

Improvement of Logistical Efficiency in the Distribution of Essential Medicines: The Case of the CAAMEBO Regional Distribution Center in Matadi

Lukamba, A. T.¹, Kaumb, G. K.¹, Cimanuka, A. B.¹, Kitho, F. N.¹, Mbuya, J. M.¹, Ndalamba, A. M.¹, Luvuezo, D. D.², Mutwale, M. K.¹, Matoba, N. M. N.³, Muzang, G. N. K.¹, & Imani, A. S. A.¹

¹Higher Institute of Medical Techniques of Matadi / Doctoral School of Health Sciences of Kinshasa, Democratic Republic of the Congo

²Higher Institute of Medical Techniques of Kinshasa, Democratic Republic of the Congo

³Presidential Clinic of the African Union, Kinshasa, Democratic Republic of the Congo

ARTICLE INFO

Received: 10 September 2025

Accepted: 28 July 2026

Published: 12 October 2026

Keywords:

Adolescent, artisanal alcohol, liver enzymes, Likasi, Democratic Republic of the Congo

Peer-Review: Externally peer-reviewed

© 2026 The Authors.

Re-use permitted under CC BY-NC 4.0
No commercial re-use or duplication.

Correspondence to:

Alexis Tohemo Lukamba

tohemoalexisluka6@gmail.com

To cite:

Lukamba, A. T., Kaumb, G. K., Cimanuka, A. B., Kitho, F. N., Mbuya, J. M., Ndalamba, A. M., Luvuezo, D.-M. D., Mutwale, M. K., Matoba, N. M. N., Muzang, G. N. K., & Imani, A. S. A. (2026). Improvement of logistical efficiency in the distribution of essential medicines: The case of the CAAMEBO Regional Distribution Center in Matadi. *Orapuh Journal*, 7(9), e1484. <https://doi.org/10.4314/orapj.v7i9.84>

ISSN: 2644-3740

Published by **Orapuh, Inc.**, F. Gaye Res., Sukuta-Jamisa, Greater Banjul, The Gambia.

Editor-in-Chief: Prof. V. E. Adamu
(editor@orapuh.org)

ABSTRACT

Introduction

Inefficient pharmaceutical logistics remains a primary barrier to accessing essential medicines in low-resource settings, particularly in the Democratic Republic of the Congo (DRC).

Purpose

This study aimed to analyze logistical operational bottlenecks at the Centrale d'Achat et de Distribution des Médicaments Essentiels de Matadi/Boma (CAAMEBO) Regional Distribution Center (CDR) in Matadi and propose evidence-based strategies to improve distribution efficiency.

Methods

A convergent mixed-methods case study design was executed between January and March 2025. Purposive sampling was used to select 5 key informants (doctor, pharmacist, pharmacy assistant, administrative manager, logistician) for semi-structured interviews. Concurrently, a structured survey was administered to 18 operational warehouse and distribution staff (N = 18). Qualitative data were analyzed thematically using NVivo 12, while quantitative variables were evaluated using descriptive statistics in SPSS (v26).

Results

Key informant analysis revealed that 80.0% (n = 4) of interviewees reported frequent stockouts (≥ 3 instances per quarter), with a mean stockout duration of 12.4 days (SD = 4.1). Quantitative survey data confirmed that 83.3% (n = 15) of operational staff experienced ≥ 3 stockouts per quarter and 72.2% (n = 13) cited delivery delays exceeding 7 days (mean delay = 9.3 days, SD = 3.5). Manual stock management was identified by 100% of participants as prone to human error, and 88.9% (n = 16) noted the complete absence of real-time stock tracking. All staff (100%) supported transitioning to a computerized management system.

Conclusion

The CAAMEBO CDR faces severe operational bottlenecks linked to manual record-keeping, vulnerable transportation infrastructure, and fragmented supply chain governance. Phased interventions—focusing on immediate workforce training, medium-term process standardization, and long-term digitalization—are essential to guarantee medicine availability.

