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Resilient retail: Transforming inventory strategies to navigate port disruptions

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Orientation: Global supply chains are increasingly vulnerable to systemic disruptions, especially in port-centric logistics networks in emerging markets. South Africa's Port of Durban, a critical point for retail supply chains, has experienced frequent inefficiencies, compounding the risks faced by import-dependent retailers.

Research purpose: This study investigates how inventory strategies, particularly those grounded in supply chain resilience theory (SCRT), can be reimagined to mitigate the impact of chronic port disruptions in South Africa.

Motivation for the study: While SCRT has been widely explored in developed contexts, its applicability to emerging economies with infrastructural volatility and institutional constraints remains under-examined. This article addresses that gap by focusing on disruption-prone environments.

Research design, approach and method: The article adopts a structured conceptual methodology, synthesising academic literature published between 2013 and 2024 and integrating industry reports, trade publications and case-based insights. The approach involves thematic synthesis and comparative analysis, with attention to limitations inherent in desktop research.

Main findings: The analysis reveals that lean, just-in-time (JIT) systems are increasingly unsustainable in South Africa's port environment. Resilience-oriented strategies, such as redundancy, collaboration and digital visibility, provide stronger protection for retail supply chains. Inventory redundancy, though cost-intensive, emerges as a strategic asset rather than a liability.

Practical/managerial implications: Retailers are encouraged to adopt modular, context-sensitive adaptations of SCRT, including selective redundancy for high-margin products, supplier diversification and technology-driven visibility. Policymakers should prioritise infrastructural modernisation and improved port governance.

Contribution/value-add: This article contributes to supply chain resilience literature by adapting SCRT to the realities of emerging markets and by proposing a revised conceptual framework for inventory structuring under disruption. It highlights the importance of balancing efficiency and resilience in high-risk port environments. Policy and managerial implications include prioritising infrastructural upgrades, promoting public-private collaboration and adopting modular, context-sensitive inventory strategies to enhance supply chain resilience in emerging market retail.

Keywords: supply chain resilience; inventory redundancy; port disruption; retail logistics; SCRT; Durban port; emerging markets; South Africa.

Introduction

The strategic significance of inventory management within supply chain networks has long been recognised (Christopher & Peck 2004; Sheffi & Rice 2005), but it has recently assumed renewed urgency in light of chronic port disruptions that challenge the assumptions of just-in-time (JIT) logistics (Ivanov 2021; Tsolakis et al. 2023). Global supply chains have been reshaped by shocks such as the coronavirus disease 2019 (COVID-19) pandemic, the Suez Canal blockage and geopolitical tensions (Ivanov & Das 2020; Wieland & Durach 2021). In emerging economies such as South Africa, the consequences of port fragility are particularly pronounced (Du Plessis, Van Eeden & Goedhals-Gerber 2022; Vhumbunu 2021).

The Port of Durban, Africa's largest and busiest container terminal, has suffered repeated operational backlogs, strikes, infrastructural breakdowns and cyberattacks (Transnet National Ports Authority

2023; World Bank 2024). These disruptions threaten not only the punctuality of goods movement but also the continuity of business operations for South African retailers who depend on timely imports (Magagula, Meyer & Niemann 2020; Ngcobo & Naudé 2022). Inventory, often viewed primarily as a cost to be minimised, can also serve as a critical buffer that absorbs shocks and helps maintain supply chain continuity (Ponomarov & Holcomb 2009; Sheffi & Rice 2005).

Conventional resilience theories, like supply chain resilience theory (SCRT), have faced criticism for their limited relevance in contexts with infrastructural difficulties and institutional volatility (Dubey et al. 2021a, 2021b; Mubarik et al. 2021b). This highlights the need to adapt existing models and develop innovative solutions that effectively address complex modern risks. This research employs a dual methodology: it examines 'the implementation of SCRT in the South African retail sector while proposing a context-sensitive framework for inventory resilience that integrates both theoretical and practical perspectives' (Agigi, Niemann & Kotzé 2016; Hirsch, Niemann & Swart 2024). This study contributes theoretically by contextualising SCRT constructs within emerging-market retail supply chains, providing insights into how redundancy, visibility, agility and collaboration can be operationalised under persistent port disruptions.

