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Determinants of Reverse Logistics Adoption for Medical Supplies and Pharmaceutical Waste: A Case Study of Kabwe District, Zambia

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Abstract

Reverse logistics (RL) for medical supplies and pharmaceutical waste remains underexamined in sub-Saharan Africa, despite rising volumes of expired medicines and increasing regulatory pressure for environmentally sound disposal. This study examined the determinants of RL adoption in Kabwe District, Zambia. Grounded in Institutional Theory and the Resource-Based View, the study employed a convergent parallel mixed-methods design.

Quantitative data were collected through questionnaires administered to 136 health facility and pharmacy personnel, while qualitative data were gathered through 15 key informant interviews and 8 focus group discussions. Binary logistic regression, chi-square tests, and thematic analysis were used. Most facilities (69.9%) demonstrated moderate RL adoption (scores of 3–4 on a five-item index), while only 9.6% showed high adoption. In the bivariate analysis, e-LMIS use emerged as the strongest predictor of good RL practices (OR = 9.23, $p < 0.001$). In the multivariable model, training showed a positive but marginal association with good RL practices (aOR = 3.57, $p = 0.061$), barrier count was significantly associated (aOR = 2.52, $p = 0.002$), while rural health posts (aOR = 0.14, $p = 0.017$) and private pharmacies (aOR = 0.08, $p = 0.002$) had substantially lower odds of good practices than hospitals (Nagelkerke pseudo-$R^2 = 0.344$).

Qualitative findings indicated that the main barriers were structural and operational rather than primarily attitudinal. The findings extend Institutional Theory and the Resource-Based View to health-system RL in low- and middle-income countries, with practical implications for policy and practice.

Keywords: *reverse logistics, pharmaceutical waste, medical supplies, institutional theory, resource-based view, Zambia, health supply chain*

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1.0 INTRODUCTION

Health supply chains in low- and middle-income countries (LMICs) face a dual challenge: ensuring the forward distribution of essential medicines while also managing the reverse flow of expired, damaged, or recalled pharmaceutical products and healthcare waste. Reverse logistics (RL), defined as the process of planning, implementing, and controlling the efficient and cost-effective flow of materials from the point of consumption to the point of origin for value recapture

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or proper disposal (Rogers & Tibben-Lembke, 1999), has received substantial attention in manufacturing and retail but remains less developed in healthcare settings, particularly in sub-Saharan Africa. The consequences of weak pharmaceutical RL extend beyond operational inefficiency. Improper disposal of medicines can contaminate water sources, contribute to antimicrobial resistance, and pose direct risks to waste handlers and surrounding communities (Ruhoy & Daughton, 2008). The World Health Organization (WHO) estimates that approximately 15% of healthcare waste is hazardous, including pharmaceutical waste requiring specialised treatment (World Health Organization, 2014). In resource-constrained settings, this hazardous fraction is often managed in the same way as general waste. The links between pharmaceutical waste management and the Sustainable Development Goals, particularly SDG 3, SDG 6, and SDG 12, further underline the policy importance of strengthening RL systems in LMICs (United Nations, n.d.).

Zambia provides an important policy context for examining RL adoption, while Kabwe District offers the empirical case for this study. The country's public health supply chain, managed by the Zambia Medicines and Medical Supplies Agency (ZAMMSA), serves more than 3,800 health facilities. Since 2019, ZAMMSA has progressively rolled out an electronic Logistics Management Information System (e-LMIS) to support ordering, stock management, and consumption reporting (Vledder et al., 2019). However, the system was designed primarily for forward logistics, and its ability to capture reverse flows remains limited. A national assessment found that only 30% of facilities fully captured RL data within the system (Ministry of Health, 2024).

Kabwe District in Central Province was selected as the study site. As a peri-urban district with two hospitals, 29 health centres, and about 12 licensed private pharmacies, Kabwe includes a mix of facility types that reflects the broader Zambian health system. The district's supply chain challenges, including periodic stock-outs, overstocking, and limited waste disposal infrastructure, are well documented (Schultz & Lundmark, 2021) and mirror wider national patterns. Yet no previous study has systematically examined the institutional, organisational, and resource-related factors that shape the extent to which individual facilities adopt RL practices.

