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Research Article

PNG National Supply Chain and Data Management Assessments: Phase 1 Findings for the Medical Supplies M&E and Data Strategy Implementation Framework (2026–2030)

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Abstract

The medical supply chain in Papua New Guinea has long been constrained by systemic weaknesses such as chronic drug shortages, poor forecasting, fragmented reporting, and weak accountability, undermining access to essential medicines and eroding public confidence in the health system. To address these challenges, three complementary assessments were undertaken: the National Supply Chain Assessment (NSCA), the Data Maturity Assessment (DMA), and the Business Process Mapping (BPM). The objective was to build a comprehensive evidence base for reform by establishing a functional baseline, diagnosing organizational readiness for data-driven decision-making, and designing optimized workflows. The NSCA applied the Capability Maturity Model across ten functional areas, revealing uneven maturity, visible operational failures, and systemic fragmentation across provinces. The DMA evaluated leadership, culture, skills, tools, and data use, exposing governance gaps, weak accountability, and limited workforce capacity despite existing technical systems. The BPM documented current ("As-Is") workflows and collaboratively designed optimized ("As-Desired") processes, identifying bottlenecks such as manual approvals, siloed reporting, and duplication, while proposing digitized, integrated, and accountable workflows aligned with KPI-linked reporting. Results from the three assessments highlighted cross-cutting weaknesses in governance, workforce skills, system integration, and operational efficiency, while also identifying pockets of strength in financial sustainability and technical capability. Collectively, these findings informed the Monitoring & Evaluation and Data Strategy Implementation Framework (2026–2030), which prioritizes governance and accountability structures, workforce development, digitization and system integration, improved forecasting, cold chain monitoring, and pharmacovigilance. In conclusion, the assessments provide a coherent, evidence-based roadmap for transforming the medical supply chain into a resilient, transparent, and data-driven system, ensuring reforms are technically sound, strategically aligned, and operationally feasible.

Keywords

Medical Supply Chain, National Supply Chain Assessment, Data Maturity Assessment, Business Process Mapping, Governance and Accountability, Workforce Capacity and Data Literacy, Digitization and System Integration, Monitoring & Evaluation Framework (2026-2030)

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1. Introduction

Medical supply chains are critical to ensuring equitable access to essential medicines and sustaining public confidence in health systems. However, in many low- and middle-income countries, including Papua New Guinea, systemic weaknesses such as chronic drug shortages, poor forecasting, fragmented reporting, and weak accountability have persisted despite significant funding allocations [1, 2]. These challenges undermine service delivery, compromise patient outcomes, and highlight the urgent need for evidence-based reforms. Global studies emphasize that resilient supply chains require strong governance, data-driven decision-making, and workflow optimization to strengthen efficiency and responsiveness [3-5].

To address these challenges, three complementary assessments were conducted: the National Supply Chain Assessment (NSCA), the Data Maturity Assessment (DMA), and the Business Process Mapping (BPM). The NSCA established a functional baseline across ten critical areas, exposing operational failures and uneven maturity across provinces. The DMA diagnosed organizational readiness, revealing governance gaps, weak accountability, and limited workforce capacity despite existing technical systems. The BPM mapped current workflows and designed optimized, digitized processes to eliminate bottlenecks and improve transparency. Together, these assessments align operational realities, governance maturity, and workflow optimization under a unified Monitoring & Evaluation and Data Strategy Implementation Framework (2026–2030).

The objective of this study is to integrate findings from these three assessments to build a comprehensive roadmap for reform. By combining baseline functionality, organizational data maturity, and workflow redesign, the framework ensures reforms are technically sound, strategically aligned, and operationally feasible. In summary, the study concludes that while technical capacity is advancing, systemic weaknesses in governance, workforce skills, and integration continue to undermine performance. The proposed framework prioritizes governance, workforce development, digitization, forecasting, and quality assurance, embedding accountability and evidence-based decision-making to transform the medical supply chain into a resilient, transparent, and data-driven system.

2. Literature Review

2.1. Global Perspectives on Medical Supply Chains

Health supply chains are widely recognized as a cornerstone of effective health systems. The World Health Organization [8] and UNICEF [9] emphasize that reliable procurement, distribution, and monitoring of medical supplies are essential for achieving universal health coverage. Global studies highlight recurring challenges in low- and middle-income countries (LMICs), including weak forecasting, fragmented logistics, and inadequate cold chain infrastructure. For example, USAID's Deliver Project [10] documented how poor data visibility and weak coordination mechanisms often lead to stock-outs and wastage, undermining service delivery.

