Original Article

Perceived Benefits and Barriers of Electronic Logistics Management Information System in Managing Medicine Expiries and Stock-Outs at Rwanda Medical Supply

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Abstract

Background
Globally, medicine management initially relied on paper-based logistics information systems, which were associated with delayed reporting, poor data quality, weak forecasting, and limited supply chain visibility, resulting in medicine stockouts and expiries. Many countries transitioned to electronic systems to address these challenges. Rwanda introduced an electronic logistics management information system in 2014; however, medicine stockouts and expiries have persisted. This study explored users' perceptions of the benefits and barriers of the electronic logistics management information system in managing medicine stockouts and expiries at Rwanda Medical Supply.

Methods
A qualitative descriptive study was conducted at the central and Kigali regional warehouses of Rwanda Medical Supply. Twenty-two staff involved in inventory management, order processing, data management, and quantification were purposively selected. Data were collected through semi-structured interviews and a focus group discussion, and data were analyzed using inductive thematic analysis.

Results
Participants reported improved stock monitoring, data visibility, and order management, supporting the reduction of stockouts and expiries as benefits of using electronic logistic information system. However, inaccurate data, limited interoperability, inadequate training, and absence of alerts reduced system effectiveness.

Conclusions
The electronic system improved stock visibility and supported timely ordering, but limited user skills and poor interoperability constrained accurate forecasting and decision-making, contributing to medicine expiries and supply interruptions.

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Keywords: Supply chain management; Essential medicines; Inventory control; Health information systems; Stockouts

Background

Globally, the management of medicines and health commodities has historically relied on paper-based Logistics Management Information Systems (LMIS) to record stock levels, consumption, and orders across health system levels.[1] Although paper-based LMIS supported basic logistics functions, they were widely associated with delayed reporting, poor data quality, limited data visibility, weak forecasting, and poor coordination across the supply chain, which contributed to frequent medicine stockouts and expiries, especially in low- and middle-income countries.[2] These inefficiencies led to increased operational costs, emergency procurement, interrupted service delivery, and compromised patient outcomes.

To address these challenges, Electronic Logistics Management Information Systems (ELMIS) were introduced globally in the early 2000s as part of broader health information system digitalization efforts. The ELMIS is an electronic system designed to collect, organize, analyze, and report logistics data on health products across all levels of the health system, enabling timely access to accurate information for decision-making.[3] The introduction of ELMIS aimed to improve data accuracy, data visibility across the supply chain, inventory control, forecasting, quantification, and coordination, ultimately improving the availability of essential medicines and reducing wastage due to expiries.[4]

The need for ELMIS emerged as a global concern, particularly in sub-Saharan Africa and other resource-limited settings, where studies reported high levels of stockouts, expiries, and weak supply chain performance. Evidence from multiple countries demonstrated that poor logistics data systems were a major contributor to inefficiencies in medicine supply chains, prompting governments and partners to adopt electronic solutions to strengthen data-driven decision-making in health commodity management.

Studies conducted in different settings have shown both the benefits and challenges of ELMIS implementation. A study conducted in Tanzania in 2023 reported that ELMIS improved users' ability to retrieve past and current logistics data, enhanced inventory management, strengthened health supply chain performance, improved data quality, and reduced losses due to expired products, ultimately contributing to improved availability of medical products and better patient outcomes.[5] However, the same study identified challenges in the use of ELMIS data for quantification and procurement, particularly related to knowledge gaps in data aggregation and bottom-up quantification processes, highlighting the need for targeted training.[5] Similarly, a study conducted in Liberia in 2019 identified barriers to ELMIS implementation, including poor collaboration between data producers and users, limited data use culture, inadequate data access, and data quality challenges, all of which negatively affected evidence-based decision-making.[6]

In Rwanda, ELMIS was introduced in 2014 as part of national efforts to strengthen medicines supply chain management and improve the availability of essential health commodities in public health facilities. Rwanda Medical Supply (RMS), the public institution responsible for the procurement, storage, and distribution of health commodities, adopted ELMIS to enhance stock monitoring, reduce medicine expiries and stockouts, and support evidence-based decision-making.[7] Despite the implementation of ELMIS, challenges with medicine stockouts and expiries have persisted in RMS warehouses and public health facilities. Studies conducted in Rwanda have identified factors such as excessive inventory, insufficient quantification skills among staff, and weak coordination between procurement and warehousing functions as contributors to medicine expiries and supply inefficiencies. [7]

