

Assessing Barriers to Supply Chain Resilience: A Case Study of Perishable Foods among Lusaka Traders

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Abstract

Despite increasing global attention to supply chain disruptions, limited research has focused specifically on the barriers to resilience in perishable food supply chains (PFSCs) in Sub-Saharan Africa. In Zambia, where informal markets play a central role in food distribution, the lack of systematic studies on PFSC resilience presents a significant gap. This study aims to assess the key barriers undermining PFSC resilience in Lusaka, the country's capital, and propose actionable strategies for improvement. Using a mixed-methods approach, data were collected through structured questionnaires administered to 410 perishable food traders and in-depth interviews with 10 stakeholders across key points in the food supply chain. Findings revealed that unpredictable market demand, cited by 31.2% of respondents, was the most significant barrier, followed by lack of financial resources (16.6%) and poor transportation infrastructure (15.9%). Climate change and weather variability, alongside inadequate storage facilities, further exacerbated challenges. Traders implemented strategies such as collaboration, investment in improved storage, and adoption of monitoring tools; however, their effectiveness was constrained by limited financial capacity and technical expertise. The study proposes a multi-faceted resilience framework grounded in the Supply Chain Resilience Framework (SCRF), emphasizing infrastructure development, technology adoption, and stakeholder capacity building. Key policy recommendations include targeted government investment, digital tool promotion, and formation of public-private partnerships to facilitate sustainable PFSC operations. Addressing these barriers is critical to reducing food loss, enhancing food security, and supporting Zambia's broader economic development goals.

Keywords: Supply Chain Resilience, Perishable Foods, Infrastructure, Technology, Food Security, Lusaka.

Introduction

Zambia, a landlocked country in Southern Africa with a population exceeding 19 million, relies heavily on agriculture for food security, employment, and economic development (Mubiru, *et al.* 2022). Approximately 70% of Zambia's population engages in agricultural activities, primarily through subsistence farming, which underscores the sector's socio-economic importance (FAO, 2021). Despite the centrality of agriculture, the country's food supply chains—especially those dealing with perishable goods such as fruits, vegetables, dairy, and meats—face persistent challenges due to infrastructural limitations, climate variability, and market inefficiencies. Perishable food supply chains (PFSCs), which involve

the movement of temperature-sensitive food products from producers to consumers, are particularly vulnerable to disruptions, given the short shelf-life of goods and the need for efficient storage, handling, and transportation systems (Osman et al., 2023).

Globally, food loss and waste remain significant concerns. The Food and Agriculture Organization (FAO) estimates that one-third of food produced globally—approximately 1.3 billion tons—is lost or wasted annually due to supply chain inefficiencies, poor infrastructure, and inadequate storage (FAO, 2021). In developing countries, particularly in Sub-Saharan Africa (SSA), post-harvest losses of perishable foods can reach up to 40% due to lack of cold storage, poor road infrastructure, and limited access to markets (World Bank, 2020). These losses have dire implications not only for food security but also for economic sustainability and environmental conservation. In Zambia, the situation is particularly acute, with an estimated 30% of food production lost annually, predominantly within PFSCs (FAO, 2018). Such inefficiencies exacerbate food insecurity, elevate prices, and erode farmer and trader incomes.

Urban centers like Lusaka, Zambia's capital, serve as critical nodes in the food distribution network. Lusaka's markets—both formal and informal—facilitate the movement of perishable goods from rural producers to urban consumers. However, these markets are characterized by poor infrastructure, fragmented logistics, and volatile market conditions, which undermine PFSC resilience. Moreover, the adverse effects of climate change, including erratic rainfall, droughts, and extreme weather events, further destabilize supply chain operations (Munyua et al., 2023).

In this context, the resilience of supply chains refers to their ability to anticipate, absorb, adapt to, and recover from disruptions. PFSCs are especially vulnerable to such disruptions, given the time-sensitive nature of the goods involved. Lusaka's traders, who are key intermediaries between smallholder farmers and urban consumers, frequently contend with unpredictable market demand, climatic shocks, limited access to refrigeration, and inadequate transport networks, all of which compromise their ability to maintain a consistent and high-quality food supply. Furthermore, the COVID-19 pandemic exposed the fragility of PFSCs across Africa, intensifying calls for systematic approaches to supply chain resilience that go beyond emergency responses (HLPE, 2020; Kamara et al., 2021).