2.2. Regional and Comparative Evidence

In the Pacific region, supply chain assessments reveal similar systemic weaknesses. Studies from Fiji, Solomon Islands, and Vanuatu point to limited human resource capacity, reliance on donor-driven procurement, and logistical barriers posed by geography [13]. Comparative evidence from other LMICs, such as Tanzania and Ghana, demonstrates that strengthening data management and logistics coordination can significantly reduce stock-outs and improve patient outcomes. These lessons provide valuable insights for Papua New Guinea, where geographic isolation and infrastructure constraints present unique challenges [13].

2.3. Papua New Guinea Context

Brown and Gilbert [7] documented systemic challenges in PNG's medical supply chain, noting that availability of medical supplies was influenced by interrelated issues such as transport, cold chain management, record keeping, and health worker competency. Their study revealed "know-do" gaps between reported practices and observed realities, highlighting weaknesses in training and adherence to standard operating procedures. More recent government and donor reports [11] have echoed these concerns, pointing to fragmented data management systems and limited integration of supply chain monitoring into national health strategies. These findings suggest that while PNG has made progress in policy development, operational inefficiencies continue to undermine supply chain reliability.

2.4. Data Management and Policy Integration

Emerging literature emphasizes the critical role of data systems in supply chain monitoring. Weak data collection and reporting mechanisms often lead to inefficiencies, poor forecasting, and limited accountability. In PNG, fragmented data management has been cited as a barrier to effective policy implementation, limiting the government's ability to track supply chain performance and respond to emerging needs. Integrating robust data strategies into supply chain assessments is therefore essential for achieving long-term sustainability and aligning with national health priorities. The current National Supply Chain Assessment (NSCA) and Data Management Assessments provide an opportunity to establish a baseline for 2026–2030, ensuring that future reforms are evidence-driven and responsive to systemic gaps [12].

3. Materials and Methods

3.1. Study Design

This study employed a mixed-methods design, combining quantitative scoring frameworks with qualitative participatory approaches. Three sequential assessments were conducted — the National Supply Chain Assessment (NSCA), the Data Maturity Assessment (DMA), and Business Process Mapping (BPM) — to triangulate evidence and build a comprehensive reform framework.

3.2. Study Sites and Participants

1) Geographic Scope: Central and Morobe Provinces were selected as representative sites for field visits and workshops.
2) Stakeholders: Participants included Provincial Health Authorities (PHAs), the National Department of Health, medical stores, hospitals, and development partners (UNFPA, World Vision, m-Supply PNG, HIV/TB programs, Express Customs Limited, PMRB, CPHA, PSSB).
3) Selection Criteria: Stakeholders were chosen based on their operational role in supply chain management, data governance, and health service delivery.

3.3. Data Sources and Instruments

1) NSCA Instruments: Structured questionnaires, binary (Yes/No) Capability Maturity Model (CMM) scoring sheets, and supply chain mapping templates.
2) DMA Instruments: Government Data Maturity Assessment Framework, participatory scoring matrices, and group exercise tools.
3) BPM Instruments: Bizagi Business Process Mapping Notation (BBPMN) software, interview guides, and document review checklists.

3.4. Data Collection Procedures

1) Field Visits: Direct observation of medical supply chain operations at provincial and facility levels.
2) Workshops: Facilitated participatory sessions with PHAs and stakeholders to complete scoring matrices and process maps.
3) Interviews: Semi-structured interviews with managers and frontline staff to validate evidence.
4) Document Reviews: Policy documents, procurement records, and facility audit reports were analyzed to corroborate findings.

3.5. Data Analysis

1) NSCA: Binary CMM scores were aggregated and analyzed to identify strengths, weaknesses, and maturity levels across ten functional areas. SWOT analysis was applied to contextualize findings.
2) DMA: Scores across six themes (leadership, culture, skills, tools, data, uses) were benchmarked to classify organizations into Beginning, Emerging, and Learning tiers.
3) BPM: "As-Is" workflows were mapped to identify bottlenecks; "As-Desired" workflows were designed to propose digitized, integrated processes.

