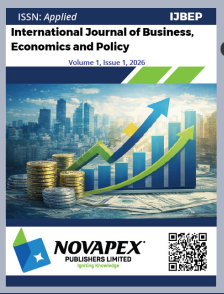

OPEN ACCESS https://doi.org/10.66817/jrv64r95

IJBEP

International Journal of Business, Economics, and Policy

RESEARCH ARTICLE Section: *Business & Management*

Risk management practices on supply chain disruptions in level 4 public hospitals in Homa Bay County, Kenya

Loretta Adhiambo Muga[1]*, Stephen Okello[1] & John Orondo[1]

[1]School of business and Economics, Tom Mboya University, Kenya

https://orcid.org/0009-0001-2441-5230

***Corresponding author's email:** *mugaloretta@gmail.com*

Published by **Novapex Publishers Ltd**, Kenya, in the *International Journal of Business, Economics, and Policy (IJBEP)*, Volume 1, Issue 2, 2026.

E - ISSN: *3136-084X*
P - ISSN: *3136-0831*

Article Details

Received: 11 June 2026
Accepted: 27 July 2026
Published: 04 September 2026

Conflict of Interest: The author/s declared no conflict of interest.

ABSTRACT

Supply chain disruptions in public hospitals compromise the availability of essential medical supplies and negatively affect healthcare quality. This study investigated the effect of risk management practices: risk avoidance, risk retention, and risk reduction on supply chain disruptions in Level 4 public hospitals in Homa Bay County, Kenya. Anchored on Uncertainty Theory and Propagation Theory, a descriptive cross-sectional survey design was employed targeting 168 respondents from all 21 Level 4 public hospitals, yielding 164 valid responses. Data were collected using structured questionnaires and semi-structured interview schedules. Findings revealed moderate implementation of risk avoidance, weak and informal risk retention, and critically underdeveloped risk reduction. Supply chain disruptions were frequent, with all three practices exhibiting significant negative correlations with disruptions. Regression analysis showed the three variables jointly explained a substantial portion of disruption variance, with risk reduction emerging as the strongest predictor. The study concludes that inadequate implementation of structured risk management practices significantly contributes to persistent supply chain disruptions. Recommendations include urgent investment in digital supply chain systems, establishment of contingency financial mechanisms, and institutionalization of staff training on risk management.

KEYWORDS: risk management, supply chain disruptions, risk avoidance, risk retention, risk reduction, public hospitals, Kenya

How to Cite:

Muga, L. A., Okello, S., & Orondo, J. (2026). Risk management practices on supply chain disruptions in level 4 public hospitals in Homa Bay County, Kenya. *International Journal of Business, Economics, and Policy, 1*(2), pp. 46-56. https://doi.org/10.66817/jrv64r95

INTRODUCTION

Healthcare supply chains are complex systems fundamental to effective service delivery. Globally, over 50% of healthcare institutions experience annual supply chain interruptions, leading to stock-outs, increased costs, and compromised care (WHO, 2020). The COVID-19 pandemic exposed the fragility of health supply networks, demonstrating how inadequate risk preparedness precipitates severe shortages (Ivanov & Dolgui, 2021). Risk management practices including risk avoidance, risk retention, and risk reduction have become central to ensuring continuity and resilience (Wagner & Bode, 2018; Kleindorfer & Saad, 2005).

In sub-Saharan Africa, 70% of hospitals experience recurrent supply chain disruptions due to logistical challenges, procurement delays, and inadequate forecasting (AfDB, 2020). In Kenya, up to 40% of county-level hospitals face periodic shortages of critical supplies (Transparency International Kenya, 2021). Extant Kenyan studies have examined risk management practices (Mutinda & Ngugi, 2019; Owich, 2023) but largely focused on urban counties or isolated practices, leaving rural contexts underexplored. Few studies have concurrently examined all three risk management dimensions. This study therefore evaluated the effect of risk avoidance, risk retention, and risk reduction on supply chain disruptions in Level 4 public hospitals in Homa Bay County, Kenya.

