



Effect of Supply Chain Vulnerabilities on the Availability of Essential Medicines in Rwanda: A Case Study of Rwanda Medical Supply Ltd

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Abstract: The study investigated the effect of supply chain vulnerabilities on the availability of essential medicines at Rwanda Medical Supply Ltd (RMS). It focused on procurement and supplier reliability, logistics and distribution infrastructure, inventory and data management, and legal and regulatory compliance vulnerabilities. The inquiry was informed by Transaction Cost Economics, Supply Chain Risk Management Theory, Resource Dependence Theory, Systems Theory, Information Processing Theory, and Institutional Theory. A descriptive and correlational design guided the quantitative strand of the wider mixed-methods study. Using a census approach, 120 RMS employees were targeted and 112 usable questionnaires were returned, representing a 93% response rate. Data were analysed in the Statistical Package for Social Sciences (SPSS) Version 25 using Pearson correlation, multiple regression, ANOVA, and hypothesis testing. The model explained 61.0% of the variation in medicine availability and was statistically significant ($R = 0.781$, $R^2 = 0.610$, $F = 41.43$, $p = 0.000$). Procurement and supplier reliability vulnerabilities had a significant negative effect ($B = -0.318$, $t = -3.878$, $p = 0.000$), followed by inventory and data management ($B = -0.281$, $t = -3.557$, $p = 0.001$), logistics and distribution infrastructure ($B = -0.247$, $t = -3.338$, $p = 0.001$), and legal and regulatory compliance vulnerabilities ($B = -0.136$, $t = -2.030$, $p = 0.045$). The study concluded that interconnected supply chain weaknesses reduce medicine availability and recommended supplier diversification, stronger logistics, improved inventory visibility and forecasting, and streamlined regulatory processes to strengthen continuous access to essential medicines nationwide.

Keywords: Supply Chain Vulnerabilities, Essential Medicines, Supplier Reliability, Logistics, Inventory Management, Regulatory Compliance.

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1. Introduction

Reliable access to essential medicines remains a central requirement for effective health-service delivery because treatment, disease prevention and continuity of care depend on medicines being available when patients need them. Pharmaceutical supply chains must therefore move products from manufacturers and suppliers through procurement, storage and distribution systems without prolonged interruption. Global health emergencies,

transport disruptions and market instability have shown that medicine availability can deteriorate rapidly when supply networks lack resilience. The World Health Organization continues to emphasise the importance of stronger medicine and vaccine supply chains, while international evidence links supply disruptions with shortages that compromise access and health-system responsiveness (World Health Organization, 2023; Khan et al., 2022).

Procurement and supplier reliability form an important part of this challenge. Pharmaceutical supply organisations often depend on external manufacturers and international markets, which can expose them to delayed deliveries, inconsistent product quality, extended lead times and disruptions associated with geopolitical or market changes. When a limited number of suppliers control essential inputs, a delay at source can affect downstream stock levels and the ability of health facilities to obtain required medicines. Studies in African health systems have similarly shown that procurement delays and supplier unreliability increase the likelihood of stock-outs, making supplier diversification, evaluation and relationship management important elements of supply continuity (Ndlovu et al., 2023; Kamanzi et al., 2022).

The movement of medicines from central stores to health facilities also depends on dependable logistics and distribution infrastructure. Weak transport networks, insufficient storage capacity, cold-chain interruptions and failures in logistics information systems can delay deliveries or damage products before they reach intended users. These problems become more serious in remote settings where distribution routes are longer and alternative transport options are limited. Evidence from sub-Saharan Africa associates infrastructure barriers with medicine-distribution difficulties, while studies from Rwanda identify transport and distribution constraints as continuing challenges for healthcare supply chains (Musa et al., 2023; Munyaneza et al., 2024).

Inventory and data management add another layer of vulnerability because procurement and distribution decisions depend on accurate information about consumption, stock levels and future demand. Inaccurate forecasting may create either excess stock or shortages, while limited stock visibility and poor tracking reduce the ability of managers to identify imbalances early. System downtime can further disrupt warehouse operations and delay replenishment decisions. Empirical work in healthcare supply chains shows that data inaccuracies and weak inventory controls are associated with medicine stock-outs, whereas real-time tracking and digital inventory tools can strengthen stock visibility and improve continuity of supply (Johnson et al., 2023; Smith & Wasiams, 2022).