This article draws on two complementary theoretical lenses. Institutional Theory (IT) explains how organisations respond to regulatory, normative, and cultural-cognitive pressures in order to secure legitimacy (Meyer & Rowan, 1977). The Resource-Based View (RBV), by contrast, focuses on the internal capabilities, including financial resources, trained personnel, infrastructure, and information systems, that enable organisations to translate institutional expectations into practice (Barney, 1991). Used together, IT and RBV help explain why RL adoption varies across facilities operating within the same regulatory environment but with different levels of organisational capacity.

The study had three objectives: first, to assess the current state of RL practices across public and private health facilities in Kabwe District; second, to identify the institutional and resource-based factors associated with RL adoption; and third, to propose practical measures for strengthening RL governance in Zambia's health supply chain. To address these objectives, the study used a convergent parallel mixed-methods case study design, combining quantitative survey data (n = 136) with qualitative insights from 15 key informant interviews and 8 focus group discussions.

2.0 LITERATURE REVIEW

2.1 Reverse Logistics in Healthcare: A Global Perspective

The concept of reverse logistics has developed substantially since its early formulation as "retro-distribution" in the 1970s. The definition proposed by Rogers and Tibben-Lembke (1999) remains one of the most widely used in the field. In healthcare, RL includes the return of expired or recalled pharmaceuticals, the reprocessing of medical devices, the recycling of packaging materials, and the safe disposal of infectious and hazardous waste (Govindan et al., 2015). Since 2015, the literature on healthcare RL has grown steadily, reflecting increased concern about

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environmental sustainability, pharmaceutical pollution, and the financial burden associated with expired medicine stockpiles (Campos et al., 2017).

2.2 Healthcare Reverse Logistics in Africa and LMICs

Health systems in Africa face distinct challenges in implementing RL. Chisholm et al. (2021) found that medical waste management across the continent is marked by inconsistent segregation, inadequate treatment technologies, weak regulatory enforcement, and chronic underfunding. Earlier work by Mwanza and Phiri (2013) in Bulawayo, Zimbabwe, demonstrated the value of integrated waste management models that incorporate environmental regulations, performance measurement, and source-based waste characterization, principles that remain relevant for pharmaceutical waste systems in Africa. Studies in other African contexts have similarly shown that public health facilities lack standardised return protocols for expired pharmaceuticals (Tesfahun et al., 2016). In Ghana, Kwateng et al. (2014) found that outpatient pharmaceutical waste management was weak across government facilities, with rural centres performing significantly worse because of geographic isolation, transport constraints, and staffing shortages.

The limited literature on pharmaceutical RL in Africa points to a consistent set of barriers: weak regulatory frameworks, limited financial resources, shortages of trained personnel, poor transport infrastructure, and underdeveloped information systems (Campos et al., 2017; Owusu-Kwateng et al., 2014; Windfeld & Brooks, 2015). These constraints often reinforce one another. Even where regulations exist, implementation is frequently weakened by limited resources (Awodele et al., 2016). Transport constraints, for example, can create a cycle in which facilities are unable to return expired products, leading to stock accumulation, pressure on storage space, and a higher risk of dispensing errors (Yadav, 2015).

2.3 The Zambian Context

Zambia's health supply chain has undergone important reforms in recent years, most notably the establishment of ZAMMSA in 2018. Although the e-LMIS has improved visibility in the forward supply chain (Vledder et al., 2019), far less attention has been given to reverse flows. Recent studies point to several related challenges. Mwanaumo et al. (2023) assessed the last mile delivery logistics of ZAMMSA and identified distribution challenges that also affect reverse flows. Bwalya and Mutono-Mwanza (2025) reported high pharmaceutical expiry rates linked to over-ordering and weak demand forecasting. Matafwali (2024) identified substantial RL inefficiencies in private pharmacies. Recent assessments have revealed major data gaps in RL tracking within the e-LMIS, while Chopo and Mwanza (2024) provided the first explicit assessment of RL in Zambia's medical supply chain. Against this background, this article presents a facility-level empirical analysis of the factors associated with RL adoption using a theoretically grounded mixed-methods design.