While previous studies have examined ELMIS implementation, medicine expiries, and stockouts from a quantitative and system-level perspective, there remains a limited understanding of users' experiences and perceptions regarding how ELMIS supports or constrains the management of medicine expiries and stockouts in practice. Understanding these user perspectives is critical for identifying contextual challenges, optimizing system use, and strengthening decision-making processes. Therefore, this study aimed to explore ELMIS users' perceptions of its benefits and challenges in managing expired medicines and stockouts at Rwanda Medical Supply (RMS).

Methodology

Study design

This study employed a qualitative descriptive design, selected to provide a detailed account of participants' experiences and perceptions while remaining close to their original meanings. This approach uses naturalistic inquiry, allowing the researcher to describe phenomena as they occur in real-world settings and interpret findings with minimal theoretical abstraction.[7] The study followed the key Consolidated Criteria for Reporting Qualitative Research (COREQ) principles, particularly in documenting the study context, participant characteristics, and data collection procedures.

Study setting

The study was conducted in Rwanda Medical Supply (RMS), namely the RMS Central Warehouse located in Kigali (Gasabo District) and the RMS Kigali Regional Warehouse, which serves public health facilities across the three districts of Kigali (Gasabo, Kicukiro, and Nyarugenge). RMS is a government-established organization mandated to manage Rwanda's end-to-end health supply chain for pharmaceuticals, consumables, and medical equipment. Its primary mission is to ensure the availability of safe, affordable, and quality medical commodities across public health institutions.

RMS was created in 2018 to replace the Medical Procurement and Production Division (MPPD) under the Rwanda Biomedical Center (RBC), consolidating supply chain coordination previously handled by multiple semi-autonomous district pharmacies.[8] Following this reform, all district pharmacies were integrated into RMS branches, resulting in one RMS branch in each of Rwanda's 30 districts. In Kigali City, the three district branches (Gasabo, Kicukiro, and Nyarugenge) collectively operate as the RMS Kigali Regional Warehouse, responsible for receiving, storing, and distributing medicines to public facilities within the region.

Study focus

Given the size and multidisciplinary mandate of RMS, the research purposively selected four units that rely heavily on ELMIS to support supply chain operations and reduce stock expiries. These units were Inventory Management, Order Processing, Quantification, and Data Management across both study sites.

Study population and eligibility criteria

The study population comprises the staff of RMS who work in the medicines inventory management (5 people), order management (22 people), data management, and quantification department (6 people) at the central warehouse of RMS and the RMS Kigali regional warehouse. The eligibility criteria were to be a staff member of RMS, working in the mentioned departments (inventory management, order management, data management, and quantification department). Although Rwanda has 30 districts, this study focused on the three districts of Kigali because these branches collectively operate as the RMS Kigali Regional Warehouse and are directly linked to the RMS Central Warehouse, where national procurement, stock receipt, and strategic quantification occur. Kigali branches handle the highest volume of transactions and therefore provide rich operational data on ELMIS implementation.

Sample size and sampling procedure

The study used a qualitative approach in which sample size was guided by data saturation rather than a predetermined number.[9] Participants were purposively selected from inventory, order management, quantification, and data management units at the RMS Central and Kigali Regional Warehouses, as these units directly use ELMIS in managing medicine availability and expiries.

Although data saturation was reached between the 12th and 14th interviews, a total of 22 interviews were completed to ensure balanced representation across facilities and roles, avoid selection bias, and strengthen descriptive validity. Saturation was systematically monitored using a saturation grid, which demonstrated a sharp decline in new codes after the 12th interview, with no new themes emerging thereafter.

To further validate and enrich the findings, eight participants from interviewees later took part in a focus group discussion to confirm preliminary themes and explore interactions among them.