Existing research on supply chain resilience has predominantly focused on global north contexts or large-scale commercial operations, with limited empirical work addressing the specific challenges faced by informal traders in African cities (Kumar & Quaddus, 2022). Furthermore, while significant research has explored general supply chain management and operational risks, limited attention has been paid to the unique challenges facing PFSCs in urban centres across African cities such as Lusaka. Zambia lacks comprehensive empirical studies focused on identifying and addressing PFSC resilience barriers at the micro-level, particularly among informal traders who dominate urban food distribution. This gap constrains the development of evidence-based interventions and policies tailored to the Zambian context. Additionally, addressing these knowledge gaps is crucial, particularly as the United Nations projects that the global population will reach nearly 10 billion by 2050,

placing increased pressure on food systems in urbanizing regions like Lusaka (UN DESA, 2019).

Therefore, this study responds to this gap by assessing the barriers to supply chain resilience within the perishable food sector in Lusaka. By employing a mixed-methods approach, it not only identifies key infrastructural, financial, technological, and environmental barriers but also evaluates the effectiveness of current coping strategies and proposes context-specific resilience frameworks. The findings aim to inform stakeholders—policy makers, traders, and development agencies—on practical interventions that can enhance the sustainability and efficiency of perishable food supply chains in Zambia and similar SSA contexts.

Problem Statement

Food loss and waste are pressing global challenges that have drawn considerable attention in recent years, particularly in the context of achieving Sustainable Development Goal (SDG) 12.3, which seeks to halve per capita global food waste by 2030. Globally, approximately one-third of all food produced—equating to 1.3 billion tons—is lost or wasted annually, with developing countries disproportionately affected due to systemic weaknesses in food supply chains (FAO, 2021). Perishable food supply chains (PFSCs), involving products such as fruits, vegetables, dairy, and meat, are especially prone to post-harvest losses owing to the time-sensitive nature of the goods and the complexity of handling, storage, and distribution processes. In Sub-Saharan Africa, post-harvest losses in PFSCs are particularly severe, with an estimated 30–40% of food losses occurring due to infrastructural inadequacies, limited cold storage, and inefficient logistics (World Bank, 2020).

Zambia exemplifies these challenges, with the Food and Agriculture Organization (FAO, 2018) reporting that up to 30% of the country's total food production is lost annually—most of it in PFSCs. These losses are particularly detrimental to smallholder farmers and informal traders who lack the financial resilience and technological capacity to absorb disruptions. In Lusaka, Zambia's capital and primary urban market hub, the situation is aggravated by unpredictable consumer demand, unreliable transportation networks, and inadequate storage infrastructure, especially in informal markets like Soweto. Moreover, the impact of climate change, including erratic rainfall patterns and temperature extremes, further destabilizes supply chains, leading to increased food spoilage, income loss, and reduced food availability for consumers (Munyua et al., 2023).

Despite growing awareness of PFSC vulnerabilities, most scholarly research in Zambia has focused broadly on agricultural productivity, food security, or general supply chain operations, without systematically exploring the specific barriers to PFSC resilience. Additionally, little is known about the efficacy of coping strategies adopted by traders and whether these strategies can be scaled or supported through policy interventions. This lack

of empirical data and contextual understanding hinders the development of targeted frameworks to enhance PFSC resilience in Zambia.

Given the projected increase in urban populations and food demand, the resilience of Lusaka's PFSCs is critical for national food security. Therefore, this study aims to fill the existing research gap by identifying and analyzing the barriers that undermine PFSC resilience in Lusaka, assessing current mitigation strategies, and proposing a context-specific resilience framework that can guide policy and practical interventions.

