

Lead-time management and supply chain performance in Ugandan public health institutions

Dorothy Kabagenyi

Department of Marketing and Management, Makerere University, Kampala, Uganda

Progress Hove-Sibanda

*Department of Logistics Management,
Nelson Mandela University – Summerstrand Campus,
Port Elizabeth, South Africa, and*

Musa Mbago and Robertson Turyamwijuka

*Department of Procurement and Supply Chain Management, Makerere University
Business School, Kampala, Uganda*

Abstract

Purpose – This study examines the association between lead-time management and supply chain performance in Ugandan public health institutions by investigating whether the order-to-delivery cycle and the cash-to-cash cycle are associated with supply chain flexibility, reliability and complete order fulfilment.

Design/methodology/approach – A cross-sectional quantitative survey design was employed. Data were collected from 340 supply chain personnel across 157 public health facilities in the Kampala Metropolitan Area using structured questionnaires. Responses were aggregated to the facility level, resulting in 115 health facilities for analysis. Pearson's correlation and multiple regression analyses were used to test the hypothesized relationships.

Findings – The results indicate that lead-time management is positively associated with supply chain performance, explaining 45.2% of the variation in performance. Both the order-to-delivery cycle and the cash-to-cash cycle exhibited significant positive associations with supply chain performance, with the order-to-delivery cycle demonstrating the stronger association.

Practical implications – The findings suggest that improving order processing, delivery coordination and financial-flow management can strengthen supply chain responsiveness, reliability and complete order fulfilment in public health institutions. The study provides practical insights for health facility managers, National Medical Stores and policymakers seeking to improve medicine availability and overall public health supply chain performance.

Originality/value – This study extends Lean Philosophy by demonstrating the relevance of lead-time management as a process-efficiency mechanism in resource-constrained public health supply chains. It provides empirical evidence from Uganda's centralized public health system, thereby enriching the literature on supply chain management in developing-country public health contexts.

Keywords Lead-time management, Order-to-delivery cycle, Cash-to-cash cycle, Supply chain performance, Lean philosophy, Public health supply chain

Paper type Research article

1. Introduction

Globally, supply chain performance (SCP) directly impacts inventory costs and customer satisfaction (Mohamed and Coutry, 2015). As global trade boosts complexity and volatility, rapid and sustained fluctuations in Lead time (LT) accelerate disruptions and inefficiencies



across supply networks (Chang and Lin, 2019). Regionally, institutions across Sub-Saharan Africa frequently grapple with severe supply chain challenges (Kanyepe *et al.*, 2023; Kimwaki, 2024). In countries like Kenya and Zimbabwe, insufficient emphasis on effective lead-time management (LTM) has been associated with reduced customer satisfaction and compromised competitive standing (Kanyepe *et al.*, 2023). Addressing these systemic inefficiencies through robust LTM is therefore essential for organizational resilience and sustained effectiveness.

Lead-time refers to the total duration from the initiation of an order until its fulfilment (Mohammed and Mandal, 2023), comprising three primary stages: order entry/pre-processing, order fulfilment/processing, and final delivery/post-processing (Mohamed and Coutry, 2015). Effective LTM involves developing strategies and procedures, such as controlling waiting times, engaging suppliers early, and automating processes, aimed at reducing this overall duration while maintaining product quality and reducing costs (Nyongesa and Chege, 2020). LTM focuses on shortening the entire customer journey (order-to-delivery cycle) and the financial flow (cash-to-cash cycle) by reducing delays in order processing, production, and payment collection, improving efficiency, cash flow, and agility (Hong, 2015; Zhu *et al.*, 2020). SCP is characterized by the operational excellence achieved in meeting end-user needs, typically measured using metrics related to cost, time, quality, and service levels (Kimwaki, 2024). Fundamentally, LT uncertainty is recognized as a pervasive form of supply uncertainty (Heydari *et al.*, 2009), which ultimately deteriorates SCP by significantly increasing inventory holding costs and the likelihood of stockouts, alongside destabilizing service levels (Mohammed and Mandal, 2023).

The consequences of poor LTM are particularly acute within the public health sector in Uganda. Evidence reveals pervasive operational failures and chronic supply unreliability. Auditor General reports spanning 2017 to 2019 documented a rising trend in procurement delays, increasing sequentially from 15 days to 20 days. Compounding this, the National Medical Stores (NMS) experienced extreme delivery delays ranging from 3 to 12 months, severely affecting medical supply distribution to public health facilities. This systemic failure resulted in catastrophic supply chain outcomes: the 2018 National Supply Chain Assessment reported stockouts exceeding 90% in health centres (HCs) and hospitals, with average stockout days ranging from 9.8 in General Hospitals (GHs) to 17.9 in HCs. As a consequence, these public health facilities routinely experience critical shortages of medical supplies (Biryabarema, 2019).