Legal and regulatory requirements are equally important because pharmaceutical products cannot move freely through the supply chain without appropriate registration, licensing, certification and quality assurance. Delays in product approval, import restrictions, changes in regulatory policy or non-compliance with procurement procedures may slow medicine acquisition and distribution. Such vulnerabilities are especially consequential when medicines are urgently required or when supply depends heavily on imported products. Research from different

pharmaceutical markets shows that legal ambiguity, enforcement weaknesses and prolonged approval procedures can reduce timely access to medicines, demonstrating that regulatory efficiency is closely connected with supply-chain responsiveness (Kumar et al., 2023; Zhang & Li, 2022).

Within Rwanda, strengthening pharmaceutical supply chains has remained important to health-system performance, yet procurement, logistics, inventory and regulatory pressures continue to affect the flow of medicines. Rwanda Medical Supply Ltd occupies a central position because it is responsible for forecasting, procuring, storing and distributing medicines and related health commodities to public healthcare facilities across the country. Weaknesses at RMS can therefore have effects beyond a single organisation, particularly when delayed procurement, transport constraints, inventory inaccuracies or approval bottlenecks interrupt the availability of medicines required by health facilities. Existing Rwandan literature continues to identify pharmaceutical supply-chain vulnerabilities and infrastructure limitations as issues requiring sustained management attention (Niyibizi & Uwimana, 2023; Niyibizi et al., 2023).

Medicine availability should consequently be understood as the result of an interconnected supply system rather than the outcome of one isolated function. A procurement delay can reduce warehouse stock, inaccurate inventory information can postpone replenishment, distribution limitations can prevent available stock from reaching facilities, and regulatory processes can slow the entry of medicines into the supply chain. This interdependence means that improving one component without addressing weaknesses elsewhere may produce only partial gains. Evidence on Rwanda's health sector therefore supports integrated approaches that combine supplier management, logistics strengthening, improved stock information and regulatory coordination to reduce disruptions and protect medicine access (Hagenimana et al., 2022; Uwimana et al., 2023).

Although prior research has examined medicine supply disruptions, important limitations remain. Much of the evidence comes from health systems outside Rwanda or from settings that differ from national medical supply operations. Earlier studies also tended to examine isolated supply-chain functions rather than the combined weaknesses affecting medicine availability within one institutional setting. This study addressed these limitations by generating evidence from Rwanda Medical Supply Ltd, the national entity responsible for procuring, storing and distributing medicines across Rwanda.

1.1 General Objective

The general objective of the study was to examine the effect of supply chain vulnerabilities on the availability of essential medicines in Rwanda, using Rwanda Medical Supply Ltd as the case study.

1.2 Specific Objectives

- 1.To evaluate the effect of procurement and supplier reliability vulnerabilities on the availability of essential medicines at RMS.
- 2.To assess the effect of logistics and distribution infrastructure vulnerabilities on the availability of essential medicines at RMS.
- 3.To determine the effect of inventory and data management vulnerabilities on the availability of essential medicines at RMS.
- 4.To examine the effect of legal and regulatory compliance vulnerabilities on the availability of essential medicines at RMS.

2. Literature Review

The literature review draws together the theoretical foundations and empirical evidence relevant to supply chain vulnerabilities and the availability of essential medicines.

2.1 Theoretical Review

Six theoretical perspectives informed the study by explaining contractual relationships, supply-chain risk, external dependence, system interconnections, information flow and institutional pressures.

2.1.1 Transaction Cost Economics Theory

Transaction Cost Economics explains how organisations select governance arrangements in order to reduce the costs and uncertainties associated with economic exchange. In pharmaceutical supply chains, supplier search, contract negotiation, monitoring, quality verification and replacement of unreliable suppliers can become costly when markets are uncertain or dependence on external sources is high. The theory is therefore useful for interpreting procurement bottlenecks, supplier unreliability and long lead times because these vulnerabilities can increase the effort and resources required to secure medicines. Applied to RMS, the perspective suggests that dependable contracts, supplier diversification and stronger governance arrangements can reduce transaction frictions and support more consistent medicine availability (Williamson, 1975).

