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Logistics Challenges in Regional Healthcare: A Case Study of RSUD Undata Palu's Medical Equipment Management

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ABSTRACT : This study examines the logistics management of medical equipment at RSUD Undata Palu, a regional referral hospital in Central Sulawesi, Indonesia, over the period 2019–2024. The research explores six key components: planning, procurement, storage, distribution, disposal, and control. Using a qualitative descriptive approach, data were collected through in depth interviews, field observations, and document analysis. Findings show that while digital integration has improved procurement transparency and semi automated distribution processes, challenges remain in real time inventory monitoring, inadequate storage conditions, delayed equipment disposal, and limited user engagement with digital tools. Storage constraints and bureaucratic hurdles in disposal processes further compromise logistical efficiency. These gaps affect the availability, reliability, and timeliness of medical services, underlining the strategic importance of logistics in healthcare delivery. The study highlights the need for holistic reform through integrated digital systems, performance tracking, and institutional capacity building. By contextualizing these findings within broader policy and technological frameworks, this research offers practical insights for strengthening logistics governance in developing healthcare systems.

Keywords: Medical Logistics, Hospital Supply Chain, Healthcare Infrastructure, RSUD Undata Palu, Digital Health Systems.

INTRODUCTION

Medical logistics systems in hospitals play a pivotal role in ensuring the availability, accessibility, and functionality of medical equipment necessary for delivering effective healthcare services. In Indonesia, particularly within its referral hospital network, the management of medical equipment logistics has become increasingly strained. This has been amplified by systemic challenges such as rising patient volumes, constrained human and financial resources, and the protracted impact of the COVID 19 pandemic. As referral hospitals such as RSUD Undata Palu attempt to maintain

continuity of care under these conditions, the capacity to manage logistics effectively becomes a defining factor for operational performance and patient outcomes.

The inadequacies in medical logistics management in Indonesian public hospitals are reflected in delays in procurement, mismatches between equipment supply and actual usage needs, and the lack of standardized operating procedures (SOPs) across departments. Firmansyah et al. (2020) noted that Indonesia's healthcare workforce was significantly outnumbered relative to the patient demand during the pandemic, severely affecting the system's ability to respond promptly. Likewise, Sukmawati & Dahlan, (2022) highlighted systemic inefficiencies and managerial overload within logistics units, contributing to operational disorganization and service delivery failures. Furthermore, the pandemic accelerated the generation of medical waste due to increased use of PPE and single use supplies, placing additional strain on hospital logistics systems (Firmalasari & Rasyidah, 2020; Rahayu et al., 2021).

Beyond the COVID 19 crisis, longstanding issues in logistics oversight and infrastructure remain evident. Many healthcare facilities, particularly in low resource settings, operate without structured programs for equipment management, leading to waste, inefficiencies, and safety risks (Ghasemi et al., 2022). These are compounded by technological gaps and limited training for personnel in logistics management. Liu et al. (2023) emphasize that digital innovation in logistics such as IoT based inventory systems could significantly enhance the reliability and responsiveness of logistics operations. Aborujilah et al. (2021) and Fang (2019) likewise advocate for real time inventory and asset tracking technologies as pivotal to reforming logistics systems and ensuring supply continuity.

Given the increasing complexity of hospital operations, the integration of advanced digital systems into logistics functions is no longer optional but essential. Platforms like SIMLOG and national e catalogue systems are designed to streamline procurement and inventory management. When effectively implemented, these systems reduce human error, improve transparency, and enhance supply chain agility (Al Qatawneh & Makahleh, 2022). Studies by Kara & Yalçın (2022) confirm that digital tools facilitate better coordination, cost efficiency, and responsiveness, particularly in underfunded hospital settings. Kuteyi & Winkler (2022) further argue that the transformation of logistics through digital systems elevates accountability and allows stakeholders to make data driven decisions across the supply chain.