In a time, characterised by escalating global instability, the robustness of retail supply chains has emerged as a vital factor for company continuity and competitiveness (Loury-Okoumba & Mafini 2018). This study examines the necessity for retail firms to innovate and modify their inventory strategy because of the increasing frequency and severity of port interruptions. The study seeks to uncover actionable methods for constructing resilient inventory systems through the examination of adaptive frameworks, technology breakthroughs and decentralised logistics models. The study utilises case studies, industry data and expert insights to advocate for a contextualised methodology that harmonises operational agility with strategic foresight.

This article enhances the discussion on supply chain resilience by providing a framework for retailers to endure shocks and utilise them as opportunities for innovation and sustainable growth. This study utilises a systematic theoretical framework, synthesising scholarly literature from 2013 to 2024 and incorporating case-based insights from three South African retail firms impacted by port interruptions (Loury-Okoumba & Mafini 2018; Weber & Badenhorst-Weiss 2018). The article is structured as follows: 'Literature review' section examines the literature, concentrating on inventory techniques that may mitigate port disruptions, innovative concepts in SCRT and a suggested resilient supply chain architecture derived from the research of Blos, Wee and Yang (2012). 'Research methods and design' section elucidates the employed approach, whereas 'Findings and implications' section presents the results and their implications. 'Conclusion' section finishes with recommendations for further research. Despite growing international scholarship on supply chain resilience, there remains limited conceptual application of SCRT within emerging market retail environments characterised by infrastructural fragility, port congestion and institutional volatility. Existing literature predominantly evaluates SCRT constructs within developed economies with stable logistics systems, thereby underrepresenting contexts such as South Africa, where chronic port disruptions fundamentally reshape inventory decision-making.

This reveals a critical knowledge gap regarding how SCRT principles can be operationalised and adapted to disruption-prone emerging markets, particularly in relation to inventory structuring under persistent port inefficiencies.

Literature review

The global and local business environments are undergoing unprecedented supply-chain upheavals (Blackhurst, Dunn & Craighead 2011). As a result of unforeseen disruptive events, supply chains have become more unstable, undermining a company's capacity to achieve a competitive advantage and enhance profitability (Butt 2021). Supply chain managers must recognise supply chain disruptions, as they can incur significant costs and adversely affect the whole supply chain because of the loss of products and services (Benton 2020). Unforeseen catastrophic occurrences have rendered supply chains vulnerable to interruption, impeding the flow of commodities and impacting profitability (Simchi-Levi, Wang & Wei 2018).

The article is divided into three sections to provide a comprehensive overview of the theoretical underpinnings and practical applications of inventory resilience in potentially interrupted supply chains. 'Objectives' section analyses literature about the progression of inventory strategy in response to port disruptions, specifically highlighting the transition from efficiency-focused systems to redundancy-oriented frameworks (Christopher & Peck 2004; Magagula et al. 2020).

The study assesses the SCRT by examining its conceptual progress and constraints in 'Inventory strategy under port disruption' section. This is done especially in relation to its relevance in emerging market environments (Ngcobo & Naudé 2022; Pettit, Croxton & Fiksel 2019; Ponomarov & Holcomb 2009). A multi-faceted resilience framework, which is based on the study of Blos, is presented in 'supply chain resilience theory' section (Wee & Yang 2012). Later utilised to develop the proposed conceptual model of the article (Blos et al. 2012; Wieland & Durach 2021). An introductory paragraph precedes each section to establish context for the discussion and ensure a coherent flow in the literature review.

Objectives

The objective of this conceptual article explores the resilience of retail in transforming inventory strategies to navigate

port disruptions. Accordingly, this study was guided by the following secondary objectives, to:

- Examine how chronic port disruptions influence inventory strategy within South African retail supply chains.
- Evaluate the applicability of SCRT constructs, redundancy, agility, visibility and collaboration, within an emerging market context.
- Adapt the layered resilience framework of Blos et al. (2012) to reflect South African operational realities.
- Propose a context-sensitive conceptual framework for resilient inventory structuring under persistent port disruption.