2.1.2 Supply Chain Risk Management Theory

Supply Chain Risk Management Theory focuses on identifying vulnerabilities, assessing their consequences and developing resilience before disruptions become severe. Christopher and Peck's resilience perspective emphasises that supply chains should anticipate threats and build the capacity to recover when interruptions occur. For essential medicines, this involves alternative sourcing, buffer arrangements, continuous risk monitoring and cooperation with suppliers and public institutions. The theory fits the present study because procurement delays, logistics interruptions, inventory weaknesses and regulatory constraints represent different sources of risk that can jointly reduce medicine availability. Strengthening resilience across these areas can therefore improve the continuity of pharmaceutical supply (Christopher & Peck, 2004).

2.1.3 Resource Dependence Theory

Resource Dependence Theory views organisations as dependent on external actors that control resources necessary for continued operation. Pharmaceutical supply organisations are particularly exposed when medicines are imported or when only a small number of suppliers can provide specialised products. Such dependence creates vulnerability because disruptions outside the organisation may limit access to required stock. For RMS, the theory helps explain how dependence on foreign manufacturers, international transport and regulatory approvals can influence medicine availability. Diversifying suppliers, building strategic partnerships and reducing excessive reliance on individual sources are therefore consistent with the theory's emphasis on actively managing external dependencies (Pfeffer & Salancik, 1978).

2.1.4 Systems Theory

Systems Theory interprets the supply chain as a set of connected components whose interactions determine overall performance. Procurement, warehousing, transportation, information systems, regulatory processes and healthcare facilities do not operate independently; a disruption in one component can create consequences elsewhere in the network. A procurement delay, for example, may reduce warehouse stock and subsequently affect order fulfilment and delivery performance. This perspective is particularly relevant to the study because the four vulnerability dimensions were analysed together rather than as unrelated problems. Viewing RMS as an open and interconnected system supports coordinated interventions that address several weaknesses simultaneously (von Bertalanffy, 1950).

2.1.5 Information Processing Theory

Information Processing Theory emphasises the ability of individuals and organisations to receive, interpret, store and use information for decision-making. Within a medicine supply chain, accurate data on stock levels, consumption, supplier status and demand forecasts are essential for timely replenishment and distribution. When information is incomplete, delayed or inaccurate, managers may order too much, order too little or fail to recognise emerging shortages. The theory therefore provides a useful explanation for inventory and data management vulnerabilities at RMS, particularly those related to forecasting accuracy, stock visibility and information-system downtime. Better information systems and stronger data practices can improve decision quality and medicine availability (Miller, 1956).

2.1.6 Institutional Theory

Institutional Theory explains how organisational practices are shaped by rules, regulations, professional standards and broader expectations in the surrounding environment. Pharmaceutical supply chains operate within strict requirements governing procurement, product registration, licensing, importation and quality assurance. These requirements can protect public health, but slow procedures, inconsistent enforcement or frequent policy changes may also delay medicine flow. In the RMS setting, the theory helps explain why regulatory compliance is both necessary and potentially vulnerable to institutional bottlenecks. Coordinated and predictable regulatory arrangements can therefore strengthen legitimacy while reducing avoidable delays in medicine access (DiMaggio & Powell, 1983).

2.2 Empirical Review

The empirical literature is organised around the four specific objectives and retains the substantive evidence reported in the dissertation while using varied academic wording.

2.2.1 Procurement and Supplier Reliability Vulnerabilities and Medicine Availability

Ndlovu et al. (2023) investigated procurement delays and supplier reliability in Zimbabwean public health facilities. The cross-sectional study examined procurement records from 150 facilities located in urban and rural areas and applied logistic regression to identify predictors of medicine stock-outs. Procurement delays and unreliable deliveries were reported to account for approximately 45% of medicine shortages. The findings demonstrate that supplier performance and procurement timing are closely connected with medicine availability, while the study also acknowledged limitations associated with restricted data access and self-reported procurement

information. Its results are relevant to RMS because a national medical supply organisation is similarly exposed to delays arising from supplier performance.