In light of these advancements, hospital logistics systems must also be evaluated using robust frameworks. Multiple Criteria Decision Analysis (MCDA) has been identified as an effective tool for assessing logistics performance using composite indicators such as cost efficiency, delivery timeliness, inventory accuracy, and service quality (Longaray et al., 2017; Sirisawat et al., 2024). The use of such frameworks enables hospitals to track performance against established benchmarks and identify areas requiring intervention. Ham et al. (2018) advocate for a multidimensional evaluation approach, arguing that logistics must be analyzed holistically across different departments to ensure seamless integration and policy alignment.

An additional cornerstone of effective logistics management is the development and implementation of SOPs. SOPs define procedural standards for procurement, storage,

maintenance, and disposal, creating uniformity and accountability within operations. Lau et al. (2022) and Duque Uribe et al. (2019) emphasize that well documented SOPs are instrumental in mitigating risks, ensuring regulatory compliance, and maintaining continuity during crises. In particular, the COVID 19 pandemic illustrated the importance of standardized processes in supporting operational resilience.

Global best practices demonstrate that the synergy between SOPs and digital technologies yields optimal outcomes. Avinash & Joseph (2024) highlight the utility of technologies such as barcode systems, blockchain, and IoT sensors for tracking and validating the movement and condition of medical equipment in real time. These innovations support not only logistics but also quality assurance and predictive maintenance. Moreover, successful logistics systems are characterized by cross functional coordination, continual staff training, and strategic leadership embedded within institutional governance frameworks (Duque Uribe et al., 2019).

Against this backdrop, the present study evaluates the logistics management system at RSUD Undata Palu, a regional referral hospital in Central Sulawesi. The hospital has experienced steady increases in patient visits from 2019 to 2024, underscoring the urgency of an efficient logistics system. Preliminary observations indicate persistent gaps in digital integration, storage infrastructure, SOP enforcement, and supply demand alignment. Despite incremental improvements, systemic barriers continue to constrain logistics performance.

The purpose of this study is to examine the implementation and effectiveness of medical equipment logistics management at RSUD Undata Palu by analyzing six key areas: planning, procurement, storage, distribution, disposal, and control. The study seeks to identify performance gaps and develop actionable recommendations for optimizing logistics systems in regional hospitals. This research contributes to the academic discourse on healthcare logistics by contextualizing global best practices within an Indonesian referral hospital setting and offering evidence based insights for policy development and institutional reform.

By addressing these core dimensions and highlighting the necessity of integrating SOPs with digital technologies, the study aims to support the design of sustainable logistics systems that can withstand operational shocks and enhance healthcare delivery in low resource environments. The novelty of this research lies in its longitudinal approach to assessing logistics at a regional hospital level and its potential to inform scalable logistics reforms across similar institutions in Indonesia and other developing countries.

METHOD

This study employed a qualitative descriptive design to evaluate the medical logistics management system at RSUD Undata Palu from 2019 to 2024. The qualitative descriptive approach is particularly suited for examining complex healthcare systems because it provides a comprehensive account of processes, stakeholder experiences, and institutional practices without imposing

external theoretical constructs (Kim et al., 2016). This methodology allows for a focused exploration of the logistics issues at RSUD Undata Palu through rich, contextualized descriptions derived from real time operational data, observations, and stakeholder interviews.

The research was conducted at RSUD Undata Palu, a regional referral hospital located in Central Sulawesi, Indonesia. The hospital is classified as a Type B facility, which denotes its function as a secondary referral institution serving a large and growing patient population. From 2019 to 2024, patient volume at RSUD Undata Palu increased significantly, with recorded figures rising from 108,740 in 2019 to an estimated 149,000 in 2024. This upward trend intensified the need for an efficient and scalable logistics system, making the hospital an ideal site for investigating challenges and improvements in medical equipment management.

Data collection was carried out using three primary techniques: in depth interviews, direct observation, and document analysis. These methods align with best practices for methodological triangulation in qualitative health research, enabling researchers to corroborate findings and enhance validity through cross verification (Doyle et al., 2019). In depth interviews were conducted with six key informants representing core administrative and operational units responsible for logistics at the hospital. These included the Head of Administration, Head of Planning Subdivision, Head of Procurement Unit, Head of Maternity Unit, Head of Asset Team, and Head of Accounting and Asset Management Section. Informants were selected based on their roles in logistics planning, procurement, inventory control, and financial management, ensuring comprehensive coverage of the logistics system.