INTRODUCTION

In the Democratic Republic of the Congo (DRC), ensuring continuous access to essential health products remains a persistent public health challenge despite ongoing health system strengthening reforms. In the Kongo-Central province, the Regional Distribution Center (Centrale d'Achat et de Distribution des Médicaments Essentiels de Matadi/Boma [CAAMEBO]) serves as a core node supplying public and non-profit health facilities across the region. However, CAAMEBO operations are frequently compromised by logistics inefficiencies, stockouts, and delivery delays that endanger patient safety and clinical outcomes (Batuli, 2024).

Nationally, the Congolese pharmaceutical sector is highly fragmented and dependent on international drug imports, with domestic manufacturers supplying only 10% of local demand (Okereke, 2022). In Kongo-Central, geography and deteriorating infrastructure further exacerbate supply chain vulnerabilities: of the 2,250 km road network, only 1,226 km is categorized as passable or in good condition (Ministry of Transport of the Democratic Republic of Congo, 2023). Moreover, health logistics depend heavily on external donor funding (World Health Organization [WHO], 2023). Studies in adjacent health districts, such as the Wangata health zone, confirm that rural supply chains suffer from delayed shipments, stock exposure to near-expiry conditions, and operational disruption caused by inconsistent donor funding cycles (Batuli, 2024).

Globally, low- and middle-income countries (LMICs) face structural gaps in medicine availability. WHO (2011) reported that the median availability of essential medicines across LMICs was only 40.0% in public health facilities compared to 78.1% in the private sector. Global distribution disruptions during the COVID-19 pandemic further exacerbated these disparities (WHO, 2023). In sub-Saharan Africa alone, supply chain failures and supply gaps contribute to approximately 500,000 deaths annually linked to untreated disease or exposure to substandard and falsified medical products (WHO, 2024).

While general logistics bottlenecks in developing countries are broadly documented (McCabe, 2009; Mwencha & Rosen, 2016), empirical evidence examining root operational failures within regional supply hubs

(CDRs) in the DRC remains scarce. This study addresses this gap by analyzing specific operational vulnerabilities at the CAAMEBO CDR in Matadi and identifying target areas for technological and structural modernization.

METHODS

Study Design and Setting

A convergent mixed-methods case study design combining qualitative key informant interviews and a quantitative cross-sectional survey was conducted at the CAAMEBO CDR in Matadi, Kongo-Central province, DRC, from January to March 2025.

Sampling Strategy and Participants

Participants were selected using a non-probability purposive sampling method based on professional role, operational involvement in supply chain functions, and tenure at CAAMEBO (≥ 2 years).

- a) **Qualitative Sample ($n = 5$):** Five key informants were recruited: a medical doctor ($n = 1$), a pharmacist ($n = 1$), a pharmacy assistant ($n = 1$), an administrative manager ($n = 1$), and a logistics officer ($n = 1$).
- b) **Quantitative Sample ($n = 18$):** Eighteen operational warehouse and distribution staff members ($N = 18$) completed a structured survey covering daily inventory practices and performance parameters.

Data Collection Instruments

- a) **Qualitative Interview Guide:** A standardized, semi-structured guide containing 12 open-ended questions was used to assess four core operational areas: (a) routine stock management practices, (b) drivers of stockouts, (c) shipment and delivery performance, and (d) perceptions regarding technology adoption.
- b) **Quantitative Questionnaire:** A structured questionnaire comprising 20 items (15 close-ended Likert-scale questions and 5 categorical items) evaluated delivery timelines, stockout frequencies, and inventory tracking accuracy.

Reliability, Validity, and Triangulation

Content validity was established through expert review by two senior public health logistics professors at the Higher Institute of Medical Techniques (ISTM) of Kinshasa. The quantitative instrument was pilot-tested with three logistics officers from an external distribution facility. Internal consistency for the questionnaire was strong ($\alpha = .81$). Methodological triangulation was conducted by converging thematic qualitative outputs with quantitative descriptive statistics to cross-verify patterns of supply disruption and delivery delays (Delaney et al., 2018).

Data Analysis

Audio-recorded qualitative interviews were transcribed verbatim and analyzed via thematic framework analysis using NVivo (Version 12). Quantitative survey data were processed in SPSS (Version 26.0) to generate descriptive statistics, including frequencies, percentages, means (M), and standard deviations (SD).

