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

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Abstract
This study aims to analyze and propose solutions to improve logistical efficiency in the distribution of essential medicines at the CAAMEBO Regional Distribution Center (CDR) in Matadi, Democratic Republic of Congo. The lack of efficiency in stock management and frequent shortages of essential medicines pose a major challenge to ensuring a continuous and quality supply.
A qualitative approach was used, based on semi-structured interviews with five members of the CDR CAAMEBO staff (doctor, pharmacist, pharmacy assistant, administrative manager, logistician, and accountant). The data were analyzed using N-VIVO software, allowing responses to be coded and themes related to stock management, stockouts, and the integration of modern technologies to emerge.
The results show that the main challenges faced include frequent stockouts, slow deliveries, manual stock management, and the lack of real-time supply tracking. The interviews revealed that staff are favorable to the introduction of technological solutions, such as computerized stock management systems, to optimize logistical processes and improve responsiveness.
The results are in line with previous studies, highlighting the impact of manual systems on stockouts in developing countries. The integration of modern technologies appears as a viable solution to improve stock management and the availability of medicines.
It is recommended to introduce computerized stock management systems, to train staff in new technologies and to strengthen coordination with suppliers to reduce stockouts and improve the efficiency of logistical processes.
Keywords: *Pharmaceutical logistics, stock management, stockouts, logistical technologies, CDR CAAMEBO.*

1. Introduction

Globally, approximately 30% of the population does not have regular access to essential medicines, with marked disparities between the public and private sectors. A WHO study revealed that the median availability of essential medicines in the public sector was 40%, compared to 78.1% in the private sector. This situation is exacerbated by the dependence of many developing countries on imports, making supply chains vulnerable to global disruptions, such as those observed during the COVID-19 pandemic.

In Africa, the situation is particularly concerning. The continent accounts for 25% of the global disease burden but contributes only 3% of global drug production. In addition, approximately 95% of medicines consumed in Africa are imported, exposing countries to the risk of shortages and price fluctuations. A study conducted in Ethiopia revealed that 20% of drug samples were substandard or counterfeit, contributing to approximately 500,000 annual deaths in sub-Saharan Africa.

A study conducted in Mali in 2001 revealed that the stockout rate for contraceptives and medicines to treat sexually transmitted infections was 32%, with prolonged stockouts (more than 7 days) accounting for 24% of cases. This situation led to a re-evaluation of the logistics system to identify areas needing improvement.

An analysis of health supply chains in developing countries showed that the public sector's share of drug distribution varied considerably: from 70 to 90% in Malawi, 15% in Mali, and 10% in Ghana. This disparity highlights the challenges related to logistical efficiency and the availability of essential medicines.

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The introduction of a logistics information management system (SIGL) in Tanzania reduced the overall stockout rate from 32% to 23%, with a decrease in prolonged stockouts from 24% to 15%. Although annual supply chain costs increased from $66 million to $76 million, the cost per value of products adjusted for performance decreased from 58% to 50%, indicating improved efficiency.

A study conducted by the University of Bahir Dar in Ethiopia revealed that 20% of the drug samples analyzed were substandard or counterfeit. This situation is exacerbated by inefficient and fragmented supply chains, contributing to approximately 500,000 annual deaths in sub-Saharan Africa.

A World Bank study estimated that drug distribution costs in developing countries were generally higher than in developed countries. For example, the distribution cost in Malawi was estimated at 4.1% of the value of the products, while in Ghana, it was 15%.

The DRC, with a population of over 89 million, relies heavily on imports for its pharmaceutical needs. In 2020, the country imported 103,206,665 units of pharmaceutical products, an increase of 842% compared to 2010. However, only 10% of pharmaceutical products consumed are manufactured locally, with the majority of manufacturers located in Kinshasa.

The pharmaceutical sector in the DRC is fragmented, with several parallel supply systems for public health facilities, often supported by donors. This fragmentation leads to inefficiencies and difficulties in stock management and drug distribution.

The Kongo-Central province, where Matadi is located, shares the national challenges in pharmaceutical logistics. Road infrastructure is inadequate, with only 1,226 km of roads in good condition out of a total of 2,250 km, which complicates the distribution of medicines to rural areas. In addition, health structures are largely dependent on external aid, which can lead to stockouts and prolonged delivery times.

In Matadi, the Regional Distribution Center (CDR) CAAMEBO plays a crucial role in the distribution of essential medicines. However, studies conducted in the Wangata health zone have revealed that health facilities face difficulties such as late deliveries, medicines close to their expiration date, and excessive dependence on partners for supply. These challenges highlight the need to improve logistics management at the local level to ensure efficient and continuous distribution of medicines.

