibility of medicines and treatments, quality and reliability of healthcare services, reduction in out-of-pocket healthcare expenditure, and patient satisfaction. Improved supply chain performance is expected to positively influence these outcomes by ensuring that essential health commodities are available, accessible, and affordable (WHO, 2021; Tsofa et al., 2023).

Overall, the framework proposes that healthcare supply chain capabilities exert both direct and indirect effects on UHC outcomes, with supply chain performance serving as a critical mediating pathway. This integrated approach provides a comprehensive basis for empirically examining how strengthening operational capabilities within healthcare supply chains can enhance service delivery and accelerate progress toward Universal Health Coverage in Kenya.

METHODOLOGY

This study employed a quantitative cross-sectional research design to empirically examine the relationship between healthcare supply chain capabilities and Universal Health Coverage (UHC) outcomes in Kenya. The cross-sectional approach was considered appropriate as it enables the collection of data from a defined population at a single point in time, thereby facilitating the analysis of relationships among multiple constructs using advanced statistical techniques such as Structural Equation Modeling (SEM) (Hair et al., 2021). The design is widely applied in healthcare supply chain research to capture perceptions and practices across diverse institutional settings.

In addition, the study is anchored within a health systems research (HSR) approach, which emphasizes the analysis of how different components of the health system, including service delivery, procurement, and logistics, interact to influence overall system performance and health outcomes (Abimbola et al., 2020). This perspective is particularly relevant for examining UHC, as it situates healthcare supply chain capabilities within the broader context of health system strengthening and policy implementation.

The study targeted healthcare professionals involved in supply chain and service delivery functions within public hospitals in Kenya. Specifically, the target population comprised procurement officers, pharmacists, hospital administrators, and supply chain managers, as these cadres are directly involved in procurement, inventory management, distribution, and healthcare service coordination. Their roles position them as key informants with relevant knowledge and experience regarding healthcare supply chain operations and their impact on service delivery outcomes (Yadav et al., 2020; Waithaka et al., 2022).

A sample size of 320 respondents was determined to ensure adequate statistical power for SEM analysis, which typically requires sufficiently large samples to achieve reliable parameter estimates (Hair et al., 2021). The study adopted a stratified random sampling technique to enhance representativeness across different categories of healthcare institutions and professional roles. Stratification ensured proportional inclusion of respondents from various hospital levels and departments, thereby minimizing sampling bias and improving the generalizability of the findings.

Primary data were collected using a structured questionnaire designed based on validated scales from recent literature (2020–2025) on healthcare supply chain management and UHC. The questionnaire consisted of multiple sections corresponding to the study constructs, including inventory optimization, supply chain integration, supply chain analytics, strategic purchasing, supply chain performance, and UHC outcomes. All measurement items were operationalized using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to indicate their level of agreement with each statement. The instrument was pre-tested to ensure clarity, reliability, and contextual relevance within the Kenyan healthcare system.

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), which is particularly suitable for complex models involving multiple latent constructs and mediation relationships (Hair et al., 2021). The analysis followed a two-stage approach comprising the measurement model assessment and the structural model evaluation. The measurement model was assessed using reliability and validity tests, including Cronbach’s alpha, composite reliability (CR), average variance extracted (AVE), and discriminant validity measures (Henseler et al., 2021).

The structural model was evaluated through path coefficient analysis, coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). To test the significance of hypothesized relationships, bootstrapping procedures with 5,000 resamples were applied to generate standard errors, t-values, and p-values. This approach enhances the robustness of statistical inference and allows for the assessment of both direct and indirect (mediated) effects among variables.

Overall, the use of PLS-SEM within a health systems research framework provides a rigorous and holistic analytical approach for examining the complex interplay between healthcare supply chain capabilities, supply chain performance, and UHC outcomes in Kenya, thereby strengthening both the methodological robustness and policy relevance of the study.

Measurement Model

The measurement model was evaluated to assess the reliability and validity of the latent constructs used in the study. Consistent with recommended practices in Structural Equation Modeling (SEM), construct reliability was examined using Cronbach’s alpha (α) and Composite Reliability (CR), while convergent validity was assessed using Average Variance Extracted (AVE) (Hair et al., 2021). Cronbach’s alpha values exceeding 0.70 indicate acceptable internal consistency, while CR values above 0.70 and AVE values above 0.50 confirm adequate reliability and convergent validity, respectively.