Data collection instruments and procedures

Data collection instruments

Data were collected using a self-developed semi-structured interview guide aligned with the research objectives. The guide included open-ended questions on participants' experiences with stock management, order processing workflows, data quality challenges, interoperability issues across digital systems, and strategies to overcome supply chain constraints. The same guide was adapted and used in both one-to-one interviews and the focus group discussion to ensure consistency in the information generated.

Recruitment and Consent

Participants were approached in person at their duty stations and provided with a clear explanation of the study's purpose, procedures, expected duration, voluntary nature, and the right to withdraw at any time without consequences. All willing participants signed written informed consent prior to data collection.

For telephone interviews, verbal informed consent was obtained and recorded before proceeding.

Audio recording procedures

With participants' explicit permission, interviews and the focus group discussion were audio recorded to ensure accuracy and support verbatim transcription. Consent to record was requested separately from general study consent and was granted by all participants.

Individual interviews

A total of 22 interviews were conducted. Of these, 17 were conducted one-to-one interviews and five via telephone. Telephone interviews were scheduled for participants who were not physically present at the warehouse during the data collection period. one-to-one interviews were conducted in private offices at the RMS central warehouse and the Kigali regional warehouse to ensure confidentiality. Each interview lasted 10–15 minutes; however, the time was devoted entirely to the research questions, as consent reading, study explanation, and rapport establishment had already occurred during recruitment and scheduling, usually a day before the interview.

Focus group discussion

Following preliminary analysis of the individual interview transcripts, one focus group discussion (FGD) was conducted to validate and refine the emerging findings. Eight participants, purposively selected from the original 22 interviewees, participated in the FGD. These participants were drawn from the RMS central warehouse and the Kigali regional warehouse (Gasabo, Kicukiro, and Nyarugenge districts) and represented key roles including inventory management, order management, quantification, and data management.The 30-minute FGD enabled participants to collectively reflect on the preliminary themes emerging from the individual

interviews, validate interpretations, and clarify areas of agreement or divergence, thereby strengthening the credibility and triangulation of the findings.

Rationale for using both interviews and focus group discussions

Individual interviews were conducted first to capture personal perceptions and individual experiences without peer influence. Following preliminary analysis, a focus group discussion involving a subset of interview participants was used to facilitate collective reflection on the emerging findings, enabling discussion, comparison of perspectives, and identification of shared practices or areas of disagreement across roles and sites. The sequential use of both methods enhanced data depth, confirmed thematic saturation, and strengthened methodological triangulation.

Data collection team

All authors reviewed and contributed to the development of the interview guide to ensure relevance and content validity. Data collection was conducted by two authors, both trained in qualitative interviewing and with prior experience in health supply chain systems. No external research assistants were recruited. Prior to fieldwork, the two authors reviewed the finalized interview guide, practiced probing and neutral questioning techniques, and agreed on consistent documentation procedures.

Timeline

Data collection occurred between 2 April 2024 and 10 May 2024.

Confidentiality

No identifiable personal information was collected. Participants were assigned numeric identifiers, and no role titles or facility names were linked to transcripts.

Data processing and analysis

The collected data were analyzed using a thematic analysis approach, a qualitative research method used for identifying, analyzing, and interpreting patterns or themes within qualitative data, such as interview transcripts, written narratives, or observational notes.

Thematic analysis allows for systematic examination of participants' perspectives while ensuring that findings are grounded in the data.[10] Thematic analysis used in this study followed Braun and Clarke's six-step framework:[10]

1. *Familiarisation:* Co-authors read transcripts multiple times to understand content and note initial patterns.
2. *Coding:* Meaningful data segments were labeled with descriptive codes.
3. *Theme identification:* Codes were grouped into categories and overarching themes.
4. *Reviewing themes*: Themes were reviewed iteratively to ensure consistency and accuracy.
5. *Defining and naming themes*: Each theme was clearly described with supporting categories.
6. *Reporting:* Representative quotes were selected to illustrate themes, and findings were synthesized in the final report.