2.4 Theoretical Framework

This study draws on Institutional Theory and the Resource-Based View as complementary lenses for explaining RL adoption. Institutional Theory, as developed by Meyer and Rowan (1977), explains how organisations adopt practices not only for technical efficiency but also in response to institutional pressures that confer legitimacy. It highlights three main mechanisms: coercive pressures arising from regulatory requirements, normative pressures linked to professional standards and training expectations, and mimetic pressures shaped by the imitation of apparently successful peers. In the Zambian health supply chain, coercive pressures include the Medicines and Allied Substances Act (Republic of Zambia, 2013) and environmental health regulations; normative pressures stem from WHO guidelines and pharmaceutical training norms; and mimetic pressures may arise through demonstration effects from better-resourced hospitals or donor-supported programmes.

The Resource-Based View complements Institutional Theory by focusing on the internal resources and capabilities that allow organisations to respond effectively to these external pressures. Barney (1991) argued that sustained competitive advantage depends on resources

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that are valuable, rare, inimitable, and non-substitutable. In a public health setting, relevant resources include trained staff with waste management competencies, physical infrastructure, and information systems capable of capturing reverse-flow data. Prakash and Barua (2016) showed the relevance of RBV to hospital RL in India, finding that resource adequacy explained a significant share of variation in RL performance. Taken together, IT and RBV make it possible to examine both the external pressures that encourage RL adoption and the internal capabilities that support it in practice.

3.0 METHODOLOGY

3.1 Research Design

The study used a convergent parallel mixed-methods case study design (Creswell and Plano Clark, 2017), combining quantitative and qualitative data collection and analysis within a single case, Kabwe District (Yin, 2018). The quantitative component was used to assess levels of RL adoption and identify associated predictor variables, while the qualitative component provided contextual depth and explanatory insight. Both strands were collected concurrently in October 2025 and analysed separately before being integrated at the interpretation stage.

3.2 Study Setting and Population

Kabwe District, located in Zambia's Central Province, was purposively selected as the study site. The district's health infrastructure includes two hospitals, 29 health centres, and about 12 licensed private pharmacies (ZAMRA, 2023). This mix of facilities provides variation in facility type, location, ownership, and resource capacity. The study population consisted of all personnel involved in pharmaceutical supply chain management, inventory control, or waste management across these facilities, estimated at 204 individuals.

3.3 Sampling and Sample Size

The quantitative component used stratified proportionate sampling. Yamane's (1967) formula, $n = N / (1 + Ne^2)$, was applied using N = 204, a 5% margin of error, and a 95% confidence level, resulting in a minimum sample size of 135. A total of 136 valid questionnaires were completed and included in the analysis. Respondents were stratified by facility type: hospitals (36.8%), urban health centres (27.2%), rural health posts (16.2%), and private pharmacies (12.5%), with the remaining respondents drawn from the district health office staff (7.4%). For the qualitative component, purposive sampling was used to select 15 key informants and 8 focus group discussions, each comprising six to eight participants.

3.4 Data Collection Instruments

The quantitative instrument was a structured self-administered questionnaire with five sections: demographic and facility characteristics; RL practice adoption, measured through a composite index of five binary items covering designated storage, documentation, return scheduling, e-LMIS capture, and compliant disposal; institutional factors; resource adequacy; and perceived barriers. The instrument was pilot-tested with 15 respondents from a neighbouring district. Internal consistency was assessed using Cronbach's alpha: RL practices ($\alpha = 0.78$), institutional factors ($\alpha = 0.81$), and resource adequacy ($\alpha = 0.74$), all of which exceeded the 0.70 threshold (Field, 2018).

Qualitative data were collected through semi-structured interview guides and focus group discussion facilitation protocols organised around the study's theoretical framework. Interviews and FGDs were audio-recorded with informed consent, conducted in English and Bemba where appropriate, and lasted 40–60 minutes for interviews and 60–90 minutes for FGDs.

3.5 Data Analysis

Quantitative data were analysed using SPSS version 26. The RL Practices Index was calculated as the sum of five binary items, giving a score range of 0–5, and was then dichotomised at a score of 3 or above to classify facilities as having good RL practices for regression analysis. Descriptive statistics were used to summarise the sample and RL practice patterns. Bivariate

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associations were tested using chi-square analysis, and odds ratios with 95% confidence intervals were calculated. Variables with p-values below 0.25 in the bivariate analysis were entered into a multivariable binary logistic regression model. The final model included training in RL or waste management, system maturity, barrier count, facility stratum, and professional experience. Adjusted odds ratios with 95% confidence intervals were reported, and model fit was assessed using the Nagelkerke pseudo-R^2.