Each interview was semi structured to allow for thematic exploration while maintaining consistency across participants. Questions focused on logistics planning, procurement strategies, storage conditions, distribution workflows, equipment disposal, and system control mechanisms. Interview sessions were audio recorded with consent and transcribed verbatim for accuracy.

Observational data were gathered through field visits to logistics storage areas, procurement offices, and medical equipment distribution points. These visits enabled researchers to examine physical infrastructure, storage capacity, equipment conditions, and the presence (or absence) of environmental controls such as temperature regulation in specialized storage spaces. Observations were systematically documented using structured field notes and photo evidence where permitted.

The third data source comprised hospital documents spanning the six year period under review. These included procurement records, storage logs, equipment usage reports, maintenance schedules, and internal audit findings. Document analysis provided historical context and continuity to the findings obtained from interviews and observations, reinforcing the rigor of the study through data triangulation.

To ensure data credibility and trustworthiness, the study employed triangulation of sources and peer debriefing among researchers. By comparing findings across interviews, observations, and documents, the study minimized single source bias and increased reliability. Member checking was

also applied, whereby preliminary interpretations were reviewed and verified by key informants to confirm representational accuracy (Doyle et al., 2019).

Data analysis followed the conventional process of qualitative content analysis: data reduction, data display, and conclusion drawing. Interview transcripts, observation notes, and document extracts were coded inductively using open coding techniques to identify themes related to each of the six focus areas: planning, procurement, storage, distribution, disposal, and control. Coding was conducted independently by two researchers and subsequently compared to resolve discrepancies. Identified themes were then categorized and synthesized to form a comprehensive narrative of logistical operations at RSUD Undata Palu.

Although this study adopted a qualitative methodology, the research design included analytical rigor through structured protocols and systematic validation processes. By grounding its approach in descriptive methodology, the study captures the practical realities of medical logistics management as they unfold within the institutional context of a public hospital.

While the research primarily emphasized descriptive insights, it is intended to lay the groundwork for future quantitative investigations. By identifying key areas of strength and deficiency in the current logistics system, this study provides a basis for hypothesis development and metric design in subsequent studies that may employ cross sectional surveys, experimental designs, or performance analytics to quantify logistical efficiency and patient care outcomes.

Overall, the methodology reflects a commitment to empirical integrity, transparency, and contextual relevance key tenets of qualitative healthcare research. Through the integration of multiple data sources and stakeholder perspectives, this study provides a robust foundation for understanding and improving medical logistics in Indonesian hospital settings.

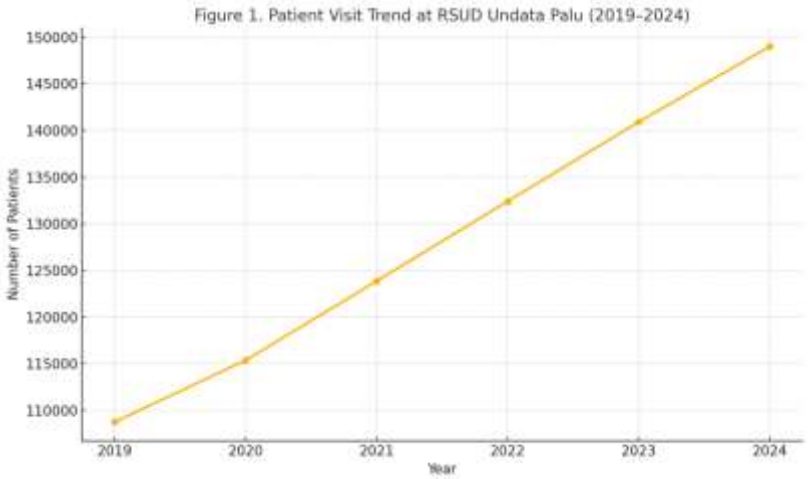
RESULT AND DISCUSSION

The results of this study are organized according to the six key domains of medical equipment logistics management at RSUD Undata Palu: planning, procurement, storage, distribution, disposal, and control. Each domain is discussed based on empirical findings from interviews, observations, and hospital documentation over the period of 2019 to 2024, complemented by relevant literature to contextualize and support the analysis.

