

HOSPITAL PHARMACEUTICAL LOGISTICS MANAGEMENT: A CASE STUDY OF A PRIVATE HOSPITAL IN INDONESIA

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Abstrak

Logistik farmasi berperan penting dalam menjamin ketersediaan obat, keselamatan pasien, dan efisiensi operasional rumah sakit, terutama di tengah peningkatan kompleksitas dan digitalisasi. Penelitian ini menganalisis pengelolaan logistik farmasi pada rumah sakit swasta skala menengah di Indonesia melalui enam dimensi: manajemen mutu, pengukuran kinerja dan benchmarking, *green* dan *reverse logistics*, kepatuhan regulasi dan keamanan, penilaian risiko, serta inovasi logistik. Penelitian menggunakan studi kasus kualitatif melalui wawancara semi-terstruktur dengan informan kunci yang ditriangulasi dengan observasi lapangan dan telaah dokumentasi. Hasil menunjukkan adanya pengendalian mutu, pemantauan kinerja internal, pengelolaan limbah dan pengembalian produk, pengadaan terpusat dan pengendalian keamanan, serta mitigasi risiko operasional. Sistem berbasis *web* terpusat telah mendukung informasi stok secara *real-time* dan alur kerja digital, meskipun beberapa aktivitas masih manual. Praktik-praktik tersebut saling berkaitan dalam mendukung keamanan farmasi, keberlanjutan operasional, keberlanjutan lingkungan, dan pencegahan kerugian. Namun, *benchmarking* terstandar, manajemen risiko sistematis, dan integrasi digital masih perlu diperkuat. Penelitian merekomendasikan perbaikan bertahap sesuai konteks dengan memanfaatkan infrastruktur digital yang telah tersedia.

Kata Kunci: logistik farmasi; logistik rumah sakit; digitalisasi; *reverse logistics*; manajemen risiko

Abstract

Pharmaceutical logistics is essential to medicine availability, patient safety, and efficient hospital operations, particularly amid increasing operational complexity and digitalization. This study examines pharmaceutical logistics management in a medium-sized private hospital in

Indonesia across six dimensions: quality management, performance measurement and benchmarking, green and reverse logistics, regulatory compliance and security, risk assessment, and logistics innovation. A qualitative single-case study was conducted using a semi-structured interview with a key informant, triangulated with field observations and documentary review. The findings reveal established quality controls, internal performance monitoring, waste and product-return practices, centralized procurement and security controls, and operational risk mitigation. A centralized web-based system supports real-time stock information and digital workflows, although several activities remain manual. These interconnected practices support pharmaceutical safety, operational continuity, sustainability, and loss prevention. However, standardized benchmarking, systematic risk management, and digital integration require further development. The study recommends gradual, context-sensitive improvements that build on the hospital's existing digital infrastructure rather than immediate full automation.

Keywords: *pharmaceutical logistics; hospital logistics; digitalization; reverse logistics; risk management*

A. INTRODUCTION

The availability of medicines and medical devices is essential to healthcare quality and patient safety (Basu et al., 2019; Kretchy et al., 2025; Thangavelu et al., 2008). Pharmaceutical logistics supports this availability through procurement, storage, distribution, inventory control, returns, and waste management (Iliashenko et al., 2022; Putri et al., 2023). Effective logistics can reduce inventory inefficiencies and improve medicine availability (Dachyar & Novita, 2016; Namweseza et al., 2025). However, as hospitals expand, growing services, patient capacity, and inventories increase logistics complexity and the need for more structured and technology-supported management (Boonsothonsatit et al., 2025).

In response, hospitals are increasingly moving from fragmented manual processes toward integrated digital systems (Machado et al., 2023; Zerka & Jawab, 2026). Web- and real-time technologies can improve information access, monitoring, and operational decision-making (Guo & Yang, 2023; Rácz-Szabó et al., 2020). Yet digitalization does not necessarily mean full automation, as partially integrated systems may still rely substantially on human intervention (Jebbor et al., 2023). At the same time, operational problems such as stockouts, inventory limitations, procurement delays, and poor storage practices continue to affect hospital logistics

and potentially the continuity of patient care (Romero, 2013; Tefera et al., 2021; Wylegała et al., 2023).

Beyond these operational challenges, research remains relatively fragmented. Smaller private and community hospitals are less represented than academic or university-affiliated hospitals (Rego et al., 2025; Rossier et al., 2026), while regulatory compliance, reverse logistics, performance measurement, sustainability, and digital transformation are often examined separately (Kalubanga & Mbekeka, 2024; Shaik & Abdul-Kader, 2012). Although recent studies have begun connecting some of these dimensions, their integration remains partial (Krzywda & Krzywda, 2026; Ozmutlu & Kirmiziloglu, 2026). This creates an opportunity for a more integrated examination of pharmaceutical logistics, particularly in small and medium-sized private hospitals.

