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Supply Chain Resilience Strategies and Organizational Performance in Public-Sector Agri-Food Operations: Evidence from Zambia National Service Milling Plants

Like Likando

MBA (General), Institute of Distance Education, University of Zambia

Abstract: ***Agri-food supply chains in developing economies are increasingly exposed to disruptions arising from climatic volatility, infrastructural weaknesses, and market instability. In Zambia, maize milling is a strategic sector for national food security, yet milling operations continue to face persistent supply chain disruptions that undermine efficiency, cost control, and service reliability. This study examined how supply chain resilience strategies influence disruption mitigation and organizational performance within Zambia National Service (ZNS) milling plants located in Mpika, Chongwe, and Monze districts. Drawing on Inventory Theory, Stakeholder Theory, Resource Dependence Theory, and Supply Chain Resilience Theory, the study adopted a descriptive case study design using a mixed-methods approach. Data were collected from 60 respondents through structured questionnaires and semi-structured interviews with supply chain personnel and managers. Quantitative data were analysed using descriptive statistical techniques, while qualitative data were analysed thematically. The findings indicate that ZNS milling plants experience frequent supply chain disruptions, predominantly driven by delays in raw maize supply, transportation bottlenecks, climate variability, and internal coordination deficiencies. These disruptions significantly reduced production efficiency, increase operational costs, and weakened customer satisfaction. Although resilience strategies such as buffer stock maintenance, alternative sourcing, and responsive operational adjustments were in place, their overall effectiveness remained moderate due to constrained storage capacity, weak forecasting systems, and limited digital integration. The study concludes that strengthening internal supply chain capabilities, supplier collaboration mechanisms, and technology-enabled planning systems is critical for improving resilience and organizational performance. The study contributes empirical evidence to the limited literature on public-sector agri-food supply chains in Sub-Saharan Africa.***

Keywords: supply chain resilience, organizational performance, public-sector, milling industry, Zambia

1. Introduction

Supply chains across industries increasingly operate within environments characterized by uncertainty, volatility, and complexity. Factors such as climate change, pandemics, geopolitical tensions, and fluctuating demand patterns have heightened exposure to supply chain disruptions, making operational continuity more difficult to sustain (Ivanov & Dolgui, 2020). Empirical evidence consistently demonstrates that supply chain disruptions adversely affect production efficiency, cost structures, inventory stability, and customer satisfaction, ultimately threatening organizational competitiveness and survival (Craighead et al., 2007).

Within agri-food systems, the consequences of supply chain disruptions are particularly severe because interruptions directly affect food availability and affordability, with broader implications for social and economic stability (Melkonyan et al., 2017). In Zambia, maize milling plays a central role in national food security, as mealie meal constitutes the primary staple food for the majority of households. Despite this importance, the milling sector continues to experience persistent supply chain challenges linked to maize supply variability, transportation inefficiencies, inventory imbalances, and demand uncertainty (Kasweshi, 2023; Millers Association of Zambia, 2023).

The Zambia National Service (ZNS), established in 1971, was initially mandated to provide national defence training and civic service. Over time, its mandate expanded to include agricultural and industrial production aimed at supporting national socio-economic development (Lungu & Ngoma, 2005). In response to recurring mealie meal shortages and price instability, ZNS established milling plants in Mpika, Chongwe, and Monze districts beginning in 2020. These facilities were intended to strengthen domestic production capacity and stabilize supply. However, like many agri-food operations in developing economies, ZNS milling plants continue to face supply chain disruptions that constrain operational performance.

Although supply chain resilience has attracted significant scholarly attention globally, much of the existing literature focuses on private-sector firms in developed economies. Empirical research examining resilience strategies within public-sector-led agro-industrial operations in Sub-Saharan Africa remains limited (Kamalahmadi & Parast, 2017). This study addresses this gap by examining the role of supply chain resilience strategies in mitigating disruptions and enhancing organizational performance within ZNS milling plants.

2. Literature Review

2.1 Supply Chain Disruptions and Performance Implications

A supply chain comprises a network of organizations, activities, and processes involved in the transformation of raw materials into finished products delivered to end users (Chopra & Meindl, 2021). Disruptions within this network

may originate from internal inefficiencies or external shocks, including supplier failures, transportation delays, climate-related events, and demand volatility (Scheibe & Blackhurst, 2018).

Empirical studies have demonstrated that supply chain disruptions negatively affect operational performance by reducing production output, increasing operational costs, destabilizing inventory levels, and eroding customer satisfaction (Tang & Tomlin, 2019). Longitudinal evidence further suggests that organizations experiencing severe disruptions often suffer lasting financial and reputational damage unless effective mitigation strategies are in place (Craighead et al., 2007).