In the area of logistics planning, RSUD Undata Palu conducts annual review meetings to assess inventory consumption and forecast needs for the following fiscal period. This planning integrates budgeting through mechanisms such as the Rencana Anggaran Biaya (RAB) and APBD. However, interviews revealed persistent gaps between planned forecasts and actual usage due to limited integration of real time consumption data. Despite the adoption of the SIMLOG system, inconsistencies in data entry and delayed updates compromise the accuracy of planning outputs. These issues resonate with Lando et al. (2022), who emphasize that accurate historical data and

stakeholder involvement are essential for aligning planning with actual needs. Although the planning process involves heads of departments and logistics staff, gaps remain in feedback integration from end users such as clinical teams, limiting the responsiveness of the logistics strategy.

Figure 1. Trends in Patient Visits at RSUD Undata Palu (2019–2024)



Procurement processes at RSUD Undata Palu transitioned from conventional methods to an e catalogue system around 2021. This change enhanced transparency, reduced processing time, and aligned purchasing with national procurement regulations. Nevertheless, challenges persist in the form of delivery delays, discrepancies in product specifications, and limited catalog options for specialized equipment. During urgent needs, the hospital relies on direct purchasing mechanisms to expedite procurement, echoing findings by Farida et al. (2021) and Madao et al. (2023), who note the importance of flexible procurement pathways during crises. Despite improvements, the dual track procurement approach e catalogue for routine and direct for emergencies requires better integration to avoid inefficiencies and accountability gaps.

The storage capacity at RSUD Undata Palu has doubled since 2019 with the addition of auxiliary storage units. However, current capacity remains insufficient relative to the hospital's logistical demands, particularly as patient volumes rise. Table 1 shows that the central warehouse operates near its maximum capacity and lacks temperature control systems, posing risks to sensitive equipment. These findings are consistent with Z. Liu & Liu (2018), who demonstrate that poor environmental control directly impacts equipment longevity and reliability. From 2021 to 2024, proposals to develop a centralized logistics warehouse were initiated, yet implementation has been slow due to budget constraints and spatial limitations.

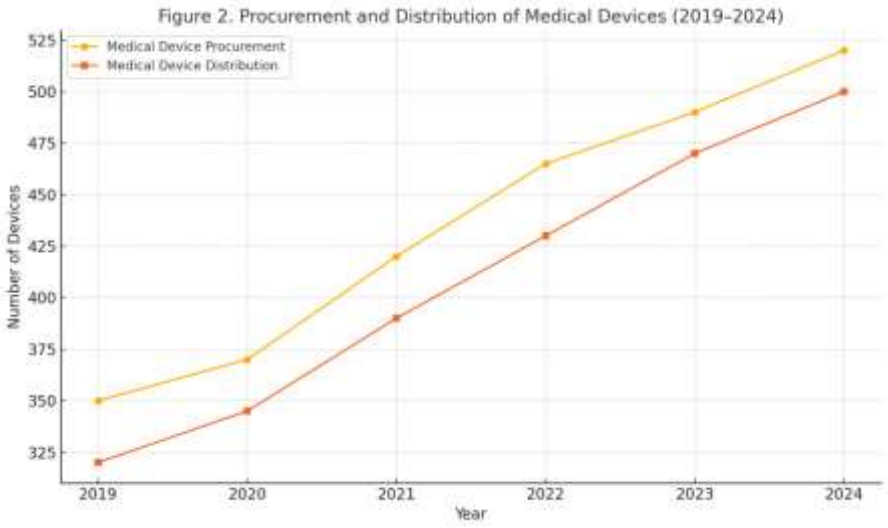
Table 1. Capacity of Central and Unit Warehouses at RSUD Undata Palu (2023)

Location	Maximum Capacity (m^3)	Utilized Capacity (m^3)	Remarks

Central Warehouse	90	76	Not equipped with cooling system
Pharmacy Warehouse	25	19	Clean, well-organized
Maternity Unit	8	6	Does not have logistics shelving

Distribution systems have gradually evolved from fully manual to semi digital processes using the SIMLOG platform. Distribution logs now capture equipment requests and allocations more accurately, improving traceability and reducing administrative burden. However, real time validation of stock levels remains limited, requiring manual reconciliation that increases the potential for delays and discrepancies. Junejo et al. (2023) underscore that semi digital systems are crucial transitional tools in resource constrained settings, allowing incremental digitization while maintaining operational continuity.