LITERATURE REVIEW

Theoretical Framework

This study is anchored on two complementary theories: Uncertainty Theory and Propagation Theory. Their integration provides a robust explanatory framework for understanding how risk management practices influence supply chain disruptions in hospital settings.

Uncertainty Theory, formalized by Liu (2015), addresses decision-making under conditions where probabilities are difficult to establish or historical data are unreliable. In hospital supply chains, managers routinely confront epistemic uncertainty: demand for medical supplies surges unpredictably due to disease outbreaks or seasonal patterns; funding from county governments is irregular; and supplier reliability varies without consistent performance histories. Under such conditions, traditional probabilistic risk assessment becomes impractical. Uncertainty Theory posits that decision-makers must instead rely on belief-based judgments and structured safeguards that do not depend on precise probability estimates (Liu, 2015; Zhou, 2023).

This theoretical lens directly links to the three risk management practices examined in this study. Risk avoidance - the deliberate exclusion of high-risk suppliers or procurement methods - serves as a response to supply-side uncertainty: when a hospital cannot reliably estimate a supplier's failure probability, avoiding that supplier eliminates the uncertain variable from the decision space entirely. Risk retention - absorbing manageable risks internally through buffer stocks or contingency funds - addresses uncertainty by creating internal capacity to absorb variability that cannot be predicted or avoided. Risk reduction - implementing digital inventory systems, forecasting technologies, and staff training - functions to convert epistemic uncertainty into manageable information: better data reduces the imprecision that characterizes decision-making under uncertainty. Thus, Uncertainty Theory provides a unified rationale for why all three practices, despite their distinct mechanisms, contribute to supply chain stability.

Propagation Theory, articulated in supply chain literature as disruption propagation or the "ripple effect," describes how an initial shock at one node spreads through networked relationships, amplifying impact downstream (Craighead et al., 2007). In hospital supply chains, a single supplier failure, logistics bottleneck, or information breakdown rarely remains localized. The disturbance propagates through interconnected processes - procurement, storage, distribution - causing sequential stock-outs, cascading delays, and ultimately service failures at the point of care (Li, 2020). Propagation Theory therefore explains why localized disruptions become systemic problems.

This theoretical lens maps directly onto the three risk management practices by identifying their position in the disruption pathway. Risk avoidance operates at the source of potential shocks - preventing the initial disturbance from entering the system by excluding risky suppliers or processes. Risk retention operates at the point of absorption - creating internal buffers that contain a shock before it propagates further through the network. Risk reduction operates along the transmission pathway - implementing monitoring systems, forecasting tools, and communication channels that detect and interrupt propagation before amplification occurs. Together, the three practices address distinct stages of the disruption process: prevention at origin (avoidance), containment at entry (retention), and interruption during transmission (reduction).

The integrated theoretical framework generates specific testable propositions. First, because uncertainty is endemic in public health supply chains, practices that operate effectively under imprecise information - avoidance through supplier vetting, retention through buffer stocks, reduction through real-time monitoring - should each contribute to reduced disruptions. Second, because disruptions propagate through interconnected nodes, practices positioned at different disruption stages should function complementarily rather than interchangeably: strengthening one dimension without addressing others may leave specific propagation pathways unaddressed. Third, the relative impact of each practice depends on both its theoretical position in the disruption pathway and its current implementation level. A practice with strong theoretical potential but weak current implementation will exhibit significant but attenuated empirical effects - a proposition the present study was designed to test.

Prior empirical work supports the utility of this integrated framework. Christopher and Peck (2004) demonstrated that resilience requires combining avoidance (eliminating risky sources) with mitigation and recovery capabilities, implicitly recognizing multiple disruption pathway positions. Kleindorfer and Saad (2005) classified practices by their theoretical function - avoidance for high-impact risks, retention for manageable risks, reduction for systemic risks - without empirically testing their relative contributions. The present study extends this work by explicitly linking each practice to its theoretical mechanism and empirically examining their combined and individual effects.

Empirical Review

Global evidence establishes the foundational role of risk avoidance. Christopher and Peck (2004) identified avoidance of high-risk suppliers as essential to resilience. El Baz and Ruel (2021), surveying 470 French firms during COVID-19, demonstrated that formal risk management practices mediated disruption impacts on resilience. Kleindorfer and Saad (2005) concluded that avoidance is effective for high-impact, low-likelihood risks when alternatives exist.