3.6. Ethical Considerations

1) Participation was voluntary, with informed consent obtained during workshops and interviews.
2) Data confidentiality was maintained by anonymizing stakeholder inputs and securing institutional records.
3) The study was conducted in alignment with PNG medical research advisory committee ethics approval official registered reference MRAC # 26.18.

4. Results

4.1. National Supply Chain Assessment (NSCA)

4.1.1. Central Province

Central Province NSCA Results

Table 1. *Capability Maturity Model Score and Range of Scores Prseented by Level of Health Facility for Each Functional Module in 5 Districts of Central Pha.*

MODULE	Reporting H/Facility -Goilala	Reporting H/Facility -Abau	Reporting H/Facility- Rigo	Reporting H/Facility Hiri Koari	Reporting H/FacilityKairiku
	No M =5	No of M= 4	n = 5	n = 5	n = 5
Human Resources	0-1	0-1	1-2	2-3	1-2
Financial Sustainability	0-1	0-1	2-3	2-3	2-3

MODULE	Reporting H/Facility -Goilala	Reporting H/Facility -Abau	Reporting H/Facility- Rigo	Reporting H/Facility Hiri Koari	Reporting H/FacilityKairiku
Quality and Pharmacovigilance	0-1	0	1	1	1
Warehousing and Storage	0-1		1-2	1-2	1
Logistics Management Information System	0-1	0-1	1-2	1-2	1-2

1) Overall Maturity: Facilities generally scored at Level 1–2 (Initial–Managed), reflecting fragile but emerging capacity.
2) Strengths: Financial sustainability was the strongest area, with Rigo, Hiri Koari, and Kairiku consistently reaching Level 2–3. Human resources showed modest improvement in Hiri Koari.
3) Weaknesses: Quality assurance and pharmacovigilance remained critically weak (Level 0–1). Warehousing and LMIS were uneven, with gaps in digitization and documentation.
4) Implication: Central Province demonstrated gradual progress in finance and HR but remains critically weak in quality assurance and logistics systems.

Table 2. *Shows the medical supply chain capability maturity level status for Central Provincial Health Authority three districts assessed.*

Dimension	Findings
Overall Maturity	Level 1–2 (Initial–Managed), fragile but emerging capacity
Strengths	Financial sustainability strong (Rigo, Hiri Koari, Kairiku: Level 2–3); HR modest improvement in Hiri Koari
Weaknesses	Quality & pharmacovigilance stuck at Level 0–1; warehousing and LMIS uneven
Implication	Gradual progress in finance/HR but critically weak in QA and logistics

4.1.2. Morobe Province

Morobe Province NSCA Results

Table 3. *Capability Maturity Model Score and Range of Scores Prseented by Level of Health Facility for Each Functional Module in 5 Districts of Morobe Pha.*

MODULE	Reporting H/Facility Markham No M =5	Reporting H/Facility Huon Gulf No of M= 3	Reporting H/Facility Lae n = 4	Reporting Facility Nawaeb n = 4	Reporting H/Facility Tewai Siasi n = 3
Human Resources	1-2	0-2	2	0-2	
Financial Sustainability	2-3		3	0-1	0-1
Quality and Pharmacovigilance	1			1	0-1
Warehousing and Storage	1-2	0-2	1	0-3	0-2
Logistics Management Information System	1-2	0-2	2		

Table 4. Capability Maturity Model Score and Range of Scores Prseented by Level Health Facility for Each Functional Module in the Districts of Morobe Pha.

MODULE	Reporting H/Facility Menyamya	Reporting H/Facility Wau Waria	Reporting H/Facility Bulolo	Reporting H/Facility Kabum	Reporting H/Facility Finschhafen
	No M =2	No of M= 4	n = 4	n = 5	n = 3
Human Resources	0	2	2	0-3	0-3
Financial Sustainability	1	3	3	0-1	0
Quality and Pharmacovigilance		1	1	0-1	
Warehousing and Storage				0-2	2
Logistics Management Information System		1	2	1	

1. Overall Maturity: Facilities clustered around Level 1–2, with urban/semi-urban districts outperforming rural ones.
2. Strengths: Financial sustainability was relatively strong in Lae, Wau Waria, and Bulolo (Level 3). Warehousing showed isolated strength in Finschhafen (Level 3). LMIS was moderately developed in Lae and Bulolo.
3. Weaknesses: Human resources remained weak in rural districts (Menyamya, Kabum, Tewai Siasi). Quality assurance and pharmacovigilance were consistently poor (Level 0–1). Warehousing and LMIS were fragmented in rural districts.
4. Implication: Morobe PHA showed pockets of strength in finance and warehousing, but systemic weaknesses in HR and quality systems continue to undermine supply chain performance.