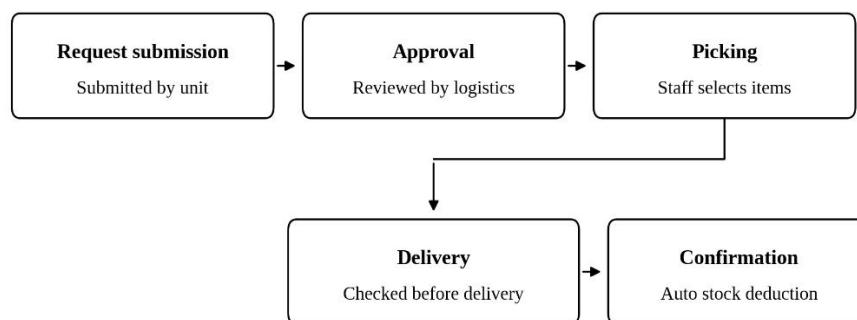
To address this gap, this study examines pharmaceutical logistics in a medium-sized private hospital in Indonesia by integrating quality management, performance measurement and benchmarking, green and reverse logistics, regulatory compliance and security, risk management, and digitalization. The study considers how these practices support quality, efficiency, safety, and sustainability within the hospital's operational constraints and ongoing digital transition. Specifically, the study examines: (1) TQM practices for pharmaceutical quality and safety; (2) KPI evaluation and benchmarking against automation trends such as AS/RS and IoT; (3) green and reverse logistics for waste and expired or near-expiry products; (4) regulatory compliance and centralized procurement controls for pharmaceutical security; (5) major supply chain risks and mitigation strategies; and (6) the contribution of the current semi-manual web-based system and opportunities for further automation. Accordingly, the study aims to assess current pharmaceutical logistics practices, identify key risks and operational constraints, and propose realistic improvements during the hospital's digital transition.

B. METHOD

This study employs a qualitative single-case study design to examine pharmaceutical logistics management at a medium-sized private hospital in Indonesia undergoing institutional and digital transition. Primary data were collected through a semi-structured interview with a purposively selected key informant responsible for both logistics and pharmacy operations. The interview covered six analytical dimensions: Total Quality Management (TQM), KPIs and benchmarking, green and reverse logistics, regulatory compliance and security, risk assessment, and logistics innovation. To strengthen the findings, interview data were triangulated with direct field observations and documentary evidence, including SOPs, procurement flowcharts, and an internal risk matrix. The combined evidence was then analyzed descriptively against relevant pharmaceutical service regulations and contemporary logistics practices and automation trends.

C. RESULTS AND DISCUSSIONS

Before examining the six analytical dimensions, Picture 1 illustrates the hospital's general internal logistics workflow, from unit request and approval to picking, delivery, and receiving confirmation, after which stock is automatically updated. While approval and stock recording are digitally supported, physical activities such as picking and verification remain manual. This combination of digital and manual processes provides the operational context for the following analysis.



Picture 1. Internal Logistics Operational Flow at The Study Hospital

Source: Authors' analysis based on field observations and interview data (2026).

1. Total Quality Management (TQM)

Consistent with the importance of medicine quality for patient safety (Basu et al., 2019; Kretchy et al., 2025; Thangavelu et al., 2008), the hospital applies quality controls across receiving, storage, and pre-distribution. Interview findings indicate that medicines must have more than two years of remaining shelf life, batch numbers are verified against invoices and physical stock, and cold-chain products exceeding 8°C upon receipt are returned. Before distribution, product names, quantities, and physical conditions are also verified. These findings were supported by field observation and documentation, which confirmed dedicated refrigerators maintained at 2–8°C with automatic temperature alarms. Together, these findings indicate quality controls at several critical stages of pharmaceutical handling.

However, these controls do not yet fully reflect the broader scope of TQM, which emphasizes continuous improvement and organization-wide quality commitment (Aruna et al., 2025; Jonny & Kriswanto, 2017; Tzortzopoulos, 2018). Elements of continuous improvement are evident through logistics–IT collaboration in system evaluation and user acceptance testing, although their systematic integration into an organization-wide TQM framework remains limited. Thus, the hospital combines established operational quality controls with emerging continuous improvement practices, supporting effective logistics and reducing the risk of quality failures affecting subsequent processes and patient care (Dachyar & Novita, 2016; Namweseza et al., 2025).