Inventory strategy under port disruption

Logistical issues greatly impact global and local distribution networks by causing stockouts and inventory deficiencies that disrupt production and sales cycles (Sheffi & Rice 2005). These delays raise transportation costs and cause businesses to keep more safety stockpiles, which tie up cash (Ponomarov & Holcomb 2009). On a larger scale, congestion boosts freight prices and makes transit times longer. This slows down commerce and adds to inflationary pressures in the economies that are impacted (Dubey et al. 2021; Mokoena & Mara 2022). Furthermore, conventional supply chain models frequently fail to adequately handle the complexities arising from infrastructural and institutional constraints, underscoring the necessity for revised frameworks that more effectively encapsulate these emerging risks (Mubarik et al. 2021b).

Also, port problems are bad for economies that depend heavily on ports, like South Africa. For instance, the Port of Durban is responsible for a large part of the country's containerised commerce (World Bank 2024). In this situation, inventory planning is a key tool for making things more resilient. Conventional lean and JIT methodologies, centred on cost reduction and inventory minimisation, have demonstrated inadequacy in the face of persistent delays, port congestion and systemic breakdowns (Magagula et al. 2020). There is a rising trend towards tactics that focus on redundancy and risk buffering instead. Inventory is becoming less of a cost centre and more of a strategic asset. Managers who see inventory as a strategic asset may make the supply chain more resilient by adding redundancy and risk buffers that lessen the impact of interruptions.

Companies may keep running even when supplies are temporarily cut off if they have strategic inventory buffers, including safety stock of important parts or completed items. This lowers the danger of stockouts and production stops (Infor 2024). This method also helps address client needs when unexpected things happen, which keeps service levels high and builds brand loyalty (LinkedIn 2023). Also, companies lessen their reliance on a single supplier or transportation channel by spreading out their inventory and boosting their buffer stockpiles. This makes them less likely to be affected by port congestion, natural catastrophes or geopolitical problems (NetSuite 2023).

While building redundancy may increase holding costs, it balances these expenses against the potentially severe financial and reputational losses caused by supply chain failures (NetSuite 2023). Overall, viewing inventory as a strategic tool allows managers to create more flexible and robust supply chains capable of adapting to evolving risks.

Reconceptualising inventory hold levels

The foundational logic underpinning inventory management in many supply chains has historically been economic based, especially with respect to lean philosophy. The goal was to minimise holding costs, increase inventory turnover and rely on stable lead times (Christopher & Peck 2004). However, port disruptions challenge these assumptions by introducing irregular flow patterns, unpredictability in delivery schedules and bottlenecks that ripple through the supply chain. Under such conditions, minimising inventory can shift from a strength into a critical vulnerability. And suddenly, the carefully balanced system unravels. Shipments stall at congested ports because of labour strikes, equipment failures or natural disasters, causing unpredictable delays and extended transit times (Christopher & Peck 2004). This disrupts the JIT flow, leading to inventory shortages at critical points in the supply chain (Christopher & Peck 2004).

Manufacturers face production slowdowns, retailers experience stockouts and customers encounter unmet demand (Christopher & Peck 2004). The ripple effect escalates costs dramatically, including demurrage fees, expedited shipping charges and overtime labour costs as companies scramble to respond to logistic bottlenecks (Christopher & Peck 2004). Without sufficient safety stock reserves, the risk of lost sales and damaged customer relationships intensifies, forcing firms to rethink their lean inventory strategies and embrace higher inventory levels as a buffer against ongoing uncertainty (Christopher & Peck 2004). What was once an asset optimised for cost-efficiency suddenly becomes a liability that threatens the entire supply chain's resilience and service levels (Christopher & Peck 2004).

Recent disruptions at the Port of Durban, including delays caused by infrastructural underinvestment, labour unrest and weather-related damage, have resulted in severe service and delivery disruptions (Transnet National Ports Authority 2023). This prompted South African retailers to reassess their inventory strategies. Rather than strictly adhering to lean principles, firms have begun incorporating resilience-focused practices. These include things like strategic hoarding, spreading out inventories over several sites and preparing depending on different scenarios.

People are now thinking about inventory to protect against unpredictability. This method is in line with the idea of 'adaptive buffering' in resilience literature, where inventory

serves as a shock absorber that keeps service levels high even when there are problems upstream (Pettit et al. 2019). This signifies a fundamental transformation from perceiving inventory as waste to acknowledging it as a catalyst for continuity (Pettit et al. 2019).

Redundancy as strategic insurance

There are several ways to build redundancy into inventory systems, such as having safety stock, having alternative supply sources or using more than one distribution centre. Ivanov (2021) says that these steps make the supply chain more complicated and expensive, but they are necessary to make it stronger. In South Africa, where there are not many other ways to get goods into the country and the country relies heavily on imports, redundancy is not just a good idea but also necessary.