Qualitative data were analysed using Braun and Clarke's (2006) six-phase thematic approach. Transcripts were coded both inductively and deductively, with deductive codes informed by the IT–RBV framework. Trustworthiness was strengthened through member checking, peer debriefing, and thick description (Lincoln and Guba, 1985).

3.6 Ethical Considerations

Ethical clearance was obtained from the University of Zambia Humanities and Social Sciences Research Ethics Committee (reference: HSSREC-2025-SEP-061). Additional authorisation was secured from the Kabwe District Health Office and the National Health Research Authority. Informed consent was obtained from all participants, and data were anonymised to protect confidentiality.

3.7 Data Integration

Quantitative and qualitative findings were integrated following Creswell and Plano Clark's (2017) convergent design protocol. After each strand had been analysed separately, the results were compared using a joint display matrix. Convergence was assessed by identifying areas of corroboration, complementarity, and divergence. Where discrepancies arose, they were examined to generate deeper insight rather than treated as inconsistencies alone (Tashakkori and Teddlie, 2010).

4.0 RESULTS

4.1 Descriptive Profile of RL Practices

The survey achieved a 100% response rate, with all 136 distributed questionnaires completed. Respondents were drawn from hospitals (36.8%), urban health centres (27.2%), rural health posts (16.2%), private pharmacies (12.5%), and district health office staff (7.4%). Only 33.8% reported having received formal training in RL or pharmaceutical waste management. Return scheduling was mainly annual (72.1%), while only 3.7% reported monthly returns. Although 94.9% of facilities had designated storage areas for expired or returned products and all respondents reported some form of documentation, only 30.3% fully captured RL data within the e-LMIS. Reported disposal methods included open burning (31.6%), on-site incineration (22.1%), transfer to the District Health Office (18.4%), return to supplier (12.5%), and burial (9.6%).

Table 1 - *Questionnaire Respondents by Facility Stratum (N = 136)*

Stratum	n	%
Public hospital	50	36.8
Urban health centre	37	27.2
Rural health post	22	16.2
Private pharmacy	17	12.5
District health office/other	10	7.4

Note. Other includes eligible personnel from the District Health Office and specialised units.

The RL Practices Index was constructed from five binary indicators: designated storage, record-keeping, scheduled returns, e-LMIS capture, and compliant disposal. The index had a mean score of 3.29 (SD = 1.02) on a 0–5 scale. Good RL practices were defined as a score of 3 or above,

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indicating the presence of at least three of the five process elements. Table 2 shows the distribution of scores.

Table 2 - *Distribution of RL Practices Index Scores (N = 136)*

Adoption Level	Score Range	n	%
Low	0–2	28	20.6
Moderate	3–4	95	69.9
High	5	13	9.6

Note. Mean ± SD: 3.29 ± 1.02. Good RL practices defined as score ≥3.

Nearly 70% of facilities demonstrated moderate RL adoption, reflecting partial implementation of formal processes. Only 9.6% showed high adoption across all five dimensions, while about one-fifth remained at low adoption levels.

Table 3 - *Primary Disposal Methods for Expired Pharmaceutical Products (N = 136)*

Disposal Method	n	%
Open burning	43	31.6
On-site incineration	30	22.1
Transfer to District Health Office	25	18.4
Return to supplier (ZAMMSA/private)	17	12.5
Burial	13	9.6
Other (flushing, waste authority, unsure)	8	5.8

Note. Multiple methods could be reported.

A substantial proportion of facilities relied on environmentally non-compliant disposal methods, with open burning and burial together accounting for 41.2%. By contrast, only 12.5% reported returning products through formal reverse channels.

4.2 Determinants of RL Adoption

Good RL practices (RL Practices Index score ≥3) were tested for bivariate associations using chi-square tests. Table 4 presents the results.

Table 4 - *Bivariate Associations With Good RL Practices (x^2 Tests)*

Predictor	Comparison	x^2 (df)	p-value	OR (95% CI)
Formal training	Yes vs. No	4.35 (1)	0.037	2.93 (1.03–8.30)
Stratum	Hospitals vs. others	2.10 (1)	0.147	1.98 (0.78–5.07)
e-LMIS use	Yes vs. No	25.19 (1)	<0.001	9.23 (3.55–23.98)

Note. ORs were calculated from 2 × 2 tables with continuity correction applied where necessary.