On risk retention, findings are conditional. Ozdemir et al. (2022) found that selective retention with digital monitoring reduced stockouts in UK perishable goods industries, while pure retention without visibility tools prolonged recovery. The OECD (2025) concluded that uncoordinated retention undermines resilience, recommending pairing with buffer mechanisms. Ding et al. (2024) demonstrated that anticipation capabilities reduced stockout frequency in Chinese hospitals even when risks were retained.

On risk reduction, evidence is consistently strong. Tang and Musa (2021) confirmed through meta-analysis that proactive risk reduction significantly lowers disruption probability and duration. Ivanov and Dolgui (2022) demonstrated that digital monitoring and dual sourcing accelerated recovery during COVID-19. Wieland and Wallenburg (2021) found that risk reduction practices reduced both disruption frequency and severity across 173 firms.

African evidence aligns with global patterns. Boakye et al. (2021) found single-supplier reliance increased stock-out frequency in Ghana. Okoro and Adebayo (2020) established weak supplier pre-qualification correlated with delivery failures in Nigeria. Dogbe (2023) reported that hospitals retaining risks due to budget limitations experienced more frequent stockouts. Mensah and Adusei (2022) found

that risk assessment and supplier audits reduced disruptions in Ghana.

Kenyan studies extend these findings locally. Kamau (2023) found risk reduction practices improved medicine availability in Nairobi. Wambua (2024) reported early-warning mechanisms enhanced supply chain performance in Kisii. Otieno (2024) demonstrated inventory monitoring reduced stockouts in Homa Bay. Owich (2023) confirmed supplier risk management improved supply chain performance in Western Kenya.

Research Gap

Despite this breadth, three gaps persist. First, most studies examined practices in isolation, limiting understanding of relative importance and combined effect. Second, Kenyan studies predominantly focused on urban counties, leaving rural contexts underexplored. Third, few studies integrated quantitative and qualitative approaches in public health supply chains. This study addressed these gaps by concurrently examining all three practices in Level 4 public hospitals in Homa Bay County, employing a mixed-methods approach explicitly grounded in an integrated theoretical framework.

DATA AND METHODOLOGY

Research Design and theoretical orientation

A descriptive cross-sectional survey design was employed (Kothari, 2004). The study was anchored on Uncertainty Theory, which explains decision-making under imprecise information in hospital supply chains (Liu, 2015), and Propagation Theory, which describes how disruptions spread through networked relationships (Craighead et al., 2007). These theories framed risk avoidance, retention, and reduction as mechanisms for reducing disruption likelihood and impact. A mixed-methods approach enhanced validity (Creswell, 2014).

Study Setting and Participants

The study was conducted in Homa Bay County, western Kenya, targeting all 21 Level 4 public hospitals across eight sub-counties. The target population comprised 168 respondents: hospital administrators (n=21), procurement officers (n=21), accountants (n=21), and healthcare workers (n=105). A census approach was adopted, including all eligible personnel directly involved in procurement and supply chain operations.

Data Collection Tools and Procedures

Data were collected using structured questionnaires and semi-structured interview schedules. The questionnaire measured demographics, risk avoidance (7 items), risk retention (6 items), risk reduction (7 items), and supply chain disruptions (6 items) on a five-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). Content validity was established through expert review and pilot testing. Reliability was confirmed via Cronbach's alpha (overall α=0.785; constructs 0.781–0.790), exceeding the 0.70 threshold (Tavakol & Dennick, 2011). Questionnaires were administered via drop-and-pick-later method. Interviews were conducted face-to-face with administrators, procurement officers, and accountants. Ethical approval was obtained, and written informed consent secured from all participants.