Kamanzi et al. (2022) assessed the influence of supplier reliability on medicine stock levels in Rwandan district hospitals. Using a descriptive correlational approach, the researchers surveyed 100 procurement officers with structured questionnaires and analysed the data through Pearson correlation and multiple regression. Supplier unreliability was associated with longer stock-out durations, with delayed deliveries and inconsistent supply schedules identified as important operational weaknesses. Although the study concentrated on district hospitals rather than a national medical supply organisation, it provides locally relevant evidence that unstable supplier performance can translate directly into reduced medicine availability.

Boateng et al. (2024) examined procurement inefficiencies and supplier performance within Ghana's health sector. Their mixed-methods design combined surveys of 200 procurement managers with qualitative interviews, while descriptive statistics, thematic analysis and chi-square tests supported the analysis. Procurement delays and unreliable suppliers were reported to account for a substantial share of stock-outs. The authors identified weaknesses in procurement planning and supplier evaluation as priority areas for reform. These findings reinforce the need for RMS to manage supplier selection, performance monitoring and procurement lead times as important determinants of medicine continuity.

2.2.2 Logistics and Distribution Infrastructure Vulnerabilities and Medicine Availability

Musa et al. (2023) examined logistics and infrastructure barriers affecting medicine distribution in sub-Saharan Africa and documented how weak transport systems and inadequate distribution infrastructure interfere with medicine access. The study highlights the practical importance of road networks, storage capacity and distribution reliability in ensuring that medicines move from central supply points to health facilities. These observations are relevant to RMS because national availability depends not only on stock entering central warehouses but also on the ability to transport that stock efficiently to different parts of the country.

Munyaneza et al. (2024) focused on logistics and infrastructure challenges in Rwanda's healthcare supply chains. Their work identified distribution limitations that can delay the movement of medicines and weaken supply continuity. The Rwandan setting gives the evidence direct relevance to RMS, where distribution planning must connect central stock with healthcare facilities located across diverse geographical areas. The study supports the view that improving transport coordination,

infrastructure reliability and logistics systems can reduce distribution delays and strengthen medicine availability.

Niyibizi et al. (2023) investigated infrastructure challenges and medicine distribution in Rwanda and reported that weaknesses in distribution infrastructure can affect the timely flow of pharmaceutical products. The findings underscore the importance of linking warehouse operations, transportation planning and delivery systems so that medicines already procured can reach health facilities without unnecessary interruption. In the present study, logistics and distribution vulnerabilities were therefore treated as a distinct source of risk to medicine availability at RMS, reflecting the practical dependence of supply continuity on the efficiency of downstream movement.

2.2.3 Inventory and Data Management Vulnerabilities and Medicine Availability

Johnson et al. (2023) investigated inventory and data management vulnerabilities in 15 National Health Service hospitals in England. Their mixed-methods design combined a twelve-month analysis of inventory-system data with interviews involving pharmacy managers and supply-chain personnel. Descriptive statistics, correlation and regression were used to identify factors associated with medicine shortages. The study showed that stock-control weaknesses, data-entry errors and technological limitations can undermine consistent availability. Although the setting involved large hospitals in the United Kingdom, the evidence illustrates how data quality and inventory systems influence medicine continuity.

Smith and Wasiams (2022) examined real-time inventory tracking within United Kingdom hospitals and found that improved stock visibility reduced discrepancies and supported medicine availability. Their findings demonstrate that timely information on stock position enables faster identification of shortages and better replenishment decisions. This evidence is applicable to RMS because inaccurate inventory records or delayed stock information can affect forecasting, procurement and distribution decisions simultaneously. Stronger real-time tracking can therefore help reduce both stock-outs and unnecessary overstocking.

Patel et al. (2024) reviewed digital innovations aimed at improving medicine supply chains and highlighted the contribution of technology to stock visibility and supply-chain resilience. At the same time, the literature recognises that system outages and digital vulnerabilities can introduce new operational risks. The study therefore supports a balanced approach in which digital inventory systems are strengthened alongside cybersecurity, data quality and staff capability. For RMS, effective inventory management depends on both the availability

of technology and the reliability of information generated through that technology.

