

The Effect of Pharmaceutical Inventory Management Practices on the Performance of Public Health Institutions: Evidence from Ndola Teaching Hospital, Zambia

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Abstract

Effective inventory management is central to the ability of public health institutions to keep essential medicines and medical supplies available, accessible, and appropriately used. This study examined the effect of pharmaceutical inventory management practices on the organizational performance of Ndola Teaching Hospital, a public referral hospital in Zambia's Copperbelt Province. Using a descriptive case-study design combined with a mixed-methods approach, the study administered structured questionnaires to a census of 96 pharmacy, pharmacy-technology, and supply-chain personnel at the hospital. Data were analyzed using descriptive statistics and Pearson correlation, complemented by an ordinary least squares regression of organizational performance on inventory shrinkage, inventory records accuracy, and staff competence level. The results show a weak, statistically non-significant negative correlation between inventory shrinkage and organizational performance ($r = -0.0264$, $p = 0.689$). By contrast, inventory records accuracy ($r = 0.3728$, $p = 0.004$) and staff competence level ($r = 0.2921$, $p = 0.038$) were positively and significantly associated with performance. The regression model explained approximately 19.7% of the variance in organizational performance ($R^2 = 0.1968$, $F(3, 92) = 5.31$, $p = 0.0025$). The findings suggest that, in this setting, accurate record-keeping and workforce competence are more consequential levers of hospital performance than shrinkage control alone. The study recommends that the Ministry of Health and hospital management prioritize staff training

and the strengthening of electronic inventory record systems as part of efforts to improve supply-chain performance in Zambia's public health sector.

Keywords

Inventory Management, Inventory Shrinkage, Inventory Records Accuracy, Staff Competence, Organizational Performance, Public Health Supply Chain, Zambia

1. Introduction

Reliable access to medicines and medical supplies is a precondition for quality healthcare, and the systems that keep those supplies moving from procurement to the patient bedside are, in large part, inventory management systems. In Zambia, as in many low- and middle-income countries, public hospitals must simultaneously avoid the clinical and reputational costs of stock-outs and the financial costs of overstocking, expiry, and shrinkage (Coyle et al., 2003). Ndola Teaching Hospital, the principal referral facility for the Copperbelt Province, illustrates both the stakes and the difficulty of this balancing act: it depends on a functioning pharmacy supply chain to serve a large catchment population, yet, like many public facilities in the region, it has struggled to keep essential-medicine availability above the 80% benchmark recommended for public health systems.

Zambia, with donor support, has invested in strengthening its pharmaceutical supply chain, including the construction of regional warehouse hubs, a new warehouse management system, and the roll-out of an electronic Logistics Management Information System (eLMIS). Since 2003, the Global Fund has disbursed over US\$1.6 billion to Zambia for the HIV, tuberculosis and malaria response, with its malaria investments complemented by the U.S. President's Malaria Initiative (Global Fund Office of the Inspector General [OIG], 2022). Despite this investment, inventory management challenges persist, including unreliable logistics data, uninvestigated stock count variances, capacity gaps in key supply chain functions, and recurrent stock-outs. The OIG audit found that regional hub stock count variances were not investigated, that the electronic logistics management information system covered only 45% of health facilities, and that the Ministry of Health's pharmaceutical services department had only one staff member in place (OIG, 2022). Between October 2021 and April 2022, an average of 26% of facilities in Southern Province reported stock-outs of antiretrovirals and 48% reported stock-outs of essential medicines, according to Choma regional hub reports cited in the audit (OIG, 2022). (World Health Organization [WHO], 2015). National audit processes have repeatedly flagged weaknesses in stock accounting and losses from expired or unaccounted-for medicines in public hospitals, underscoring that the problem is systemic rather than confined to any single facility (Office of the Auditor General of Zambia [OAG], 2021).

Against this backdrop, this study investigates how three dimensions of inven-

tory management practice, namely inventory shrinkage, inventory records accuracy, and staff competence level, relate to the organizational performance of Ndola Teaching Hospital. Specifically, the study sought to (i) determine the effect of inventory shrinkage on organizational performance, (ii) establish the effect of inventory records accuracy on organizational performance, and (iii) establish the effect of pharmacy staff competence on organizational performance. By quantifying these relationships, the study aims to give hospital management and policy-makers an evidence base for prioritizing interventions, whether in security and loss-prevention controls, records systems, or staff training.