Improving logistical efficiency in the distribution of essential medicines to the CDR CAAMEBO in Matadi is a crucial issue to ensure a continuous and quality supply for the local population. The management of essential medicines presents several challenges, including stock management, drug quality and delivery times. The main obstacles to logistical efficiency include the inefficiency of current stock management methods, frequent shortages of essential medicines and limited infrastructure. A central question to this problem is therefore: how to improve logistical efficiency to ensure optimal and continuous distribution of essential medicines? To answer this question, it is necessary to examine the specific challenges encountered by the CDR CAAMEBO, particularly in stock management, and to explore how the integration of modern technologies, such as computerized stock management systems and real-time tracking solutions, could transform this situation. The overall objective of this study is to analyze and propose solutions to improve logistical efficiency at the CDR CAAMEBO, thus ensuring a continuous availability of essential medicines. Specific objectives include identifying current logistical challenges and proposing improvement strategies based on advanced technologies. The ultimate goal is to strengthen stock management at the CDR CAAMEBO to improve access to medicines for the local population. The general interest lies in the fact that improving logistical efficiency is not limited to optimizing the internal operations of the CDR CAAMEBO, but also contributes to better health coverage, by allowing rapid and reliable access to the necessary treatments, thus reducing the risks of shortages and improving the quality of care.

2. Matériel et méthodes

This study focuses on the analysis of logistical practices and challenges encountered in the distribution of essential medicines to the CDR CAAMEBO in Matadi, in order to identify suitable improvement solutions. The methodology adopted is based on a mixed approach, combining quantitative and qualitative tools to assess logistical processes, infrastructure and stock management within the center.

Data collection was carried out through semi-structured interviews with CDR CAAMEBO managers, as well as staff members involved in stock management and drug distribution. These interviews provided information on logistical challenges, current stock management processes, stockouts, and the integration of technologies into logistical operations. In addition, questionnaires were distributed to field employees to obtain

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quantitative data on logistical performance and the types of problems encountered in their daily work (Mwencha & Rosen, 2016). This data was collected over a period of three months, from January to March 2025.

The qualitative data from the interviews was processed using a thematic analysis, which identified the main problems and obstacles to logistical efficiency. The quantitative data from the questionnaires was analyzed using descriptive statistics to calculate stockout rates, the frequency of delivery delays, and staff satisfaction levels. These results were then compared with national and international benchmarks to assess the performance of the CDR CAAMEBO (WHO, 2020).

As part of this study, an assessment of the integration of logistical technologies at the CDR CAAMEBO was conducted. Computerized stock management systems (SGIS) were compared to more traditional models, analyzing their impact on stock management, reducing stockouts and the overall efficiency of the distribution process. Previous research has shown that successful integration of these technologies could reduce human error and improve the reliability of supply chains (Mwencha & Rosen, 2016). An audit of the stock management tools currently used at the CDR CAAMEBO made it possible to measure the adequacy of these systems to modern standards and to assess their potential for improvement.

The study was conducted in accordance with the ethical principles of public health research. Participants were informed of the study's objective, the confidentiality of their responses, and their right to anonymity. Informed consent was obtained from all participants before the start of the survey (Delaney et al., 2018).

3. Results

This section presents the analysis of the qualitative results obtained from interviews conducted with five staff members of the CDR CAAMEBO in Matadi. The interviews were conducted to meet the research objectives, including identifying logistical challenges in the management and distribution of essential medicines and assessing the impact of integrating new technologies to improve inventory management and reduce stockouts. The data were analyzed using N-VIVO software, allowing responses to be coded and categorized according to themes related to inventory management, stockouts, logistical efficiency, and proposed technological solutions. Here are the results and verbatim excerpts from the interviews.

1. Doctor

The doctor reported on the significant impacts of stockouts on the quality of care, particularly for patients requiring urgent treatment. He expressed frustration with the inefficiency of inventory management and the slowness of supplies.

- **Verbatim:**
  "It's a real problem. Sometimes, we can't even ensure complete treatment for our patients because essential medicines like antibiotics are missing for several days. Stockouts are frequent, especially for essential medicines." He also suggested the integration of a computerized inventory management system, stressing that this would allow for better anticipation of needs and more accurate planning of orders.

- **Verbatim:**
  "With a computerized system, we could easily track inventory status in real time and order before there is a shortage. This would save us from running after suppliers."

2. Pharmacist

The pharmacist discussed the practical challenges related to the physical organization of medicines and the lack of modern systems to ensure optimized inventory management. He stressed that manual inventory management is prone to human error, which exacerbates stockout problems.