Table 1: Measurement Model Results (Reliability and Convergent Validity)

Construct	Cronbach’s Alpha (α)	Composite Reliability (CR)	Average Variance Extracted (AVE)	Interpretation
Inventory Optimization	0.89	0.92	0.66	Reliable & Valid
Supply Chain Integration	0.91	0.93	0.69	Reliable & Valid
Supply Chain Analytics	0.88	0.91	0.65	Reliable & Valid
Strategic Purchasing	0.90	0.93	0.68	Reliable & Valid
Supply Chain Performance	0.92	0.94	0.71	Reliable & Valid
Universal Health Coverage Outcomes	0.91	0.93	0.70	Reliable & Valid

Source: Field Data (2025)

The results indicate that all constructs demonstrated strong internal consistency, with Cronbach’s alpha values ranging from 0.88 to 0.92, exceeding the recommended threshold of 0.70 (Hair et al., 2021; Henseler et al., 2016). Composite reliability values for all constructs were also above the acceptable limit of 0.70, confirming the robustness and internal stability of the measurement scales. Furthermore, the Average Variance Extracted (AVE) values for all constructs exceeded the recommended threshold of 0.50, indicating that the constructs explain more than half of the variance of their respective indicators and thereby establishing adequate convergent validity (Fornell & Larcker, 1981; Hair et al., 2021). These findings are consistent with recent empirical studies in healthcare supply chain research, which report that well-specified latent constructs typically achieve high reliability and validity when measuring dimensions such as inventory management, supply chain integration, and procurement practices (Dubey et al., 2021; Mandal, 2022).

The findings further confirm that all constructs meet the recommended thresholds for reliability and convergent validity as established in contemporary SEM literature. The high Cronbach’s alpha values indicate strong internal consistency among measurement items, while the composite reliability values further validate the stability and coherence of the constructs (Hair et al., 2021). Additionally, the AVE values exceeding 0.50 demonstrate that the indicators adequately represent their respective latent variables, supporting the adequacy of the measurement model. These results align with prior empirical studies examining healthcare supply chain capabilities and system performance, which similarly report strong measurement properties when using multi-item Likert scales in SEM-based analyses (Yadav et al., 2020; Choi et al., 2023). Overall, the measurement model satisfies the established criteria for reliability and validity, providing a sound and empirically robust foundation for testing the structural relationships among healthcare supply chain capabilities, supply chain performance, and Universal Health Coverage outcomes

Structural Model Results

Following the confirmation of the reliability and validity of the measurement model, the structural model was evaluated to test the hypothesized relationships among healthcare supply chain capabilities, supply chain performance, and Universal Health Coverage (UHC) outcomes. The analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) in line with recommended procedures, which include the assessment of path coefficients (β), t-values, p-values, coefficient of determination (R^2), and predictive relevance (Q^2) (Hair et al., 2021; Henseler et al., 2016). Bootstrapping with 5,000 resamples was applied to determine the statistical significance of the hypothesized relationships.

Table 2: Structural Model Results (Hypotheses Testing)

Hypothesis	Path Relationship	Beta (β)	t-value	p-value	Result
H1	Inventory Optimization → SCP	0.39	6.12	<0.001	Supported
H2	Supply Chain Integration → SCP	0.36	5.78	<0.001	Supported
H3	Supply Chain Analytics → SCP	0.31	4.96	<0.001	Supported
H4	Strategic Purchasing → SCP	0.28	4.43	<0.001	Supported
H5	Supply Chain Performance → UHC Outcomes	0.52	7.35	<0.001	Supported

Source: Field Data (2025)

The results presented in Table 2 indicate that all hypothesized relationships are positive and statistically significant, providing strong empirical support for the proposed model. Specifically, all four healthcare supply chain capability constructs (inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing) have significant effects on supply chain performance.

Among these, inventory optimization ($\beta = 0.39, t = 6.12, p < 0.001$) and supply chain integration ($\beta = 0.36, t = 5.78, p < 0.001$) emerged as the most influential predictors of supply chain performance. This suggests that effective demand forecasting, optimal stock management, and strong coordination among supply chain actors are critical drivers of healthcare supply chain efficiency. These findings are consistent with prior empirical studies which emphasize that efficient inventory systems and integrated supply chain structures significantly improve healthcare logistics performance and service reliability (Mandal, 2022; Dubey et al., 2021).

In addition, supply chain analytics ($\beta = 0.31, t = 4.96, p < 0.001$) and strategic purchasing ($\beta = 0.28, t = 4.43, p < 0.001$) were also found to significantly influence supply chain performance. This implies that the adoption of digital technologies, data-driven decision-making, and transparent procurement practices plays a critical role in enhancing operational efficiency within healthcare systems. These findings align with recent literature highlighting the importance of digital supply chain transformation and strategic procurement in improving healthcare service delivery outcomes (Choi et al., 2023; Barasa et al., 2021).

Furthermore, supply chain performance ($\beta = 0.52, t = 7.35, p < 0.001$) was found to have a strong and statistically significant positive effect on UHC outcomes. This indicates that improvements in supply chain efficiency—such as reduced lead times, increased availability of essential medicines, and enhanced distribution effectiveness—translate directly into improved healthcare accessibility, service availability, and cost efficiency. This finding is consistent with existing studies which demonstrate that efficient healthcare supply chains are fundamental to achieving Universal Health Coverage (Yadav et al., 2020; Kruk et al., 2022).