Data preparation and transcription

All interviews were audio-recorded, transcribed verbatim, and reviewed to ensure accuracy and authenticity. Transcripts were anonymised to remove any identifying information. The interviews were initially conducted in Kinyarwanda, then transcribed in Kinyarwanda before being translated into English; seven co-authors assisted with the transcription and translation. Each transcript was cross-checked by at least two co-authors to ensure fidelity to the original meaning and to maintain consistency in translation.

Roles of co-authors

The study was conceptualised and designed by the lead author, with input from selected co-authors. Data collection was conducted by two authors. Seven co-authors contributed to transcription, translation, and qualitative data analysis. All authors contributed to interpretation of findings, manuscript drafting or revision, and approved the final version.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of the College of

Medicine and Health Sciences, University of Rwanda (Approval No. CMHS/IRB/206/2024). Authorisation for data collection was granted by Rwanda Medical Supply. Written informed consent was obtained from all participants, and permission for audio recording was sought separately. Participation was voluntary, and participants could withdraw at any time. Confidentiality was ensured by protecting personal identifiers and safeguarding all data.

Results

Participants characteristics

Among the 22 study participants, 19 held a bachelor's degree or higher, while the remaining 3 had advanced diplomas. Twelve participants were male, and ten were female. Nine participants were drawn from the RMS central warehouse, and thirteen were from the RMS Kigali regional warehouse. The participants had varied professional training backgrounds, including nursing, pharmacy, procurement and logistics, inventory management, and data management. To maintain participant confidentiality, quotations are identified using codes indicating the participant's work unit and sequence number. The letters represent work areas (H: Headquarters, B: Branch, I: Inventory management, O: Order processing, D: Data management, Q: Quantification, and G: Group discussion), followed by the participant number. "RMS" refers to Rwanda Medical Supply.

Emerging Themes

Thematic analysis identified two main themes reflecting users' perceptions of ELMIS in managing medicine stockouts and experiences at the Rwanda Medical Supply. The first theme, perceived benefits, included four subthemes: stock monitoring, improved data visibility, strengthened order management, and enhanced data collection. The second theme, barriers to effective use, encompassed data inaccuracy, lack of interoperability with other systems, inadequate training for facility store managers, and absence of automated alerts. These findings highlight both the advantages and challenges of ELMIS implementation from the users' perspective.

Table 1. Themes, subthemes, and codes of the study

Themes	Subthemes	codes
Benefits of ELMIS	Stock Monitoring	Real-time stock visibility; electronic receiving of medicines; validation of orders based on available stock; monitoring expiration dates; application of FEFO principle.
	Data Visibility	National visibility of facility stock levels; identification of medicines at risk of expiry; informed redistribution decisions; access to shelf-life information.
	Order Management	Electronic order submission; order validation by branches; allocation based on availability; FEFO-based picklists; coordination between facilities and central warehouse.
	Data Collection	Consumption tracking; verification of consumption reports; quantification support; forecasting future needs; financial valuation of medicines.
Barriers to Effective Use of ELMIS	Inaccuracy of Data	Incomplete consumption reporting; delayed data entry; discrepancies between physical stock and system data; system default errors
	Lack of Interoperability with Other Systems	No linkage with EMR/OpenMRS; no linkage with HMIS; duplicated data entry; unreliable consumption estimates.
	Inadequate Training of Health Facility Store Managers	High staff turnover; insufficient onboarding; limited ELMIS skills; delayed or incorrect reporting.
	Lack of Alerts	No expiry alerts; no emergency reorder alerts; delayed decision-making; missed redistribution opportunities.

1. Benefits of ELMIS in the reduction of medicine expiries and stockouts

Participants reported that ELMIS helps reduce medicine expiries and stockouts by providing inventory officers with up-to-date stock information, including expiration dates. It supports order managers in applying the first-expiry, first-out (FEFO) method and enables the data management team to analyse consumption patterns, improving stock planning and preventing shortages or wastage.

1.1 Stock monitoring

Participants responded that the functions of ELMIS involve receiving medicines electronically to have the data of the available medicines, validating the orders of the health facilities or branches to RMS central warehouse referring the stored data, which all helps to make decisions of which medicines to be given, what quantity to be given for availing the needed quantity of medicine at the right place at the right time.