Figure 2. Trends in Medical Equipment Procurement and Distribution at RSUD Undata Palu (2019–2024)



The disposal process of obsolete medical equipment remains one of the most underdeveloped aspects. Although RSUD Undata Palu adheres to national regulations for disposal, internal delays occur due to fragmented responsibilities and lack of standard operating procedures. Disposal approval often requires external authorization, leading to bottlenecks. This finding supports Rahmawati & Fattah (2024), who identify insufficient documentation and regulatory overdependence as primary barriers to timely disposal. Moreover, departments frequently defer disposal decisions due to concerns over regulatory audits and accountability.

Control mechanisms have shifted from physical inspections to digital reporting, with SIMLOG gradually being used for inventory verification and discrepancy tracking. However, user uptake remains low, primarily due to limited training and unfamiliarity with the digital interface. Aghenta & Iqbal (2019) and Ravaghi et al. (2020) highlight the importance of staff training in enhancing digital tool utilization, which remains a gap at RSUD Undata Palu. Additionally, the lack of

automated alerts or performance dashboards limits the system's potential as a proactive management tool.

Overall, while RSUD Undata Palu has achieved several milestones in modernizing its logistics management from digital procurement to partial distribution automation the system remains hampered by infrastructural and procedural constraints. Continued investment in human resources, digital literacy, and environmental infrastructure, alongside policy updates to streamline disposal and enhance real time monitoring, will be critical to sustain improvements and ensure that medical equipment logistics fully supports the hospital's growing service demands.

The findings of this study on the logistics management system at RSUD Undata Palu reflect a nuanced landscape of operational progress and persistent institutional challenges. While efforts toward digitalization and improved procedural governance have gained traction, several systemic and infrastructural barriers continue to limit full implementation. In this section, each key area of logistics is discussed in relation to global standards and emerging literature, offering insights into the contextual realities faced by public hospitals in developing regions.

In terms of logistics planning, although RSUD Undata Palu has institutionalized annual review cycles and adopted digital systems such as SIMLOG, the lack of integration with real time consumption data undermines the accuracy and adaptability of planning mechanisms. This aligns with the observations of Lando et al. (2022), who underscore the importance of aligning budget planning with actual usage statistics to avoid under or over procurement. Furthermore, the limited involvement of clinical staff in the planning process indicates a disconnection between operational logistics and patient care demands, a concern echoed by Jafari et al. (2021), who advocate for participatory planning frameworks to enhance responsiveness and stakeholder ownership.

Procurement processes at RSUD Undata Palu have evolved through the integration of the national e catalogue system, which has facilitated compliance with procurement regulations and increased transparency. However, operational bottlenecks such as delivery inconsistencies, mismatch in specifications, and limited catalog diversity persist, particularly for specialized medical equipment. These challenges are consistent with the findings of Purwono et al. (2024), who note that the rigid structure of e catalogues can inhibit rapid responsiveness during medical emergencies. The hospital's reliance on dual procurement channels routine via e catalogue and emergency via direct purchase requires more agile and integrated procurement governance to reconcile efficiency with flexibility, especially in crisis situations as described by Madao et al. (2023).

Storage infrastructure has seen substantial expansion, yet remains insufficient when measured against the rising demand for equipment driven by increasing patient loads. Moreover, the absence of environmental controls such as temperature and humidity regulation threatens the longevity and reliability of stored medical devices. Z. Liu & Liu (2018) and Sirijindadirat (2023) both highlight that adverse environmental conditions significantly compromise equipment performance, leading to higher maintenance costs and service delays. The absence of a fully integrated centralized warehouse system at RSUD Undata Palu further exacerbates these issues, revealing an urgent need for capital investment and facility redesign.