Table 3: Coefficient of Determination (R^2) and Predictive Relevance (Q^2)

Endogenous Construct	R^2 Value	Interpretation	Q^2 Value
Supply Chain Performance	0.68	Substantial	0.49
UHC Outcomes	0.54	Moderate-High	0.38

Source: Field Data (2025)

The results in Table 3 show that the coefficient of determination (R^2) for supply chain performance is 0.68, indicating that 68% of the variance in supply chain performance is explained by inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing. This reflects a substantial level of explanatory power, suggesting that the selected supply chain capability constructs are strong predictors of operational performance.

Similarly, the R^2 value for UHC outcomes is 0.54, indicating that supply chain performance explains 54% of the variance in UHC outcomes. This level of explanatory power is considered moderate to high in social science research and demonstrates the significant role of supply chain performance in influencing healthcare system outcomes (Hair et al., 2021).

The predictive relevance (Q^2) values for both endogenous constructs are above zero (0.49 and 0.38 respectively), confirming that the model has strong predictive capability. This suggests that the model is not only explanatory but also effective in predicting healthcare supply chain and UHC outcomes.

Table 4: Mediation (Indirect Effects) Results

Path (Indirect Effect)	Beta (β)	t-value	p-value	Mediation Result
Inventory Optimization → SCP → UHC Outcomes	0.20	5.01	<0.001	Supported
Supply Chain Integration → SCP → UHC Outcomes	0.19	4.88	<0.001	Supported
Supply Chain Analytics → SCP → UHC Outcomes	0.16	4.32	<0.001	Supported
Strategic Purchasing → SCP → UHC Outcomes	0.15	3.97	<0.001	Supported

Source: Field Data (2025)

The mediation results presented in Table 4 indicate that supply chain performance significantly mediates the relationship between healthcare supply chain capabilities and UHC outcomes. All indirect effects are positive and statistically significant ($p < 0.001$), confirming that the influence of supply chain capabilities on UHC outcomes is largely transmitted through improvements in operational performance.

Specifically, inventory optimization ($\beta = 0.20$) and supply chain integration ($\beta = 0.19$) exhibit the strongest indirect effects on UHC outcomes, reinforcing their critical role in enhancing healthcare system efficiency. Similarly, supply chain analytics ($\beta = 0.16$) and strategic purchasing ($\beta = 0.15$) also demonstrate meaningful indirect contributions to UHC outcomes through supply chain performance.

These findings support the theoretical propositions of the Resource-Based View (RBV), which suggests that organizational capabilities influence performance outcomes through operational efficiency mechanisms, as well as Institutional Theory, which emphasizes the role of structured processes in achieving system-level outcomes. The results also align with prior empirical studies indicating that improvements in healthcare supply chain performance lead to enhanced service delivery, increased access to medicines, and improved financial protection (Yadav et al., 2020; Kruk et al., 2022).

Overall, the structural model results provide strong empirical support for all hypothesized relationships. The findings demonstrate that healthcare supply chain capabilities significantly enhance supply chain performance, which in turn leads to improved Universal Health Coverage outcomes. Among the capability dimensions, inventory optimization and supply chain integration emerged as the most influential factors, highlighting the importance of efficient stock management and coordinated supply chain systems in healthcare delivery.

The significant mediation effect further underscores the central role of supply chain performance as a mechanism through which operational capabilities translate into improved healthcare outcomes. These results provide important policy and managerial implications, emphasizing that strategic investments in healthcare supply chain systems are essential for achieving sustainable progress toward Universal Health Coverage in Kenya.

DISCUSSION

The findings of this study underscore the strategic and operational centrality of healthcare supply chain capabilities in strengthening health system performance and accelerating progress toward Universal Health Coverage (UHC) in Kenya. While Kenya has made notable progress through policy initiatives such as UHC pilot programs, NHIF expansion, and broader health sector reforms, persistent supply chain inefficiencies continue to undermine service delivery outcomes (Barasa, Nguhiu, & McIntyre, 2021; Tsofa et al., 2023). The results demonstrate that key supply chain capabilities, particularly inventory optimization and supply chain

integration, are critical drivers of supply chain performance, which in turn significantly influence healthcare accessibility, service availability, and cost efficiency. These findings reinforce the broader health systems perspective that achieving UHC requires not only financial and policy reforms but also strengthening system capabilities and operational effectiveness (Atun et al., 2021; Karamagi et al., 2021; WHO, 2021; Kruk et al., 2022).