E-LMIS use was strongly associated with good RL practices (OR = 9.23, p < 0.001), suggesting that facilities using digital platforms were about nine times more likely to report good RL practices. Formal training was also significantly associated at the bivariate level (OR = 2.93, p = 0.037). Hospitals were more likely than other facility types to report good practices, although this difference was not statistically significant (p = 0.147). A multivariable logistic regression

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model was then fitted to identify independent predictors of good RL practices (score ≥ 3), while adjusting for institutional and resource-related factors. Table 5 presents the results.

Table 5 - *Multivariable Logistic Regression for Predictors of Good RL Practices (Score ≥3)*

Predictor	aOR	95% CI	p-value
Training in RL/WM (Yes vs. No)	3.57	0.94–13.53	0.061
System maturity (per 1-point)	1.48	0.81–2.73	0.205
Barrier count (per additional)	2.52	1.41–4.53	0.002
Stratum (ref = Hospital)			
Urban health centre	2.97	0.49–17.82	0.234
Rural health post	0.14	0.03–0.70	0.017
Private pharmacy	0.08	0.02–0.41	0.002
Other/administrative	1.32	0.12–14.27	0.820
Experience (ref = <1 year)			
1–3 years	1.81	0.26–12.56	0.547
4–6 years	4.21	0.53–33.31	0.173
7+ years	0.80	0.10–6.30	0.836

Note. aOR = adjusted odds ratio; CI = confidence interval. Model fit: Nagelkerke pseudo-R^2 = 0.344. Good RL practices defined as RL Practices Index score ≥3.

The model accounted for approximately 34.4% of the variation in RL adoption (Nagelkerke pseudo-R^2 = 0.344). Training in RL or waste management was associated with good RL practices (aOR = 3.57, p = 0.061), indicating a potentially meaningful effect. The positive association between barrier count and good RL practices (aOR = 2.52, p = 0.002) appears counterintuitive. One possible explanation is that facilities more actively engaged in RL are also better able to identify and report operational challenges, rather than barriers themselves leading to better practice.

Facility type was a significant predictor. Rural health posts (aOR = 0.14, p = 0.017) and private pharmacies (aOR = 0.08, p = 0.002) had substantially lower odds of good RL practices than hospitals, pointing to important contextual and resource-related differences. System maturity showed a positive but non-significant association, while years in the current role did not independently predict good RL practices. Overall, the findings suggest that RL adoption is shaped by the interaction between institutional context and resource-related factors, particularly training, facility context, and engagement with operational constraints.

4.3 Reported Barriers to RL Implementation

Table 6 - *Barriers to RL Implementation Reported by Facility Personnel (N = 136)*

Barrier	n	%
Transport limitations for returns	79	58.1
Absence of standard operating procedures	64	47.1
Lack of trained staff	63	46.3
Limited storage space	56	41.2
No dedicated RL budget	25	18.4

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Barrier	n	%
Approval delays from DHO	23	16.9

Note. Multiple responses could be reported.

Transport limitations were the most frequently cited barrier (58.1%), followed by the absence of standard operating procedures (47.1%), lack of trained staff (46.3%), and limited storage space (41.2%). The pattern varied by facility type. Rural health posts reported transport barriers at much higher rates (78.9%) than urban facilities (43.2%), while private pharmacies were more likely to cite the absence of SOPs (68.8%).

4.4 Qualitative Findings

The thematic analysis identified four overarching themes that provided context for the quantitative findings.

4.4.1 The Enforcement Gap

Key informants consistently described a gap between pharmaceutical regulations and their enforcement in practice. Participants reported that inspection visits were infrequent, penalties for non-compliance rarely applied, and regulatory guidance on RL procedures vague. One district pharmacist noted: 'The law says we must dispose of medicines properly, but nobody tells us exactly how or checks whether we do it.' This enforcement gap corresponds to a weakening of coercive institutional pressure.

4.4.2 The Normative Vacuum

Participants described limited professional socialisation into RL practices. The low proportion of respondents who had received formal RL training (33.8%) was reinforced by qualitative accounts indicating that RL was largely absent from pre-service curricula. As one environmental health officer observed, "We learn by watching what others do, not from any official training programme." In the absence of strong normative expectations, mimetic behaviour appeared to become an important mechanism, although its influence was constrained by the limited number of facilities demonstrating strong RL practices.