Ethical Considerations

Ethical clearance was granted by the Institutional Review Board of the Higher Institute of Medical Techniques of Kinshasa (Ref: [ISTMK/CE/2024-089](#); Dated December 15, 2024). Written informed consent was secured from all participants prior to data collection. Data confidentiality and anonymity were maintained throughout the research process.

RESULTS

Quantitative Performance Indicators

Quantitative findings from operational staff (n = 18) demonstrated severe functional bottlenecks in inventory tracking, stock continuity, and lead times (Table 1). A total of 83.3% (n = 15) of respondents reported experiencing 3 or more stockouts per quarter, with a mean stockout duration of 12.4 days (SD = 4.1). Additionally, 72.2% (n = 13) of staff noted central-level delivery delays exceeding 7 days (M = 9.3 days, SD = 3.5).

Table 1:
Frequency and Characteristics of Logistical Challenges Reported by Field Staff (n = 18)

Operational Indicator	Category / Response	n	%	M (SD)
Frequency of stockouts per quarter	1-2 times	3	16.7	3.8 (1.2) times
	3-5 times	10	55.6	

Average stockout duration	> 5 times	5	27.8	12.4 (4.1) days
	4-7 days	4	22.2	
	8-14 days	9	50.0	
	> 14 days	5	27.8	
Delivery delay from central supplier	< 3 days	2	11.1	9.3 (3.5) days
	4-7 days	3	16.7	
	> 7 days	13	72.2	
Real-time stock tracking available	No	16	88.9	—
	Yes	2	11.1	—
Manual system prone to human error	Agree /	18	100.0	—
	Strongly Agree			

Note. Data reflect self-reported operational responses from warehouse and logistics staff at CAAMEBO CDR.

Qualitative Thematic Synthesis

Four core themes emerged from the thematic analysis of key informant interviews (n = 5), as summarized in Table 2.

Table 2:
Thematic Synthesis of Key Informant Interviews (n = 5)

Theme	Citation Frequency	Core Operational Insight
1. Manual stock management & error vulnerability	5/5 (100.0%)	Excessive reliance on manual registers; time-consuming stock counts prone to discrepancy.
2. Recurrent essential medicine stockouts	4/5 (80.0%)	High vulnerability in key tracer categories (antimalarials, first-line antibiotics).
3. Transport & procurement delays	4/5 (80.0%)	Inbound supply bottlenecks caused by road infrastructure and non-automated reordering.
4. Willingness & perceived barriers to digitalization	5/5 (100.0%)	Universal support for automated LMIS; concerns center on capital costs and training gaps.

Detailed Theme Descriptions

Theme 1: Inefficiency of Manual Inventory Management. All key informants (100.0%) characterized paper-based ledgers as outdated for current inventory volumes. Participants noted that manual tracking increases processing times and leads to record discrepancies, supporting the quantitative findings in Table 1.

Theme 2: Impact of Stockouts on Care Quality. Four key informants (80.0%) emphasized that prolonged stockouts (exceeding 7 days) interrupt therapeutic regimens for urgent conditions, particularly malaria and bacterial infections.

Theme 3: Supply Chain and Transportation Infrastructure Bottlenecks. Informants observed that stockouts at CAAMEBO stem primarily from upstream delivery delays

and lack of automated reorder thresholds, rather than absolute national manufacturing shortages.

Theme 4: Preparedness for Technological Integration. Staff across all levels demonstrated strong willingness to adopt digital solutions. Administrative managers cited capital funding as a primary obstacle, whereas clinical and technical staff emphasized the need for comprehensive software training.

DISCUSSION

The empirical findings from this study demonstrate that the operational difficulties observed at the CAAMEBO CDR in Matadi are systemic issues common to public pharmaceutical supply chains in low-resource settings.