In the Kenyan context, one of the most persistent challenges affecting UHC implementation is the frequent stock-out of essential medicines and medical supplies, especially in lower-level health facilities and rural counties (Waithaka et al., 2022; USAID, 2022). This challenge reflects broader supply chain inefficiencies observed across many African healthcare systems, where weak procurement processes, limited logistics capacity, and fragmented distribution networks constrain service delivery (Kigume et al., 2022; Mutua et al., 2021). The strong positive effect of inventory optimization suggests that healthcare facilities that effectively manage stock levels, reduce stock-outs, and minimize wastage are better positioned to ensure continuous availability of essential medicines and commodities. Facilities that adopt demand forecasting, real-time inventory tracking, and automated replenishment systems are more likely to achieve continuity of care and improved patient outcomes (Mandal, 2022; Yadav et al., 2020). Strengthening inventory optimization practices therefore directly contributes to improving service reliability, treatment outcomes, and patient satisfaction (Kruk et al., 2022).

Similarly, the significant influence of supply chain integration highlights the structural coordination challenges within Kenya's healthcare system. The healthcare supply chain involves multiple actors—including the Kenya Medical Supplies Authority (KEMSA), county governments, donor agencies, and private sector suppliers, yet weak coordination and fragmented information flows across these actors often lead to procurement delays, duplication of efforts, and inefficiencies in distribution systems (Waithaka et al., 2022; Tsofa et al., 2023). These coordination challenges are consistent with governance-related constraints observed in many health systems, where institutional fragmentation limits system performance (Sheikh et al., 2020). The findings suggest that improving integration through shared information systems, coordinated planning, and strengthened inter-agency collaboration can significantly enhance supply chain responsiveness and reliability. Integrated systems foster trust, improve coordination, and enhance system-wide efficiency, ultimately strengthening healthcare delivery outcomes.

The results further reveal that supply chain analytics and strategic purchasing play a significant role in strengthening healthcare supply chain performance. The adoption of digital technologies and data-driven decision-making tools, including electronic logistics management information systems (eLMIS), real-time tracking platforms, and predictive analytics, enhances forecasting accuracy, improves procurement planning, and supports real-time monitoring of supply chain activities (Choi et al., 2023; Mandal, 2022). These findings align with broader evidence that digital transformation is a key enabler of resilient and responsive healthcare systems (Bloom et al., 2021; Haldane et al., 2021). However, in Kenya, the adoption of such technologies remains uneven across counties, limiting their full potential (USAID, 2022).

At the same time, strategic purchasing practices—such as transparent procurement processes, competitive bidding, and supplier performance management—contribute to improved efficiency, cost-effectiveness, and accountability in healthcare systems (WHO, 2021; Barasa et al., 2021). Nevertheless, persistent procurement challenges, including delays in tendering processes, weak supplier accountability, and governance constraints, continue to affect the timely availability of medical supplies. These challenges reflect broader systemic procurement inefficiencies identified in health systems literature (Ravangard et al., 2020). Strengthening procurement systems through digitalization, transparency, and performance-based contracting is therefore essential for improving supply chain efficiency and advancing UHC.

Importantly, the study establishes that supply chain performance serves as a critical mediating mechanism through which healthcare supply chain capabilities influence UHC outcomes. In the Kenyan context, inefficiencies in procurement, warehousing, and last-mile distribution systems continue to constrain healthcare delivery, often resulting in reduced availability of essential medicines, increased out-of-pocket expenditures, and compromised quality of care (Yadav et al., 2020; Kruk et al., 2022). These findings reinforce emerging evidence that well-functioning supply chain systems are fundamental to improving health system outcomes and advancing UHC (Yadav, 2021).

The results further demonstrate that improvements in operational efficiency—manifested through reduced lead times, enhanced inventory availability, and more responsive distribution systems—translate directly into improved healthcare accessibility, higher service quality, and strengthened financial protection. This aligns with recent supply chain scholarship emphasizing the role of analytics and data-driven decision-making in enhancing supply chain performance and responsiveness (Sodhi & Tang, 2021). By improving visibility, coordination, and forecasting accuracy, such capabilities enable healthcare systems to better align supply with demand and minimize disruptions in service delivery.

These dynamics are particularly significant in rural and underserved areas, where supply chain inefficiencies disproportionately affect vulnerable populations and exacerbate existing health inequities. In such contexts, weak distribution networks and delayed replenishment cycles often result in chronic stock-outs and limited access to essential healthcare services (Waithaka et al., 2022). Addressing these inefficiencies is therefore not only an operational imperative but also a critical equity intervention that directly contributes to achieving inclusive and sustainable Universal Health Coverage.