Data Analysis Strategy

Quantitative data were analyzed using SPSS version 31. Descriptive statistics (frequencies, percentages, composite means, standard deviations) summarized demographics and constructs. Pearson's correlation assessed bivariate relationships (thresholds: 0.00–0.30=weak; 0.31–0.50=moderate; 0.51–0.70=strong; 0.71–1.00=very strong). Multiple linear regression assessed predictive effects using: $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \varepsilon$. Multicollinearity was assessed via VIF (<5.0). Model fit was evaluated using R^2 and ANOVA. Significance was tested at α=0.05. Qualitative data underwent thematic analysis.

RESULTS

This section presents the study findings for the three risk management practices: risk avoidance, risk retention, risk reduction and their effect on supply chain disruptions in level 4 public hospitals in Homa Bay County, Kenya. The results are structured around descriptive statistics, correlation analysis and multiple regression modeling.

Descriptive Statistics: Risk Management Practices

Table 1 summarizes the descriptive statistics for the three indicators of risk management practices: risk avoidance, risk retention, risk reduction.

Table 1: Descriptive Statistics of Risk Management Practices

Indicator	Mean	Standard Deviation	N
Risk Avoidance	3.38	1.19	164
Risk Retention	3.30	1.20	164
Risk Reduction	3.07	1.19	164

Risk avoidance was moderately implemented (M=3.38), indicating practices exist but are inconsistently applied. Interview data revealed strengths in supplier prequalification but operational gaps in inventory planning and quality control, particularly during emergencies. Risk retention was weak and informal (M=3.30), with hospitals absorbing minor risks by necessity but critically lacking contingency funds and structured payment management. Risk reduction was the weakest dimension (M=3.07), characterized by severe deficits in digital systems, forecasting technology, and staff training. Supply chain disruptions were frequent (M=3.48), with unanimous acknowledgment of negative patient care impact.

Correlation Analysis

Table 2 presents the Pearson's Correlation matrix examining the relationship between risk avoidance, risk retention, risk reduction and supply chain disruptions.

Table 2: Pearson Correlation Matrix

Variables	Risk Avoidance	Risk Retention	Risk Reduction	Supply Chain Disruptions
Risk Avoidance	1			
Risk Retention	0.421**	1		
Risk Reduction	0.612**	0.488**	1	
Supply Chain Disruptions	-0.657**	-0.589**	-0.742**	1

Note: **p < 0.01 (2-tailed) N=164

All three risk management practices exhibited statistically significant negative correlations with supply chain disruptions ($p<0.01$). Risk reduction showed the strongest association (r=-0.742, very strong negative), indicating that improvements in digital systems, forecasting, and training are most powerfully linked to reduced disruptions. Risk avoidance demonstrated a strong negative relationship (r=-0.657), confirming that supplier vetting and procurement compliance significantly reduce disruptions. Risk retention showed a moderate-to-strong negative relationship (r=-0.589), its lower magnitude reflecting the weak institutionalization of financial buffers and documentation systems. The inter-correlations among independent variables (r=0.421 to 0.612) confirmed related but distinct constructs.

Regression Analysis: Predicting Supply Chain Disruption

Multiple linear regression analysis was conducted to determine the combined and individual predictive effects of risk avoidance, risk retention, and risk reduction on supply chain disruptions. The analysis proceeded in three stages: first, the ANOVA table was examined to establish whether the overall regression model was statistically significant; second, the model summary was interpreted to determine the proportion of variance in supply chain disruptions explained by the three predictor variables; and third, the regression coefficients were examined to establish the individual contribution of each predictor, including the direction, magnitude, and statistical significance of each effect. All assumptions for multiple regression - linearity, independence of residuals, homoscedasticity, normality of residuals, and absence of problematic multicollinearity were assessed prior to interpretation. Multicollinearity was evaluated using Variance Inflation Factor (VIF) values, with all values below 5.0 confirming that the independent variables were not excessively correlated with each other.

Table 3: ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	52.311	3	17.437	98.23	<0.001
Residual	29.108	160	0.182		
Total	81.419	163			

The analysis of variance (ANOVA) results show that the overall regression model is statistically significant ($F = 98.23$, $p < 0.001$). This indicates that risk avoidance, risk retention, and risk reduction jointly have a significant influence on supply chain disruptions. Consequently, the model provides a good fit for the data and is suitable for explaining variations in supply chain disruptions among Level 4 public hospitals in Homa Bay County.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.801	0.642	0.635	0.421

The model summary provides measures of the strength and explanatory power of the regression model. The multiple correlation coefficient ($R=0.801$) indicates a strong combined relationship between the three predictor variables and supply chain disruptions.