Research Objectives

This study is guided by the following objectives:

1. To identify and analyze the key barriers to perishable food supply chain resilience among traders in Lusaka, Zambia.
2. To assess the strategies employed by traders and other stakeholders to enhance resilience within perishable food supply chains.
3. To propose a context-specific resilience framework applicable to perishable food supply chains in Lusaka, with a focus on improving infrastructure, technology adoption, and stakeholder capacity.

Literature Review

Barriers to Perishable Food Supply Chain Resilience

Perishable food supply chains (PFSCs) globally face a series of challenges that compromise their efficiency and sustainability. These include poor infrastructure, lack of access to modern technology, insufficient logistics, inadequate storage facilities, weak market systems, and vulnerability to climate change (Osman et al., 2023). In Sub-Saharan Africa, infrastructural deficits—particularly poor road networks, unreliable electricity supply, and limited refrigerated transport—result in delayed food delivery, increased spoilage, and elevated transaction costs (Igbinovia et al., 2023). For instance, bad road networks not only prolong transportation time but also increase the risk of damage to perishable products, especially in rural-to-urban distribution (Olawale & Alabi, 2023).

Lack of access to technology, such as real-time tracking, cold storage monitoring, and mobile inventory tools, further exacerbates these challenges (Kumar & Quaddus, 2022). In many African contexts, PFSC actors operate informally and often lack the digital literacy or financial resources necessary to adopt such tools. Moreover, insufficient logistics and distribution systems limit market reach for producers and traders, contributing to mismatch between supply and demand (Nnaji et al., 2023).

Climate change and weather variability add another layer of complexity to PFSC resilience. Erratic rainfall patterns, temperature extremes, and climate-induced disruptions affect not only food production but also transportation and storage conditions, leading to higher post-harvest losses (Munyua et al., 2023). These risks, compounded by weak institutional support and financial constraints, significantly reduce the ability of PFSC actors to adapt and recover from shocks.

Strategies to Enhance PFSC Resilience

Addressing these challenges requires a multi-pronged approach. Cold chain development, involving investments in temperature-controlled storage and transport, is one of the most effective strategies for reducing spoilage and maintaining food quality (Ezeani et al., 2023). In Zambia, cold chain infrastructure remains underdeveloped, particularly in informal markets, limiting its effectiveness in mitigating food loss.

Digital technology integration, including mobile platforms for market information, blockchain for traceability, and IoT-based sensors for monitoring, has the potential to improve supply chain transparency and responsiveness (Chirwa & Mweemba, 2024). However, access to these technologies is limited by cost, literacy, and connectivity challenges.

Strengthening local market linkages—such as through producer cooperatives, aggregation centers, and market information systems—can enhance resilience by reducing transaction costs, improving price stability, and increasing trader bargaining power (Kafumbe et al., 2023).

Resilience Frameworks and their Applicability to Zambia

Several models offer insights into how PFSC resilience can be structured. The Supply Chain Resilience Framework (SCRF) categorizes resilience into robustness, flexibility, and redundancy, focusing on risk assessment, mitigation, and recovery strategies (Hendriksen et al., 2023). While SCRF is comprehensive, its application in Zambia is constrained by financial and institutional limitations.

The Resilience Engineering Model emphasizes the capacity of systems to anticipate, absorb, adapt, and recover from disruptions. This model is applicable in Lusaka, where informal PFSC actors often employ adaptive strategies to cope with daily challenges, albeit without systemic support (Braimoh et al., 2018).

The Dynamic Capability Framework focuses on organizational learning and resource reconfiguration in response to external shocks. In PFSCs, this model supports continuous improvement and agility, which are essential for survival in volatile environments (Zhao & Li, 2024).

Finally, a recent integrated assessment framework by Jennings, S., et al. (2023) highlights the importance of combining stakeholder knowledge with climate and land-use modeling to inform resilience strategies in Zambia. Their findings suggest that diversification of crops and investment in irrigation are critical for building resilience in the face of climate extremes—a conclusion highly relevant for PFSC resilience planning in Zambia (Jennings, S., et al., 2023).