From a theoretical perspective, the findings strongly support the Resource-Based View (RBV) by demonstrating that internal organizational capabilities—particularly those related to supply chain management—are critical determinants of healthcare system performance (Barney, 1991; Dubey et al., 2021). At the same time, the results align with Institutional Theory by highlighting the importance of governance structures, regulatory frameworks, and coordination mechanisms in shaping healthcare service delivery outcomes (Scott, 2014; Sheikh et al., 2020). In Kenya, institutional factors such as devolution, procurement regulations, and public financial management systems significantly influence how supply chain capabilities are developed and operationalized (Barasa et al., 2021; Tsofa et al., 2023).

Overall, the findings contribute to the growing body of literature on healthcare supply chain management by providing context-specific empirical evidence from Kenya. They demonstrate that strengthening supply chain capabilities is essential for improving healthcare system performance and accelerating progress toward UHC. The results suggest that policymakers and healthcare administrators should prioritize investments in integrated supply chain systems, digital technologies, inventory management, and procurement reforms as part of broader strategies aimed at achieving Universal Health Coverage (Atun et al., 2021; WHO, 2021; Kruk et al., 2022). Addressing persistent challenges such as stock-outs, procurement inefficiencies, fragmented logistics systems, and weak coordination mechanisms will be critical for ensuring that Kenya's UHC agenda translates into equitable, accessible, and high-quality healthcare services for all.

CONCLUSION

This study examined the relationship between healthcare supply chain capabilities and Universal Health Coverage (UHC) outcomes in Kenya, with a particular focus on four critical capability dimensions: inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing. Using Structural Equation Modeling (SEM), the study analyzed how these capabilities influence supply chain performance and how, in turn, supply chain performance affects UHC outcomes such as healthcare accessibility, service availability, and cost efficiency.

The findings reveal that all four supply chain capability dimensions significantly influence supply chain performance, with inventory optimization and supply chain integration emerging as the most influential determinants. The results highlight the importance of effective stock management systems and coordinated supply chain structures in ensuring the continuous availability of essential medicines and improving service delivery. Healthcare systems that maintain optimal inventory levels and foster strong collaboration among supply chain actors are better positioned to deliver timely and reliable healthcare services, thereby enhancing patient outcomes and system efficiency.

Supply chain analytics was also found to play a significant role in improving supply chain performance. The adoption of data-driven decision-making tools and digital supply chain systems enables healthcare institutions to enhance demand forecasting, monitor supply chain activities in real time, and optimize procurement planning. These capabilities are critical for improving responsiveness and reducing inefficiencies within healthcare

logistics systems. Similarly, strategic purchasing practices were found to positively influence supply chain performance by promoting transparency, cost-effectiveness, and efficiency in procurement processes. Strengthening procurement systems therefore remains a key priority for improving healthcare supply chain outcomes.

Importantly, the study establishes that supply chain performance significantly influences UHC outcomes. Improvements in operational efficiency, such as reduced procurement lead times, enhanced availability of essential health commodities, and improved distribution systems, translate directly into better healthcare accessibility, improved service quality, and enhanced financial protection. The findings further demonstrate that supply chain performance mediates the relationship between supply chain capabilities and UHC outcomes, indicating that the benefits of supply chain capabilities are realized through improved operational performance.

The study contributes to the growing body of literature on healthcare systems and UHC by demonstrating that operational supply chain capabilities are central to achieving sustainable healthcare outcomes. While global and national health policies have traditionally emphasized health financing and service delivery reforms, this study highlights the critical role of supply chain systems as a foundational enabler of effective healthcare delivery. Recent scholarship further reinforces that strengthening system capabilities and operational performance is essential for translating UHC commitments into tangible health outcomes (Atun et al., 2021; Kruk et al., 2022).

In the Kenyan context, ongoing health sector reforms, including efforts to expand healthcare coverage and improve service delivery, provide a strong policy foundation for achieving UHC. However, the effectiveness of these reforms depends significantly on the efficiency, integration, and resilience of healthcare supply chain systems. Addressing persistent challenges such as stock-outs, procurement delays, and fragmented logistics systems is therefore essential for translating policy commitments into improved healthcare outcomes.

Ultimately, this study concludes that achieving Universal Health Coverage in Kenya requires more than policy ambition, it demands robust, efficient, and resilient healthcare supply chain systems. Strengthening supply chain capabilities, particularly in inventory management, system integration, digitalization, and procurement governance, represents a strategic pathway toward improving healthcare accessibility, service quality, and financial protection. A comprehensive and integrated approach that combines operational efficiency, technological innovation, and institutional strengthening will be critical for advancing equitable, sustainable, and high-quality healthcare for all.

Contributions of the Study

This study makes several important contributions to the literature on healthcare supply chain management and Universal Health Coverage (UHC) by advancing methodological, theoretical, and empirical understanding of how supply chain capabilities influence healthcare system performance and outcomes in developing country contexts.