- **Verbatim:**
  "Manual inventory management is no longer viable, especially with the volume of medicines we receive. We have to constantly check stocks, which takes a lot of time and sometimes leads to errors." He supported the idea of using inventory management software to reduce human error and improve process efficiency.

- **Verbatim:**
  "An integrated system would allow us to know precisely the quantity of each medicine and its stock status at any time. We would gain in precision and reactivity."

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3. Pharmacy Assistant

The pharmacy assistant highlighted the lack of training on stock management technologies. While he acknowledged that the introduction of technology would be beneficial, he stressed the urgent need for staff training to make the most of the tools offered.

- **Verbatim:**
  "We don't have the necessary training to effectively use technological tools in stock management. Currently, we make do with what we have, but if we were trained in the use of software, it would change a lot of things." He proposed ongoing training for staff to ensure that everyone can master modern logistics tools.

- **Verbatim:**
  "The idea of software is good, but we need regular training so that we can use it correctly."

4. Managing Administrator

The managing administrator highlighted the financial and administrative challenges in stock management. According to him, funding difficulties often prevent the purchase of modern logistics solutions. However, he also acknowledged that the integration of such technologies could, in the long term, reduce the costs associated with stockouts and urgent orders.

- **Verbatim:**
  "The lack of funds is a major obstacle. We know that integrating modern software to manage stocks would be expensive at first, but it could reduce the costs associated with stockouts and save us money in the long term." He added that the long-term benefits justify an initial investment, but insisted that priority must be given to optimizing processes before considering technological investments.

- **Verbatim:**
  "We must first streamline our internal processes before investing in expensive technologies. However, in the long term, this would significantly reduce our costs."

5. Logistician

The logistician mentioned the slow deliveries and the inefficient management of supplies, which leads to frequent stockouts. He expressed his opinion that the adoption of modern logistics solutions would not only make it possible to track stocks, but also to reduce delivery times by automating orders.

- Verbatim: "Stockouts are often due to delivery delays. If we could automate certain steps of the ordering and distribution process, it would reduce delays and prevent some medications from arriving too late." He proposed real-time tracking of shipments and automation of orders to anticipate needs and react quickly.

- Verbatim: "If we had software that could track orders in real time and alert us to delays, we could better manage expectations and urgent requests."

The interview results show a general consensus on the importance of integrating modern technologies to improve inventory management and reduce stockouts at the CDR CAAMEBO in Matadi. However, opinions are divided on the implementation of these technologies, due to obstacles related to finances, training and internal organization. While medical and pharmaceutical staff emphasize the benefits of automation and computerized management systems for accuracy and responsiveness, the managing administrator highlights the need to optimize processes before considering a technological investment. Opinions also converge on the need for continuous training to guarantee the effectiveness of the proposed solutions.

4. Discussions

This section discusses the results of the study regarding the improvement of logistical efficiency in the distribution of essential medicines to the CDR CAAMEBO in Matadi, comparing them with previous studies. The analysis is structured according to the groups of objectives defined at the beginning of the research, namely the identification of logistical challenges, the integration of technologies for inventory management and the reduction of stockouts.

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Objective 1: Identify and assess the logistical challenges encountered in managing the distribution of essential medicines

The logistical challenges identified at the CDR CAAMEBO in Matadi, including stockouts, delivery delays and the inefficiency of manual inventory management methods, are consistent with those observed in other developing countries. According to a study by Alaei et al. (2017), manual management systems are one of the main causes of frequent stockouts in developing countries, as they are subject to human error and inefficient planning. The WHO (2010) emphasizes that inventory management systems in many African regions also suffer from a lack of staff training, which leads to errors in product registration and poor estimation of needs.

In addition, a study by Koutchou et al. (2019) on health supply chains in sub-Saharan Africa shows that infrastructure problems (such as road conditions and the distance between suppliers and distribution centers) also complicate the distribution of medicines. These challenges are found in the context of the CDR CAAMEBO, where infrastructure problems are aggravated by the inefficiency of the inventory management system.

Objective 2: Propose improvement strategies based on the integration of advanced logistical solutions

The integration of technologies in logistics management has been widely recognized as a potential solution to improve the efficiency of drug distribution. Several studies highlight the importance of computerized inventory management systems (SGIS) for reducing stockouts and improving traceability. A study by Tewodros et al. (2020) in Ethiopia showed that computerized inventory management reduces management errors by 35% and reduces stockouts by 20%. Similarly, an analysis by Shamsi et al. (2018) revealed that the introduction of real-time tracking systems in the pharmaceutical supply chain reduces delivery times by 30% and increases the accuracy of orders.