2.2 Conceptualising Supply Chain Resilience

Supply chain resilience refers to the ability of a supply chain system to anticipate, absorb, adapt to, and recover from disruptions while maintaining acceptable levels of performance (Ponomarov & Holcomb, 2009). Resilient supply chains are characterized by preparedness, flexibility, and rapid recovery capabilities, enabling them to minimize disruption impacts and restore operations efficiently (Sheffi, 2005).

Key resilience mechanisms identified in the literature include inventory buffering, supply chain agility, supplier diversification, information visibility, and collaborative relationships among supply chain actors (Christopher & Peck, 2004; Shashi et al., 2020). Organizations that invest in these capabilities tend to recover more quickly from disruptions and experience smaller performance losses compared to less resilient counterparts (Pettit et al., 2013).

3. Theoretical Foundations

This study integrates four complementary theoretical perspectives to explain the relationship between supply chain resilience strategies and organizational performance.

Inventory Theory emphasizes the role of safety stock, reorder points, and adaptive inventory practices in mitigating supply uncertainty and preventing production interruptions (Jacobs & Chase, 2013). Maintaining buffer stock enables organizations to absorb short-term supply shocks, particularly in volatile agri-food supply chains.

Stakeholder Theory posits that organizational outcomes are shaped by interactions among internal and external stakeholders, including suppliers, employees, customers, and regulators (Freeman, 1984). Effective communication, collaboration, and trust among these actors enhance collective capacity to detect risks early and coordinate responses during disruptions (Paulraj et al., 2017).

Resource Dependence Theory explains how organizations rely on external actors for critical inputs such as raw materials and logistics services, exposing them to uncertainty and vulnerability (Pfeffer & Salancik, 1978). To mitigate these risks, organizations must diversify suppliers, strengthen partnerships, and develop internal capabilities that reduce overreliance on external entities (Nair & Vidal, 2011).

Supply Chain Resilience Theory integrates pre-disruption preparedness with post-disruption response and recovery capabilities. This perspective highlights the importance of proactive planning, flexibility, and learning mechanisms in sustaining performance under conditions of uncertainty (Ponis & Koronis, 2012).

4. Methodology

A descriptive case study design was employed to examine supply chain resilience strategies at ZNS milling plants in Mpika, Chongwe, and Monze districts. A mixed-methods approach was adopted to enhance analytical depth and methodological triangulation.

Data were collected from 60 respondents drawn from production, procurement, inventory management, logistics, distribution, and plant management functions. Structured questionnaires based on a five-point Likert scale were used to collect quantitative data on supply chain disruptions, resilience strategies, and performance outcomes. Semi-structured interviews were conducted with plant commanders and senior supply chain personnel to obtain qualitative insights into operational challenges and strategic decision-making.

Quantitative data were analysed using descriptive statistical techniques, including frequencies and percentages. Qualitative data were analysed thematically, allowing patterns and explanatory narratives to emerge in relation to the study objectives.

The study obtained the necessary ethical approval, and informed consent was secured from all participants.

5. Results

The analysis of data collected from 60 respondents across the three Zambia National Service (ZNS) milling plants revealed that supply chain disruptions were both frequent and systemic in nature. A substantial majority of respondents indicated that disruptions were not occasional anomalies but recurring operational challenges embedded within the supply chain structure. Among the various forms of disruption identified, delays in the supply of raw maize emerged as the most dominant and persistent challenge. These delays were primarily associated with seasonal supply fluctuations, dependence on smallholder farmers, and logistical inefficiencies in aggregating maize from production areas to milling facilities. Respondents consistently reported that such delays resulted in unplanned production stoppages, underutilization of milling capacity, and difficulty in meeting distribution schedules.

In addition to raw material delays, transportation bottlenecks were identified as a major source of disruption. These bottlenecks were attributed to poor road infrastructure in some sourcing areas, limited availability of reliable transport services, and high transportation costs. Transportation challenges were found to compound the effects of maize supply delays, as even when maize was available at farm level, delays in transportation prevented timely delivery to milling plants. Supplier unreliability further intensified these

disruptions, particularly in cases where contracted suppliers failed to meet agreed delivery quantities or timelines. Power interruptions also featured prominently in the findings, with respondents noting that inconsistent electricity supply disrupted milling operations and increased reliance on alternative power sources, thereby raising operational costs. Climate variability, especially erratic rainfall patterns, was identified as a cross-cutting external factor influencing maize availability and amplifying upstream supply uncertainty.

