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Research Article

Warehouse Operations: Factors Responsible for Incomplete Order Fulfillment in Medicines and Medical Commodities Distribution

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ABSTRACT

Background: Incomplete order fulfillment of medicines and medical commodities to health facilities is a recognised threat to healthcare delivery continuity in public sector supply chains. This study examines supply error records at the Plateau State Drugs and Medical Commodities Management Agency (PS-DMCMA) to identify the operational factors responsible for incomplete order fulfillment incidents across Hospital Management Board (HMB)-managed facilities in Plateau State, Nigeria. Methods: A retrospective review of complaint and supply error tracker records documented between August 2025 and May 2026 was conducted. Data were extracted from a structured Excel-based error tracker capturing facility name, error type, complaint details, possible causes, transfer price value in naira, corrective action, resolution status, and resolution time. Results: Incomplete order fulfillment events were documented across multiple months and facilities. The principal causal factors were: pick-and-pack errors, confirmation errors, loading errors, requisition errors, short-dated products, and wrong commodity supply. The aggregate transfer price value of undersupplied commodities across December 2025, January 2026, and May 2026 exceeded ₦2,452,477. Conclusion: Pick-and-pack errors and confirmation errors are the primary operational drivers of incomplete order fulfillment at PS-DMCMA. Systemic corrective actions including dual-check verification protocols at picking and loading, systematic pick-list reconciliation, and strengthened last-mile documentation—are recommended.

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INTRODUCTION

Incomplete order fulfillment of medicines and medical commodities is a widely documented challenge in sub-Saharan African public health supply chains (Yadav, 2015). When health facilities receive fewer units than ordered and invoiced, the consequences cascade into stockouts at the point of care, disruption of clinical protocols, financial reconciliation burdens, and progressive erosion of facility confidence in the supply system (Lugada et al., 2022; Karimi et al., 2021).

The Plateau State Drugs and Medical Commodities Management Agency (PS-DMCMA) is the statutory public sector supply chain body responsible for the procurement, storage, and last-mile distribution of medicines and medical commodities to HMB-managed health facilities across Plateau State, Nigeria. As part of ongoing quality improvement efforts, PS-DMCMA introduced a real-time complaint and supply error tracking system comprising: a dedicated phone line for direct facility calls; a WhatsApp platform for messaging; and a structured commentary section on delivery invoices enabling facility staff to record feedback at the point of receipt. These channels collectively constitute an institutional supply error surveillance system.

Despite verification checks at the point of pick-list creation and at the point of packing and loading, incomplete order fulfillment incidents continue to recur, with documented financial and operational consequences. The published literature identifies warehouse operational failures including poor inventory management, information system weaknesses, and distribution process deficiencies as key contributors to supply discrepancies in essential medicines supply chains (Papalexi et al., 2020; Management Sciences for Health [MSH], 2012). However, context-specific data from state-level public sector supply agencies in Nigeria remain limited (Olutuase et al., 2022).

This paper presents a retrospective analysis of PS-DMCMA supply error tracker records to identify and categorise the operational factors responsible for incomplete order fulfillment, quantify their financial implications, and inform evidence-based corrective action.

METHODS

2.1 Study Design and Setting

A retrospective descriptive study was conducted using routinely collected operational data. The study setting was the PS-DMCMA warehouse and last-mile distribution (LMD) system serving HMB-managed facilities in Plateau State, Nigeria a network encompassing general hospitals, cottage hospitals, and a comprehensive health centre across both urban and rural local government areas.

2.2 Data Source

The primary data source was the PS-DMCMA Supply Error Tracker: a structured Excel workbook maintained on a multi-sheet monthly basis. The tracker captured: date and time of complaint; facility name; error type (e.g., incomplete order fulfillment, excess supply, invoice or product mismatch, wrong commodity); complaint details; possible causes; transfer price value of the error in naira; corrective action taken; resolution status; and resolution time. Entries were reported via the dedicated WhatsApp platform and phone calls by facility pharmacists and other commodity-receiving healthcare staff. Reported errors were validated against conveyor delivery reports.

2.3 Study Period and Inclusion Criteria

Records from August 2025 to May 2026 were reviewed. Only entries classified as, or containing, an incomplete order fulfillment component were included in the primary analysis. Records with incomplete cause attribution were noted but not excluded from the frequency count of causes.