2. Literature Review

2.1. Conceptual Definitions

Inventory management is understood here as the coordinated set of activities involved in procuring, storing, distributing, and accounting for medicines and medical supplies so that patients and clinical staff can obtain what they need, when they need it, while costs and losses are kept within acceptable bounds (Coyle et al., 2003). Three constructs anchor the empirical analysis. Inventory shrinkage refers to the loss of inventory through causes such as expiry, damage, theft, or obsolescence, and is typically measured as the gap between recorded and physically verified stock (APICS, 2016; National Retail Federation, 2020; Oballah et al., 2015). Inventory records accuracy refers to the degree to which recorded stock data (quantities, locations, descriptions) correspond to physical stock on hand (APICS, 2016). Staff competence level refers to the knowledge, skills, and proficiency of personnel responsible for inventory-related tasks. Organizational performance, the outcome of interest, is operationalized through indicators of service delivery that are meaningful in a hospital pharmacy context: drug availability, planning and scheduling effectiveness, and perceived contribution to patient/customer service.

2.2. Empirical Review

In public health supply systems, the costs of poor inventory practice include shortage costs (emergency procurement, clinical delay, patient risk) and holding costs (storage, handling, obsolescence, and loss) (Management Sciences for Health, 2012). Where forecasts diverge from actual demand, facilities tend either toward stock-outs or toward costly excess holding, both of which erode performance (Onkundi & Bichanga, 2016). In the East African public-hospital context, Oballah, Waiganjo, and Wachiuri (2015) found that inventory shrinkage was negatively associated with organizational performance while inventory-records accuracy was positively associated with it, a pattern broadly consistent with the theoretical expectation that loss control and record integrity pull performance in opposite directions when one is weak.

Within the African public-health sector specifically, Mengesha et al. (2021) documented that weak inventory-control practices for anti-malarial medicines in Ethiopian public facilities produced avoidable stock-outs and wastage, and Bekele,

Kumsa, and Ayalew (2022) similarly found significant gaps in inventory management for maternal and child health commodities in Ethiopian public hospitals. In Zambia specifically, the World Health Organization's assessment of the country's multi-tiered medicine distribution system found persistent gaps between the intended and actual. Outside the health sector, John et al. (2015) reported that flour milling firms in Nigeria that adopted best-practice, model-based inventory management achieved better capacity utilization, higher service levels and shorter lead times than firms relying on ad hoc, demand-based approaches. Similarly, Ogbo et al. (2014) found that effective inventory control was associated with improved sales effectiveness and reduced operational costs at a Nigerian bottling company, and Okumu and Bett (2019) found that economic order quantity and inventory control practices were positively and significantly correlated with the performance of steel firms in Kenya. These findings, while drawn from adjacent sectors, support the general proposition that the quality of inventory practice, not merely its existence, is associated with organizational outcomes and actual performance of the public supply chain, particularly at the point where central-level stock is translated into facility-level availability (WHO, 2015), while national audit reports have repeatedly identified stock discrepancies and losses from expired or unaccounted-for medicines in public hospitals as a recurring weakness (OAG, 2021). Taken together, the regional and Zambian evidence suggests that inventory shrinkage, records accuracy, and staff competence are plausible, complementary levers for improving hospital pharmacy performance, which is the premise this study tests empirically at Ndola Teaching Hospital.

2.3. Theoretical Framework

The study draws on the Theory of Constraints, which holds that the performance of any system is limited by a small number of binding constraints at any given time, and that performance improves when those constraints are identified and systematically addressed rather than treated as fixed (Goldratt & Cox, 1984). Mokgatlha and Kadama (2017) apply this reasoning to a public-sector pharmaceutical supply chain, showing that constraints arise at each link between the medical stores, the hospital and its clinics, and that identifying and addressing them improves the availability of supplies. Applied to hospital pharmacy inventory, the theory frames shrinkage, records inaccuracy, and staff incompetence as candidate constraints on performance: each represents a point at which the flow of usable stock to patients can be interrupted or degraded, and each is, in principle, manageable through targeted intervention. A comparable approach is taken by Kanda and Iravo (2015), who draw on the Theory of Constraints to examine procurement processes, ICT infrastructure, distribution channels and staff competency as factors affecting the efficiency of the medical supply chain to public health centres in Kenya.

2.4. Conceptual Framework

Following Jabareen's (2009) account of a conceptual framework as an interlinked network of constructs that together explain a phenomenon, this study conceptu-

alizes inventory shrinkage, inventory records accuracy, and staff competence level as independent variables acting on organizational performance, the dependent variable (**Figure 1**). The framework guided both the design of the survey instrument and the specification of the regression model reported in Section 4.