"I use ELMIS in my daily work. When customers place their orders, yes, that's how I use it, and it's also where I get the data I rely on. Ah! To approve or deny the medicines they request, depending on our stock level" (BO1, RMS).

"However, when ELMIS is used properly, it helps us to monitor and analyse these issues in real-time. Since we validate client orders, the system helps us know whether a medicine is available or not" (HO3, RMS).

"I use it in the transaction of receiving drugs systematically. Referring to my position, I use it in receiving medicine, inventory management, and monitoring the stock status I have and seeing how it is. on the side of clients, when you are going to respond to their requests, you ought to promise them and validate them systematically depending on available medicines by only extracting the available stock in the system without moving from item to item physically" (BI4, RMS).

"Another benefit of ELMIS is tracking the consumption and usage of items, allowing us to know who requested which items and how they are being used, helping to prevent stock shortages and expiration risks" (HIG4, RMS).

1.2 Data Visibility

Participants noted that the ELMIS system makes data visible to users, enabling them to make different decisions about supply chain activities to prevent stockouts and expiries.

"In my role within ELMIS, I have visibility of all ELMIS customers' stocks nationwide. So, ah! Through ELMIS, I can check the stock a customer has on hand and view its shelf life. This makes it easier or helps me to know if they have stock at risk of expiring, so I can reduce what I need to supply them" (BO3, RMS).

"The ELMIS provides visibility into stock levels, allowing us to identify items at risk of expiration and plan accordingly for redistribution or other shipments to prevent stock-outs and expirations" (HD1, RMS).

1.3 Order Management

Participants noted that ELMIS facilitates order management between health facilities, RMS branches, and the central warehouse. Health facilities submit medicine requests to their RMS branch, which in turn places orders with the central warehouse. The system enables branches to process requests, allocate medicines based on availability, and ensure timely distribution, allowing users to manage orders efficiently and prevent stockouts.

"Additionally, when processing orders to the final picklist, the system includes expiration dates and batch numbers. The system is designed to use the FEFO (First Expiry, First Out) method as required. This means it prioritises the medicines that will expire soonest. It is very helpful because the system ensures that the medicine that is about to expire first is dispensed first" (BO2, RMS).

"The ELMIS, which stands for Electronic Logistic Management Information System, is used to track, manage, and order medicines in health facilities under the Ministry of Health, including health posts" (HQ1, RMS).

1.4 Data Collection

Participants in this research have shown that ELMIS supports data collection on drug consumption across different levels of the supply chain, enabling decision-making on quantification and procurement to prevent stockouts and expiries.

"The ELMIS system is our main source of data for quantification. We use it to track consumption, distribution, and stock levels for monitoring purposes" (BD1, RMS).

"ELMIS provides valuable data that helps us predict consumption patterns and manage inventory effectively. For instance, through the "Verification of Consumption" feature, we can anticipate stockouts and take pre-emptive measures. Additionally, ELMIS helps in identifying expiring medicines, enabling us to take timely actions such as redistribution or disposal" (BI5, RMS).

"You can enter the system and find out about a specific medicine, including its code, and see its usage at different levels, whether nationally, regionally, or at specific health facilities. The system provides comprehensive data on where and how medicines are consumed" (HQ1, RMS).

"ELMIS helps us determine the amount of medicine used and plan for future needs based on this data. It also helps with financial aspects, such as creating invoices and understanding the monetary value of the medicines" (HQ1, RMS).

2. Barriers of ELMIS to reducing medicine expiries and stockouts

Participants reported several barriers to ELMIS use. Data inaccuracy was noted, partly due to the system's limited interoperability with other health systems such as EMR and HMIS, which can mislead decision-making. High turnover of health facility store managers reduces knowledge and proper use of the system. Additionally, the lack of automated alerts limits ELMIS's ability to fully prevent medicine expiries and stockouts at Rwanda Medical Supply.