Theoretical Framework

This study is underpinned by two complementary theories: Complexity Theory and the Resource-Based View (RBV). These frameworks provide a comprehensive lens through

which to analyze the multifaceted challenges affecting perishable food supply chain (PFSC) resilience in Lusaka.

Complexity Theory

Complexity Theory examines how systems composed of numerous interconnected elements behave under stress. In PFSCs, various actors—including farmers, traders, transporters, and consumers—interact dynamically, and disruptions in one part of the chain can have cascading effects throughout the system. This theory is particularly relevant in the Zambian context, where informal markets, unpredictable climate patterns, and infrastructural deficiencies introduce high levels of complexity. Complexity Theory helps explain how minor disturbances, such as a delay in transportation due to poor road conditions or a sudden price fluctuation, can amplify across the supply chain, leading to significant food loss and economic instability (Khan et al., 2021). It also highlights the need for adaptive capacity and systemic resilience, emphasizing the importance of local context and feedback loops in shaping supply chain outcomes.

Resource-Based View (RBV)

The Resource-Based View (RBV) theory posits that an organization's ability to achieve competitive advantage and resilience is determined by the strategic use of its internal resources—whether tangible (e.g., infrastructure, technology) or intangible (e.g., expertise, networks). In the context of PFSCs, access to resources such as cold storage facilities, reliable transportation, skilled labor, and financial capital directly influences a trader's ability to respond to disruptions and maintain product quality. RBV is especially pertinent in Lusaka's informal markets, where resource disparities among traders result in varying degrees of resilience. Those with better access to storage or collaborative networks are more likely to withstand disruptions than those operating in isolation or with limited resources (Barney, 1991). This theory provides a framework for analyzing how resource acquisition and utilization can be enhanced through policy interventions, capacity-building, and public-private partnerships.

By integrating Complexity Theory and RBV, this study captures both the systemic interactions and the resource dynamics that influence PFSC resilience, offering a holistic understanding of the challenges and opportunities within Lusaka's perishable food markets.

Conceptual Framework

The conceptual framework for this study illustrates the relationship between key independent variables (barriers and resilience strategies) and the dependent variable (supply chain resilience outcomes). It conceptualizes how specific barriers—such as poor infrastructure, limited access to technology, financial constraints, and climate variability—negatively impact PFSC resilience. Conversely, it outlines how the adoption of targeted

strategies, including collaboration, technological integration, and improved storage facilities, mediates these barriers and enhances supply chain performance.

Central to the framework is the hypothesis that contextual enablers—such as government policy support, public-private partnerships, and trader capacity-building—moderate the effectiveness of resilience strategies. The framework aligns with the Supply Chain Resilience Framework (SCRF), integrating dimensions of robustness, flexibility, and redundancy to assess how PFSC actors can mitigate risk and maintain functionality during disruptions (Hendriksen et al., 2023).

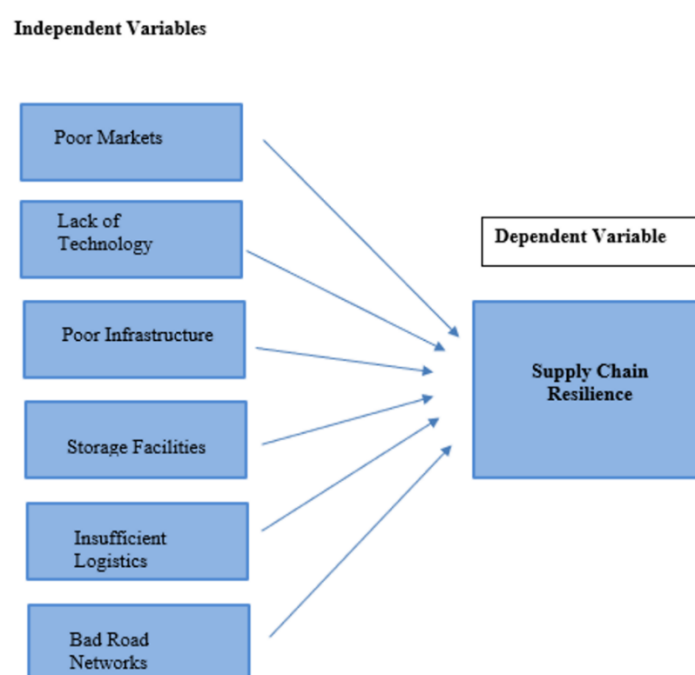


Figure 1: Conceptual Framework Linking Barriers, Strategies, and Supply Chain Resilience Outcomes