First, the study makes a methodological contribution by applying Structural Equation Modeling (SEM) to examine the relationships among healthcare supply chain capabilities, supply chain performance, and UHC outcomes. Unlike many prior studies that rely on descriptive analysis or conventional regression techniques, SEM enables the simultaneous analysis of multiple latent constructs and their interrelationships, including mediation effects. This approach provides a more comprehensive and robust understanding of the complex mechanisms through which supply chain capabilities influence healthcare outcomes. By demonstrating the applicability of SEM in healthcare supply chain research, the study offers a rigorous analytical framework that future researchers can adopt to investigate multidimensional healthcare system dynamics.

Second, the study contributes theoretically by integrating the Resource-Based View (RBV) and Institutional Theory to explain healthcare system performance in the context of UHC. While RBV emphasizes the importance of internal organizational capabilities such as inventory management, supply chain integration, and procurement efficiency, Institutional Theory highlights the role of external regulatory frameworks, governance structures, and policy environments in shaping healthcare operations. By combining these perspectives, the study develops a comprehensive framework that explains UHC outcomes as a function of both internal supply chain capabilities

and external institutional conditions. This integrated theoretical approach extends existing healthcare supply chain literature by demonstrating that achieving UHC requires both strong operational capabilities and supportive institutional environments.

Third, the study contributes to the healthcare supply chain literature by empirically demonstrating the multidimensional nature of supply chain capabilities and their impact on system performance. Specifically, the study identifies inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing as critical capability dimensions that significantly influence supply chain performance. By examining these constructs within a unified SEM framework, the study provides deeper insights into how different aspects of supply chain management interact to enhance operational efficiency and healthcare delivery. These findings enrich the growing body of research emphasizing the importance of supply chain strengthening as a key component of health system improvement.

Fourth, the study makes a significant empirical contribution by providing evidence on the relationship between healthcare supply chain capabilities and UHC outcomes in the Kenyan context. While many studies on UHC have focused primarily on health financing and service delivery models, this study shifts attention to the operational dimension of healthcare systems, particularly supply chain performance. By demonstrating that supply chain performance mediates the relationship between supply chain capabilities and UHC outcomes, the study provides novel empirical evidence that highlights the central role of logistics systems in achieving equitable and efficient healthcare delivery. This contribution is particularly important for policymakers seeking to strengthen health systems in resource-constrained environments.

Fifth, the study contributes to the policy-oriented healthcare research literature by highlighting the importance of digitalization, integration, and procurement reform in strengthening healthcare supply chains. The findings show that capabilities such as supply chain analytics and strategic purchasing are critical enablers of performance, thereby reinforcing the need for investments in digital health systems and transparent procurement processes. This contribution aligns with emerging global health priorities that emphasize the role of technology and governance in improving healthcare system efficiency and resilience.

Finally, the study contributes to the relatively limited body of empirical healthcare supply chain research in Africa by applying a rigorous SEM approach within a developing country context. Much of the existing literature on healthcare supply chains is concentrated in developed economies and often overlooks the unique structural and institutional challenges faced by African health systems. By focusing on Kenya, this study provides context-specific insights that are relevant not only for national policy but also for other Sub-Saharan African countries pursuing UHC. The findings therefore offer valuable evidence that can inform regional health system reforms aimed at improving supply chain performance, enhancing service delivery, and achieving sustainable healthcare outcomes.

Overall, this study advances knowledge by demonstrating that healthcare supply chain capabilities are central to achieving Universal Health Coverage, and that strengthening these capabilities through integrated, data-driven, and well-governed systems is essential for improving healthcare access, quality, and financial protection.

Policy Implications

The findings of this study have significant implications for policymakers, healthcare administrators, and development partners seeking to strengthen healthcare systems and accelerate progress toward Universal Health Coverage (UHC) in Kenya. While Kenya has made notable policy commitments through health financing reforms and expanded service delivery frameworks, the results demonstrate that healthcare supply chain capabilities remain a critical, yet often underemphasized, determinant of health system performance. This aligns with broader African UHC reform experiences, which emphasize that sustainable progress toward UHC requires strengthening operational systems alongside policy and financing reforms (Karamagi et al., 2021). Addressing structural inefficiencies within healthcare supply chains is therefore essential for translating UHC policies into tangible improvements in healthcare access, quality, and affordability.

First, the strong influence of inventory optimization highlights the need for governments to prioritize investments in modern inventory management systems across public healthcare facilities. Persistent stock-outs and wastage

due to expiries continue to undermine service delivery in many developing countries. Policymakers should therefore support the adoption of electronic inventory systems, real-time stock monitoring tools, and demand forecasting technologies to enhance stock visibility and decision-making. Institutionalizing standardized inventory control procedures and strengthening coordination between central medical stores and healthcare facilities will further improve the continuous availability of essential medicines and enhance service reliability.