To address these persistent operational challenges, this study adopts Lean Philosophy as its theoretical foundation (Kimwaki, 2024). Lean Philosophy emphasizes the elimination of non-value-adding activities, continuous process improvement, and reduction of waiting time to improve operational flow (Womack and Jones, 1996). Within public health supply chains, LTM represents a practical application of Lean principles because it focuses on reducing delays across procurement, ordering, transportation, and inventory processes (Nyongesa and Chege, 2020). By shortening order-processing and delivery cycles while improving cash-flow efficiency, health facilities can achieve greater responsiveness, reliability, and complete order fulfilment despite operating under resource constraints.

Although LTM has received considerable attention in manufacturing and commercial supply chains, considerably less empirical evidence exists regarding its application within public health systems in low-income countries (Kanyepe *et al.*, 2023). Existing studies largely focus on private-sector organizations where supply chains operate under different institutional arrangements, financing mechanisms, and demand characteristics. Consequently, limited evidence explains how LTM contributes to SCP within centralized public health systems such as Uganda's.

This study addresses this gap by examining the association between LTM and SCP in Ugandan public health institutions. Beyond testing established relationships, the study explains why different dimensions of LTM contribute differently to performance in a resource-constrained public health context. In doing so, the study extends Lean Philosophy by

demonstrating that process-flow efficiency, particularly through effective management of the order-to-delivery cycle, represents a critical mechanism for improving public health SCP.

Beyond contributing to the literature on public health supply chains, this study contributes directly to *Modern Supply Chain Research and Applications* by extending Lean Philosophy to a resource-constrained public-sector context. Specifically, the study demonstrates how operational-flow efficiency and financial-flow efficiency differ in their associations with supply chain performance, thereby providing context-specific evidence from Sub-Saharan Africa that broadens current understanding of supply chain improvement strategies in emerging economies.

The remainder of the paper is structured as follows. The next section outlines the theoretical framework. This is followed by a review of the relevant literature and development of hypotheses. The fourth section discusses the methodology employed, followed by the results and discussion. Finally, conclusions, policy implications, and limitations of the study are presented.

2. Theoretical foundation

Lean Philosophy, originally advanced by [Womack et al. \(1990\)](#) through studies of the Toyota Production System, emphasizes the elimination of waste, continuous flow, and cycle-time reduction. The theory assumes that organizational processes are inherently burdened by non-value-adding activities that can be systematically identified and eliminated to enhance efficiency and reliability ([Womack and Jones, 1996](#)). Lean further assumes that reduced process variability and shorter cycle times improve responsiveness and overall operational performance. Lean Philosophy is relevant to this study because it directly links process-flow efficiency particularly lead-time reduction to improvements in SCP, including reliability, flexibility, and complete order fulfilment. In public health supply chains, where delays and stockouts are prevalent, Lean principles provide a framework for examining how wasteful processes prolong order-to-delivery cycles and undermine system performance.

Despite its strengths, Lean Philosophy has several limitations. Its implementation often assumes standardized processes, stable operating environments, and sufficient organizational capacity, conditions that are frequently absent in developing-country public health systems ([Radnor et al., 2012](#)). Nevertheless, the theory remains highly relevant because it conceptualizes LTM as a process-efficiency mechanism through which delays, waiting time, and non-value-adding activities can be minimized. In Uganda's public health supply chain, characterized by centralized procurement, recurrent stockouts, and prolonged medicine delivery delays, Lean Philosophy provides an appropriate theoretical lens for explaining how improvements in order-to-delivery and cash-to-cash processes are associated with enhanced SCP. Accordingly, this study extends Lean Philosophy beyond manufacturing by demonstrating its applicability within resource-constrained public-sector supply chains.

3. Literature review and hypotheses development

3.1 Lead-time management and supply chain performance

Lead-time is widely recognized as a critical measure of SCP, directly impacting operational metrics such as inventory cost and customer satisfaction ([Mohamed and Coutry, 2015](#)). Empirical research consistently demonstrates that increased lead-time uncertainty severely deteriorates SCP. Studies using simulation models revealed that higher lead time variability leads to increased inventory costs, stockouts, and product delivery delays ([Mohammed and Mandal, 2023](#)). Specifically, lead time variance has been found to positively correlate with amplified order variance, subsequently increasing both holding inventory and stock-out amounts simultaneously, thereby creating destructive inventory fluctuations ([Heydari et al., 2009](#)). Further quantitative analysis using system dynamics models confirms that greater lead time uncertainty significantly raises average inventory and carbon costs while lowering the

average service level, weakening overall system stability (Li *et al.*, 2019). Conversely, the strategic implementation of formal LTM practices, such as early supplier engagement, process automation, and effective transport management, has been empirically linked to a significant and positive enhancement of SCP (Kimwaki, 2024). These collective findings necessitate a robust investigation into the positive association between LTM and SCP metrics. Accordingly, the following hypothesis is proposed;

H1. Lead-time management is positively associated with supply chain performance.