(Source: Author's Computation, 2024)

This framework guides data collection and analysis by linking systemic barriers to trader responses and resilience outcomes. It underscores the importance of external support (e.g., policy, finance) in enhancing strategy effectiveness and improving supply chain performance.

Methodology

Research Philosophy and Approach

The study adopts a pragmatist philosophy, which emphasizes practical solutions to real-world problems through flexible research strategies. Pragmatism allows for methodological pluralism and values both qualitative and quantitative data in generating comprehensive, actionable insights (Creswell & Plano Clark, 2018). Given the complexity of

PFSC resilience in Lusaka, a mixed-methods approach was selected, integrating both quantitative and qualitative methodologies to triangulate findings and enhance the validity and applicability of results.

Research Design

The study employed a convergent parallel mixed-methods design, wherein quantitative and qualitative data were collected concurrently but analyzed independently before integration at the interpretation stage. This design allows for the corroboration of findings across data types and supports a holistic understanding of PFSC barriers and strategies (Tashakkori & Teddlie, 2010).

Study Area and Population

The research was conducted in Lusaka, Zambia's capital city, which serves as a central hub for perishable food trade. The target population included traders involved in the sale and distribution of perishable goods (fruits, vegetables, dairy, meat) across three strategic sites: Soweto Market (informal), Shoprite, and Game Stores (formal). These sites were selected to represent the diverse operational contexts within Lusaka's PFSC, enabling comparative analysis of resilience challenges and responses.

Sampling Strategy

For the quantitative component, a stratified random sampling technique was used to select 424 traders, ensuring representation across different market types and trader demographics. Stratification was based on market location and type (formal vs. informal), allowing for nuanced analysis.

For the qualitative component, purposive sampling identified 20 key informants, including supply chain managers, food safety regulators, logistics providers, and representatives from trader associations. This approach ensured that diverse perspectives on PFSC resilience were captured, particularly from individuals with strategic insight into systemic issues and interventions.

Data Collection Tools

Quantitative data were gathered using a structured questionnaire designed to capture demographic information, perceived barriers, resilience strategies, and outcomes. The instrument was pre-tested via a pilot study, with reliability measured using Cronbach's alpha ($r = 0.823$), indicating high internal consistency.

Qualitative data were collected through semi-structured interviews, enabling the exploration of nuanced issues and context-specific insights not captured through the survey. Interviews were recorded, transcribed, and thematically coded for analysis.

Data Analysis and Integration

Quantitative data were analyzed using descriptive statistics (frequencies, percentages) and inferential statistics (cross-tabulations, chi-square tests) via SPSS software. Qualitative data were subjected to thematic analysis, with themes derived both deductively (from literature) and inductively (from participant narratives).

Data were integrated during interpretation, with qualitative findings used to explain, elaborate, and contextualize quantitative trends. This integration enriched the analysis and strengthened the validity of the conclusions drawn.

Results

Demographic Characteristics of Respondents

The study surveyed 424 perishable food traders across Soweto Market, Shoprite, and Game Stores in Lusaka. Of these, 57.2% were male and 42.8% female, indicating male dominance in the sector. Age distribution revealed that 43.5% of respondents were aged 21–30 years, 35.7% aged 31–40 years, while 13.3% were below 20 years, and 6.5% above 41 years, suggesting a youthful trading demographic. In terms of education, 42% had completed secondary education, 40% had primary education, and 13% attained tertiary education, while 5% reported no formal education. The average trading experience was 2.39 years, highlighting a relatively new but active trader population in the PFSC space.