The findings showed that these disruptions mainly occurred at the upstream and midstream stages of the supply chain. Upstream disruptions were mainly linked to procurement and sourcing of raw maize, while midstream disruptions were associated with transportation, storage, and processing activities. The concentration of disruptions at these stages suggests the presence of structural vulnerabilities within the supply chain rather than isolated operational failures. This indicates that disruptions are embedded within the broader supply chain configuration, including sourcing strategies, infrastructure limitations, and coordination mechanisms.

With regard to organizational performance, the results demonstrated a clear and substantial negative impact of supply chain disruptions on key performance indicators. Reduced production efficiency was one of the most frequently reported consequences, as disruptions often forced milling plants to operate below capacity or suspend operations altogether. Respondents indicated that irregular maize supply often forced adjustments to production schedules, causing inefficiencies in labour use and more frequent machine downtime. Inventory management was also significantly affected, with disruptions resulting in frequent stock-outs during periods of maize scarcity and excess inventory during periods of oversupply. This imbalance undermined effective inventory planning and increased storage and handling costs.

Operational costs were found to increase markedly during periods of disruption. Respondents reported that emergency procurement, expedited transportation, and reliance on alternative suppliers significantly raised procurement and logistics costs. These cost increases were particularly pronounced when milling plants were forced to source maize from distant locations or engage suppliers at short notice under unfavourable terms. The cumulative effect of these cost pressures reduced overall cost efficiency and constrained the ability of the milling plants to maintain stable pricing in the market.

Customer satisfaction was also negatively affected by supply chain disruptions. Respondents noted that production delays and inconsistent product availability led to delayed deliveries and, in some cases, unmet demand at distribution points. These challenges resulted in increased customer complaints and weakened trust among distributors and retail partners. The findings suggest that disruptions not only affect internal operations but also have downstream implications for service reliability and market responsiveness.

The study further examined the resilience strategies employed by ZNS milling plants to mitigate the impact of these disruptions. The results indicated that several resilience measures were in place, including buffer stock maintenance, use of alternative suppliers, and responsive operational adjustments during periods of disruption. Buffer stock was widely used as a primary mitigation strategy, particularly to cushion short-term maize supply delays. However, respondents indicated that storage capacity constraints limited the effectiveness of this strategy, as existing facilities were often insufficient to hold adequate reserves during peak procurement periods.

Alternative sourcing was also employed as a resilience mechanism, especially when primary suppliers failed to meet delivery commitments. While this strategy provided some level of flexibility, its effectiveness was constrained by the limited pool of reliable alternative suppliers and the higher costs associated with emergency sourcing. Responsive operational adjustments, such as rescheduling production and reallocating available resources, enabled milling plants to continue operating under constrained conditions. However, these adjustments were largely reactive in nature and often resulted in inefficiencies rather than sustained performance improvements.

6. Discussion

The findings of this study align with prior empirical evidence demonstrating that supply chain disruptions significantly undermine organizational performance in agri-food systems (Melkonyan et al., 2017; Ochieng, 2018). The prominence of maize supply delays and climate variability underscores the vulnerability of agri-based supply chains to environmental uncertainty, particularly in developing economies.

From an inventory theory perspective, the moderate effectiveness of buffer stock strategies suggests that inventory management practices at ZNS milling plants are insufficiently integrated with forecasting and replenishment systems. This limits their ability to absorb supply shocks effectively. Stakeholder theory is reflected in the finding that weak coordination among internal departments and limited supplier collaboration exacerbate disruption impacts, highlighting the importance of relational governance in supply chain resilience.

Consistent with resource dependence theory, the high reliance on smallholder farmers and external logistics providers exposes ZNS milling plants to risks beyond their direct control. While alternative sourcing strategies were employed, their limited effectiveness suggests the need for deeper diversification and strategic partnerships. Overall, the findings support supply chain resilience theory by demonstrating that resilience outcomes depend on the integration of preparedness, response, and recovery capabilities rather than isolated interventions.

7. Conclusion

This study provides empirical evidence on the role of supply chain resilience strategies in mitigating disruptions and enhancing organizational performance within a public-sector-led agri-food context in Zambia. The findings demonstrate that while ZNS milling plants have adopted foundational resilience measures, their effectiveness remains constrained by internal capability gaps and external dependencies.

Strengthening internal coordination, inventory planning, supplier collaboration, and digital enablement is essential for achieving sustained performance improvements. The study contributes to the limited literature on supply chain resilience in Sub-Saharan Africa and offers practical insights for policymakers and practitioners seeking to enhance food supply chain stability.

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