Comparison With Contextual Literature

The finding that 83.3% of surveyed field staff report ≥ 3 stockouts per quarter with a mean duration of 12.4 days aligns with findings from Batuli (2024) in the Wangata health zone (DRC), where chronic stockouts were linked to external funder dependence and delayed reorders. Similar logistics gaps were documented by DELIVER (2005) in Mali, which reported a 32.0% stockout rate for essential reproductive health products, with extended stockouts (> 7 days) representing 24.0% of total occurrences.

Conversely, evidence from East Africa demonstrates that these vulnerabilities can be addressed. Mwencha and Rosen (2016) showed that deploying an electronic Logistics Management Information System (LMIS) in Tanzania reduced national drug stockout rates from 32.0% to 23.0%. This suggests that the prolonged delivery delays (> 7 days for 72.2% of shipments) observed at CAAMEBO can be mitigated through process automation and systemic reforms.

Structural Drivers: Governance, Financing, and Human Resources

The persistence of paper-based inventory tracking at CAAMEBO can be attributed to three main structural factors:

1. **Governance and System Fragmentation:** As McCabe (2009) noted, health logistics in the DRC are characterized by vertical, donor-funded supply channels that operate with limited horizontal

integration. The absence of real-time inventory visibility (reported by 88.9% of field staff) reflects weak central coordination.

2. **Financial Constraints:** Administrative concerns regarding initial capital outlay for software reflect short-term budget planning. The World Bank (2015) observed that distribution overhead in LMICs (accounting for up to 15.0% of product value in countries like Ghana) remains elevated due to underinvestment in modern supply infrastructure. Recurring operational losses from emergency procurements during stockouts likely exceed the capital investment required for software implementation.
3. **Human Resource Capacity:** The training deficits identified by 60.0% of key informants mirror conclusions by WHO (2011), which highlighted that logistics failures in sub-Saharan Africa stem primarily from inadequate workforce training rather than equipment shortages alone.

Impact of Digital Supply Chain Systems

The unanimous support among CAAMEBO staff for digital stock management is supported by empirical literature across comparable health systems. Tewodros et al. (2020) demonstrated that introducing automated inventory software in Ethiopian health facilities reduced record discrepancies by 35.0% and decreased stockout incidence by 20.0%. Similarly, Phaolao and Santivach (2020) observed a 40.0% drop in stockouts and a 25.0% gain in distribution responsiveness following inventory automation in hospital networks. Real-time fleet and stock tracking technologies have also been shown to reduce delivery lead times by 30.0% (Shamsi & Molla, 2018). These findings support the consensus among CAAMEBO staff that automated inventory systems and automated reorder points can address manual entry errors and delivery delays.

Study Limitations

This study has several limitations. First, the key informant sample ($n = 5$) was small, which may restrict full thematic saturation, although purposive sampling ensured representation across all key operational roles. Second, as a single-site case study at CAAMEBO Matadi, the results

may not fully generalize to all 20+ CDR facilities in the DRC, which operate under varying regional conditions and infrastructure resources. Third, self-reported response bias may affect quantitative and qualitative estimates of inventory performance. Finally, the quantitative sample size ($n = 18$), while representative of the facility's dedicated operational staff, limits statistical analysis to descriptive parameters. Multi-center studies with larger sample sizes are recommended for future research.

Policy and Practice Implications

Digital system deployment should be preceded by standardizing routine inventory workflows. Transitioning from donor-managed parallel supply networks to a unified, government-led LMIS backed by dedicated operational budgets is critical, as advocated by the *African Medicines Agency* (2023).

CONCLUSION

This study demonstrates that the CAAMEBO CDR in Matadi faces significant operational supply chain challenges: 83.3% of operational staff report frequent stockouts ($M = 12.4$ days) and 72.2% experience inbound delivery delays exceeding 7 days. These challenges are driven by manual paper-based inventory tracking, weak inter-agency coordination, and insufficient workforce training. Addressing these bottlenecks requires a phased strategy:

- i. **Short-Term (0–6 Months):** Implement structured on-the-job training modules in Good Distribution Practices (GDP) and standardized stock-ledger management for all 23 operational staff members, accompanied by baseline competency assessments.
- ii. **Medium-Term (6–18 Months):** Standardize paper-based reorder workflows, institute minimum/maximum stock thresholds, and establish binding Service Level Agreements (SLAs) with suppliers to reduce mean delivery lead times from 9.3 days to under 5 days.
- iii. **Long-Term (18–36 Months):** Procurement and deployment of an open-source or specialized electronic LMIS (e.g., mSupply or OpenLMIS) featuring barcode integration, automated reorder alerts, dedicated maintenance budgets, and off-grid solar energy support.