Table 1: Demographic Characteristics of Respondents

		Statistics			
		Gender	Age in Years	Level of Education	Years of Experience in Food Trading or Processings
N	Valid	409	410	407	410
	Missing	5	4	7	4
Mean		1.42	2.36	2.63	2.39
Median		1.00	2.00	3.00	2.00
Mode		1	2	3	2
Std. Deviation		.494	.795	.776	.844

(Source: Author’s Field Data, 2024)

Key Barriers to PFSC Resilience

Respondents identified unpredictable market demand as the most pressing barrier, reported by 31.2% (n=128) of traders. This was followed by lack of financial resources (16.6%, n=68), poor transportation infrastructure (15.9%, n=65), and climate change and

weather variability (24.9%, n=102). Additionally, inadequate storage facilities (6.1%, n=25) and poor handling practices (5.4%, n=22) were also cited, albeit less frequently.

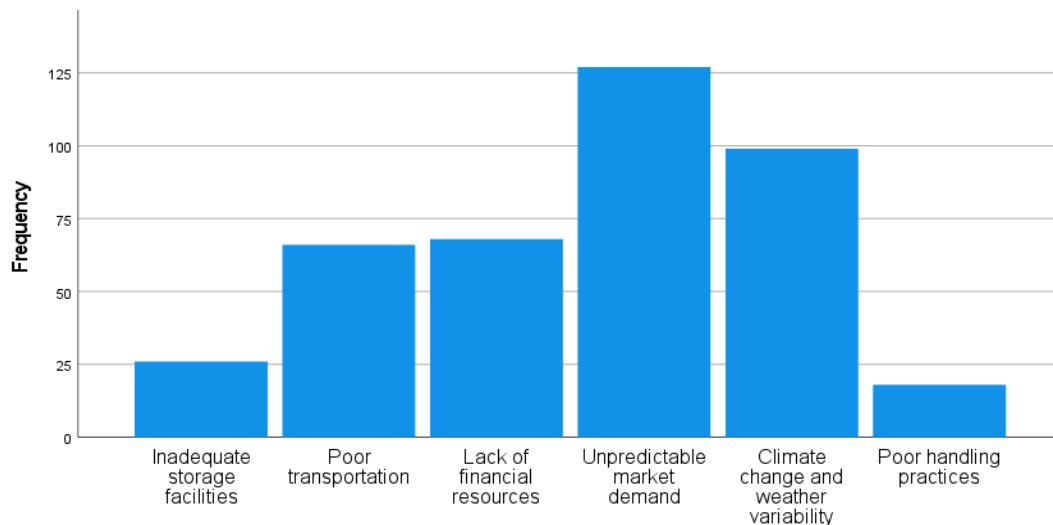


Figure 1: Reported Barriers to Perishable Food Supply Chain Resilience

(Source: Author's Field Data, 2024)

These findings emphasize the dominance of demand-side challenges in Lusaka's PFSC, compounded by infrastructural and climatic risks. Climate variability, particularly erratic rainfall and extreme temperatures, was frequently mentioned during interviews as contributing to increased spoilage and transport delays.

Strategies Adopted to Enhance PFSC Resilience

Among coping strategies, collaboration with farmers and fellow traders was most common, cited by 31.7% (n=130) of respondents. Technology use, including mobile phones for inventory and market data, was reported by 19.5% (n=80). Improved storage solutions (e.g., solar-powered refrigeration) were employed by 16.6% (n=68), while enhanced transportation arrangements (e.g., shared logistics) were adopted by 15.9% (n=65). A smaller group (13.9%, n=57) employed flexible supply chain operations, adjusting sourcing and distribution practices dynamically.