3.2 Order-to-delivery cycle and supply chain performance

Order-to-delivery cycle is the time from order placement to receipt (Heinonen, 2015). Empirical evidence consistently links the order-to-delivery cycle with key dimensions of supply-chain performance (Lulagala *et al.*, 2023; Forslund *et al.*, 2021; Holopainen *et al.*, 2023). Simulation and empirical studies show that longer or more variable order-to-delivery lead-times increase stockouts and inventory costs while reducing on-time, in-full deliveries, thereby degrading reliability and fulfilment rates (Chang and Lin, 2019). Measurement studies of the order-to-delivery process further demonstrate that reducing cycle time and variability is positively associated with response speed and consistency across supply networks (Sundström and Tollmar, 2018; Bushuev, 2018). In low-resource health systems, these relationships are amplified: long order-to-delivery intervals correlate with high unavailability of essential medicines and impaired service delivery (Lugada *et al.*, 2022). Despite contextual differences, the cross-study consensus justifies testing the direct association of order-to-delivery cycle on supply-chain performance in Uganda's public health institutions.

In this study, the order-to-delivery cycle refers to the effectiveness with which procurement, processing, transportation and delivery activities are managed. Higher scores therefore represent shorter, more predictable and better-managed delivery cycles rather than longer lead times. Based on Lean Philosophy and previous empirical studies, improved management of the order-to-delivery cycle is expected to be positively associated with SCP. Accordingly, the following hypothesis is proposed:

H1a. The order-to-delivery cycle is positively associated with supply-chain performance

3.3 Cash-to-cash cycle and supply chain performance

Empirical research increasingly treats the cash-to-cash cycle (C2C), also often called cash conversion cycle, (CCC) as a meaningful metric of supply chain and working-capital efficiency, with implications for overall supply-chain performance. For example, firm-level studies show that a shorter CCC (i.e. faster turnover of inventory and receivables, and efficient payables management) is associated with higher financial performance, suggesting that efficient capital flow supports operational agility and supply-chain responsiveness (Hong, 2015). In supply-chain-specific contexts, a study of manufacturing firms in Indonesia found that shorter cash-conversion cycles correlate with better "supply-performance" including delivery performance and perfect order fulfilment (i.e. supply-chain performance) when combined with good inventory and receivables management practices (Roespinoedji *et al.*, 2019). Another investigation among pharmaceutical firms in Kenya revealed that firms that paid attention to C2C cycle time alongside production flexibility and delivery performance tended to report enhanced supply-chain performance (Oketch *et al.*, 2014). Moreover, recent work argues that cash when efficiently managed creates value throughout a supply chain by enabling firms to buffer disruptions, invest in necessary inventory, and meet contractual delivery/fulfilment obligations faster; thus, shorter or well-managed cash-to-cash cycles enhance supply-chain reliability and resilience (Zhang and Yu, 2025). However, results are not always uniform. Some firm-level studies find a non-linear or weak relationship between CCC and profitability (or performance), suggesting contextual factors (industry type, supply-chain

design, working-capital constraints) moderate the relationship (Kukeli *et al.*, 2025). In sum, the empirical evidence especially from manufacturing and supply-chain settings in developing economies supports the conjecture that better (shorter) cash-to-cash cycles are associated with improved supply-chain performance.

Similarly, higher scores on the cash-to-cash cycle represent more efficient management of inventory turnover, supplier payments and financial flows rather than longer financial cycles. Efficient financial-flow management enables timely procurement, reduces inventory shortages and is positively associated with operational responsiveness. Accordingly, the following hypothesis is proposed:

H1b. The cash-to-cash cycle is positively associated with supply-chain performance

3.4 Theoretical framework

The above hypotheses are based on the theoretical model demonstrated in Figure 1.

4. Methodology

4.1 Design, population and sample

This study adopted a cross-sectional quantitative survey design grounded in the positivist research paradigm, which emphasizes objective measurement and hypothesis testing using quantitative data. Consistent with the limitations of cross-sectional research, the study examined the associations between LTM and SCP rather than establishing causal relationships. The study was conducted in the Kampala Metropolitan Area, comprising Kampala City, Wakiso, Mukono and Mpigi districts. The area was selected because it contains the largest concentration of Uganda’s public health facilities and key public health supply chain actors.