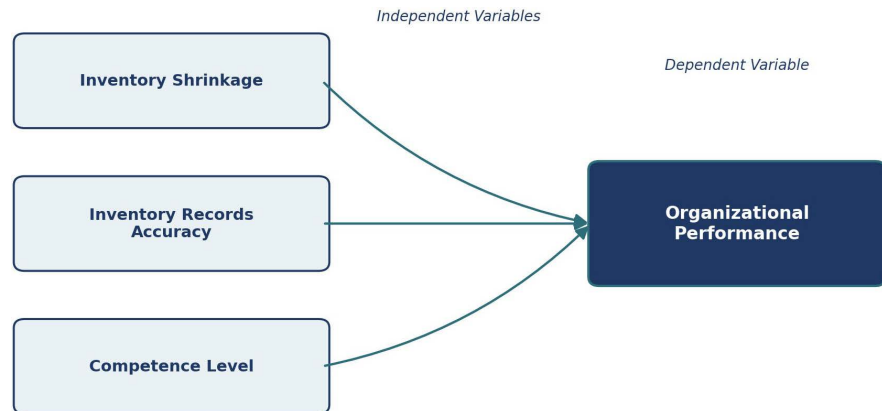


Figure 1. Conceptual framework linking inventory management practices to organizational performance.

3. Materials and Methods

3.1. Research Design

The study adopted a descriptive case-study design combined with a mixed-methods approach, integrating quantitative survey data with open-ended qualitative responses. A case-study design was selected because it allows an in-depth, contextually grounded account of inventory management practice at a single, purposively selected institution, rather than a shallower comparison across many facilities (Ellram, 1996; Mustaffa & Potter, 2009), and descriptive research of this kind is well suited to capturing the present state of a phenomenon.

3.2. Study Population and Sample

Ndola Teaching Hospital employs approximately 500 healthcare workers across clinical and non-clinical functions. The target population for this study, however, was the subset of staff directly involved in pharmaceutical inventory management: pharmacists, pharmacy technologists, and supply-chain/logistics personnel, comprising a total of 96 eligible staff. Given the manageable size of this target group relative to the wider hospital workforce, the study adopted a census approach, inviting all 96 eligible staff to participate rather than drawing a probability sample from the larger population of 500. All 96 questionnaires were completed and returned, yielding a 100% response rate within the target population. This census strategy, rather than a probability sample, is the primary reason the achieved sample is smaller than the hospital's total workforce: it reflects the size of the eligible population, not a sampling shortfall, though single-site, cross-sectional data of this kind still limit generalization beyond Ndola Teaching Hospital (see Section 6).

3.3. Data Collection

Primary data were collected using a structured questionnaire administered via Google Forms over a two-week window, combining closed five-point Likert-scale items (1 = strongly disagree to 5 = strongly agree) with open-ended questions.

3.4. Data Analysis

Quantitative data were analyzed in SPSS (version 20). Descriptive statistics (frequencies and percentages) were used to summarize demographic characteristics and Likert-scale responses. The Shapiro-Wilk test and visual inspection of Q-Q plots indicated that the outcome variable departed from normality; logarithmic, square-root, and reciprocal transformations did not materially improve normality. Given this, and consistent with common practice for moderately sized survey samples, Pearson correlation and ordinary least squares (OLS) regression were retained as the primary inferential tools, with results interpreted cautiously in light of the non-normality. Pearson's correlation coefficient was used to assess the strength and direction of association between organizational performance and each of the three independent variables, and a multiple linear regression was estimated with organizational performance as the dependent variable. Open-ended responses were analyzed thematically.

3.5. Ethical Considerations

The study received ethical clearance from the Ethics Review Committee of the University of Lusaka. Participation was voluntary and based on informed consent; respondent identities were not recorded, and all data were held confidentially and reported only in aggregate form.

4. Results

4.1. Demographic Characteristics of Respondents

Table 1 summarizes the demographic profile of the 96 respondents. The sample was slightly female-majority (54.0%), concentrated in the 30 - 39 age band (59.4%) and the pharmacist and pharmacy-technologist professions (91.3% combined), and reasonably experienced, with 58.0% reporting five or more years of service at the hospital.

Table 1. Demographic characteristics of respondents (N = 96).