2.4 Data Extraction and Analysis

Error type, possible causes, affected commodities, facilities, and financial values were extracted and tabulated. Causes were classified into five operational categories derived directly from the tracker's own nomenclature: (i) pick-and-pack error; (ii) confirmation error; (iii) loading error; (iv) requisition error; and (v) product-related causes (short expiry, wrong commodity, sourcing issues). Frequency of each cause category and aggregate financial values of incomplete order fulfillment events were calculated across the study period.



2.5 Ethical Considerations

This study is based exclusively on routinely collected, anonymised operational records. No individual patient data were accessed. Ethical approval was not required under applicable national guidelines for retrospective secondary analysis of de-identified administrative records.

RESULTS

3.1 Volume and Distribution of Incomplete Order Fulfillment Events

Incomplete order fulfillment incidents were documented across multiple months and facilities throughout the study period. In the August–October 2025 period, complaints were categorised primarily as invoice or product mismatches, delayed supply, and quantity discrepancies (e.g., 9 packs of capillary tubes and 1 blood bag reported undersupplied). In December 2025, three facilities General Hospital Tunkus, General Hospital Kwal, and General Hospital Mabudi reported incomplete order fulfillment events with an aggregate transfer price value of ₦413,116. January 2026 recorded the highest single-month incomplete order fulfillment value: ₦1,132,203 across four facilities (General Hospital Shendam, General Hospital Barkin Ladi, Cottage Hospital Bokkos, and General Hospital Pankshin). In May 2026, 14 or more discrete incomplete order fulfillment entries were recorded across at least 10 facilities, with an aggregate value of ₦907,158.

3.2 Operational Factors Responsible for Incomplete Order Fulfillment

The tracker's 'Possible Causes' field identified the following operational factors across all documented incomplete order fulfillment events:

- **Pick-and-Pack Error:** The most frequently cited cause, documented in virtually every incomplete order fulfillment event across all months. Pick-and-pack errors occur when warehouse staff select incorrect items, incorrect quantities, or omit items from an order during the fulfillment process.
- **Confirmation Error:** Consistently co-listed with pick-and-pack errors. Confirmation errors represent failures at the verification stage, where

outgoing goods are not adequately checked against the pick list, invoice, or order before loading or dispatch. The simultaneous occurrence of excess supply and incomplete order fulfillment for different products at the same facility documented repeatedly in the tracker data is a hallmark pattern of confirmation failure rather than stock shortage.

- **Loading Error:** Documented as a distinct contributing cause in at least two incidents notably the incomplete supply of Dextrose Saline to Cottage Hospital Bokkos (January 2026; ₦67,200) and surgical gloves to General Hospital Pankshin (May 2026; ₦322,000). Loading errors occur when correctly picked items are either left behind at the warehouse during vehicle loading or placed on the wrong consignment.
- **Requisition Error:** Identified in May 2026 records, specifically in an incident involving laboratory reagents at General Hospital Tunkus. Requisition errors arise upstream, when a facility submits an order containing inaccuracies incorrect quantities, wrong product, or missing items which then propagate downstream as apparent incomplete order fulfillment.
- **Product-Related Factors:** Two additional cause types appeared in May 2026 records: (a) short-dated products Amlodipine tablets (5 mg and 10 mg) were rejected at General Hospital Mabudi due to near-expiry, constituting an effective incomplete order fulfillment; and (b) product sourcing issues the unit cost of Atropine Injection was flagged as excessive, with a value discrepancy of ₦5,060 noted. A wrong commodity error was also documented at General Hospital Tunkus, where 60 mg Artesunate was supplied instead of 120 mg.

3.3 Financial Implications

The aggregate transfer price value of undersupplied commodities documented in the three months with structured financial data (December 2025, January 2026, and May 2026) totalled approximately ₦2,452,477. These figures represent transfer prices not retail or market values and thus likely understate the true economic and clinical cost of the incomplete order fulfillment events. Resolution of incidents typically



required action at the subsequent LMD cycle, with some events recorded as 'In Progress' at the time of data review, indicating prolonged supply gaps at affected facilities.

DISCUSSION

The findings indicate that pick-and-pack errors and confirmation errors are the dominant operational drivers of incomplete order fulfillment within the PS-DMCMA warehouse and distribution system. These errors reflect underlying weaknesses in warehouse operations, distribution planning, and quality control processes at the point of fulfillment.