The coefficient of determination ($R^2=0.642$) indicates that the three risk management practices jointly explain 64.2% of the variance in supply chain disruptions. In practical terms, this means that approximately 64% of the differences observed in disruption levels across hospitals can be attributed to differences in their implementation of risk avoidance, risk retention, and risk reduction practices. This is a substantial proportion, confirming that risk management is a major determinant of supply chain stability.

The adjusted R^2 (0.635) is slightly lower than R^2, reflecting a minor penalty for the number of predictors in the model. The small difference between R^2 and adjusted R^2 confirms that the model's explanatory power is not inflated by the inclusion of unnecessary predictors—all three variables contribute meaningfully.

The standard error of estimate (0.421) indicates the average distance that observed values deviate from the regression line. Given that supply chain disruptions were measured on a 1–5 Likert scale, an average prediction error of approximately 0.42 points suggests the model provides reasonably precise predictions.

It is important to note that 35.8% of the variance ($1 - R^2$) remains unexplained. This residual

variance is attributable to factors outside the model, such as county budgetary allocation cycles, KEMSA distribution efficiency, supplier market conditions, and infrastructural constraints not captured in this study.

Table 5: Multiple Regression Results

Variable	Beta (β)	Std. Error	95% Cl (Lower)	95% Cl (Upper)	Standardized β	t-value	Sig.	VIF
Constant	4.218	0.312	3.602	4.834	-	13.52	0.000	-
Risk Avoidance	-0.312	0.058	-0.427	-0.197	-0.311	-5.38	0.000	1.65
Risk Retention	-0.241	0.063	-0.365	-0.117	-0.210	-3.82	0.000	1.35
Risk Reduction	-0.467	0.052	-0.570	-0.374	-0.495	-8.98	0.000	1.72

The coefficients table provides the individual contribution of each predictor variable to supply chain disruptions, holding the other variables constant.

Constant (β=4.218, p<0.001): The constant represents the predicted level of supply chain disruptions when all three risk management practices are zero. A value of 4.218 on the 1–5 scale indicates that in the complete absence of risk avoidance, retention, and reduction practices, supply chain disruptions would be very high. This provides a baseline that confirms the severity of disruptions in the absence of any structured risk management.

Risk Avoidance (β=-0.312, 95% CI [-0.427, -0.197], p<0.001): The unstandardized coefficient indicates that a one-unit increase in risk avoidance practices is associated with a 0.312-unit decrease in supply chain disruptions, holding risk retention and risk reduction constant. The negative sign confirms the inverse relationship: stronger avoidance practices reduce disruptions. The 95% confidence interval does not cross zero, confirming the reliability of this estimate. The standardized coefficient (β=-0.311) indicates that risk avoidance makes a moderate contribution relative to the other predictors. The VIF of 1.65 confirms no problematic multicollinearity.

Risk Retention (β=-0.241, 95% CI [-0.365, -0.117], p<0.001): A one-unit increase in risk retention practices is associated with a 0.241-unit decrease in supply chain disruptions, controlling for the other variables. The effect is statistically significant, as indicated by the p-value below 0.001 and a confidence interval that excludes zero. However, the magnitude is smaller than that of risk avoidance and risk reduction, as reflected in the lower standardized coefficient (β=-0.210). This smaller effect is consistent with the descriptive finding that risk retention practices are poorly institutionalized. The VIF of 1.35 is the lowest among the three predictors, confirming its distinct contribution.

Risk Reduction (β=-0.467, 95% CI [-0.570, -0.364], p<0.001): Risk reduction is the strongest predictor of supply chain disruptions. A one-unit increase in risk reduction practices is associated with a 0.467-unit decrease in disruptions, holding the other variables constant. The standardized coefficient (β=-0.495) indicates that risk reduction has the largest relative influence among the three predictors. The confidence interval is relatively narrow, suggesting precise estimation. The VIF of 1.72 is within acceptable limits, confirming that despite its moderate correlation with risk avoidance (r=0.612), the two constructs are sufficiently distinct for independent interpretation.