Characteristic	Category	n	%
Gender	Female	52	54.01
	Male	44	46.03
Age (years)	20 - 29	29	30.43
	30 - 39	57	59.42
	40 and above	10	10.14

Continued

Profession	Pharmacist	56	57.97
	Pharmacy Technologist	32	33.33
	Other	8	8.70
Education	Master's degree	10	10.14
	Bachelor's degree	50	52.17
	Diploma	35	36.23
	Certificate	1	1.45
Tenure at NTH (years)	0 - 4	40	42.03
	5 - 9	39	40.58
	10 and above	17	17.39

4.2. Perceived Inventory Management Practices

Table 2 summarizes respondents' agreement with statements on inventory shrinkage, records accuracy, competence, and organizational performance. The strongest agreement, at or above 90%, concerned the effect of long procurement procedures on performance (97.1%), up-to-date records on accuracy (93.2%), and proper inventory management on customer service (92.75%). Among the drivers of shrinkage, damage (82.6%) and obsolescence (81.2%) were seen as considerably more consequential than theft (59.4%). Competence in pharmaceutical inventory management was rated moderately high or high by all respondents (100%), and on-the-job training was the most strongly preferred development modality (92.75%).

Table 2. Summary of perceived inventory management practices, by construct.

Construct	Survey item	% Agree/Strongly Agree
Inventory Shrinkage	Medicine expiration increases shrinkage	66.66
	Medicine damage increases shrinkage	82.61
	Medicine theft increases shrinkage	59.42
	Medicine obsolescence increases shrinkage	81.16
Records Accuracy	Up-to-date records affect accuracy	93.20
	Complete accounting records affect accuracy	85.51
	Proper records management affects accuracy	71.01
Competence & Training	Competence rated moderately high or high	100.00
	Support for continuing education programs	88.41
	Support for off-the-job training	88.40
	Support for on-the-job training	92.75

Continued

	Inventory management contributes to performance	63.57
	Inventory management aids planning/scheduling	79.71
Organizational Performance	Long procurement procedures undermine performance	97.10
	Insufficient funding contributes to poor performance	82.61
	Proper inventory management improves customer service	92.75

4.3. Qualitative Feedback

Open-ended responses converged on two dominant themes: about two-fifths of respondents (40.6%) called for more skilled, adequately staffed inventory teams and continued on-site training, and close to half (49.3%) called for faster, more capable inventory software. Smaller numbers raised regular stock assessments, closer ward-level monitoring, and openness to innovation. These themes reinforce the quantitative pattern: staff capability and systems, more than shrinkage control alone, dominated respondents' own framing of what would improve inventory management at the hospital.

4.4. Correlation Analysis

Table 3 presents the Pearson correlation matrix. Organizational performance was weakly and non-significantly, negatively correlated with inventory shrinkage ($r = -0.0264$). It was positively correlated with competence level ($r = 0.2921$) and, more strongly, with inventory records accuracy ($r = 0.3728$). Among the independent variables themselves, correlations were weak throughout ($r = 0.0015$ to 0.1577), consistent with shrinkage, records accuracy, and competence being related but conceptually distinct practices.

Table 3. Pearson correlation matrix.

	Org. Performance	Inv. Shrinkage	Competence Level	Records Accuracy
Organizational Performance	1.0000			
Inventory Shrinkage	-0.0264	1.0000		
Competence Level	0.2921	0.0015	1.0000	
Inventory Records Accuracy	0.3728	0.0531	0.1577	1.0000

4.5. Regression Analysis

A multiple linear regression of organizational performance on inventory shrinkage, competence level, and inventory records accuracy was statistically significant overall, $F(3, 92) = 5.31$, $p = 0.0025$, explaining approximately 19.7% of the variance in organizational performance ($R^2 = 0.1968$; adjusted $R^2 = 0.1597$; RMSE = 10.184) (Table 4). Inventory shrinkage was not a statistically significant predictor ($b = -0.0356$, $p = 0.689$), whereas both competence level ($b = 0.5632$, $p = 0.038$) and inventory records accuracy ($b = 0.5002$, $p = 0.004$) were statistically significant, positive predictors of performance (Table 5): each one-unit improvement in competence level and in records accuracy was associated with roughly half a unit of predicted improvement in organizational performance.

Table 4. Regression model summary.

R^2	Adjusted R^2	Root MSE	F (3, 92)	Prob > F
0.1968	0.1597	10.184	5.31	0.0025

Table 5. Regression coefficients (dependent variable: organizational performance).