2.1 Inaccuracy of data

Participants have shown that the ELMIS provides inaccurate data to decision-makers, leading them to make the wrong decisions about procuring the necessary medical products and redistributing drugs to areas where they are most needed to reduce the expiry of items at risk. This is because it recommends that health settings store managers enter the ELMIS system the used drugs data for their health settings (consumption data), yet they do not have enough time to do so, depending on how overloaded they are. Another factor contributing to data inaccuracy identified in this study was system-related default errors. Some respondents reported that the system occasionally assigned incorrect expiry dates or automatically flagged medicines as expired before their actual expiry. Such inaccuracies may distort inventory visibility and lead decision-makers to initiate unnecessary procurement or redistribution actions, even when adequate physical stock remains available.

"The system can only provide information based on the data it receives. If consumption data is not entered, it won't show up in the system" (HQ1, RMS).

"Through ELMIS, we can view the stock status and reports from health facilities. However, the system may indicate that medicines are still available while the physical stock is already depleted. This happens because medicines are consumed at the facility but are not recorded in the system in a timely manner." (HD1, RMS).

"One challenge is ensuring the accuracy of data input, particularly when it comes to recording consumption at health facilities. We rely on reports provided by these facilities to place orders accurately.

However, sometimes discrepancies arise due to inaccurate reporting or lack of knowledge among health facility staff" (BI6, RMS).

*"The system doesn't directly track end users. We track what we have distributed and use this information to understand consumption. However, we don't always trust end-user daily data to be accurate. We take the quantities we've distributed over several months and make an average, which helps us determine our needs" (*HIG2, RMS).

2.2 Lack of Interoperability with Other Health Systems

Participants have shown that ELMIS's inability to exchange data with other information systems used in health care services, such as OpenMRS and the reporting systems used to collect data in health settings, like HMIS, is a challenge that hinders the reduction of expiries and stock-outs in the Rwanda Medical Supply. This challenge is attributed to the busy health facilities' store managers who change job locations frequently and take a new one who ought to show the consumption of drugs in ELMIS and make them available at their facilities by entering the received medicines in Open MRS to be used by health care providers and accountants in invoicing the patients. Sometimes he forgets to show the consumption in ELMIS or enters the wrong data. The participants have shown the need to make ELMIS capable of exchanging data with other health systems as a sustainable solution for obtaining accurate consumption data.

"Although ELMIS solves some problems, there is the information it provides, but there is also information it does not provide, like "What might be the consumption in the hospital routinely, the number of patients they have who are consuming a given medical product", etc. Uhmm! It requires that it may be connected to other systems so that you can search for hospital information, perhaps through it, and get it" (BI7, RMS).

"In addition, if there is an employee who uses the ELMIS system regularly and the system is able to work with other invoicing systems in the health centers, normally, it would go well" (BD2, RMS).

2.3 Inadequate training of health facilities' store managers due to high turnover

The research participants have shown that the training of health facilities' store managers who use this system is inadequate due to the high turnover of the health care providers who serve as these facilities' store managers and have been trained. The newly recruited ones start even before getting the basics of showing consumption data in ELMIS. Participants have shown that inadequate skills among new store managers in health facilities lead some of them to fail to submit consumption reports on time, enter inaccurate consumption data in ELMIS, or record the consumption of medicines using the system. This causes the RMS staff to use inaccurate data for quantification and procurement, leading to stockouts and the expiry of medicines.

"One challenge is ensuring the accuracy of data input, particularly when it comes to recording consumption at health facilities. We rely on reports provided by these facilities to place orders accurately. However, sometimes discrepancies arise due to inaccurate reporting or lack of knowledge among the health facility staff" (BIG1, RMS).

"Another issue is the high turnover of staff at the health facilities. We train new staff on ELMIS, and then they leave, which disrupts continuity. Additionally, it would help if training included not just the store manager but also the data manager" (BI6, RMS).

"Because that's what I told you, as I explained to you about people not getting enough training on that system, particularly on doing the consumption reports." (HI5, RMS).

2.4 Lack of Alerts

Participants' understanding to this point is that the ELMIS system's lack of active alerts on medicines at risk of expiring and at an emergency order point hinders timely decision-making to prevent expiries and stockouts.

"One enhancement could be the integration of alerting systems to notify users of critical events, such as impending expirations or low stock levels. For example, if a medication is about to expire or is at risk of running out within 2 days, the system could send an alert. This would help streamline operations and prevent potential stockouts or expired items" (BI6, RMS).