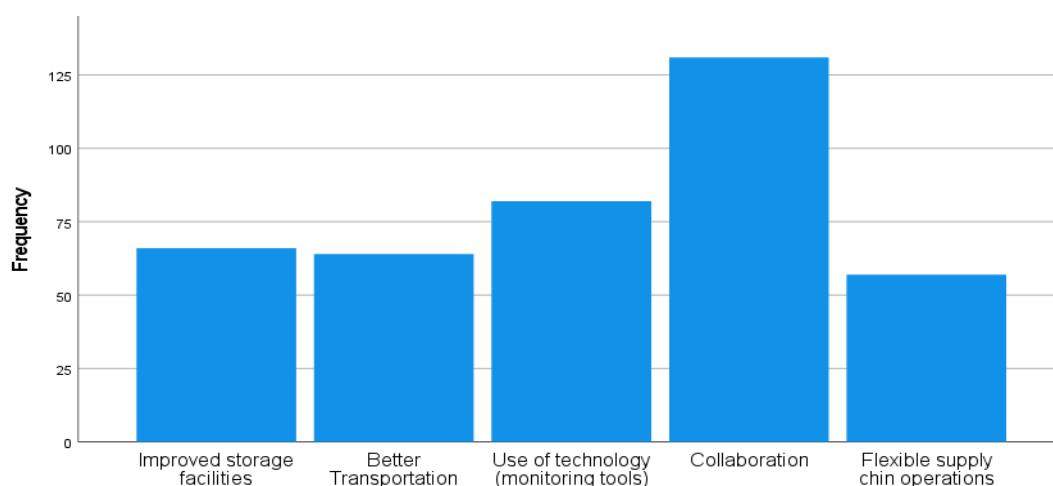


Figure 2: Strategies Adopted by Traders to Enhance PFSC Resilience

(Source: Author's Field Data, 2024)

However, effectiveness ratings varied: 42% rated strategies as “moderately effective”, 24% as “highly effective”, and 34% as “ineffective”, attributing limitations to financial constraints and lack of technical knowledge.

Discussion of Findings

Barriers to Perishable Food Supply Chain Resilience

This study's identification of unpredictable market demand as the primary barrier to PFSC resilience aligns with findings by Nnaji et al. (2023), who emphasized demand volatility in African urban markets due to informal pricing systems and consumer unpredictability. In Lusaka, informal market dynamics and seasonality contribute to price swings and stock fluctuations, creating planning challenges for traders. This unpredictability exacerbates spoilage, particularly for traders without access to real-time demand data or forecasting tools.

Poor transportation infrastructure and inadequate cold storage further compound these challenges. As supported by Igbinovia et al. (2023), poor road conditions in urban and peri-urban areas delay perishable food delivery, accelerating spoilage. Similarly, Ezeani et al. (2023) underscore that the lack of cold chain systems across Sub-Saharan Africa results in temperature abuse, particularly in informal trade hubs like Soweto Market.

Climate change impacts—notably erratic rainfall and temperature extremes—have increased PFSC vulnerability. Traders cited frequent spoilage during hot seasons due to lack of refrigeration. These observations echo Munyua et al. (2023), who identified climate variability as a systemic disruptor in Zambia's food supply, affecting both upstream production and downstream distribution.

Interestingly, poor handling practices were underreported (5.4%), despite evidence from interviews and observations of improper packaging and hygiene. This suggests a gap in

awareness, consistent with findings by World Bank (2020), recommending training in handling and storage to reduce post-harvest loss.

Strategy Efficacy: Opportunities and Constraints

The second objective focused on evaluating strategies used by traders to enhance PFSC resilience. The dominance of collaboration (31.7%) as a coping strategy reflects the reliance on peer support in informal markets to manage risks and pool resources. This supports findings by Kafumbe et al. (2023), who emphasized the role of local market linkages and cooperatives in enhancing food supply chain resilience in Zambia. However, collaboration alone is insufficient without systemic support.

Technology use, though adopted by nearly 20% of respondents, remains underutilized. The gap between potential and actual use of digital tools—such as mobile apps for inventory tracking and climate forecasting—suggests barriers related to cost, literacy, and infrastructure (Kumar & Quaddus, 2022). Improved storage facilities, particularly cold storage, were cited as a key strategy; however, traders reported limited access and capacity. This finding echoes Munyua et al. (2023), who identified cold chain development as central to reducing perishable food losses in Zambia.

Despite adopting these strategies, effectiveness remains mixed—only 24% rated interventions as highly effective. This is largely due to financial constraints, lack of training, and limited policy support, reinforcing the relevance of the Resource-Based View, which emphasizes resource access as a determinant of resilience (Barney, 1991).