2. Key Performance Indicators (KPI) and Benchmarking

The hospital uses internal KPIs to monitor pharmaceutical logistics, including a maximum expired-product rate of 0.04%, a procurement budget target of 17.5%, distribution timeliness, stock availability, and vital medicine management. These indicators are evaluated monthly and reported to the Hospital Director and Quality Unit. However, performance is primarily assessed

against internal targets rather than standardized external benchmarks. In comparison, the SCOR model provides standardized metrics for performance measurement and benchmarking (Kusrini & Miranda, 2021), while benchmarking enables comparison with relevant standards or practices (Kailash et al., 2021).

This gap is also reflected in the hospital's level of automation. Field observations and system documentation confirmed a centralized web-based system with real-time stock updates, while interview findings identified remaining manual processes, including quantity entry, physical picking, and tiered approval. Together, this triangulated evidence shows that internal performance monitoring and digital infrastructure are already established, but formal benchmarking and automation can be further strengthened. Building on the existing system, feasible improvements include barcode or QR scanning, automated budget alerts, and early-warning notifications for critical or near-expiry stock. Table 1 compares current practices with modern automation trends and potential adaptations.

Table 1. Benchmarking of Current Logistics Practices Against Modern Automation Trends

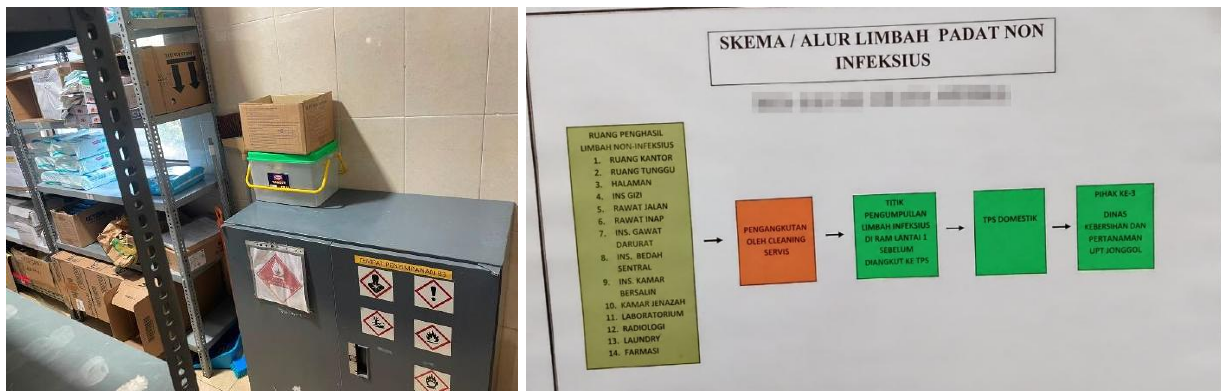
Dimension	Current System	Modern Automation Trend (AS/RS & IoT Era)	Adaptation Opportunity
Data entry & validation	Manual search-and-click; staff look up item names in the web system and enter quantities per invoice	Zero-touch input via RFID or wireless barcode scanners, enabling automatic stock updates	QR/barcode scanning integrated into the existing web system as a lower-cost alternative to RFID
Storage & retrieval	Manual but system-guided; staff identify item locations digitally and retrieve them physically from shelves	Automated Storage & Retrieval Systems (AS/RS) using goods-to-person mechanisms	Small-scale AS/RS, such as mini-load or vertical carousel systems, for high-value pharmaceutical and medical-device items
Workflow control & validation	Tiered digital approval, including director-level approval for new items	Predictive or AI-supported approval based on historical consumption and operational data	Automated budget-limit alerts before requests proceed to higher-level approval
Stock & expiry management	Centralized, real-time stock data accessible to relevant units	Intelligent expiry monitoring and FEFO prioritization using sensors and algorithms	Automated early-warning dashboard for critical and near-expiry stock

Source: Authors' analysis based on interview findings, field observations, documentation, and relevant literature (Kailash et al., 2021; Kusriani & Miranda, 2021).

Importantly, Table 1 represents developmental benchmarking rather than a call for immediate advanced automation. Given the hospital's scale, budget, and existing infrastructure, incremental improvements to the current web-based system offer a more feasible pathway toward greater automation. Thus, benchmarking helps identify not only performance gaps but also context-appropriate improvements.

3. Green and Reverse Logistics

The hospital integrates green logistics into pharmaceutical operations through waste segregation, separate collection of hazardous pharmaceutical waste, authorized third-party disposal, and a zero-plastic-bag policy. These interview findings were corroborated by field observation of the hazardous-waste collection facility and documentation of the waste management SOP, as shown in Picture 2, and are consistent with green and reverse logistics practices in the literature (Kalubanga & Mbekeka, 2024; Shaik & Abdul-Kader, 2012).