Using Yamane’s (1967) sample size determination formula, a sample of 157 public health facilities was obtained. These comprised one National Medical Stores (NMS) distribution centre, two national referral hospitals, three regional referral hospitals, three general hospitals, ten Health Centre IVs, 56 Health Centre IIIs and 82 Health Centre IIs. Stratified random sampling was employed to ensure adequate representation of each facility category.

The public health facility constituted the unit of analysis, while supply chain personnel constituted the unit of inquiry. Three knowledgeable respondents were purposively selected from each sampled facility to obtain multiple perspectives on organizational supply chain practices. These respondents included facility in-charges, procurement managers, logistics officers, store managers, and transport personnel. Accordingly, 471 questionnaires (157 × 3) were distributed across the sampled facilities.

A total of 340 usable questionnaires were returned, representing a 72% response rate at the respondent level. Because response rates varied across facilities, the number of completed questionnaires differed among health facilities. To derive organizational-level measures,

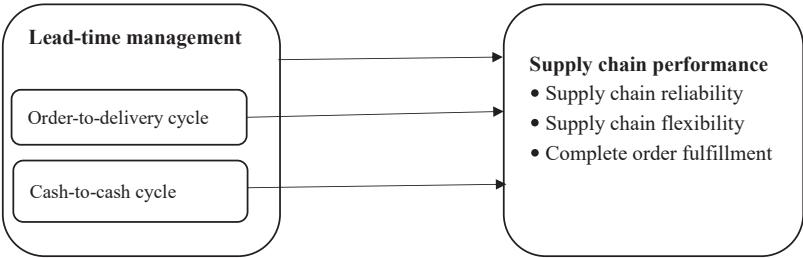


Figure 1. Theoretical framework. Source: Compiled by authors

responses from all available respondents within each facility were aggregated by computing the arithmetic mean for each measurement item. Facilities with sufficient usable responses to permit aggregation were retained for analysis, resulting in a final analytical sample of 115 public health facilities, representing a 73.2% facility response rate (115/157).

The aggregated facility-level scores were subsequently used to construct composite measures for LTM and SCP. Consequently, all descriptive statistics, correlation analyses, and multiple regression analyses were performed at the facility level ($N = 115$).

Data were collected using structured self-administered questionnaires adapted from previously validated instruments. Prior to the main survey, the questionnaire was pilot-tested to improve clarity, reliability, and contextual relevance. Ethical approval was obtained from the relevant institutional ethics committee. Participation was voluntary, respondent anonymity was guaranteed, and no questionnaire contained substantial missing data; therefore, only complete cases were retained for analysis. Because the unit of analysis was the public health facility, individual responses from the same facility were aggregated using arithmetic mean scores to generate a single observation for each participating health facility before statistical analysis.

4.2 Measurement of variables

LTM was operationalized using two dimensions: the order-to-delivery cycle and the cash-to-cash cycle. Measurement items were adapted from [Heinonen \(2015\)](#) and [Hong \(2015\)](#). SCP was measured using three dimensions: supply chain reliability, supply chain flexibility, and complete order fulfilment, adapted from [Hove \(2015\)](#) and Huang [Huan et al. \(2004\)](#). All items were measured on a five-point Likert scale ranging from 1 = *Strongly Disagree* to 5 = *Strongly Agree*. Higher scores on the LTM dimensions represent better-managed and shorter operational and financial cycles, rather than longer cycle durations. A complete list of measurement items is presented in [Appendix A](#).

4.3 Measurement validation

Before hypothesis testing, several diagnostic tests were conducted to determine whether the data satisfied the assumptions underlying parametric statistical analysis.

4.3.1 Normality. Normality was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. As shown in [Table 1](#), neither test produced statistically significant results ($p > 0.05$), indicating no evidence of departure from normality. This conclusion is further supported by skewness and kurtosis statistics, all of which fall within the recommended range of ± 1.0 .

4.3.2 Homogeneity of variance. Homogeneity of variance was satisfied because the Levene’s test significance values exceeded 0.05 for both variables as shown in [Table 2](#) below.

4.3.3 Data reliability and validity. The convergent validity was assessed using the Average Variance Extracted. Each of the variable dimensions had AVE values that were above 0.500. Internal consistency was assessed in terms of Cronbach’s Alpha and composite reliability by considering indices above 0.7 ([Hair et al., 2017](#)). All VIF values ranged from 1.416 to 1.820, well below the recommended threshold of 5.0, indicating that multicollinearity was not a concern as shown in [Table 3](#) below.