2.2.4 Legal and Regulatory Compliance Vulnerabilities and Medicine Availability

Kumar et al. (2023) investigated legal compliance and medicine availability within India's pharmaceutical environment using a qualitative design. Semi-structured interviews with regulators, manufacturers and healthcare providers were analysed thematically to identify recurring compliance challenges. The study showed that regulatory procedures and enforcement arrangements can affect the speed with which medicines are approved and made available. Although the study was limited to the Indian regulatory environment, its findings demonstrate that legal requirements can become supply-chain bottlenecks when approval and compliance processes are prolonged or unclear.

Zhang and Li (2022) explored pharmaceutical regulatory vulnerabilities in China through a mixed-methods approach combining compliance surveys and qualitative case studies. Regulatory officials, pharmaceutical executives and healthcare practitioners from urban and rural areas contributed to the evidence. Regression analysis linked weaknesses in regulatory compliance with medicine shortages and delayed access, particularly outside major urban centres. The study demonstrates that enforcement gaps and legal ambiguity can affect medicine availability even where supply capacity exists, making regulatory efficiency an important component of supply-chain performance.

Adeyemi et al. (2024) examined regulatory loopholes and enforcement deficiencies in Nigeria and linked these weaknesses with medicine shortages and the circulation of counterfeit products. Their cross-sectional study used structured questionnaires and logistic regression to evaluate associations between regulatory practices and medicine availability. The authors concluded that stronger enforcement and clearer regulatory arrangements are necessary to protect both access and safety. The findings are pertinent to RMS because certification, licensing, importation rules and quality assurance requirements directly influence the timing and reliability of medicine supply.

3. Methodology

The methodology emphasised the quantitative evidence required to test how the four categories of supply chain vulnerability related to the availability of essential medicines at RMS.

3.1 Research Design

Within the larger mixed-methods research, the quantitative component was directed by a descriptive and correlational design. The researcher was able to statistically analyze the direction, strength, and significance of the links between vulnerability patterns and pharmaceutical availability, and the design allowed them to define the patterns.

3.2 Study Population and Sampling

Roughly 120 workers from various departments of Rwanda Medical Supply Ltd were the subjects of the research. The population was considered manageable; hence a census method was used instead of a smaller sample. The dataset used for the analysis in the study consisted of 112 valid replies out of 120 surveys that were sent out.

3.3 Data Collection Instrument

A self-administered, structured questionnaire was used to collect quantitative data on topics such as critical drug availability, logistics and distribution infrastructure, dependability of suppliers, management of inventory and data, compliance with laws and regulations, and so on. Incorporating open-ended replies from the broader mixed-methods dissertation into the statistical findings presented in the paper was not possible.

3.4 Pilot Study, Validity and Reliability

To ensure the instrument was clear, relevant, valid, and consistent before the primary data collection, it was piloted in four wholesale pharmacies in Kigali. The research literature was consulted while creating the questionnaire to ensure content validity. The reliability was evaluated using Cronbach's Alpha, with a minimum acceptable threshold being a coefficient above 0.70. The reliability evaluation in the dissertation uses 18

questionnaire questions, however the reported Cronbach's Alpha coefficient is missing.

3.5 Data Analysis

The data were analyzed using SPSS Version 25. Pearson correlation looked at the relationships between the independent variables and drug availability, whereas multiple linear regression and ANOVA looked at individual and combined effects at the 5% level of significance. The estimated model was $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \epsilon$, where Y represented the availability of essential medicines, X_1 procurement and supplier reliability vulnerabilities, X_2 logistics and distribution infrastructure vulnerabilities, X_3 inventory and data management vulnerabilities, and X_4 legal and regulatory compliance vulnerabilities.

3.6 Ethical Considerations

Ethical clearance was obtained from the University of Kigali and institutional authorisation was sought from RMS Ltd. Participation was voluntary, informed consent was obtained, and personal identifiers were removed or coded to preserve anonymity. Access to raw data was restricted, electronic files were password-protected, and the information collected was used for academic purposes.

4. Results and Discussions

The manuscript reports the response rate and inferential findings before discussing the results in relation to the four study objectives and relevant literature.

4.1 Response Rate

Response-rate analysis indicates the extent to which the census participants returned usable questionnaires for the quantitative analysis.