Although the reviewed literature does not specifically identify pick-and-pack or confirmation errors as named categories, it consistently highlights deficiencies in inventory management, information flow, and distribution processes as key contributors to medicine supply chain discrepancies in sub-Saharan Africa (Yadav, 2015; Olutuase et al., 2022). Papalexi et al. (2020) identified communication failures, process complexity, and inadequate quality control at distribution points as key sources of operational inefficiency in pharmaceutical supply chains—findings that correspond closely to the confirmation and loading error patterns documented at PS-DMCMA. The present findings therefore extend existing evidence by demonstrating how discrete operational errors at the warehouse fulfillment stage contribute to order completion failures within the broader context of public pharmaceutical supply chain management.

The WHO Good Distribution Practices (GDP) guidelines WHO Technical Report Series No. 957, Annex 5 (2010) explicitly require documented dispatch procedures, traceability, stock reconciliation, and accurate distribution records as core components of a pharmaceutical quality system. These standards are intended to minimise distribution errors, facilitate early detection of discrepancies, and ensure that the correct products and quantities reach their intended destinations (World Health Organization, 2010). The PS-DMCMA error tracker represents a foundational step towards this standard; the challenge lies in translating tracker data into systematic process corrections.

The simultaneous co-occurrence of oversupply and incomplete order fulfillment within the same delivery—documented repeatedly in the PS-DMCMA records is operationally significant. This pattern is characteristic of pick-and-pack failures rather than systemic stock shortages, and has important implications for corrective action: interventions should target warehouse-level process improvement rather than procurement expansion.

Loading errors, though less frequently documented as a standalone cause, represent a distinct vulnerability in last-mile distribution particularly where goods are consolidated for multi-facility deliveries on the same vehicle. PS-DMCMA distributes to geographically dispersed facilities across Plateau State's seventeen LGAs, inherently increasing the risk that goods intended for one facility are inadvertently included in another's consignment or left behind at the warehouse. MSH (2012) identifies multi-stop consolidated distribution as a structural risk factor for loading discrepancies in LMIC pharmaceutical supply chains.

The emergence of requisition errors as a contributing factor, though documented in fewer incidents, confirms that incomplete order fulfillment is not solely a warehouse phenomenon. Facility-level capacity to prepare accurate, correctly specified requisitions forms part of the supply chain quality chain. Evidence from Karimi et al. (2021) supports the role of facility-level LMIS capacity in reducing supply chain stock-outs; by extension, improving requisition accuracy at facility level is a complementary intervention to warehouse process correction.

The financial value of incomplete order fulfillment events exceeding ₦2.45 million at transfer prices across just three months of structured data underscores the economic significance of operational errors in public pharmaceutical supply chains. These figures exclude indirect costs including stockout consequences, therapeutic substitutions, emergency procurement, and potential patient harm which may be substantially higher. Seidman and Atun (2017) demonstrated that targeted supply chain process improvements in LMICs yielded measurable cost savings and improved commodity availability; the PS-



DMCMA error tracker provides the data infrastructure needed to pursue analogous targeted improvements.

CONCLUSION AND RECOMMENDATIONS

Pick-and-pack errors and confirmation errors are the principal operational factors responsible for incomplete order fulfillment at PS-DMCMA. The following evidence-based corrective measures are recommended:

- Implement dual-check (four-eyes) verification at both the picking and loading stages, requiring independent confirmation by a second warehouse staff member before any consignment is sealed and dispatched.
- Establish systematic reconciliation of pick lists against invoices and physical goods prior to vehicle loading, with mandatory sign-off by a supervising pharmacist or warehouse officer.
- Deliver structured staff training on Standard Operating Procedures for order fulfillment, with specific modules on pick-list execution, loading verification, and consignment segregation for multi-facility deliveries.
- Strengthen last-mile documentation, including signed Proof of Delivery for all individual line items, to provide an auditable record for post-distribution discrepancy resolution.
- Build facility-level capacity for accurate requisition preparation through standardised requisition tools and periodic training for facility pharmacy and receiving staff.
- Sustain regular use of the supply error tracker with structured monthly review sessions and feedback loops to warehouse staff, to enable continuous improvement and trend monitoring.

Further research should examine the temporal resolution rates of reported incomplete order fulfillment events and the direct clinical impact of commodity gaps at affected facilities.

Limitations

This study is limited to incidents entered into the tracker by reporting staff; unreported events are not captured and the true incidence of incomplete order fulfillment is likely higher. Cause attribution relied on

assessments recorded in the tracker, which reflect the judgement of the reporting officer rather than a formal root-cause analysis. Financial values are based on transfer prices and do not fully reflect the total economic or clinical impact of supply failures.

Declaration

The data used in this study are operational records of PS-DMCMA, used with institutional approval for quality improvement purposes. The authors declare no conflicts of interest.

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