Companies that have been able to get through Durban's port problems the best prefer to keep goods in places farther away from the port. This means they do not have to rely on real-time replenishment as much. This method aligns with the research conducted by Hirsch et al. (2024), indicating Fast-Moving Consumer Goods (FMCG) businesses employing proactive redundancy planning achieved superior order fulfilment rates during peak interruption times.

There are trade-offs, though, when it comes to redundancy. It costs money to store it, tie up resources and risk it becoming obsolete. So, South African stores have started using selective redundancy methods, focusing on goods with high margins and fast sales. Inventory modelling tools have become vital in determining optimal stock levels, helping firms balance the costs of holding inventory against the risks of stockouts.

Inventory segmentation and prioritisation

Inventory subdivision is putting items into groups based on how important they are, how much demand they have and how profitable they are. Then, you use various resilience tactics for each group. For instance, vital commodities may need more safety stock and a wider range of sources, whereas non-essential goods would need less. This is like what Du Plessis et al. (2022) found: that container imbalances on export routes need a selected approach to inventory planning.

South African businesses might better prioritise their limited resources using segmented inventory systems. This frequently means putting extra effort into making sure that stock-keeping units (SKUs) that have high substitute prices or a big effect on reputation are not lost. It also makes it easier to align inventory choices with the company's overall risk appetite.

Visibility as a prerequisite for inventory resilience

Effective inventory resilience depends critically on visibility of stock across the supply chain (Pettit et al. 2019). Visibility enables firms to make informed decisions on safety stock deployment, lead time adjustments and risk mitigation (Ponomarov & Holcomb 2009). However, many South African retailers operate with fragmented Information and Communication Technology (ICT) infrastructure and limited digital integration, particularly among SMEs (Ngcobo & Naudé 2022). This impedes access to real-time inventory data and undermines scenario-based planning. Without visibility, redundancy strategies risk becoming inefficient, as firms cannot accurately align buffer stock with disruption-prone nodes (Hirsch et al. 2024). Thus, inventory visibility is not optional but foundational to achieving supply continuity in volatile logistics environments.

Risk-based inventory decision-making

The movement towards resilient inventory management also involves greater reliance on risk-based decision-making tools. Scenario analysis, simulation and stress testing are increasingly used to anticipate disruption impacts and evaluate mitigation options. Daneshvar Kakhki and Gargeya (2019) explain that these tools enable firms to quantify the trade-offs between cost efficiency and resilience.

For example, probabilistic models help firms estimate the expected loss from stockouts versus the cost of carrying additional inventory. This enables more informed and strategic decisions rather than reactive responses. In South Africa, where port delays are semi-systemic, companies benefit from integrating risk scenarios into their monthly or quarterly inventory planning cycles.

Human capital and organisational culture

Inventory resilience is not purely a technical matter. It also involves organisational behaviour. Firms that promote cross-functional collaboration between procurement, logistics and finance departments tend to coordinate resilience efforts more effectively. Agigi et al. (2016) emphasise that resilient supply chain design in South African FMCG companies often stems from leadership commitment to agility and responsiveness.

Transforming organisational culture around inventory from a cost-obsessed mindset to one oriented towards continuity requires internal education and incentive realignment. Inventory managers must be empowered to make buffering decisions based on risk assessments rather than solely on historical consumption data. This cultural shift is especially critical in sectors characterised by high demand variability or long lead times.

Cost-resilience trade-offs

Perhaps, the most complex challenge in adopting redundancy-based inventory strategies is justifying the associated costs. Inventory is capital intensive and increases balance sheet exposure. However, Sheffi and Rice (2005) argue that investments in resilience should be viewed as

options that protect the firm from substantial downside risks. This perspective is gaining traction in the South African retail sector, particularly following the COVID-19 pandemic and the 2021 civil unrest, both of which triggered widespread supply disruptions (Vhumbunu 2021).

Retailers are increasingly recognising that the cost of not having inventory when needed, lost sales, reputational harm and operational downtime, can far outweigh the costs of holding extra stock. Nevertheless, the scale and nature of these trade-offs vary widely depending on firm size, sector and customer base, necessitating customised strategies.