Distribution practices at the hospital have transitioned into a semi digital format using SIMLOG, improving traceability and administrative efficiency. However, real time validation and synchronization with inventory systems remain incomplete, requiring manual reconciliation and thus introducing room for human error. These limitations mirror those reported by Junejo et al. (2023), who stress that semi digital systems serve only as transitional solutions and must eventually give way to fully automated logistics infrastructures to achieve consistency and scalability.

The disposal of obsolete equipment continues to be hindered by bureaucratic complexities and fragmented internal governance. As noted by Rahmawati & Fattah (2024), the absence of a streamlined decision making framework and over reliance on external authorization mechanisms delay timely decommissioning and recycling of unserviceable assets. These procedural delays not only occupy valuable storage space but also expose the institution to audit risks and inefficiencies. This underscores the necessity for a standardized, internally accountable disposal policy supported by digital asset tracking systems.

Control functions have incrementally shifted toward digital monitoring, with SIMLOG being utilized for inventory checks and reporting. Nevertheless, limited user adoption and the absence of performance dashboards reduce the system's potential as a proactive management tool. The need for comprehensive user training and cultural change in digital tool adoption is well documented in the works of Aghenta & Iqbal (2019) and Ravaghi et al. (2020), who emphasize the role of structured training programs in enhancing institutional competence and adherence to logistics protocols.

The broader institutional barriers to digital transformation such as legacy infrastructures, staff resistance, and fragmented policy environments are consistent with the findings of Darmawan & Laksono (2021) and Gegenhuber et al. (2022). These studies reveal that successful digital transitions in hospital logistics depend on strategic leadership, long term financial planning, and interdepartmental coordination to overcome technological inertia and foster a culture of innovation.

Logistical inefficiencies identified in this study ranging from delayed procurement and insufficient storage to inconsistent disposal practices directly affect the timeliness and quality of patient care. Snowdon et al. (2024) suggest that operational delays in logistics can manifest in increased patient waiting times and procedural backlogs, undermining service delivery quality and clinical safety. As such, logistics must be viewed not as a back end support function but as an integral component of health system performance.

Several policy interventions can support logistics reform in resource constrained hospitals like RSUD Undata Palu. (Williams et al., 2021) promote the use of innovation platforms that engage multiple stakeholders in co developing logistics solutions tailored to institutional realities. Similarly, public private partnerships, as illustrated by Perves et al. (2024), can leverage private sector efficiencies to bolster public health logistics through capacity sharing, joint procurement, and infrastructure support. Moreover, Atiga et al. (2024) demonstrate that adopting innovative logistics

technologies such as drone delivery particularly in remote settings can alleviate last mile delivery challenges and reduce time lags in equipment availability.

The findings from RSUD Undata Palu affirm that while partial reforms in logistics management have been implemented, systemic transformation remains incomplete. Integrating digital systems with SOPs, building staff capacity, securing targeted infrastructure investment, and aligning hospital policies with national healthcare priorities are necessary to ensure that medical logistics evolve in step with clinical demands and population health needs. Addressing these gaps is not only a managerial priority but a prerequisite for achieving equitable, timely, and quality health service delivery.

CONCLUSION

This study evaluated the implementation of medical equipment logistics management at RSUD Undata Palu across six core domains: planning, procurement, storage, distribution, disposal, and control. The findings reveal a transitional system with meaningful advancements in digital integration and procedural reform, particularly in procurement and distribution. However, limitations persist in real time inventory validation, centralized storage capacity, timely equipment disposal, and user adoption of digital tools. These inefficiencies have implications for service delivery quality, patient care timeliness, and operational cost effectiveness. The research contributes to the broader field of healthcare logistics by offering a longitudinal, institution level analysis in a resource constrained setting. It also highlights the interplay between infrastructure, policy, and human resource capacity in shaping logistics performance. For policymakers and hospital administrators, the results underscore the need for an integrated logistics strategy that combines digital tools, SOP standardization, cross functional training, and infrastructural investment. Future studies should expand on performance metrics, economic evaluation of logistics reforms, and comparative assessments across different hospital types or regions to support scalable policy solutions.

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