Table 1. Kolmogorov–Smirnov and Shapiro–Wilk test results

	Kolmogorov–Smirnov		Shapiro–Wilk	
	Statistic	Sig.	Statistic	Sig.
Lead-time management	0.300	0.161	0.858	0.222
Supply chain performance	0.229	0.146	0.910	0.281

Source(s): Compiled by authors

Table 2. Homogeneity of variances

	Levene statistic	Sig.
Lead-time management	0.964	0.413
Supply chain performance	0.637	0.593
Source(s): Compiled by authors		

Table 3. Reliability and validity assessment

Lead-time management	Cronbach's alpha	CR	AVE	VIF
Order-to-delivery cycle	0.782	0.902	0.821	1.702
Cash-to-cash cycle	0.796	0.868	0.623	1.820
<i>Supply chain performance</i>				
Complete order fulfilment	0.779	0.858	0.604	1.700
Supply chain flexibility	0.775	0.856	0.599	1.627
Supply chain reliability	0.731	0.829	0.549	1.416
Source(s): Compiled by authors				

4.3.4 Discriminant validity. We further assessed discriminant validity among the study variables using Heterotrait- Monotrait Ratio (HTMT). The values were below the recommended threshold of 0.90 as recommended by [Henseler et al. \(2015\)](#), indicating that the independent variables are distinct from each other in associating with SCP as shown in [Table 4](#) below.

4.3.5 Controlling for common methods bias (CMB). To control for CMB, we used procedural remedies such as keeping questions short and precise, avoiding double-barrelled questions and limiting the use of negatively worded items. We ensured respondents' anonymity which enabled them to give unbiased responses. Further, we conducted multiple follow-up calls and e-mail reminders for those who delayed to answer the questionnaire. In addition, we adapted previously validated measurement scales to suit the study context. We also contacted three professional academics and two health care professionals to ensure the items were clear and captured their respective constructs.

5. Results and discussion

5.1 Descriptive results

[Table 5](#) shows that the majority of respondents were female (58.8%), aged 31–40 years (49.7%), and held a diploma (47.1%). Most had 6–8 years of service (29.4%), while facility

Table 4. Heterotrait Monotrait ratios of the study variables

Lead-time management		Cash-to-cash cycle	Order-to-delivery cycle
Cash-to-cash cycle		0.546	
Order-to-delivery cycle			
Supply chain performance	Complete order fulfilment	Supply chain flexibility	Supply chain reliability
Complete order fulfilment			
Supply chain flexibility	0.436		
Supply chain reliability	0.628	0.762	
Source(s): Compiled by authors			

Table 5. Respondents characteristics

Variable	Category	Freq	Percent	Cum. Percent
Gender	Male	140	41.2	41.2
	Female	200	58.8	100.0
Age bracket	21–30 years	51	15.0	15.0
	31–40 years	169	49.7	64.7
	41–50 years	87	25.6	90.3
	51–60 years	33	9.7	100.0
Education level	Certificate	99	29.1	29.1
	Diploma	160	47.1	76.2
	Degree	58	17.1	93.3
	Masters	21	6.2	99.5
Length of service	PHD	2	0.5	100.0
	3–5 years	69	20.3	20.3
	6–8 years	100	29.4	49.7
	9–11 years	82	24.1	73.8
Position held	12 years and above	89	26.2	100.0
	Facility in-charge	112	32.9	32.9
	Procurement manager	19	5.6	38.5
	Stores manager	112	32.9	71.5
Professional training	Logistics officer	32	9.4	80.9
	Transporter	65	19.1	100.0
	CIPS	13	3.8	3.8
	CILT	2	0.6	4.4
	CMI	4	1.2	5.6
	CPA	1	0.3	5.9
	ACCA	1	0.3	6.2
	None	303	89.1	95.3
	Others	16	4.7	100.0
		340		

Source(s): Compiled by authors

in-charges (32.9%) and stores managers (32.9%) constituted the largest respondent groups. In addition, 89.1% of the respondents reported having no professional procurement or logistics certification. Further, [Table 6](#) indicates that most facilities were Health Centre III (43.5%) and Health Centre II (40.0%). The largest proportion had been in operation for 12–17 years (33.9%) and employed 1–5 supply chain staff (72.1%). Most facilities replenished supplies bi-monthly (84.3%), experienced delivery delays of 45–59 days (27.0%), relied on the push ordering system (73.0%), and identified late delivery (56.5%) as the leading cause of delays. This implies that the public health sector in Uganda is dominated mainly by health centre IIIs, with few employees, long lead-times and high demand for medicines and medical supplies.