Table 5. Shows the overall medical supply chain capability maturity level status for Morobe Provincial Health Authority six districts assessed.

Dimension	Findings
Overall Maturity	Level 1–2, urban/semi-urban stronger than rural
Strengths	Finance strong in Lae, Wau Waria, Bulolo (Level 3); warehousing strong in Finschhafen (Level 3); LMIS moderately developed in Lae & Bulolo
Weaknesses	HR weak in rural districts; QA consistently poor (Level 0–1); warehousing & LMIS fragmented in rural areas
Implication	Pockets of strength in finance/warehousing but systemic HR & QA weaknesses undermine performance

4.2. Data Maturity Assessment (DMA)

1) Overall Data Maturity: Uneven progress across organizations, grouped into three tiers:
   a) Foundational (Beginning): CPHA (1.2), PMRB (1.0) — weak leadership, systems, and accountability.
   b) Transitional (Emerging): PSSB (1.6), World Vision/m-Supply PNG (~1.7), HIV/TB Program (2.9) — progress in systems and decision-making but weak ethics, protection, and workforce skills.
   c) Advanced (Learning): Express Customs Limited (3.3), MSPDD (3.15, with Mastering elements) — strong technical capability but governance and workforce gaps.
2) Strengths: Advanced organizations demonstrated ethical data use and strong technical systems; transitional groups showed readiness to scale data practices.
3) Weaknesses: Governance, accountability, and workforce skills lagged behind technical investments. Evidence-based decision-making culture was weak across most organizations.
4) Implication: The sector risks becoming technically capable but strategically adrift without deliberate investment in leadership, governance, and workforce development.

Table 6. Shows the data maturity status for the seven stakeholders that participated.

Tier	Organizations	Score	Key Characteristics
Foundational	CPHA, PMRB	1.0–1.2	Weak leadership, systems, accountability
Transitional	PSSB, World Vision/mSupply PNG, HIV/TB	1.6–2.9	Progress in systems & decision-making; weak ethics/work-force
Advanced	Express Customs Ltd, MSPDD	3.15–3.3	Strong technical capability; governance/workforce gaps

4.3. Business Process Mapping (BPM)

4.3.1. As-Is Findings

1) Manual, paper-based requests and approvals caused delays of weeks before orders reached Area Medical Stores.
2) Fragmented data entry across spreadsheets and handwritten registers led to duplication and poor visibility.
3) Weak accountability: proof of delivery forms was rarely returned, limiting visibility on medicine distribution.
4) Siloed reporting: donor-managed HIV/TB commodities were tracked separately, creating duplication and inefficiencies.
5) Implication: Current workflows are fragmented, manual, and reactive, undermining transparency and responsiveness.