Summary of reviewed inventory strategy

Studies from 2013 onwards have traced the shift from lean inventory principles to resilience-oriented models in response to rising disruption frequency (Agigi et al. 2016; Magagula et al. 2020). South African research reflects this trend in the context of port unreliability and constrained infrastructure (Du Plessis et al. 2022; Vhumbunu 2021). Inventory redundancy, previously deemed inefficient, is now cited as a resilience mechanism under systemic risk (Hirsch et al. 2024; Ivanov 2021). Scholars also emphasise digital visibility as a foundational enabler of responsive inventory systems (Daneshvar Kakhki & Gargeya 2019; Ngcobo & Naudé 2022).

Consequently, the literature offers the essential conceptual framework to investigate SCRT more comprehensively. The evolution of inventory strategy has been influenced by persistent issues at ports, both practically and theoretically. This research establishes the foundation for subsequent sections that will explore the theoretical foundations of SCRT and present a comprehensive resilience framework tailored for the South African environment.

Supply chain resilience theory

Supply chain resilience theory is the conceptual and practical framework that elucidates how supply networks may foresee, endure, adjust to and recuperate from interruptions while preserving continuity and performance (Daneshvar Kakhki & Gargeya 2019). It is grounded on systems thinking and risk management, highlighting flexibility, redundancy, agility and collaboration as fundamental principles. The theory is a prominent theory in operations and logistics research. It provides a systematic framework for businesses to understand, plan for and react to disruptive occurrences (Pettit et al. 2019). This technique exceeds conventional risk management by emphasising resilience to shocks and the adaptability and restructuring of supply chain systems in response to emerging threats (Christopher & Peck 2004; Sheffi & Rice 2005). This section thoroughly examines the evolution of SCRT. It outlines the theoretical evolution, lists its core ideas, analyses the supporting evidence and responds to critiques about its implementation in developing economies.

Historical development of supply chain resilience theory

The intellectual underpinnings of SCRT originated in the early 2000s, influenced by significant global disruptions such as the 9/11 terrorist attacks, the 2002 West Coast port lockout in the United States and the SARS (severe acute respiratory syndrome) epidemic, which commenced in November 2002 and continued until 2004 (Sheffi & Rice 2005). These calamities revealed the weaknesses in global supply systems that emphasised efficiency above resilience (Ponomarov & Holcomb 2009). Christopher and Peck (2004) provided one of the earliest formal definitions of supply chain resilience, describing it as a complex capacity that includes agility, cooperation, visibility and redundancy (Mara & Mokoena 2024).

Their concept acknowledged resilience as a developing result of inter-organisational collaboration and proactive risk detection, rather than merely a product of internal capability. This first inquiry laid the groundwork for further empirical research. Subsequent studies have examined various resilience facilitators, such as the function of enterprise systems (Daneshvar Kakhki & Gargeya 2019), dynamic capabilities for risk adaptation (Dubey et al. 2021) and the application of digital technologies to improve real-time responsiveness (Hirsch et al. 2024; Mara & Mokoena 2024).

Core constructs of supply chain resilience theory

Supply chain resilience theory emphasises that resilience stems from capability development across three temporal phases: *Readiness*, *Response* and *Recovery* (Pettit et al. 2019; Sheffi & Rice 2005). These are enabled by four core constructs namely:

- Agility is the speed and flexibility of a supply chain's response to disruptions, often involving route reconfiguration or inventory reallocation (Ivanov & Das 2020). It enables rapid adaptation in volatile, low-forecast-accuracy environments (Ponomarov & Holcomb 2009). Agile capabilities have been linked to improved performance during crises, including COVID-19 (Wieland & Durach 2021). In South Africa, agile routing and sourcing helped counter Port of Durban congestion (Du Plessis et al. 2022).
- Collaboration refers to strong inter-firm relationships with suppliers, logistics providers and institutional partners (Tsolakis et al. 2023). It fosters shared visibility, joint risk planning and trust-based adaptation (Christopher & Peck 2004). Collaboration enhances learning, innovation and recovery (Dubey et al. 2021). In South Africa's FMCG sector, it improves logistics efficiency and resilience via synchronised demand and capacity management (Loury-Okoumba & Mafini 2018).
- Visibility is access to real-time data on inventory, demand and logistics capacity, enabling timely decisions (Hirsch et al. 2024). It underpins agility and redundancy (Sheffi & Rice 2005). High visibility supports disruption containment (Daneshvar Kakhki & Gargeya 2019). In

South Africa, SMEs often face visibility gaps because of fragmented ICT and poor node integration (Ngcobo & Naudé 2022).