Acknowledgments: The authors express their gratitude to the executive management and operational personnel of the Centrale d'Achat et de Distribution des Médicaments Essentiels de Matadi/Boma (CAAMEBO) for facilitating access to data collection. We also acknowledge the Provincial Health Directorate of Kongo-Central for their technical guidance throughout this investigation.

Use of Artificial Intelligence (AI) Declaration: During the preparation of this manuscript, the authors used Google Gemini 1.5 Pro for initial assistance with translation (from French to English) and text formatting. After using this tool, the authors critically reviewed, revised, and verified the entire content of the manuscript. The authors assume full responsibility for the final content of the publication.

Authors' Contributions:

- i. **Alexis Tohemo Lukamba:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Project administration.
- ii. **Gabin Kalau Kaumb:** Methodology, Investigation, Validation, Writing – review & editing.
- iii. **André Bashona Cimanuka:** Methodology, Investigation, Validation, Writing – review & editing.
- iv. **Francine Nasiamia Kitho:** Methodology, Investigation, Validation, Writing – review & editing.
- v. **Jean Mbonzi Mbuya:** Methodology, Investigation, Validation, Writing – review & editing.
- vi. **Alain Makonga Ndalamba:** Methodology, Investigation, Validation, Writing – review & editing.
- vii. **Dieu-Merci Dimpanga Luvuezo:** Formal analysis, Resources, Supervision, Writing – review & editing.
- viii. **Marcel Kasongo Mutwale:** Formal analysis, Resources, Supervision, Writing – review & editing.
- ix. **Norbert Mathieu Ngwisani Matoba:** Formal analysis, Resources, Supervision, Writing – review & editing.
- x. **Geneviève Nuncia Kon Muzang:** Formal analysis, Resources, Supervision, Writing – review & editing.
- xi. **Aide Stéphane Amisi Imani:** Formal analysis, Resources, Supervision, Writing – review & editing.

Data Availability Statement: The datasets generated and analyzed during the present study are available from the corresponding author Alexis TOHEMO LUKAMBA (tohemolexisluka6@gmail.com) upon reasonable academic request. Data are not publicly available due to confidentiality agreements with the CAAMEBO Regional Distribution Center in Matadi to protect participant anonymity.

Ethical Approval: Ethical approval for this protocol was granted by the Ethics Committee of the Higher Institute of Medical Techniques of Kinshasa (Approval Ref: ISTMK/CE/2024-089; Approved December 15, 2024). Research protocols adhered strictly to the principles of the Declaration of Helsinki.

Informed Consent and anonymity: All study participants provided written informed consent.

Funding: This research received no specific grant or external financial support from any funding agency in the public, commercial, or non-profit sectors.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

ORCID iDs:

Lukamba, A. T.¹: <https://orcid.org/0009-0008-5782-738X>
 Kaumb, G. K.¹: <https://orcid.org/0009-0000-5386-4740>
 Cimanuka, A. B.¹: <https://orcid.org/0009-0003-6893-8871>
 Kitho, F. N.¹: <https://orcid.org/0009-0004-2143-741X>

Mbuya, J. M.¹: <https://orcid.org/0009-0003-4792-856X>
 Ndalamba, A. M.¹: <https://orcid.org/0009-0001-6198-0247>
 Luvuezo, D. D.²: <https://orcid.org/0009-0005-3080-5314>
 Mutwale, M. K.¹: <https://orcid.org/0009-0009-9800-0888>
 Matoba, N. M. N.³: <https://orcid.org/0009-0009-8792-1059>
 Muzang, G. N. K.¹: <https://orcid.org/0009-0006-2546-3804>
 Imani, A. S. A.¹: <https://orcid.org/0009-0009-7928-546X>

Open Access: This original article is distributed under the Creative Commons Attribution Non-Commercial (CC BY-NC 4.0) license. This license permits people to distribute, remix, adapt, and build upon this work non-commercially and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made are indicated, and the use is non-commercial. See: <https://creativecommons.org/licenses/by-nc/4.0/>.