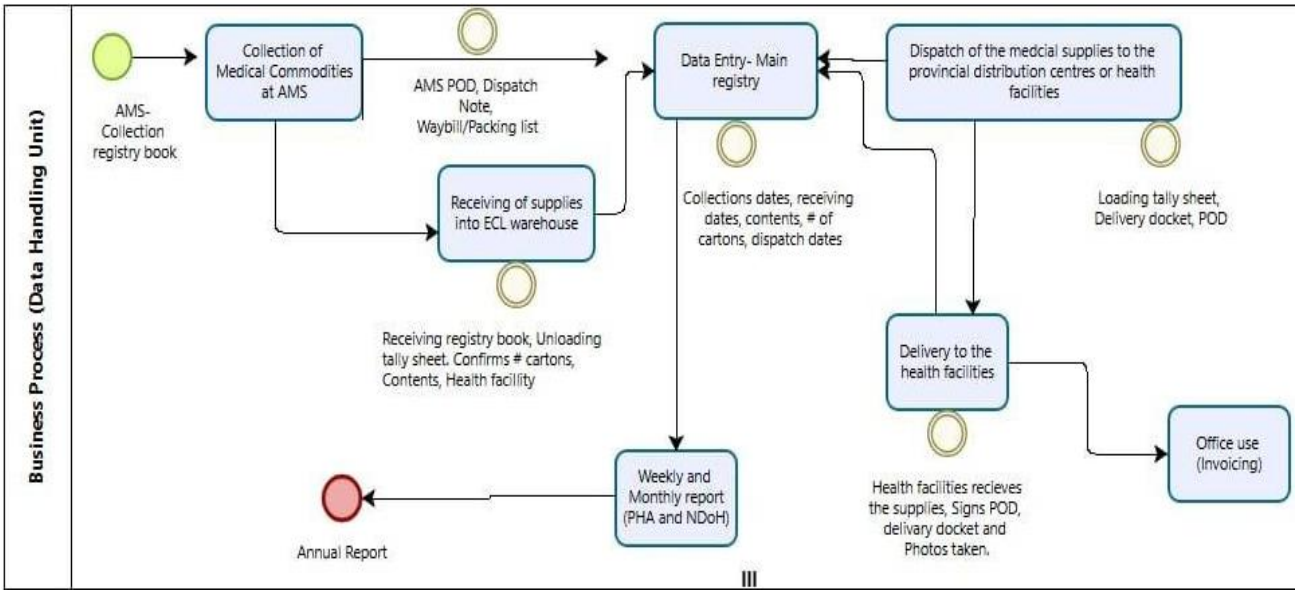

Figure 1. shows an example of a logistics company "As Is" BPM.

4.3.2. As-Desired Findings

1) Centralized digital requests via a unified LMIS with automated validation.
2) Standardized, digitized documentation across government and NGO actors.
3) Digitized inspections with electronic audit trails for quality assurance.
4) Real-time dashboards for stock, cold chain, and delivery monitoring.
5) Unified reporting into a national information system for consolidated visibility.
6) Implication: Transformation from manual, fragmented processes to digitized, integrated, and accountable workflows is essential for transparency, reduced delays, and evidence-based decision-making.

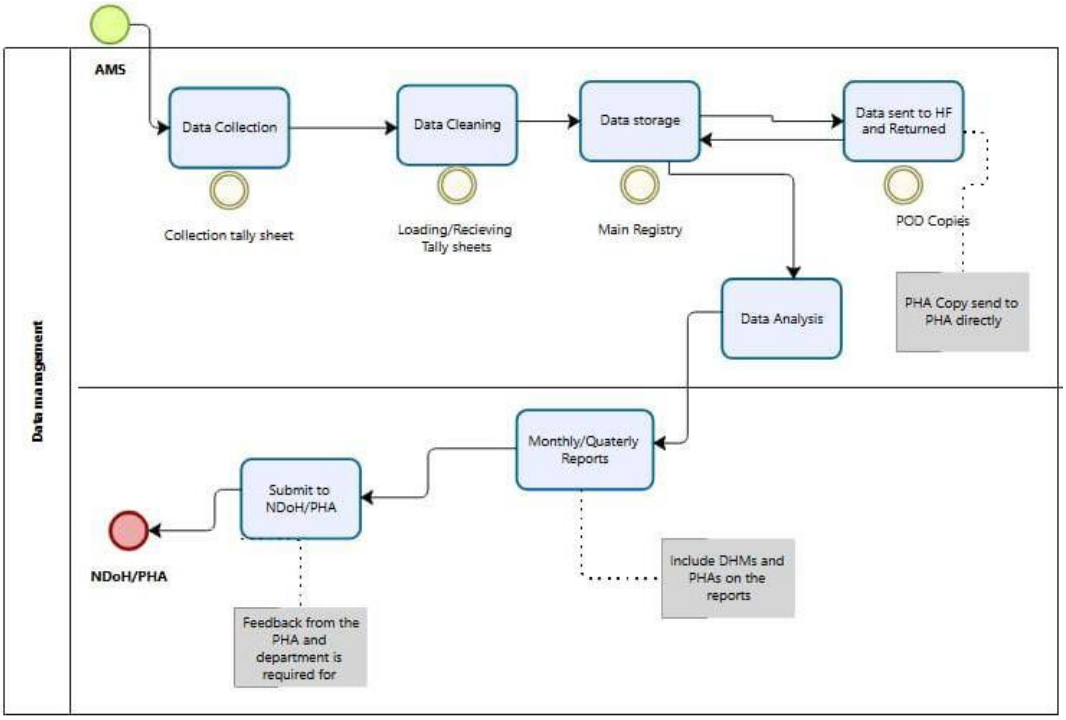

Figure 2. Shows an example of a logistics company "As Desired" BPM.