The standardized beta coefficients allow direct comparison of the relative strength of each predictor. Risk reduction (β=-0.495) is approximately 1.6 times stronger than risk avoidance (β=-0.311) and approximately 2.4 times stronger than risk retention (β=-0.210). This ranking - risk reduction as strongest, followed by risk avoidance, then risk retention - is consistent with the correlation analysis and provides a clear basis for prioritizing interventions.

DISCUSSION

This study examined the effect of risk avoidance, risk retention, and risk reduction on supply chain disruptions in Level 4 public hospitals in Homa Bay County. All three practices significantly predicted

lower disruption levels, with risk reduction emerging as the strongest determinant. The discussion critically interprets these findings against existing literature while acknowledging design limitations.

Risk avoidance significantly predicted lower disruptions (β=-0.312, p<0.001), consistent with Christopher and Peck (2004) and Owich (2023). However, moderate implementation (M=3.38, SD=1.19) suggests imbalance: supplier-facing practices are relatively established, while internal functions - inventory planning, quality control - lag. This matters theoretically: per Propagation Theory (Craighead et al., 2007), risks avoided at the supplier interface still propagate through weak internal systems. The coefficient likely underestimates avoidance's potential under balanced implementation (Kleindorfer & Saad, 2005). Reverse causality remains possible given the cross-sectional design.

Risk retention significantly predicted lower disruptions (β=-0.241, p<0.001), the weakest effect among the three. This reflects poor institutionalization rather than unimportance. Descriptive results (M=3.30) indicate informal retention without contingency funds or structured payment management - retention by default, not design. This aligns with El Baz and Ruel (2021) and Dogbe (2023), who found retention without buffers amplifies disruption impacts. The smaller coefficient may represent a floor effect: underdeveloped retention produces attenuated measurable associations. Propagation Theory explains why - without financial buffers, shocks propagate to suppliers and future deliveries.

Risk reduction was simultaneously the strongest predictor (β=-0.467, p<0.001) and weakest implemented dimension (M=3.07). The very strong correlation (r=-0.742) and narrow confidence interval (95% CI [-0.570, -0.364]) provide robust evidence. This aligns with Ivanov and Dolgui (2022) and Tang and Musa (2021), who demonstrated the efficacy of digital monitoring and proactive mitigation. The pattern represents a significant policy gap. However, three cautions apply: cross-sectional design prevents causal inference; self-reported data may inflate associations via common method bias; and the composite measure masks heterogeneous sub-practice effects.

The model explained 64.2% of variance (R^2=0.642). Moderate inter-correlations among predictors (r=0.421 to 0.612) suggest the practices function as an interconnected system rather than isolated levers, consistent with the theoretical framing of distinct disruption pathways. The unexplained 35.8% likely resides in external factors such as county budget cycles, KEMSA efficiency, market conditions, identified by Transparency International Kenya (2021) and Ministry of Health (2022). Facility-level risk management alone cannot fully mitigate these systemic constraints.

CONCLUSION

This study provides evidence that risk avoidance, risk retention, and risk reduction each significantly predict lower supply chain disruptions in Level 4 public hospitals in Homa Bay County. Three conclusions emerge.

First, risk avoidance is moderately implemented but imbalanced - stronger in supplier-facing practices, weaker in internal management functions. Its significant effect (β=-0.312) confirms contribution to stability, but full potential is constrained by this imbalance.

Second, risk retention is practiced by default rather than design. The absence of contingency funds, structured payment management, and documentation systems limits its predictive power (β=-0.241), which reflects poor institutionalization rather than unimportance.

Third, risk reduction is simultaneously the strongest predictor (β=-0.467) and least developed dimension (M=3.07). Acute deficits in digital systems, forecasting, and training represent the most critical gap. The robust evidence - very strong correlation (r=-0.742), narrow confidence interval - supports prioritizing this area.