- Redundancy is maintaining excess resources, suppliers, stock or facilities, as operational buffers (Dubey et al. 2021). Once deemed inefficient, it is now seen as strategic insurance in high-risk contexts (Ivanov 2021). South African retailers with redundant stockholding and decentralised hubs-maintained service during port crises (Magagula et al. 2020). The cost of redundancy must be weighed against the potential impact of inaction (Pettit et al. 2019).

These constructions are interdependent and mutually reinforcing. Together, they constitute what Ponomarov and Holcomb (2009) describe as a 'resilient supply network'. They reflect a systemic orientation where resilience emerges from dynamic interplays between capabilities, rather than isolated investments in individual practices.

Empirical support and application

Scholars noted that the application of SCRT has been validated in manufacturing, retail and logistics through qualitative and quantitative research. Ivanov and Das (2020) utilised simulation modelling to assess the effects of supplier diversity, inventory buffering and lead time flexibility on resilience during pandemic-like disruptions. Their findings demonstrated that supply chains marked by redundancy and agility are more proficient at absorbing shocks and facilitating quick recovery, hence validating SCRT's emphasis on dynamic capabilities and system flexibility. The study by Tsolakis et al. (2023), discovered that inter-organisational coordination accelerates recovery amid significant uncertainty in a multi-tier cooperation. These findings corroborate SCRT's core, which argued that resilience is derived from strategically aligned skills, such as visibility, redundancy and collaboration (Pettit et al. 2019; Sheffi & Rice 2005).

In South Africa, evidence highlights the importance of SCRT in emerging markets. Magagula et al. (2020) found that merchants mitigated port disruptions by utilising decentralised inventory systems and warehouse redundancies. Agigi et al. (2016) observed a rising implementation of safety stocks and supplier diversification in the FMCG sector. Supply chain resilience theory has also been combined with other frameworks. Dubey et al. (2021) integrated it with dynamic capacities theory, associating resilience with organisational learning and creativity. Mubarik et al. (2021) demonstrated how SMEs modify SCRT concepts to fit resource-limited environments, customising tactics to align with operational realities.

Supply chain resilience theory limitations

Even if people use SCRT, it is criticised for making normative assumptions and suggesting ideal behaviours like agility and visibility without taking real-world limitations into account (Wieland & Durach 2021). These kinds of talents frequently rely on modern ICT infrastructure, which is not very common in many underdeveloped nations. Digital skills in South Africa's industrial sector are not evenly distributed and are not getting enough money (Ngcobo & Naudé 2022).

Supply chain resilience theory also implies that many companies don't have flexible resources. SMEs frequently lack the resources, negotiating leverage or authority to execute redundancy or cooperation successfully. For instance, South African SMEs have trouble exchanging information and integrating platforms because their digital ecosystems are broken and there are power inequalities (Weber & Badenhorst-Weiss 2018).

Also, SCRT generally does not consider limitations in institutions and infrastructure. To make South Africa more resilient, the government must change the rules, invest in infrastructure and work together with businesses (Magagula et al. 2020; Ngcobo & Naudé 2022). In the absence of such measures, concepts from industrialised markets may be ineffective in regions characterised by unreliable transportation, insufficient supervision and informal economies (Ivanov 2021). In such circumstances, resilience often derives from informal networks, indigenous knowledge and grassroots solutions that surpass conventional SCRT models (Magagula et al. 2020).

A resilient supply chain

Blos et al. (2012) put up a layered paradigm that breaks down resilience capabilities into three levels: strategic, operational and tactical. This arrangement works effectively for the many kinds of problems that might happen at ports in growing economies like South Africa. Utilising South African retail logistics studies (Du Plessis et al. 2022; Magagula et al. 2020) and more general criticisms (Agigi et al. 2016; Loury-Okoumba & Mafini 2018), the paradigm may be adapted for situations of persistent port disruption.