5. Discussion

The findings from the National Supply Chain Assessment (NSCA), Data Maturity Assessment (DMA), and Business Process Mapping (BPM) highlight systemic weaknesses in Papua New Guinea's medical supply chain. These weaknesses—spanning governance, workforce, systems integration, and operational efficiency—are not unique to PNG but resonate with broader evidence from low- and middle-income countries (LMICs).

5.1. Supply Chain Maturity and Quality Assurance

The NSCA results show that both Central and Morobe Provinces remain at Level 1–2 maturity, with fragile but emerging capacity. The Ghana national supply chain assessment, as summarized in published work on capacity development, also identified deficiencies across multiple functions, including human resources, financial sustainability, quality and pharmacovigilance. This provides a relevant comparison for the PNG findings, while recognizing that the Ghana assessment is a separate country-level assessment and does not establish the causes of PNG's results [2]. The isolated strengths in financial sustainability and warehousing (e.g., Finschhafen and Bulolo) suggest that targeted investments may yield localized improvements, but the PNG assessment indicates that weaknesses in HR and QA remain important constraints.

Comparison with literature:

1) Evidence from Ghana and Tanzania shows that supply-chain improvement requires coordinated attention to financial sustainability, workforce capacity, governance and quality-related functions. Ghana's national assessment identified deficiencies across multiple supply-chain functions, including human resources, financial sustainability, quality and pharmacovigilance. [7] In Tanzania, reforms to the Medical Stores Department were associated with improved availability of essential health commodities, although the authors identified increasing government receivables as a risk to sustaining progress [8]. These studies support an integrated-reform approach, but do not establish that insufficient HR and QA investment caused short-lived gains in either country [2, 3].
2) The PNG findings also highlight that information systems need to be supported by workforce capability, appropriate processes and accountability. Evidence from health supply-chain capacity development and routine health information systems identifies human-resource capacity, training, supervision and usable tools as important factors in effective implementation and data use [2, 5].

5.2. Data Maturity and Governance

The DMA revealed a paradox: organizations are becoming technically capable but strategically adrift [11]. Advanced actors (Express Customs, MSPDD) demonstrate strong technical systems but lack governance and workforce depth. This

reflects global evidence that data investments often prioritize technology over leadership and culture.

Comparison with literature:

1) Published work on digital health data governance in low- and middle-income countries emphasizes that data-driven health programmes require clear ethical oversight, data-access controls, responsible data stewardship and appropriate legal safeguards. This supports the DMA finding that technical capability should be accompanied by governance and accountability arrangements [4].
2) The DMA also suggests that technical readiness alone does not guarantee routine use of data for decision-making. A scoping review of routine health data use in low- and middle-income countries identified workforce capacity and user-friendly data-collection tools as important at facility level, while analytical capacity and governance structures were important at district and national levels. These findings are consistent with the need to strengthen leadership, workforce skills and institutional arrangements alongside technical systems [5].

5.3. Business Process Mapping and Workflow Efficiency

The BPM analysis identified manual, fragmented and siloed processes in the PNG settings assessed, including paper-based requisitions, duplicated spreadsheets and weak accountability loops. The above findings in Tables 7 and 8 showed the "As Is" and "As Desired" BPMs of a logistics company. Comparative research from Ghana identifies gaps in supply-chain data visibility and coordination, while an Ethiopian assessment of procurement and supply-chain reforms found that performance improved in some areas even as other challenges persisted [12, 13]. These studies support the importance of evaluating processes and performance across the wider supply chain, but they do not independently verify the specific delays observed in PNG [2, 6].