Table 1: Response Rate

Questionnaires Distributed	Questionnaires Returned	Not Returned	Response Rate (%)
120	112	8	93.0

Source: Field Data (2026)

Of the 120 questionnaires distributed to RMS employees, 112 were returned and usable, producing a response rate of 93.0%. The high participation level provided sufficient coverage of the census population for the correlation and regression analyses.

4.2 Inferential Statistics

Inferential statistics established the direction of the relationships and estimated the independent and combined effects of the supply chain vulnerabilities on essential medicine availability.

4.2.1 Correlation Analysis

chain vulnerability and the availability of essential medicines.

Pearson correlation analysis measures the strength and direction of association between each category of supply

Table 2: Correlation Matrix

		Procurement and supplier reliability vulnerabilities	Logistics and distribution infrastructure vulnerabilities	Inventory and data management vulnerabilities	Legal and regulatory compliance vulnerabilities	Availability of essential medicines
Procurement and supplier reliability vulnerabilities	Pearson Correlation	1	0.604**	0.571**	0.496**	-0.742
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	112	112	112	112	112
Logistics and distribution infrastructure vulnerabilities	Pearson Correlation	0.604**	1	0.648**	0.563**	-0.598
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	N	112	112	112	112	112
Inventory and data management vulnerabilities	Pearson Correlation	0.571**	0.648**	1	0.617**	-0.661
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	112	112	112	112	112
Legal and regulatory compliance vulnerabilities	Pearson Correlation	0.496**	0.563**	0.617**	1	-0.462
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	112	112	112	112	112
Availability of essential medicines	Pearson Correlation	-0.742	-0.598	-0.661	-0.462	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	112	112	112	112	112

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Field Data (2026)

Table 2 shows statistically significant negative relationships between medicine availability and all four vulnerability categories. Procurement and supplier reliability recorded the strongest negative correlation ($r = -0.742$, $p = 0.000$), followed by inventory and data management ($r = -0.661$, $p = 0.000$), logistics and distribution infrastructure ($r = -0.598$, $p = 0.000$), and legal and regulatory compliance vulnerabilities ($r = -0.462$, $p = 0.000$). Higher vulnerability levels were

therefore associated with lower availability of essential medicines.

4.2.2 Regression Analysis

Multiple regression analysis estimates how strongly the four vulnerability dimensions contribute to medicine availability when their effects are considered simultaneously.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate	Durbin-Watson
1	.781 ^a	.610	.60	2.160	2.15559

a. Predictors: (Constant), Legal and Regulatory Compliance Vulnerabilities, Procurement and Supplier Reliability Vulnerabilities, Inventory and Data Management Vulnerabilities, Logistics and Distribution Infrastructure Vulnerabilities

Source: Field Data (2026)

Table 3 indicates a strong combined relationship between the predictors and medicine availability ($R = 0.781$). The R^2 value of 0.610 shows that the four supply

chain vulnerabilities jointly explained 61.0% of the variation in availability of essential medicines. The Durbin-Watson statistic of 2.15559 was close to 2,

indicating that the residuals did not show substantial autocorrelation.

Table 4: Analysis of Variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	35.786	4	8.947	41.43	.000b
Residual	22.863	107	.214		
Total	58.649	111			

a. Dependent Variable: Availability of Essential Medicines

b. Predictors: (Constant), Legal and Regulatory Compliance Vulnerabilities, Procurement and Supplier Reliability Vulnerabilities, Inventory and Data Management Vulnerabilities, Logistics and Distribution Infrastructure Vulnerabilities

Source: Field Data (2026)

Table 4 confirms that the regression model was statistically significant, $F(4, 107) = 41.43$, $p = 0.000$. The four vulnerability dimensions therefore provided a

statistically meaningful joint explanation of changes in essential medicine availability at RMS.