The findings support a systems view: the three practices address distinct but interconnected disruption pathways and should be strengthened concurrently. However, 35.8% of unexplained variance points to external factors requiring systemic intervention beyond facility-level management.

Based on the empirical findings, the following recommendations are justified: investing in

digital inventory and forecasting systems; establishing contingency funds for supply emergencies; institutionalizing staff training on risk management; and adopting an integrated approach that concurrently strengthens all three dimensions.

REFERENCES

African Development Bank. (2020). Health systems resilience in Africa: Strengthening supply chains for future pandemics. AfDB Press.

Boakye, G., et al. (2021). Assessment of local supply chains and stock management structures at health facilities in Ghana. *Journal of Health Supply Chain Management*, 8(2), 45-62.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management,* 15(2), 1-14.

Craighead, C. W., et al. (2007). The severity of supply chain disruptions: Design characteristics and mitigation capabilities. *Decision Sciences*, 38(1), 131-156.

Dogbe, C. S. K. (2023). Healthcare supply chain risks and resilience during the COVID-19 pandemic in sub-Saharan Africa. *African Journal of Health Economics*, 9(2), 44-59.

El Baz, J., & Ruel, S. (2021). Can supply chain risk management practices mitigate the disruption impacts of COVID-19? *International Journal of Operations & Production Management,* 41(9), 1493-1518.

Ivanov, D., & Dolgui, A. (2021). A digital supply chain twin for managing the disruption risks and resilience in the COVID-19 pandemic. *International Journal of Production Research*, 59(12), 3791-3805.

Ivanov, D., & Dolgui, A. (2022). Global supply chain risk reduction practices under COVID-19 disruption scenarios. *International Journal of Production Research*, 60(10), 3031-3048.

Kamau, P. (2023). Supply chain risk management practices and operational performance in public hospitals in Nairobi County. *Journal of Business and Management Studies*, 9(2), 78-93.

Kleindorfer, P. R., & Saad, G. H. (2005). Managing disruption risks in supply chains. *Production and Operations Managemen*t, 14(1), 53-68.

Kothari, C. R. (2004). Research methodology: *Methods and techniques* (2nd ed.). New Age International Publishers.

Liu, B. (2015). *Uncertainty theory* (4th ed.). Springer-Verlag.

Mutinda, D., & Ngugi, P. (2019). Risk management practices and performance of supply chain systems in public hospitals in Nairobi County, Kenya. *International Journal of Procurement and Supply Chain Management*, 3(4), 45-57.

OECD. (2025). Global supply chain vulnerabilities and resilience after COVID-19. Organisation for Economic Co-operation and Development *Policy Paper Series*, No. 232.

Okoro, T., & Adebayo, K. (2020). Supplier pre-qualification and procurement performance in Nigerian tertiary hospitals. *West African Journal of Health Management*, 7(3), 88-102.

Otieno, J. (2024). Inventory management and medicine availability in Level 4 hospitals in Homa Bay County, Kenya. *Kenyan Journal of Supply Chain and Logistics*, 6(1), 110-124.

Owich, P. A. (2023). Supplier risk management and procurement performance in public referral hospitals in Western Kenya. *Strategic Journal of Business & Change Management*, 10(3), 221-239.

Ozdemir, A., Elçi, M., & Kayıkcı, Y. (2022). Resilience and supply chain risk management in perishable goods industries. *International Journal of Production Economics*, 247, 108414.

Tang, O., & Musa, S. (2021). A systematic review of supply chain risk management: Practices, trends, and future directions. *International Journal of Production Economics*, 231, 107862.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53-55.

Wagner, S. M., & Bode, C. (2018). An empirical examination of supply chain performance along risk management dimensions. *Journal of Supply Chain Management*, 54(2), 25-41.

Wambua, M. (2024). Risk reduction in public procurement and healthcare supply efficiency in Kisii County. *Journal of African Procurement and Policy Studies*, 5(2), 67-85.

World Health Organization. (2020). Global health supply chain resilience and lessons from the COVID-19 pandemic. WHO Press.

Zhou, J. (2023). Uncertainty theory and decision-making in public sector logistics. *Journal of Public Procurement*, 23(2), 156-178.