4.4.3 Resource Complementarity Failure

Qualitative findings showed how individual resource deficits interacted to produce compounding effects. Transport constraints, for example, contributed to storage pressures, documentation burdens, and environmental risks. This pattern of missing complementary resources was especially pronounced in rural settings. As one rural health centre in-charge explained, "Even when we know what to do and keep the records, the products just sit there because no vehicle comes to collect them."

4.4.4 Digital Infrastructure as a Lever

The strong bivariate association between e-LMIS use and RL adoption was echoed in the qualitative data. Participants explained that digital visibility strengthened accountability by enabling supervisors to monitor expiry patterns, ZAMMSA to identify facilities with large return volumes, and district health offices to plan collection schedules more effectively. At the same time, participants noted that the RL module in the e-LMIS was not fully functional in many facilities because of connectivity problems, limited training, and a system design that continued to prioritise forward logistics processes.

5.0 DISCUSSION

The findings add to the limited literature on healthcare reverse logistics in sub-Saharan Africa and show the value of combining Institutional Theory and the Resource-Based View to analyse RL adoption within public health supply chains.

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5.1 Institutional Pressures and the Adoption Paradox

The findings point to a tension within the institutional environment shaping RL practice in Kabwe District and, more broadly, in Zambia's health supply chain. Although a formal regulatory framework is in place, the qualitative data suggest that coercive pressures are weakened by limited enforcement. This pattern is consistent with findings from other African settings (Tesfahun et al., 2016) and Ghana (Kwateng et al., 2014). Meyer and Rowan's (1977) concept of decoupling helps to explain this pattern: many facilities appeared to maintain the visible forms of compliance while continuing to rely on non-compliant disposal practices.

The normative dimension was also important. Only 33.8% of personnel had received formal RL training, and qualitative accounts further indicated that RL was largely absent from professional curricula, pointing to a norma tive gap. The marginal significance of training in the multivariable model (aOR = 3.57, p = 0.061) suggests that where training is available, it may have a meaningful effect, but its limited coverage reduces its broader system-level influence. The wide confidence interval (0.94–13.53) may also reflect sample-size limitations rather than the absence of a substantive relationship.

5.2 Resources as Enablers and Constraints

The bivariate findings also support the relevance of the Resource-Based View. E-LMIS use showed the strongest association with good RL practices (OR = 9.23, p < 0.001), suggesting that information systems act as an organisational capability that shapes how facilities manage RL. By making reverse flows more visible and measurable, the e-LMIS strengthens oversight and coordination in ways that may be understood, in RBV terms, as a valuable organisational resource. This finding is consistent with Subramanian et al. (2020), who identified information systems as an important determinant of sustainability in public health supply chains.

Qualitative findings further suggest that resource gaps were often experienced in combination rather than in isolation, which adds depth to the RBV interpretation. The combined effects of transport constraints, limited storage, and training gaps indicate that the relationship between resources and RL adoption is interactive rather than linear. Interventions that address only one resource constraint at a time are therefore unlikely to produce substantial improvements unless they form part of a broader and mutually reinforcing strategy.

5.3 Facility Type Disparities

The significantly lower odds of good RL practices among rural health posts (aOR = 0.14) and private pharmacies (aOR = 0.08) point to important structural disparities. Rural health posts appear to face a threefold disadvantage: geographic isolation, limited staffing, and restricted fiscal autonomy. These findings are consistent with evidence from other LMIC settings. The particularly low odds observed among private pharmacies are also concerning. Unlike public facilities operating within ZAMMSA's distribution network, private pharmacies remain largely outside the formal RL system. Matafwali (2024) reported a similar pattern, showing that pharmacies lacked both institutional guidance and practical mechanisms for returning pharmaceutical products. This gap matters because private pharmacies account for an increasing share of medicine dispensing in Zambia.

5.4 Interpreting the Barrier-Adoption Association

The positive association between barrier count and good RL practices (aOR = 2.52, p = 0.002) requires careful interpretation. Rather than implying that barriers improve practice, the result may reflect an awareness and engagement effect: facilities that are more actively implementing RL are also more likely to encounter and report operational difficulties, whereas less-engaged facilities may report fewer barriers. This interpretation is consistent with the Resource-Based View, which treats capability development as a learning process (Wernerfelt, 1984), and is further supported by the qualitative findings.