Table 5: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients		Collinearity Statistics		
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1 (Constant)	3.951	.684		7.623	.000		
Procurement And Supplier Reliability Vulnerabilities	-0.318	.082	-0.291	-3.878	.000	0.548	1.825
Logistics And Distribution Infrastructure Vulnerabilities	-0.247	0.074	-0.258	-3.338	.001	0.472	2.119
Inventory And Data Management Vulnerabilities	-0.281	0.079	-0.286	-3.557	.001	0.506	1.976
Legal And Regulatory Compliance Vulnerabilities	-0.136	0.067	-0.149	-2.030	.045	0.611	1.637

a. Dependent Variable: Availability of essential medicines

Source: Field Data (2026)

Table 5 indicates that all four vulnerabilities had statistically significant negative effects. Procurement and supplier reliability produced the largest unstandardized effect ($B = -0.318$, $\beta = -0.291$, $t = -3.878$, $p = 0.000$), followed by inventory and data management ($B = -0.281$, $\beta = -0.286$, $t = -3.557$, $p = 0.001$), logistics and distribution infrastructure ($B = -0.247$, $\beta = -0.258$, $t = -3.338$, $p = 0.001$), and legal and regulatory compliance vulnerabilities ($B = -0.136$, $\beta = -0.149$, $t = -2.030$, $p =$

0.045). The estimated equation was $Y = 3.951 - 0.318X_1 - 0.247X_2 - 0.281X_3 - 0.136X_4 + \epsilon$.

4.3 Decision on Null Hypotheses

The four null hypotheses were assessed from the regression coefficients using a significance level of 0.05.

Table 6: Decision on Null Hypotheses

Research Hypothesis	B	t	p-value	Decision
H01: Procurement and supplier reliability vulnerabilities do not significantly affect medicine availability.	-.318	-3.878	.000	Rejected
H02: Logistics and distribution infrastructure vulnerabilities do not significantly affect medicine availability.	-.247	-3.338	.001	Rejected
H03: Inventory and data management vulnerabilities do not significantly affect medicine availability.	-.281	-3.557	.001	Rejected
H04: Legal and regulatory compliance vulnerabilities do not significantly affect medicine availability.	-.136	-2.030	.045	Rejected

Source: Field Data (2026)

All four null hypotheses were rejected because each p-value was below 0.05. The regression evidence therefore confirms statistically significant effects of procurement and supplier reliability, logistics and distribution infrastructure, inventory and data management, and legal and regulatory compliance vulnerabilities on the availability of essential medicines at RMS.

4.4 Discussion of Research Findings

The discussion connects the inferential evidence with previous studies and the theoretical perspectives guiding the inquiry.

4.4.1 Procurement and Supplier Reliability Vulnerabilities and Medicine Availability

Procurement and supplier dependability vulnerabilities had the most detrimental impact on drug availability, demonstrating that delays, irregular supply, and supplier dependency may significantly affect stock continuity at RMS. This finding is consistent with Ndlovu et al. (2023), who connected procurement delays and inconsistent delivery to a significant share of pharmaceutical shortages in Zimbabwean hospitals. Kamanzi et al. (2022) discovered that supplier unreliability was related with longer stock-out periods in Rwandan district hospitals. The confluence of these data shows that consistent supply schedules and improved supplier performance are critical to medication availability.

The findings are also consistent with Transaction Cost Economics and Resource Dependence Theory. Unreliable supply connections raise the expenses of looking for alternatives, renegotiating contracts, and managing interruptions, while over-reliance on a small supplier base exposes the organization to external disruptions. Strengthening supplier assessment, preserving alternative sources, and developing more solid contractual ties may help RMS decrease transaction uncertainty as well as dependency-related risk.

4.4.2 Logistics and Distribution Infrastructure Vulnerabilities and Medicine Availability

Logistics and distribution infrastructure vulnerabilities exhibited a statistically significant detrimental impact, indicating how flaws in transportation, distribution coordination, cold-chain systems, and logistics information might jeopardize pharmaceutical continuity. Musa et al. (2023) recognized logistical and infrastructural limitations as significant restrictions to drug delivery in Sub-Saharan Africa. Munyaneza et al. (2024) detailed logistical and infrastructural difficulties in Rwanda's healthcare supply chains. These research, taken together, corroborate the current notion that drug availability is determined by the dependability of the physical and information infrastructure used to transport stock to healthcare institutions.

Systems Theory is beneficial for interpreting distribution performance since it is linked to procurement, warehousing, and inventory status. Even once drugs have been acquired, inadequate transportation or distribution planning might prevent them from reaching the facilities where they are needed. As a consequence, the findings favor coordinated improvements in transportation planning, cold-chain dependability, route management, and logistics information systems over handling distribution issues as discrete operational incidents.