"Additionally, the system could have an alert feature for medicines about to expire within six months, notifying you to either push it to facilities that need it or redistribute it" (HIG4, RMS).

"If the device itself had the alert to tell you that this medicine is in overstock, this medicine is going to expire, it would be easier to work" (BI4, RMS).

Discussion

This study aimed to explore RMS staff perceptions of ELMIS regarding its benefits and barriers in reducing medicine expiries and stockouts. The findings indicate that ELMIS is widely perceived as an important tool for medicines management. Participants reported that the system improves stock monitoring, enhances data visibility and accessibility, simplifies ordering processes, and supports data-driven supply chain decision-making. At the same time, challenges such as inaccurate or incomplete data entry, lack of automated alerts, limited interoperability with other digital systems, and insufficient user training were identified as barriers to optimal system utilization. These insights align with the Government of Rwanda's objectives for ELMIS implementation, which include strengthening the functions of reporting, monitoring, quantification, and pharmaceutical planning.[11] Evidence from previous Rwanda studies reinforces this observation, showing that facilities that consistently update ELMIS are more likely to maintain essential medicines and significantly reduce stock-outs.[12]

The benefits identified in this study are consistent with earlier research. A 2018 evaluation of Rwanda's ELMIS reported improved visibility of stock data at both central and facility levels, enabling redistribution of commodities and reducing the likelihood of expiries and shortages. [13] Research from Tanzania also reported similar benefits, noting the use of ELMIS to detect overstocking and understocking and to support stock redistribution to minimize wasted medicines. [5]These findings suggest that when fully utilized, ELMIS supports financial savings, optimizes supply chain performance, and promotes better health outcomes by ensuring that medical products are available when needed.

Despite these strengths, several limitations hinder the optimal use of ELMIS. First, participants reported challenges related to inaccurate and incomplete data entry. This concern has been echoed in other studies in Rwanda, which attribute data inaccuracies to inconsistent facility-level updates. [13] The Ministry of Health has similarly emphasized the need for routine data entry and recommended that key ELMIS fields be completed to improve data accuracy and reliability.[11] Comparable evidence from Tanzania and Malawi found that poorly trained personnel and inadequate data systems compromise the quality of logistics data, contributing to poor procurement decisions and frequent stock management failures.[5,14]

Another barrier identified is the lack of functional alerts for medicines nearing expiration, low stock, or overstock. This contradicts supply chain guidance, indicating that ELMIS should generate automated warnings to aid timely decision-making.[11]

Although clinical alerting systems have been shown to minimize errors,[11] concerns about alert fatigue remain valid and may require more adaptive alert configurations that prioritize high-value notifications.

Lack of interoperability between ELMIS and other digital systems also limits its potential. The need to work across multiple non-integrated platforms increases workload, introduces opportunities for error, and undermines efforts to maintain accurate consumption data. This challenge has been noted in Rwanda and elsewhere. Tanzania addressed similar concerns by developing an integrated HMIS/LMIS dashboard in DHIS2, enabling alignment between service delivery data and commodity consumption trends.[15] Rwanda's supply chain policy framework acknowledges the need for integration, but practical implementation remains limited.[11]

Finally, inadequate and inconsistent training emerged as a significant constraint, particularly due to frequent turnover among health facility store managers. Participants emphasized that knowledge and skill gaps discourage effective ELMIS use and contribute to data errors that undermine national forecasting and procurement processes. Studies from Canada and Ethiopia support this finding, highlighting insufficient training as a recurring barrier to effective use of digital health systems. [16-17]Strengthening continuous ELMIS capacity-building, refresher programs, and targeted support for newly appointed store staff would therefore be critical to improving medicine availability and minimizing wastage. Collectively, these findings reinforce the dual reality of ELMIS implementation: the system has strong potential to reduce stockouts and expiries when fully utilized, yet weaknesses in data quality, interoperability, alerting functions, and user training remain obstacles that require institutional attention. Investments in integration, human resources development, and supportive digital functionalities are essential to achieving the full benefits of electronic supply chain management across Rwanda.