5.2 Descriptive statistics

[Table 7](#) presents the descriptive statistics for the study variables. The mean scores indicate that respondents expressed neutral perceptions regarding LTM practices, with the order-to-delivery cycle (Mean = 3.09, SD = 0.701) recording slightly higher ratings than the cash-to-cash cycle (Mean = 2.83, SD = 0.745). These findings suggest that although LTM practices exist within public health institutions, respondents perceived opportunities for further improvement, particularly regarding financial-flow management.

Conversely, respondents generally agreed that SCP was satisfactory. Supply chain reliability recorded the highest mean score (Mean = 3.74, SD = 0.718), followed by complete order fulfilment (Mean = 3.66, SD = 0.822) and supply chain flexibility (Mean = 3.55, SD = 0.796). Overall, the results suggest that while operational performance is perceived positively, improvements in LTM could further strengthen public health SCP.

Table 6. Organization characteristics

Variable	Category	Freq	Percent	Cum. Percent
Category of health facility	National Medical stores	1	0.9	0.9
	National Hospital	2	1.7	2.6
	Referral Hospital	3	2.6	5.2
	District Hospital	3	2.6	7.8
	Health Centre IV	10	8.7	16.5
	Health Centre III	50	43.5	60.0
Number of years in Operation	Health Centre II	46	40.0	100.0
	1–5 years	18	15.7	15.7
	6–11 years	36	31.3	47.0
	12–17 years	39	33.9	80.9
	18 years and above	22	19.1	100.0
Number of supply chain employees	1–5 Employees	83	72.1	72.1
	6–10 Employees	17	14.7	86.8
	11–15 Employees	9	7.9	94.7
	16–20 Employees	2	2.1	96.8
	Above 21 Employees	4	3.2	100.0
Period to replenish	Every after two weeks	2	1.7	1.7
	Monthly	2	1.7	3.4
	Bi-Monthly	97	84.3	87.8
	Quarterly	13	11.3	99.1
	Semi yearly	1	0.9	100.0
Frequency of delays	1–14 days	23	20.0	20.0
	15–29 days	21	18.3	38.3
	30–44 days	27	23.5	61.7
	45–59 days	31	27.0	88.7
	Above 60 days	13	11.3	100.0
Ordering system adopted	E-ordering	28	24.3	24.3
	ERP	2	1.7	26.1
	DRP	1	0.9	27.0
	Push System	84	73.0	100.0
Causes of delay	Late delivery	65	56.5	56.5
	Late ordering	20	17.4	73.9
	Transport breakdown	18	15.7	89.6
	Increased order size	12	10.4	100.0
		115		

Source(s): Compiled by authors

Table 7. Descriptive statistics of study constructs

Variable	Dimension	Mean	Std. Deviation	Interpretations
Lead-time management	Order-to-delivery cycle	3.09	0.701	Neutral
	Cash-to-cash cycle	2.83	0.745	Neutral
Supply chain performance	Supply chain reliability	3.74	0.718	Agree
	Supply chain flexibility	3.55	0.796	Agree
	Complete order fulfilment	3.66	0.822	Agree

Source(s): Compiled by authors

Table 8 presents additional descriptive statistics for the composite study variables. The maximum observed values were below the upper limit of the measurement scale, indicating room for further improvement in both LTM and SCP. Furthermore, skewness and kurtosis values were within the acceptable range of ± 1.0 , providing additional evidence that the data approximated a normal distribution.

Table 8. Descriptive statistics of composite variables

	Min	Max	Skewness	Std. Error	Kurtosis	Std. Error
Lead-time management	1.938	3.813	−0.329	0.226	−0.154	0.447
Supply chain performance	2.563	4.000	−0.626	0.226	0.144	0.447

Source(s): Compiled by authors

5.2.1 Correlation analysis. We tested for associations between the study variables using Pearson's correlation coefficient as a prerequisite to assess the direction and significance of the earlier hypothesized relationships between the independent variables and dependent variable. [Table 9](#) shows that there is a positive and significant relationship between LTM and SCP ($r = 0.670^{**}$, $p < 0.01$), order-to-delivery cycle and SCP ($r = 0.595^{**}$, $p < 0.01$) and cash-to-cash cycle and SCP ($r = 0.547^{**}$, $p < 0.01$)

5.2.2 Regression analysis. The regression analysis in [Table 10](#) above examined whether the order-to-delivery cycle and the cash-to-cash cycle are associated with SCP in Ugandan public health institutions. The overall regression model was statistically significant ($F = 139.166$, $p < 0.001$), indicating that the two LTM dimensions jointly explain a significant proportion of the variation in SCP. The model accounted for 45.2% ($R^2 = 0.452$) of the variance in SCP, suggesting that LTM dimensions jointly explain a substantial proportion of the variance in SCP.