Picture 2. Supporting Evidence of Pharmaceutical Waste Management Practices
(a) Hazardous-waste collection facility; (b) Waste management SOP

Source: Authors' field documentation (2026).

Beyond waste management, reverse logistics extends to pharmaceutical product returns. Interview findings indicate that recalled products are returned to suppliers, near-expiry medicines

are monitored three months before expiration, and invoices are retained for three years for traceability. Returns are managed through credit notes or like-for-like exchanges, supporting loss prevention and value recovery in line with closed-loop supply chain principles (Mishra et al., 2018).

Taken together, the triangulated findings show that green and reverse logistics are interconnected in practice: waste management addresses environmental concerns, while monitoring and return mechanisms support product recovery and loss prevention. This integration is particularly relevant because these dimensions are often examined separately in the literature (Kalubanga & Mbekeka, 2024; Shaik & Abdul-Kader, 2012), yet collectively contribute to more sustainable pharmaceutical logistics.

4. Regulatory Compliance and Security

The hospital's pharmaceutical logistics follows Ministry of Health Regulation No. 72 of 2016 (Kementerian Kesehatan Republik Indonesia, 2016), reflecting the role of formal standards in hospital logistics (Jawab et al., 2018; Sahaf & Rifai, 2017). A centralized, single-door procurement system ensures medicines are obtained through authorized channels and verified distributors. These interview findings were corroborated by procurement-flow documentation, which confirms a structured process from request and approval to receiving, storage, and distribution.

Beyond compliance, these controls also strengthen supply chain security. Interview findings indicate that medicines from unauthorized sources are prohibited and narcotics are secured in double-lock storage with controlled access. Such measures are important given the risk of counterfeit medicines entering legitimate supply chains (Mackey et al., 2015) and the role of supply chain controls in mitigating this risk (Lima et al., 2018). Taken together, the triangulated findings show that regulatory compliance also functions as an operational safeguard, strengthening the integrity and security of the pharmaceutical supply chain.

5. Risk Assessment

The hospital faces three major pharmaceutical supply chain risks: stockouts of vital medicines, single-distributor dependency, and procurement delays from layered budget approvals. These challenges are consistent with hospital pharmacy logistics literature (Romero, 2013; Tefera et al., 2021; Wylegała et al., 2023). Interview findings were corroborated by the documented risk matrix, which maps risks by likelihood and impact, as shown in Picture 3.

ANALISIS MATRIX GRADING RISK

Tabel 1. Penilaian dampak klinis / keselamatan / security

Tingkat Risiko	Dampak	Dampak
1	1. Tidak ada risiko	1. Tidak ada risiko
2	2. Risiko sangat rendah	2. Risiko sangat rendah
3	3. Risiko rendah	3. Risiko rendah
4	4. Risiko sedang	4. Risiko sedang
5	5. Risiko tinggi	5. Risiko tinggi

Tabel 2. Penilaian probabilitas / kemungkinan

Tingkat Risiko	Probabilitas
1	1. Sangat jarang sekali (1 kali dalam 100 tahun)
2	2. Sangat jarang (1-2 kali dalam 100 tahun)
3	3. Jarang (3-5 kali dalam 100 tahun)
4	4. Tidak sering terjadi (5-10 kali dalam 100 tahun)
5	5. Sering terjadi (lebih dari 10 kali dalam 100 tahun)

Tabel 3. Matriks Grading Risiko

Probabilitas	Tingkat Risiko	Minor	Medium	Major	Kritis
1. Sangat jarang (1-2 kali dalam 100 tahun)	1. Sangat rendah	Minor	Medium	Major	Kritis
2. Sangat jarang (1-2 kali dalam 100 tahun)	2. Rendah	Minor	Medium	Major	Kritis
3. Jarang (3-5 kali dalam 100 tahun)	3. Sedang	Minor	Medium	Major	Kritis
4. Tidak sering terjadi (5-10 kali dalam 100 tahun)	4. Tinggi	Minor	Medium	Major	Kritis
5. Sering terjadi (lebih dari 10 kali dalam 100 tahun)	5. Sangat tinggi	Minor	Medium	Major	Kritis

Tabel 4. Tindakan untuk Tingkat dan jenis risiko

Tingkat Risiko	Tindakan
1. Sangat rendah	1. Tidak ada tindakan yang perlu diambil
2. Rendah	2. Risiko sangat rendah, namun jika terjadi dengan cepat dan banyak, maka akan berdampak signifikan terhadap pelayanan
3. Sedang	3. Risiko sedang, dilakukan tindakan pencegahan dan pemantauan secara berkala
4. Tinggi	4. Risiko tinggi, dilakukan tindakan pencegahan dan pemantauan secara berkala, serta tindakan korektif jika terjadi
5. Sangat tinggi	5. Risiko sangat tinggi, dilakukan tindakan pencegahan dan pemantauan secara berkala, serta tindakan korektif jika terjadi

Picture 3. Pharmaceutical Logistics Risk Matrix at the Study Hospital
Source: Authors' field documentation (2026).