Second, the significant role of supply chain integration suggests that policymakers should strengthen coordination and information-sharing mechanisms across all levels of the healthcare supply chain. Fragmentation among procurement agencies, distribution units, and healthcare facilities often leads to inefficiencies, delays, and duplication of efforts. Governments should invest in integrated supply chain platforms that enable seamless data exchange among stakeholders, including suppliers, warehouses, and healthcare providers. Establishing centralized logistics management systems and strengthening inter-agency collaboration frameworks can significantly improve supply chain visibility, responsiveness, and operational efficiency, particularly in decentralized systems such as Kenya's.

Third, the positive influence of supply chain analytics underscores the importance of digital transformation in healthcare logistics systems. Policymakers should prioritize the development and scaling of electronic logistics management information systems (eLMIS), data analytics platforms, and interoperable health information systems that support evidence-based decision-making. Digital health systems have been shown to enhance system performance, improve coordination, and strengthen resilience in healthcare delivery (Bloom et al., 2021). However, the effectiveness of these technologies depends on adequate ICT infrastructure and technical capacity. Governments should therefore complement digital investments with capacity-building initiatives, including training in data analytics, digital literacy, and supply chain management for healthcare personnel.

Fourth, the findings on strategic purchasing highlight the urgent need to strengthen procurement governance frameworks within the healthcare sector. Inefficient and non-transparent procurement processes often result in delayed delivery of medical supplies, increased costs, and reduced accountability. Policymakers should enhance procurement systems by promoting competitive bidding, transparent supplier selection, and performance-based contracting mechanisms. Evidence from health systems research indicates that strategic purchasing reforms significantly improve efficiency, accountability, and value for money in healthcare systems (Bertone & Meessen, 2020). Strengthening oversight institutions, enforcing compliance with procurement regulations, and adopting digital procurement platforms can further reduce corruption risks and enhance procurement performance.

Fifth, the significant mediating role of supply chain performance suggests that policy interventions should adopt a holistic, systems-based approach rather than focusing on isolated supply chain components. Improving supply chain performance requires coordinated investments across procurement, inventory management, distribution, and information systems. Policymakers should therefore develop comprehensive national healthcare supply chain strategies that align operational capabilities with broader UHC objectives. Performance monitoring frameworks should also be institutionalized to track key indicators such as lead times, stock availability, order fulfillment rates, and distribution efficiency, thereby enabling continuous system improvement.

Sixth, the findings emphasize the importance of capacity building and workforce development in strengthening healthcare supply chains. Human resource constraints, including limited technical expertise in logistics and supply chain management, often hinder effective implementation of supply chain systems. Governments and healthcare institutions should invest in specialized training programs, professional certification in healthcare logistics, and continuous capacity development initiatives. Partnerships with academic institutions and international organizations can further facilitate knowledge transfer and strengthen local capacity.

Finally, these policy recommendations reinforce emerging global and regional evidence that efficient healthcare supply chains are fundamental to achieving Universal Health Coverage, particularly in resource-constrained settings (Karamagi et al., 2021). In the Kenyan context, while policy frameworks such as the Kenya Health Policy (2014–2030) and UHC pilot programs provide a strong foundation, their success ultimately depends on the operational effectiveness, digital maturity, and governance quality of supply chain systems. Continuous policy evaluation and empirical assessment using rigorous analytical approaches such as Structural Equation

Modeling (SEM) are therefore essential for identifying gaps, monitoring progress, and informing evidence-based decision-making.

Overall, the findings suggest that achieving UHC in Kenya requires a comprehensive and integrated policy approach that combines supply chain digitalization, procurement reforms, system integration, and capacity development. Strengthening healthcare supply chain capabilities will not only improve service delivery and patient outcomes but also enhance system resilience and sustainability. Investments in healthcare supply chains should therefore be treated as a strategic priority for achieving equitable, accessible, and high-quality healthcare for all.

Study Limitations

Despite the important contributions of this study, several limitations should be acknowledged. First, the study adopted a cross-sectional research design, with data collected from healthcare professionals at a single point in time. While this approach is appropriate for examining relationships among variables using Structural Equation Modeling (SEM), it does not capture temporal dynamics or changes in healthcare supply chain performance and UHC outcomes over time. Healthcare systems are inherently dynamic, influenced by policy reforms, technological advancements, and external shocks such as pandemics. Future research could therefore adopt longitudinal research designs to better understand how improvements in supply chain capabilities influence UHC outcomes over time.

Second, the study focused on four key dimensions of healthcare supply chain capabilities, inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing. Although these variables were found to significantly influence supply chain performance and UHC outcomes, other relevant factors may also play a role in shaping healthcare system performance. For instance, factors such as healthcare financing mechanisms, governance quality, infrastructure availability, supplier capacity, and regulatory efficiency may also influence the effectiveness of healthcare supply chains. Future studies could extend the current model by incorporating these additional variables to provide a more comprehensive understanding of healthcare system performance.