Strategic layer: Network design and governance

The strategic layer includes setting up the supply chain, choosing partners and making rules. The Port of Durban in South Africa is a good example of how fragile concentrated port dependency can be. There are problems with congestion, cybersecurity and labour unrest (TNPA 2023; Vhumbunu 2021). Retailers are implementing varied port entry and inland hub strategies (Du Plessis et al. 2022), in accordance with Blos, Wee and Yang's focus on adaptability and redundancy. Strategic resilience necessitates public-private partnerships and collaboration with government entities, port authorities and industry organisations to facilitate regulatory reform and infrastructure investment (Loury-Okoumba & Mafini 2018; Magagula et al. 2020).

Operational layer: Flexibility, redundancy and visibility

Resilience skills at the operational level include managing inventories, making sure that supply and demand are in

sync and being able to change modes of transportation. To protect themselves from interruptions, South African stores employ decentralised inventories and a variety of suppliers (Magagula et al. 2020). Safety stocks, which used to be thought of as wasteful, are now very important safety measures (Agigi et al. 2016). Internet of Things (IoT) sensors and Artificial Intelligence (AI) tracking help with operational visibility, which speeds up response times when things go wrong (Hirsch et al. 2024). However, many businesses use a mix of manual and digital systems as they do not have enough resources. Flexibility in logistics, such as being able to route through Port Elizabeth or Maputo instead, shows how dynamic adaptation works (Christopher & Peck 2004). Scenario-based inventory reallocation and flexible logistics contracts enhance operational resilience.

Tactical layer: Workforce competence, response protocols and culture

The tactical layer is all about being able to act quickly through competent workers, good communication and processes for responding. In South Africa, where there are a lot of informal jobs and skill shortages, it is very important to teach frontline personnel to spot early warning signals and act on their own (Magagula et al. 2020). A 'redundancy culture' (Dubey et al. 2021) sees extra capacity and safety supplies as strategic needs instead of waste, which needs strong leadership backing. Timely communication among warehouses, transit providers and suppliers expedites recovery, in accordance with the restorative capability of SCRT (Ponomarov & Holcomb 2009).

Integration with supply chain resilience theory

The integration of supply chain resilience according to paradigm Blos et al. (2012) aligns SCRT's three abilities. The abilities include absorptive (operational buffers), adaptive (strategic reconfiguration) and restorative (tactical quick recovery) (Pettit et al. 2019). This integration is particularly pertinent in resource-limited, fragmented contexts. By dividing resilience into several levels of skills, interventions may be more focused and relevant to the situation. When used together, SCRT and the Blos, Wee and Yang model give South African merchants a practical and theoretically sound plan for dealing with recurrent port problems.

Modifying the framework for emerging market contexts

The Blos et al. (2012) model offers a stratified framework for supply chain resilience, predicated on the assumptions of institutional stability and resource plenty, circumstances often seen in industrialised countries. In rising countries such as South Africa, characterised by strained infrastructure and limited resources (Christopher & Peck 2004; Scholvin & Draper 2021), several modifications are needed, including:

- **Infrastructure Agility:** Mobile and modular infrastructure, such as portable storage facilities and refrigerated containers, can avoid problems at fixed ports and quickly adapt to bottlenecks (Chikuta, Moyo & Ncube 2023; Du Plessis et al. 2022). These methods are very important when ports are always crowded and not getting enough money.
- **Informal Economy Integration:** Informal carriers and warehouse owners typically fill in the gaps in last-mile delivery, especially in peri-urban and disadvantaged areas. Incorporating them into resilience planning yields a more precise and comprehensive model (Skinner & Haysom 2021; Weber & Badenhorst-Weiss 2018).
- **Digital Resource Tiering:** Open-source logistics systems, SMS-based inventory trackers and cloud dashboards are all examples of scalable, inexpensive solutions that may help with visibility and coordination without requiring a lot of money up front (Fourie & Van Eeden 2023; Hirsch et al. 2024). These little updates make it easier to understand what is going on and respond quickly.
- **Collaborative Risk Governance:** Partnerships between governmental regulators, private businesses and community members can help them share resources and establish mechanisms for sharing information (Magagula et al. 2020; Van der Merwe, Botes & Niemann 2019). Joint contingency planning involving port authorities and merchants or cross-sector resilience forums are two examples.

This localised adaptation reflects Taleb's (2012) concept of antifragility, where systems not only withstand disruption but also improve because of it.