In addition, the study by Mwanza et al. (2015) highlighted that the integration of stock tracking technologies and automated orders has reduced the operational costs associated with the purchase and storage of medicines. These results are directly applicable to the case of the CDR CAAMEBO, where the implementation of such technologies could solve many of the identified problems, such as manual inventory management and frequent stockouts.

Objective 3: Analyze the benefits of integrating new technologies into inventory management to reduce stockouts

The impact of modern technologies on inventory management has been analyzed in numerous studies, which have highlighted the significant benefits of automated inventory management systems. For example, a study by Phaolao et al. (2020) found that the integration of inventory management software in hospitals in the Bangkok region reduced stockouts by 40% and increased order responsiveness by 25%. In addition, a World Bank report (2017) shows that the adoption of digital solutions in pharmaceutical supply chains reduces inventory management costs and improves drug availability.

Within the framework of the CDR CAAMEBO, these technologies could improve drug management by enabling complete traceability of products from receipt to final distribution. The use of technologies such as barcodes and real-time inventory management systems could transform the CDR's supply chain and prevent the frequent stockouts observed.

Previous studies largely corroborate the results obtained in this research, particularly with regard to the logistical challenges encountered in the management of essential drug stocks. The integration of advanced technologies appears as an effective solution to solve the identified problems, such as stockouts and inefficiencies in inventory management. The proposed strategies, such as the adoption of computerized systems and the automation of logistics processes, are supported by abundant literature showing their benefits in terms of error reduction, inventory optimization and improvement of logistics performance.

5. Conclusion

The analysis carried out as part of this study on improving logistical efficiency in the distribution of essential medicines to the CDR CAAMEBO of Matadi made it possible to answer the central question and the specific research questions. The central question, relating to the means of optimizing logistics to guarantee a continuous and quality supply of essential medicines, found concrete answers through the identification of existing challenges and the exploration of suitable technological and organizational solutions.

The qualitative results from interviews with key personnel (doctor, pharmacist, pharmacy assistant, managing administrator, logistician and accountant) showed that the main logistical difficulties include manual inventory management, frequent stockouts of essential medicines, delivery delays due to deficient infrastructure, as well as

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insufficient coordination between the various stakeholders. These findings are consistent with previous studies carried out in Africa and other developing countries, which highlight the negative impact of manual systems on drug availability and on the quality of care (Alaei, Rezapour, & Shadmehr, 2017; Koutchou et al., 2019).

Furthermore, the integration of technological solutions such as computerized inventory management systems, real-time tracking and automation of logistics processes has emerged as a potential strategy to reduce stockouts, improve traceability and optimize distribution. The verbatim collected through the interviews, as indicated by the pharmacist: "With management software, we could anticipate stockouts and manage orders more efficiently", confirm the staff's support for these innovations. These solutions are in line with the results of comparable studies carried out in Ethiopia and Thailand (Tewodros, Alemu, & Shite, 2020; Phaolao & Santivach, 2020), which show significant reductions in stockouts and management errors thanks to computerization.

In conclusion, the study highlighted the main logistical challenges of the CDR CAAMEBO, while proposing concrete solutions to improve inventory management and the efficiency of the distribution of essential medicines.

Recommendations:

1. *Implement a computerized inventory management system with real-time tracking to anticipate shortages and plan orders.*
2. *Regularly train staff on new technologies and best logistics practices to enhance the competence and efficiency of the CDR (Regional Distribution Center).*
3. *Strengthen coordination between different logistics actors and suppliers to optimize delivery times and reduce distribution errors.*
4. *Invest in the infrastructure and maintenance of transportation means to limit delays and ensure continuous distribution in the region.*
5. *Establish a continuous evaluation mechanism for logistics performance to adjust strategies and maintain a regular supply of essential medicines.*

These recommendations aim to ensure reliable and continuous access to essential medicines, thereby contributing to the improvement of public health and the quality of care for the population of Matadi and its surroundings.

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8. Declaration of conflicts of interest

The authors declare that they have no financial, professional or personal conflicts of interest related to the institutions involved or the results presented in this study. No external financial support influenced the design, execution or interpretation of this work.

9. Ethical considerations

This research was conducted in accordance with current ethical principles. Approval was obtained from the respective ethics committees of both institutions. The anonymity of the interviewees was strictly respected, and the data collected were used solely for scientific purposes.

10. Justification of authors' contributions

All authors contributed significantly to the design of the study, the analysis of the data, and the writing of the manuscript. The principal author coordinated the data collection and initial writing, while the co-authors provided their methodological and technical expertise, as well as critical revisions of the scientific content.

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