In response, the hospital applies ABC-VEN prioritization, buffer stock, expedited approval for critical medicines, multiple distributors, and emergency budget mechanisms. These measures broadly align with ISO 31000:2018 risk management principles (International Organization for Standardization [ISO], 2018) and supply chain risk management literature (Hermoso-Orzáez & Garzón-Moreno, 2022). Taken together, the triangulated findings indicate that risk management is embedded in pharmaceutical logistics but remains largely operational. More explicit alignment with a structured framework such as ISO 31000 could strengthen risk prioritization and proactive mitigation.

6. Logistics Innovation

The hospital has transitioned from manual bookkeeping to a centralized web-based logistics system providing real-time stock information, automatic inventory updates, and digital approval workflows. Interview findings were corroborated by field observations and system documentation, reflecting the broader shift toward integrated digital logistics and real-time decision-making (Guo & Yang, 2023; Machado et al., 2023; Rácz-Szabó et al., 2020; Zerka & Jawab, 2026).

However, digital integration has not eliminated manual processes. Item searches, quantity entry, physical picking, and expiry checks still require staff intervention, confirming that digitalization does not necessarily result in full automation (Jebbor et al., 2023). Taken together, the triangulated findings indicate a gradual digital transition, with opportunities for further innovation through barcode or QR scanning, automated expiry alerts, and integrated inventory control.

7. Managerial Implications

Drawing on the findings across the six analytical dimensions, several practical improvements can be prioritized to strengthen the hospital's pharmaceutical logistics system. Rather than pursuing immediate full automation, the recommendations emphasize incremental improvements that build on the existing web-based infrastructure while addressing supplier, financial, capacity, and sustainability constraints. Table 2 summarizes these managerial priorities.

Table 2. Managerial Recommendations for Pharmaceutical Logistics Improvement

No.	Improvement Area	Recommended Action	Objective
1	Digital system optimization	Integrate barcode or QR scanning, automated expiry alerts, and critical-stock notifications into the existing web-based system	Improve inventory accuracy and enable earlier response to near-expiry and critical stock
2	Supplier management	Establish clear service-level expectations for stock availability and expand multi-distributor arrangements for vital and essential medicines	Reduce stockout risk and single-distributor dependency
3	Financial-administrative	Integrate billing and payment monitoring between logistics and finance within the existing system	Reduce procurement disruption caused by delayed invoice settlement

No.	Improvement Area	Recommended Action	Objective
	integration		
4	Capacity and budget management	Streamline approval procedures for critical medicines and periodically review storage capacity against increasing service demand	Improve responsiveness to critical needs and demand fluctuations
5	Green logistics	Strengthen waste-segregation practices and staff awareness while continuing initiatives to reduce unnecessary packaging	Reduce hazardous-waste risks and strengthen environmentally responsible logistics

Source: Authors' analysis based on interview findings, field observations, and documentation (2026).

Taken together, these recommendations emphasize a gradual and context-sensitive improvement strategy, balancing technological advancement with the hospital's operational capacity, budget constraints, and existing control mechanisms.

D. CONCLUSIONS

This study shows that the hospital's pharmaceutical logistics integrates quality control, performance monitoring, green and reverse logistics, regulatory security, risk management, and digitalization. Together, these dimensions support pharmaceutical safety, sustainability, loss prevention, and operational continuity. However, standardized benchmarking and structured risk management remain limited, while several processes still require manual intervention. Overall, the findings indicate a gradual digital transition, in which existing operational controls and digital capabilities provide a foundation for more integrated, efficient, and sustainable pharmaceutical logistics.

E. SUGGESTIONS

Based on these findings, the hospital should prioritize incremental improvements rather than immediate full automation, including barcode or QR scanning, automated stock and expiry alerts, standardized benchmarking, and more structured risk management aligned with frameworks such as ISO 31000. At the same time, digital improvements should strengthen rather than replace existing quality, regulatory, and sustainability controls. Future research could compare multiple

private hospitals to examine how hospital size, resources, and digital maturity influence pharmaceutical logistics performance.

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