4.4.3 Inventory and Data Management Vulnerabilities and Medicine Availability

Security holes in inventory and data management have had a major detrimental impact on the supply of medicines. Smith and Wasiams (2022) demonstrated that real-time inventory monitoring may minimize inconsistencies and facilitate greater stock availability, whereas Johnson et al. (2023) found that drug shortages in NHS hospitals were caused by inadequacies in inventory management, data accuracy, and technology. Since information-system disruptions, poor stock visibility, and erroneous forecasting may all cause delays in replenishment or discrepancies between reported stock and actual demand, these results are in line with the RMS evidence.

This view is supported by Information Processing Theory, which states that managers can only make good distribution and procurement choices with up-to-date and correct information. Overstocking, stock-outs, or delayed ordering can result from data that isn't up to par, which in turn increases uncertainty. Consequently, the RMS supply chain may benefit from better decision-making and lessen the likelihood of medication shortages caused by information inadequacies if data governance, real-time visibility, demand forecasting, and system dependability were to be improved.

4.4.4 Legal and Regulatory Compliance Vulnerabilities and Medicine Availability

While the regression coefficient for the vulnerability related to legal and regulatory compliance was the smallest, it was nevertheless statistically significant. The findings show that when certification, licensing, importation regulations, and approval procedures cause delays or compliance bottlenecks, the supply of medicines might be reduced. While Zhang and Li (2022) connected regulatory deficiencies with shortages and delayed pharmaceutical access in China, Kumar et al. (2023) shown that regulatory processes may impact the speed with which medications become accessible. Regulatory efficiency is both a legal need and an operational supply-chain problem, according to these research.

The need for RMS and its affiliates to adhere to regulations set forth by governing bodies and industry norms may be better understood with the aid of Institutional Theory. Medicine quality and public safety are safeguarded by compliance, yet supply might be slowed by processes that are either unexpected or lengthy. Improving coordination, clarity, and processing efficiency is more feasible than weakening regulation. This will help accomplish compliance goals without excessive delay to drug supply.

5. Conclusions and Recommendations

The conclusions synthesize the objective-based evidence, while the recommendations focus on practical measures for reducing the principal vulnerabilities identified in the study.

5.1 Conclusion

The study concludes that supply chain vulnerabilities materially influence the availability of Buy pharmaceuticals at Rwanda Medical Supply Ltd. As the most significant risk, procurement and supplier dependability demonstrate how pharmaceutical continuity is highly dependent on trustworthy sourcing, supplier performance, and controllable procurement lead times. The significance of inventory and data

management vulnerabilities was significant as well, due to the fact that replenishment choices might be influenced by faulty forecasts, poor stock visibility, and unreliable information.

Delays in licensing, certification, and compliance procedures may further disrupt supply, as shown by legal and regulatory vulnerabilities; distribution and logistics limitations further lowered availability by impacting the transit of medications through the supply network. Results demonstrate the need of a well-coordinated system whereby regulatory, information management, logistical, and procurement procedures all work together to ensure that medicines are readily available. Strengthening resilience and ensuring more consistent access to vital medications across Rwanda may be achieved by reducing deficiencies in these areas.

5.2 Recommendations

Based on the findings and conclusions of the study, practical recommendations were proposed to address the identified gaps:

1. RMS should diversify its supplier base, strengthen supplier evaluation and performance monitoring, and maintain contingency sourcing arrangements to reduce dependence on individual suppliers and limit disruptions associated with delayed or inconsistent deliveries.
2. RMS and its logistics partners should strengthen transportation planning, cold-chain management, distribution coordination and logistics information systems so that available medicines can be delivered to health facilities with fewer delays and losses.
3. Inventory management should be reinforced through real-time stock visibility, improved demand forecasting, stronger data-quality controls and reliable information systems, accompanied by staff capacity building to reduce stock-outs, overstocking and inaccurate replenishment decisions.
4. RMS, the Ministry of Health and relevant regulatory institutions should streamline certification, licensing, importation and medicine-approval processes while maintaining required quality standards, with clearer coordination and monitoring to reduce avoidable regulatory delays.

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