Table 9. Correlation analysis

	1	2	3	4
Lead-time management-1	1.000			
Order-to-delivery cycle-2	0.841**	1.000		
Cash-to-cash cycle −3	0.861**	0.449**	1.000	
Supply chain performance. −4	0.670**	0.595**	0.547**	1.000

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

$N = 115$

Source(s): Compiled by authors

Table 10. Regression model

Model		Unstandardized coefficients		Standardized coefficients		Sig.
		B	Std. Error	Beta	<i>t</i>	
1	(Constant)	1.691	0.106		15.948	0.000
	Order-to-delivery cycle	0.332	0.034	0.438	9.720	0.000
	Cash-to-cash cycle	0.249	0.032	0.350	7.755	0.000

a. Dependent variable: supply chain performance

Model summary

R	0.673 ^a
R Square	0.452
Adjusted R Square	0.449
Std. Error	0.39338
F Statistic	139.166
Sig.	0.000

Note(s): $N = 115$

The standardized regression coefficients indicate that both LTM dimensions are positively and significantly associated with SCP. Among the two LTM dimensions, the order-to-delivery cycle exhibited the stronger association ($\beta = 0.438, p < 0.001$), followed by the cash-to-cash cycle ($\beta = 0.350, p < 0.001$). These findings suggest that improvements in operational flow management are more strongly associated with SCP than improvements in financial-flow management within Uganda’s centralized public health supply chain.

5.2.3 Interpretation of individual hypotheses

H1a: The order-to-delivery cycle is positively associated with supply chain performance.

The results show a positive and statistically significant association between the order-to-delivery cycle and SCP ($\beta = 0.438, p < 0.001$). This indicates that public health institutions reporting better-managed order-to-delivery processes also tend to report higher levels of SCP. The relatively large standardized coefficient further suggests that the order-to-delivery cycle exhibits the strongest positive association with SCP among the LTM dimensions examined. Therefore, **H1a** is supported.

H1b: The cash-to-cash cycle is positively associated with supply chain performance.

The results also indicate a positive and statistically significant association between the cash-to-cash cycle and SCP ($\beta = 0.350, p < 0.001$). This finding suggests that institutions reporting more efficient management of financial flows similarly report higher levels of SCP. Although this relationship is slightly weaker than that observed for the order-to-delivery cycle, it remains statistically significant. Accordingly, **H1b** is supported.

Overall, the regression results provide empirical support for **H1**, which proposed that LTM is positively associated with SCP. Collectively, the findings indicate that institutions with better-managed lead-time processes tend to report superior SCP. Moreover, the larger standardized coefficient for the order-to-delivery cycle ($\beta = 0.438$) compared with the cash-to-cash cycle ($\beta = 0.350$) suggests that operational flow efficiency is more strongly associated with SCP than financial-flow efficiency in Uganda’s public health supply chain.

5.2.4 Summary of supported hypothesis. The **Table 11** below shows the summary of the hypothesis relative to the findings.

6. Discussion

6.1 Lead-time management and supply chain performance

The findings demonstrate that LTM is positively associated with SCP within Ugandan public health institutions. Consistent with Lean Philosophy, facilities reporting fewer operational delays also reported higher supply chain flexibility, reliability and complete order fulfilment. Rather than demonstrating causality, the findings indicate that facilities reporting stronger LTM practices also report better SCP. These results agree with [Chang and Lin \(2019\)](#), [Mohammed and Mandal \(2023\)](#), and [Kimwaki \(2024\)](#), who found that efficient LTM is associated with operational responsiveness and delivery reliability.

Table 11. Summary of the hypotheses

	Hypothesis	Statistics	Verdict
H1	Lead-time management is positively associated with supply chain performance	(F = 139.166, $p < 0.001$)	Supported
H1a	The order-to-delivery cycle is significantly associated with supply chain performance	($\beta = 0.438, p < 0.001$)	Supported
H1b	The cash-to-cash cycle is significantly associated with supply chain performance	($\beta = 0.350, p < 0.001$)	Supported

Source(s): Compiled by authors

The Ugandan public health context provides an important theoretical extension. Unlike commercial supply chains where profitability is the primary objective, Uganda's public health system operates through a centralized procurement and distribution structure coordinated by National Medical Stores. Consequently, delays occurring anywhere within procurement, order processing or transportation directly reduce medicine availability across lower-level health facilities. These findings support Lean Philosophy by suggesting that facilities reporting lower waiting times also report superior SCP.