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Table 7- *Summary of Hypothesis Testing*

Hypothesis	Operationalisation	Key Result	Decision
H_{01} / H_{11} (Institutional)	Logistic regression for institutional/contextual variables vs. good RL practices	Significant associations for facility type; rural health posts (aOR = 0.14) and private pharmacies (aOR = 0.08)	Reject H_{01}; support H_{11}
H_{02} / H_{12} (Resource-based)	Bivariate and multivariable analysis for training, e-LMIS, and barriers vs. good RL practices	Strong bivariate association for e-LMIS use (OR = 9.23); multivariable evidence indicates positive associations for training (aOR = 3.57, marginal) and barrier count (aOR = 2.52).	Support H_{12} overall

Note. aOR = adjusted odds ratio; OR = odds ratio (bivariate). Overall, the findings suggest that both institutional and resource-based factors are relevant, although the strength of evidence differs across indicators.

5.5 Towards a Hybrid Logistics Typology

Taken together, the quantitative and qualitative findings suggest that health facilities in Kabwe District operate within a hybrid logistics system in which formal RL elements coexist with informal, ad hoc practices. Most facilities (69.9% at moderate adoption) had put some formal RL components in place while continuing to rely on informal approaches in other areas. This hybrid pattern appears to reflect the interaction between institutional pressures that encourage partial compliance and resource constraints that limit full implementation. The idea of a hybrid logistics system may also be relevant to other LMIC health supply chains undergoing similar transitions.

From an institutional perspective, the coexistence of formal and informal RL elements suggests that facilities may be in a transitional phase of institutional isomorphism, adopting visible structures that signal compliance without yet embedding the organisational routines needed for full implementation. From an RBV perspective, the strong association between e-LMIS use and good RL practices, together with the positive contribution of training, suggests that movement from hybrid to more formalised RL will depend not only on regulatory pressure but also on investment in organisational capabilities.

6.0 CONCLUSION AND RECOMMENDATIONS

This study examined the determinants of reverse logistics adoption for medical supplies and pharmaceutical waste in Kabwe District, Zambia. By combining Institutional Theory and the Resource-Based View within a convergent parallel mixed-methods design, it analysed both the external pressures and the internal capabilities that shape RL practices.

Three main findings stand out. First, RL adoption was generally moderate, with many facilities implementing some formal processes while still relying on informal practices in other areas. This hybrid pattern reflects the interaction between formal regulatory expectations and the resource constraints that limit full compliance. Second, resource-related factors, particularly e-LMIS use as the strongest bivariate predictor and training as an important enabling factor, were closely associated with good RL practices.

At the same time, marked disparities were evident across facility types, with rural health posts and private pharmacies substantially disadvantaged. Third, the main barriers were structural and operational, especially transport limitations, the absence of standard operating procedures, and shortages of trained staff, rather than primarily attitudinal, as indicated by the qualitative findings.

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Taken together, these findings suggest that district-level RL challenges in Kabwe are shaped more by institutional weaknesses and resource constraints than by individual non-compliance. The study therefore recommends strengthening RL through standardised procedures for pharmaceutical returns and disposal, the integration of dedicated RL indicators into the e-LMIS, predictable collection and disposal schedules, periodic staff training in RL and waste management, and targeted support for underperforming facility types, particularly rural health posts and private pharmacies. These measures may also inform broader health supply chain policy and practice in Zambia and other comparable settings.

This article makes three main contributions. First, it adds facility-level empirical evidence on the determinants of RL adoption in a sub-Saharan African health supply chain. Second, it shows the value of combining Institutional Theory and the Resource-Based View to capture both external drivers and internal enablers. Third, the idea of a hybrid logistics system provides a useful way of understanding transitions in RL practice within LMIC health systems.

The study has several limitations. Its single-district design limits generalisability, and the cross-sectional design does not permit causal inference. In addition, the reliance on self-reported RL practices may have introduced social desirability bias. Future research could extend the analysis to multiple districts using multilevel modelling, apply longitudinal designs, and examine the cost-effectiveness of alternative RL strategies. Comparative studies across LMIC health systems would also help assess the wider applicability of this combined theoretical lens beyond the Zambian context.

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Conflict of Interest Statement

The authors declare no conflicts of interest.

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