Comparison with literature:

1) Evidence from Ghana describes the use of an integrated electronic logistics management information system to improve the timeliness, visibility, completeness and accuracy of supply-chain information. The literature supports the potential of integrated digital systems to improve information visibility; however, a specific reduction in lead times of up to 40% should only be stated if a directly verifiable study reporting that estimate is cited [2].
2) The BPM findings on duplicated records and siloed reporting are consistent with literature describing fragmented supply-chain information and coordination challenges. Ghana's supply-chain assessment identified gaps in data visibility, coordination and alignment across functions and agencies. In Ethiopia, research on supply-chain reforms has also documented that improvements in some procurement indicators can coexist with continuing delays for other commodities, illustrating why workflow and system changes need to be assessed across the wider supply chain [2, 6].

This study advances the evidence base on medical supply chain reform in Papua New Guinea in several important ways:

1) *Integrated Assessment Approach*- Unlike prior studies that focus on single dimensions of supply chain performance, this research combines three complementary assessments — the National Supply Chain Assessment (NSCA), the Data Maturity Assessment (DMA), and Business Process Mapping (BPM). This triangulation provides a holistic baseline that captures operational maturity, organizational readiness for data-driven decision-making, and workflow efficiency.
2) *Evidence-Based Reform Roadmap (2026–2030)*- The findings directly inform the Monitoring & Evaluation and Data Strategy Implementation Framework, offering the first comprehensive roadmap that aligns technical reforms with governance, accountability, and workforce development. This framework embeds KPI-linked reporting, digitization, and ethical safeguards into supply chain reform.
3) *Participatory Workflow Redesign* -The use of Bizagi BPMN software and stakeholder workshops to co-design "As-Desired" workflows represents a methodological innovation. By engaging Provincial Health Authorities and frontline actors in process mapping, the study ensures that proposed reforms are both technically feasible and institutionally owned.
4) *Diagnosis of the Governance–Technology Paradox* The study highlights a critical paradox: organizations are becoming technically capable but remain strategically adrift due to weak governance and workforce gaps. This framing contributes to global debates on digital health governance by emphasizing that technical investments must be matched with leadership, accountability, and culture change.

Together, these innovations position the study not only as a diagnostic exercise but also as a strategic blueprint for transforming PNG's medical supply chain into a resilient, transparent, and data-driven system.

6. Conclusions

This study reveals that Papua New Guinea's medical supply chain remains at low maturity, with persistent weaknesses in governance, workforce capacity, quality assurance, and system integration. While financial sustainability and isolated warehousing practices show progress, data maturity assessments highlight a gap between technical capability and strategic leadership, and business process mapping confirms that manual, fragmented workflows continue to undermine efficiency.

The significance of these findings is clear: technical systems alone cannot ensure resilience. Sustainable reform requires integrated investment in governance, workforce skills, ethical safeguards, and digitized processes. The Monitoring & Evaluation and Data Strategic Implementation Framework (2026–2030) offers a pathway to build a transparent, accountable, and data-driven supply chain that strengthens responsiveness, reduces wastage, and improves equitable access to essential medicines.

Abbreviations

ADR	Adverse Drug Reaction
AMS	Area Medical Store
BPM	Business Process Mapping
CPHA	Central Provincial Health Authority
DMA	Data Maturity Assessment
ECL	Express Customs Limited
FEFO/FIFO	First Expiry First Out / First in First Out
HIV	Human Immunodeficiency Virus
HR	Human Resources
KPI	Key Performance Indicator
LMIS	Logistics Management Information System
MA Certificate	Marketing Authorization Certificate
M&E	Monitoring and Evaluation
MEC	Medical Evaluation Committee
MSIV	Medical Supply Issue Voucher
MSPDD	Medical Supply Procurement Distribution Division
MSPNG	m-Supply Services Papua New Guinea
NDoH	National Department of Health
NHP	National Health Plan
NPRIS	National Product Registration Information System
NSCA	National Supply Chain Assessment
PHA	Provincial Health Authority
PBoPNG	Pharmacy Board of Papua New Guinea
PMRB	Performance Monitoring Research Branch
PMS	Provincial Medical Store
PNG	Papua New Guinea
PSSB	Pharmaceutical Services Standards Branch
QA	Quality Assurance
TB	Tuberculosis
WV	World Vision

Author Contributions

Jonila Kepas: Conceptualization, Resources, Writing – review & editing

Manah Dindi: Data curation, Methodology, Formal Analysis, Investigation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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