6.2 Order-to-delivery cycle and supply chain performance

The stronger standardized coefficient ($\beta = 0.438$) suggests that operational flow efficiency is more strongly associated with SCP than financial-flow efficiency within Uganda's centralized public health supply chain which is consistent with the findings of (Zaied *et al.*, 2016; Sundström and Tollmar, 2018). This finding is particularly important within Uganda's centralized health supply chain, where medicine availability largely depends on timely procurement, dispatch and delivery from National Medical Stores. Previous Auditor General reports and National Supply Chain Assessments have documented prolonged delivery delays, a predominantly push-based ordering system and frequent stockouts across health facilities. These contextual characteristics explain why operational flow efficiency is more strongly associated with SCP than financial-flow efficiency. From a Lean perspective, the order-to-delivery cycle represents the elimination of waiting time and process bottlenecks, which is directly associated with responsiveness, reliability and complete order fulfilment.

6.3 Cash-to-cash cycle and supply chain performance

Although the cash-to-cash cycle also demonstrated a significant positive association with SCP, its contribution was comparatively weaker. This may reflect the financing structure of Uganda's public health supply chain, where procurement decisions are largely centralized and individual health facilities exercise limited control over financial flows. Nevertheless, efficient management of inventory turnover, payment processing and financial resources remains important because it supports procurement planning and reduces operational disruptions. The findings therefore suggest that while financial-flow efficiency contributes to performance, improvements in physical product flow remain the more immediate priority for public health supply chains.

7. Conclusion

This study examined the association between LTM and SCP in Ugandan public health institutions. The findings indicate that facilities reporting better-managed lead-time processes also report higher levels of supply chain flexibility, reliability and complete order fulfilment. Among the LTM dimensions, the order-to-delivery cycle exhibited the strongest association with SCP, suggesting that stronger operational flow efficiency practices are particularly important within Uganda's centralized public health supply chain. These findings extend Lean Philosophy by demonstrating that process-flow efficiency provides a useful theoretical explanation for SCP in resource-constrained public-sector settings. The study also contributes to literature published in Modern Supply Chain Research and Applications by providing empirical evidence on how lead-time management enhances supply chain performance within a centralized public health system in a developing-country context. By demonstrating the relative importance of operational-flow efficiency over financial-flow efficiency, the study broadens current understanding of LTM beyond traditional manufacturing and commercial supply chains and illustrates its relevance to contemporary public-sector supply chain management. Practically, the findings highlight the importance of reducing procurement and delivery delays alongside strengthening financial-flow management to improve medicine availability and health service delivery.

7.1 Implications for theory

This study contributes to Lean Philosophy by demonstrating that LTM functions as a process-efficiency mechanism linking operational flow improvements to SCP within a resource-constrained public health system. Whereas Lean has traditionally been applied within manufacturing environments, the findings show that its underlying principles remain applicable in centralized public-sector supply chains characterized by institutional constraints, procurement delays and medicine shortages. More importantly, the study demonstrates that operational flow efficiency, represented by the order-to-delivery cycle, contributes more strongly to SCP than financial-flow efficiency. This contextual insight extends existing supply chain knowledge by highlighting how institutional arrangements shape the relative importance of different LTM dimensions.

7.1.1 Implications for practice. For health facility in-charges, the findings highlight the importance of strengthening internal order processing, inventory monitoring, and communication mechanisms to reduce avoidable delays and improve order fulfilment.

For National Medical Stores (NMS), the results underscore the need to improve delivery scheduling, emergency replenishment mechanisms, and timely communication regarding anticipated delivery delays to enhance supply chain reliability across public health facilities.

For policymakers, the findings suggest that investments in digital procurement systems, logistics infrastructure, and integrated inventory information systems could strengthen lead-time management across the public health supply chain. Such initiatives would improve medicine availability while supporting broader health sector efficiency objectives.

7.2 Study limitations and further research directions

The findings should be interpreted in light of several limitations. First, the cross-sectional design permits examination of associations but does not support causal inference. Future longitudinal studies could examine whether changes in LTM are associated with changes in SCP over time. Second, data were collected using self-reported questionnaires, which may introduce common method bias despite the procedural and statistical remedies employed. Third, the study focused on public health institutions within the Kampala Metropolitan Area, limiting the generalizability of the findings to private-sector supply chains or health systems operating under different institutional arrangements. Finally, the study did not consider controls. Future research could employ mixed-method or comparative multi-country designs to examine contextual differences in LTM practices across developing-country health systems.

Supplementary material

The supplementary material for this article can be found online.

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Corresponding author

Dorothy Kabagenyi can be contacted at: dkabagenyi4@gmail.com