REFERENCES

- African Medicines Agency.** (2023). *African Medicines Agency: Progress and prospects for pharmaceutical supply chains in Africa*. African Union. <https://amrh.africa/>
- Alaei, A., Rezapour, A., & Shadmehr, M.** (2017). Supply chain management and its role in the health system: A review of literature. *International Journal of Healthcare Management*, 10(3), 172–178. <https://doi.org/10.1080/20479700.2016.1218749>
- Batuli, G. L.** (2024). Managers' experience in the pharmaceutical supply chain in Wangata health zone, DRC. *Health Economics and Management Review*, 5(2), 45–58.
- Delaney, A., Fitzgerald, R., & Harris, M.** (2018). Ethical considerations in public health research. *International Journal of Public Health*, 61(1), 43–50. <https://doi.org/10.1007/s00038-017-1073-5>
- DELIVER.** (2005). *Evaluation of indicators and the logistics management information system for contraceptives and medicines for the treatment of STIs in Mali*. USAID. https://www.rhsupplies.org/uploads/tx_rhscpublications/DOC87.pdf
- McCabe, A.** (2009). *Healthcare supply chains in developing countries: Situation analysis*. People that Deliver.
- Ministry of Transport of the Democratic Republic of Congo.** (2023). *Annual report on transport infrastructure 2022–2023*. Government of the DRC.
- Mwencha, M., & Rosen, J. E.** (2016). Better data visibility & data use results in lower cost and improved performance in medicine supply chains. *Journal of Pharmaceutical Policy and Practice*, 9(Suppl. 1), Article 12. <https://doi.org/10.1186/s40545-016-0064-x>
- Mwanza, F., Mugisha, P., & Ndugwa, R.** (2015). The impact of automation in pharmaceutical distribution: Case study of automated inventory systems in Uganda. *African Journal of Pharmacy and Pharmacology*, 9(13), 473–479. <https://doi.org/10.5897/AJPP2015.4165>
- Okereke, M.** (2022). The state of pharmaceutical manufacturing in the Democratic Republic of Congo. *Innovations in Pharmacy*, 13(4), 1–8. <https://doi.org/10.24926/iip.v13i4.5083>
- Phaolao, S., & Santivach, T.** (2020). The effect of automated inventory management on stockouts in the pharmaceutical supply chain: Evidence from Bangkok hospitals. *Journal of Supply Chain and Operations Management*, 18(1), 56–67.
- Shamsi, M., & Molla, S.** (2018). Impact of real-time tracking technology in the pharmaceutical supply chain. *Journal of Supply Chain Management*, 21(2), 98–105.
- Tewodros, M., Alemu, D., & Shite, S.** (2020). The effect of inventory management practices on the performance of pharmaceutical supply chains in Ethiopia. *Pharmacy Practice*, 18(4), Article 2230. <https://doi.org/10.18549/PharmPract.2020.4.2261>
- World Bank.** (2015). *Improving supply chain for essential drugs in low income countries*. World Bank Group. <https://openknowledge.worldbank.org/handle/10986/22123>
- World Bank.** (2017). *Digital solutions for supply chain management: A transformative approach for developing countries*. World Bank Group. <https://openknowledge.worldbank.org/handle/10986/27989>
- World Health Organization.** (2011). *WHO/HAI project on medicine prices and availability: Review series on pharmaceutical pricing policies and interventions*. World Health Organization.
- World Health Organization.** (2020). *Guidelines on the management of medicine supply systems in developing countries*. World Health Organization.
- World Health Organization.** (2023). *Access to essential medicines in Africa: Progress and challenges*. WHO Regional Office for Africa.
- World Health Organization.** (2024). *Fifth of medicines in Africa may be substandard or fake, research finds*. World Health Organization.