Predictor	Coefficient (b)	Std. Error	t	p
Inventory Shrinkage	-0.0356	0.0887	-0.40	0.689
Competence Level	0.5632	0.2653	2.12	0.038
Inventory Records Accuracy	0.5002	0.1671	2.99	0.004
Constant	5.6000	3.4630	1.62	0.111

5. Discussion

Inventory shrinkage was not a statistically significant predictor of organizational performance at Ndola Teaching Hospital, despite a widely shared perception among staff that expiry, damage, and obsolescence are important loss drivers. This contrasts with Oballah et al. (2015), who concluded that inventory shrinkage negatively affects organizational performance at Kenyatta National Hospital. Their conclusion, however, rested on staff agreement ratings rather than a tested predictive relationship, which suggests that shrinkage's effect on measured performance may be weaker or less direct than its salience in staff perception would suggest. It is nonetheless consistent with a broader literature documenting that shrinkage carries real financial and operational costs for public health facilities, through unplanned replenishment costs, stock-outs, and diverted staff time spent investigating losses rather than delivering care (Ganesh et al., 2011; Pinna et al., 2015), even where its statistical relationship with a composite performance measure is weak in a given sample. This suggests that shrinkage should be managed as a cost- and risk-control issue in its own right, rather than assumed to be the primary lever for improving overall organizational performance.

Inventory records accuracy showed the strongest and most consistent positive

relationship with performance in this study ($r = 0.3728$; $b = 0.5002$, $p = 0.004$), aligning with evidence from Kenyan public-health supply chains that records accuracy significantly improves supply-chain performance and service quality (Odhiambo et al., 2018), and with broader findings linking accurate health-records management to improved service delivery (Ondieki et al., 2017) and linking supply-chain optimization efforts, including at academic medical centers, to more reliable stock accounting (Labuhn et al., 2017). Rashid and Rasheed (2023) similarly found that inventory management mediates the relationship between organizational knowledge and firm performance, while Rodrigue, Slack, and Comtois (2001) note that accurate, well-organized stock-holding is central to controlling carrying costs across a supply chain. Respondents' own framing, in which almost half called for better inventory software, points to a practical pathway: strengthening the hospital's existing electronic Logistics Management Information System, including real-time tracking and automated stock updates, is likely to yield a proportionate improvement in records accuracy and, through it, in overall performance.

Staff competence level was also a significant, positive predictor of performance ($b = 0.5632$, $p = 0.038$), consistent with evidence linking staff competence to inventory management practice and service delivery in public-sector settings (Necho, 2017). The strong staff preference for on-the-job training (92.75%) suggests that structured, practice-embedded training, rather than classroom instruction alone, may be the more acceptable and potentially more effective modality for building inventory-management competence at the facility.

6. Conclusion and Recommendations

This study examined how inventory shrinkage, inventory records accuracy, and staff competence relate to the organizational performance of Ndola Teaching Hospital, using survey and regression evidence from a full census of the hospital's 96 pharmacy and supply-chain personnel. Contrary to the assumption, implicit in much practitioner attention to loss prevention, that shrinkage is the primary threat to hospital pharmacy performance, the results show that records accuracy and staff competence are the statistically significant, positive drivers of performance ($b = 0.50$ and 0.56 respectively, both $p < 0.05$), while shrinkage, though widely perceived by staff as a problem, was not a significant predictor once the other two practices were accounted for. This reframes the practical priority: for facilities resembling Ndola Teaching Hospital, investment in record-keeping systems and workforce competence is likely to move performance more than tightening loss controls alone, a nuance the existing regional literature, which treats shrinkage as a headline concern, has not clearly separated out.

Building on this evidence, the study recommends that hospital and Ministry of Health decision-makers (1) accelerate functional use of electronic Logistics Management Information Systems with real-time stock tracking; (2) institute regular, reconciled physical inventory audits; (3) expand on-the-job training for inven-

tory-management staff, the modality respondents most strongly preferred; and (4) retain, as a secondary measure, physical loss-prevention controls such as restricted access and secure storage. The study is limited by its single-facility, cross-sectional, self-reported design, which constrains causal inference and generalization beyond Ndola Teaching Hospital; multi-site and longitudinal replication, ideally triangulated with objective stock-reconciliation data, would strengthen confidence in these relationships.

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Author Contributions

Diana Kashell Mwaba conceived and designed the study, collected the data at Ndola Teaching Hospital, performed the data analysis and wrote the original draft of the manuscript. Mathews Sichone and Martina Ngoma contributed to the study design and methodology, supported the data analysis and interpretation of results, and reviewed and edited the manuscript. Shepherd Khondowe supervised the study and provided guidance on the research design and on interpreting the findings. Christina Chisanga contributed to developing the methodology and the data collection tools, and supported validation of the results. Hope Kalasa and Lawrence Simovwe assisted with data collection, data entry and data management. All authors critically reviewed and approved the final version of the manuscript for publication.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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