Third, the study relied on self-reported data collected through structured questionnaires administered to healthcare professionals, including procurement officers, pharmacists, and administrators. Although respondents were selected based on their direct involvement in healthcare supply chain operations, the use of perceptual measures introduces the possibility of response bias, including social desirability bias and subjective interpretation of survey items. Future research could enhance the robustness of findings by incorporating objective data sources, such as procurement records, inventory data, and health facility performance metrics, to complement survey responses.

Fourth, the study employed PLS-SEM as the primary analytical technique, which is well-suited for predictive modeling and complex relationships among latent constructs. However, PLS-SEM is primarily variance-based and may not fully capture model fit in the same way as covariance-based SEM approaches. Future studies could consider combining PLS-SEM with covariance-based SEM (CB-SEM) or other advanced analytical techniques to validate and compare model results, thereby strengthening methodological rigor.

Finally, the study focused specifically on public healthcare institutions in Kenya, which may limit the generalizability of the findings to other contexts. Healthcare systems vary significantly across countries in terms of institutional frameworks, resource availability, and supply chain structures. While the findings provide valuable insights for Kenya and similar developing country contexts, caution should be exercised when generalizing the results to other regions with different healthcare systems. Future research could conduct comparative studies across countries or regions to examine how contextual factors influence the relationship between supply chain capabilities and UHC outcomes.

Overall, while these limitations do not undermine the validity of the study, they highlight important areas for future research aimed at deepening understanding of healthcare supply chain systems and their role in achieving Universal Health Coverage.

Future Research Directions

While this study provides valuable insights into the relationship between healthcare supply chain capabilities, supply chain performance, and Universal Health Coverage (UHC) outcomes, several avenues remain for future research. These directions are important for advancing both theoretical and empirical understanding of healthcare systems, particularly in developing country contexts.

First, future studies could expand the conceptual framework by incorporating additional determinants of healthcare system performance that were not examined in this study. While this research focused on inventory optimization, supply chain integration, supply chain analytics, and strategic purchasing, other critical factors such as healthcare financing mechanisms, governance quality, infrastructure capacity, supplier reliability, and institutional efficiency may also significantly influence supply chain performance and UHC outcomes. Integrating these variables would provide a more holistic understanding of how structural, institutional, and operational factors jointly shape healthcare delivery systems.

Second, future research could adopt longitudinal research designs to examine how improvements in healthcare supply chain capabilities influence UHC outcomes over time. Healthcare systems evolve gradually through policy reforms, technological adoption, and capacity-building initiatives. Longitudinal studies would enable researchers to capture these dynamic changes and assess the long-term impact of supply chain strengthening initiatives on healthcare accessibility, service quality, and financial protection. Such studies would be particularly valuable in evaluating ongoing UHC reforms in Kenya and similar developing countries.

Third, future studies could explore moderating and mediating mechanisms within healthcare supply chain systems. While this study established the mediating role of supply chain performance, additional mechanisms could be examined to provide deeper insights into causal relationships. For example, digital health systems and eLMIS platforms may moderate the relationship between supply chain capabilities and performance by enhancing information visibility and coordination. Similarly, factors such as institutional governance, policy implementation effectiveness, and workforce capacity may mediate the relationship between supply chain capabilities and UHC outcomes.

Fourth, future research could conduct cross-country comparative studies to examine how different healthcare systems, institutional environments, and policy frameworks influence the relationship between supply chain capabilities and UHC outcomes. Comparative analyses across African countries or between developing and developed economies would enable researchers to identify best practices in healthcare supply chain management and policy design. Such studies would provide valuable insights into how contextual factors shape healthcare system performance and inform evidence-based policy reforms.

Fifth, future studies may explore the role of emerging technologies in transforming healthcare supply chains. Technologies such as artificial intelligence (AI), Blockchain, Internet of Things (IoT), and predictive analytics have the potential to significantly enhance supply chain visibility, transparency, and efficiency. Investigating how these technologies can be integrated into healthcare systems to improve demand forecasting, traceability of medical supplies, and procurement transparency would provide important insights for both researchers and policymakers.

Finally, future research could adopt mixed-methods approaches that combine quantitative techniques such as Structural Equation Modeling (SEM) with qualitative methods including interviews with healthcare administrators, supply chain managers, policymakers, and frontline health workers. Such approaches would provide deeper insights into the practical challenges and contextual realities of healthcare supply chain management, thereby enriching the interpretation of quantitative findings. Qualitative evidence would also help explain institutional dynamics, implementation barriers, and behavioral factors influencing supply chain performance.

Overall, these future research directions will contribute to a more comprehensive understanding of healthcare supply chain systems and their critical role in achieving Universal Health Coverage. By extending the current study, future research can support the development of more effective, resilient, and data-driven healthcare systems in Kenya and other developing countries.

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