Theoretical Implications

Complexity Theory is validated by the cascading nature of PFSC disruptions in Lusaka. Minor shocks—like transport delays—result in substantial product losses, confirming the interconnectedness of supply chain nodes. Similarly, RBV theory explains trader heterogeneity in resilience outcomes, with resource-rich traders (e.g., those with cold storage) exhibiting greater adaptability.

Policy and Practice Implications

The findings reveal that enhancing PFSC resilience requires a multi-faceted approach, combining infrastructural investment, technology adoption, and stakeholder collaboration. Government intervention is essential to address systemic issues such as road networks and storage facilities, while the private sector can drive innovation in technology and logistics. Public-private partnerships can bridge gaps in financing and capacity, especially for informal traders who dominate Lusaka's PFSC landscape.

Conclusion

This study investigated the barriers to perishable food supply chain (PFSC) resilience in Lusaka, Zambia, identified strategies employed by traders to mitigate disruptions, and proposed context-specific interventions to enhance resilience. The findings revealed that

unpredictable market demand, poor infrastructure, financial constraints, and climate variability are the predominant challenges compromising the efficiency and reliability of PFSCs in Lusaka. Traders predominantly rely on collaborative networks, basic technological tools, and improvised storage solutions to navigate these challenges. However, the effectiveness of these strategies is constrained by resource limitations, technical knowledge gaps, and insufficient institutional support.

The integration of Complexity Theory and Resource-Based View (RBV) provided a robust analytical framework to understand how systemic interdependencies and resource disparities influence PFSC resilience. The study underscores the need for multi-stakeholder interventions, involving government, private sector, and development partners, to strengthen infrastructure, promote technology uptake, and support trader capacity-building. Enhancing PFSC resilience is critical not only for reducing food loss and improving food security but also for supporting economic stability and public health in urban Zambia.

Recommendations

To address the identified barriers and enhance PFSC resilience, the following actionable recommendations are proposed:

Infrastructure Development

- Upgrade urban and peri-urban road networks to facilitate timely delivery of perishable goods.
- Invest in cold storage infrastructure at key market hubs, prioritizing solar-powered solutions.
- Promote the use of refrigerated transport, potentially through shared logistics platforms.

Technology Promotion

- Provide subsidies and incentives for traders to adopt mobile-based inventory and monitoring tools.
- Develop digital platforms for real-time market data, weather forecasts, and demand planning.
- Implement digital literacy training programs targeting informal market actors.

Financial Access and Support

- Establish micro-finance schemes tailored to PFSC actors for infrastructure and technology investment.
- Introduce supply chain insurance products to cover spoilage and market volatility losses.
- Facilitate public-private partnerships to fund cold chain innovations and logistics improvements.

Capacity Building

- Conduct regular training workshops on perishable food handling, quality control, and storage.
- Promote best practices in supply chain management and climate adaptation strategies.
- Support the formation of trader associations to enhance knowledge sharing and bargaining power.

Policy and Regulatory Support

- Develop supportive policies that incentivize private sector investment in PFSC resilience.
- Enforce food safety and handling standards across formal and informal markets.
- Create multi-stakeholder coordination platforms to align efforts across public and private sectors.

Future Research Directions

While this study provides valuable insights, further research is needed to:

- Evaluate the scalability and long-term impact of specific resilience strategies in informal markets.
- Examine consumer behavior and its influence on demand volatility and PFSC performance.
- Analyze the macroeconomic and trade policy environment affecting Zambia's PFSCs.
- Explore the impact of recent external shocks, such as pandemics or global supply disruptions, on PFSC resilience.

Study Limitations

This study was limited to Lusaka's perishable food traders and may not be generalizable to rural or regional markets in Zambia. The reliance on self-reported data introduces potential response bias, and the cross-sectional design limits insights into long-term strategy effectiveness. Additionally, the study did not account for recent external shocks (e.g., pandemics), which may influence supply chain dynamics and require further investigation.

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