Interpreted through the Technology Acceptance Model (TAM), the strong recognition of ELMIS benefits reflects high perceived usefulness, a key determinant of technology adoption. Participants viewed the system as essential to their work, which explains its widespread acceptance despite operational challenges. However, persistent barriers limit optimal utilization and reflect broader organizational and system-level constraints rather than purely technical deficiencies.[18]

Data quality challenges, including incomplete and inaccurate entries, were a major limitation. These issues are largely driven by workload pressures, inconsistent facility-level updates, limited digital skills, and weak accountability mechanisms. Similar findings in Rwanda, Tanzania, and Malawi link poor logistics data quality to inadequate training and an insufficient data-use culture, leading to suboptimal procurement and stock management decisions.[5,13,15] Within TAM, these challenges reduce perceived ease of use, thereby constraining effective engagement with the system.

The absence of automated alerts for low stock, overstock, or impending expiries further limits ELMIS's decision-support capacity. Supply chain guidance emphasizes the importance of such alerts for proactive management,[10] and their absence shifts monitoring responsibility to users, reducing system efficiency. Likewise, lack of interoperability between ELMIS and other digital health platforms increases workload and error risk, undermining data accuracy and user confidence. Experiences from Tanzania demonstrate that integrated logistics and service delivery systems can enhance forecasting and redistribution.[15]

Inconsistent training and frequent staff turnover further weaken system use. Insufficient onboarding and refresher training negatively affect users' confidence and ability to rely on ELMIS for decision-making, a finding consistent with

evidence from Canada and Ethiopia.[16-17] These constraints highlight the socio-organizational dimensions of digital system performance.

Overall, the findings highlight a dual reality: while ELMIS is accepted and perceived as useful, its full potential to reduce stock-outs and expiries is constrained by limitations affecting ease of use, interoperability, and workforce capacity. Applying TAM provides new insight into how user perceptions and system design interact within Rwanda's pharmaceutical supply chain. Strengthening integration, continuous capacity-building, and user-centered system enhancements will be essential to achieving sustainable improvements in the availability of medicine nationwide.

Study Strengths

This study contributed valuable insights into inventory and data management practices within the Rwanda Medical Supply context, an area with limited prior qualitative research. The use of a semi-structured interview guide allowed participants to express detailed perspectives relevant to their daily roles, thereby producing rich, context-specific data. In addition, interviews were conducted directly with staff working in inventory, quantification, and data management functions, ensuring that the findings were grounded in the practical experiences of individuals actively engaged in the processes being examined.

Study Limitations

Some participants may have been influenced by social desirability bias, meaning responses could have been shaped to reflect what they perceived as acceptable or expected rather than their true opinions. To reduce this risk, the researcher used probing questions and assured participants of anonymity and confidentiality. Another limitation is that the participants and the researcher had existing professional relationships, which may have affected objectivity, either consciously or subconsciously. Efforts were made to minimize this influence by maintaining a neutral, professional environment during interviews and by encouraging honest, open responses.

Conclusion

This study explored Rwanda Medical Supply staff's perceptions of the ELMIS system's use in reducing expiries and stockouts of essential medicines. The findings revealed that ELMIS plays a critical role in improving stock monitoring, data visibility, and order management within RMS operations. However, challenges remain, including limited data exchange with other health information systems and inadequate training for store managers. Additional concerns, such as the absence of timely stock alerts and inaccuracies in reported data, further reduce the system's full functionality.

To enhance ELMIS's effectiveness, it is recommended to improve interoperability by enabling integration with other platforms, such as HMIS and EMR. Targeted capacity building should be prioritized for health facility store managers, complemented by the implementation of real-time alerts to support timely decision-making. Strengthening data validation processes is also essential to improve the reliability of information used for supply chain decisions. Future research should include end users at hospital and health center levels to generate more comprehensive insights and support broader national strategies to minimize medicine expiries and stockouts across Rwanda's health system.

Conflict of Interest

The authors declare that there is no conflict of interest in this research article regarding the authorship and publication

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Authors Contribution

All authors participated in the conceptualisation of the project,

the writing of the methodology, and the writing of the original draft of the manuscript.

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