Towards a localised, layered resilience architecture

Looking at the Blos et al. (2012) framework again through the lens of South African retail shows that it is a strong model for inventory strategies based on resilience. Its layered typology, strategic foresight, operational flexibility and tactical reactivity align with the complexity of persistent port interruptions (Ivanov & Dolgui 2020; Sheffi & Rice 2005).

When combined with SCRT (Pettit, Fiksel & Croxton 2010) and supported by evidence from the Durban port instance, the model transforms into a dynamic architecture. It facilitates targeted interventions throughout the supply chain, encompassing long-term capacity enhancement and immediate disruption reaction (Manders, Caniëls & Ghijsen 2016; Scholvin & Draper 2021).

In this new way of looking at things, inventory goes from being a passive cost centre to an active resilience asset, because of decentralisation and flexible digital infrastructure (Du Plessis et al. 2022; Tang & Veelenturf 2019). Retailers that use this localised, layered strategy will be better able to deal with shocks, stay competitive and make sure that things keep going at a time of increased uncertainty (Craighead, Ketchen & Darby 2020; Govindan, Mina & Alavi 2020).

Research methods and design

This article adopts a structured conceptual research approach, aiming to develop and refine theory rather than produce empirical generalisations. Centred on an integrative synthesis of scholarly literature, it is supported by illustrative case examples from the South African retail context. This combined approach enables rigorous interrogation of supply chain resilience concepts and inventory strategies within disruption-prone environments.

Sources were selected using inclusion criteria prioritising peer-reviewed articles from 2013 to 2024, trade publications, government reports and industry case studies relevant to South African retail logistics. Exclusion criteria removed geographically irrelevant or outdated works. Secondary materials were analysed through thematic synthesis, identifying emergent SCRT constructs, redundancy strategies and inventory adaptations. Case examples of South African retail firms were chosen for illustrative purposes to demonstrate operational realities under chronic port disruption.

Conceptual framework development

The study draws on an extensive review of peer-reviewed articles from reputable academic outlets such as the *Journal of Transport and Supply Chain Management* and *Acta Commercii*, alongside global resilience literature. It synthesises theoretical developments in SCRT, inventory management and the effects of port disruptions. The layered resilience framework of Blos et al. (2012) forms the foundation for conceptual analysis, adapted through cross-referencing with empirical case findings to ensure relevance to emerging markets.

The selection of the Blos et al. (2012) layered resilience framework is justified by its multi-tiered structure, which distinguishes between strategic, operational and tactical capabilities. This stratification is particularly appropriate for the South African retail environment, where disruption occurs simultaneously at infrastructural, organisational and executional levels. Unlike linear resilience models, the layered approach accommodates systemic port fragility, governance constraints and firm-level inventory decisions within a single integrative architecture.

To visually reinforce this conceptual foundation, Figure 1 and Figure 2 align with the layered model, demonstrating how SCRT constructs map across resilience phases and operational realities in the South African context.

Figure 1 depicts the foundational constructs of SCRT, highlighting the four core capabilities that enable organisations to withstand and recover from disruptions. These capabilities include redundancy, agility, visibility and collaboration.

Figure 2 presents an adapted resilient supply chain structure based on the layered resilience framework proposed by Blos et al. (2012), contextualised for environments characterised by persistent port disruptions. The model illustrates how structural, operational and relational resilience mechanisms interact to support supply chain continuity.

Case-based illustrations

Chronic interruptions at the Port of Durban offer concrete examples that support the study's arguments. The article looks at real-world problems and the techniques that merchants use to deal with them by using secondary sources, industry studies, government publications and news coverage of things like traffic jams, labour strikes and cyberattacks. These examples show how current resilience theories can be used and how they cannot be used when there are operational restrictions. These cases were selected for illustrative purposes because they represent a range

	Prepare phase	Respond phase	Recover phase	Adapt phase
Flexibility	Identify alternative suppliers	Adjust operations rapidly	Reallocate resources	Reconfigure strategies
Redundancy	Build safety stock levels	Utilize backup systems	Maintain backup stocks	Evaluate redundancy
Visibility	Map supply chain risks	Monitor disruptions	Track recovery	Share data for learning
Collaboration	Align with partners	Joint action	Support recovery	Strengthen networks
Agility	Plan for change	Rapid response	Adjust operations	Innovate proactively

FIGURE 1: Supply chain resilience theory constructs across resilience phases.

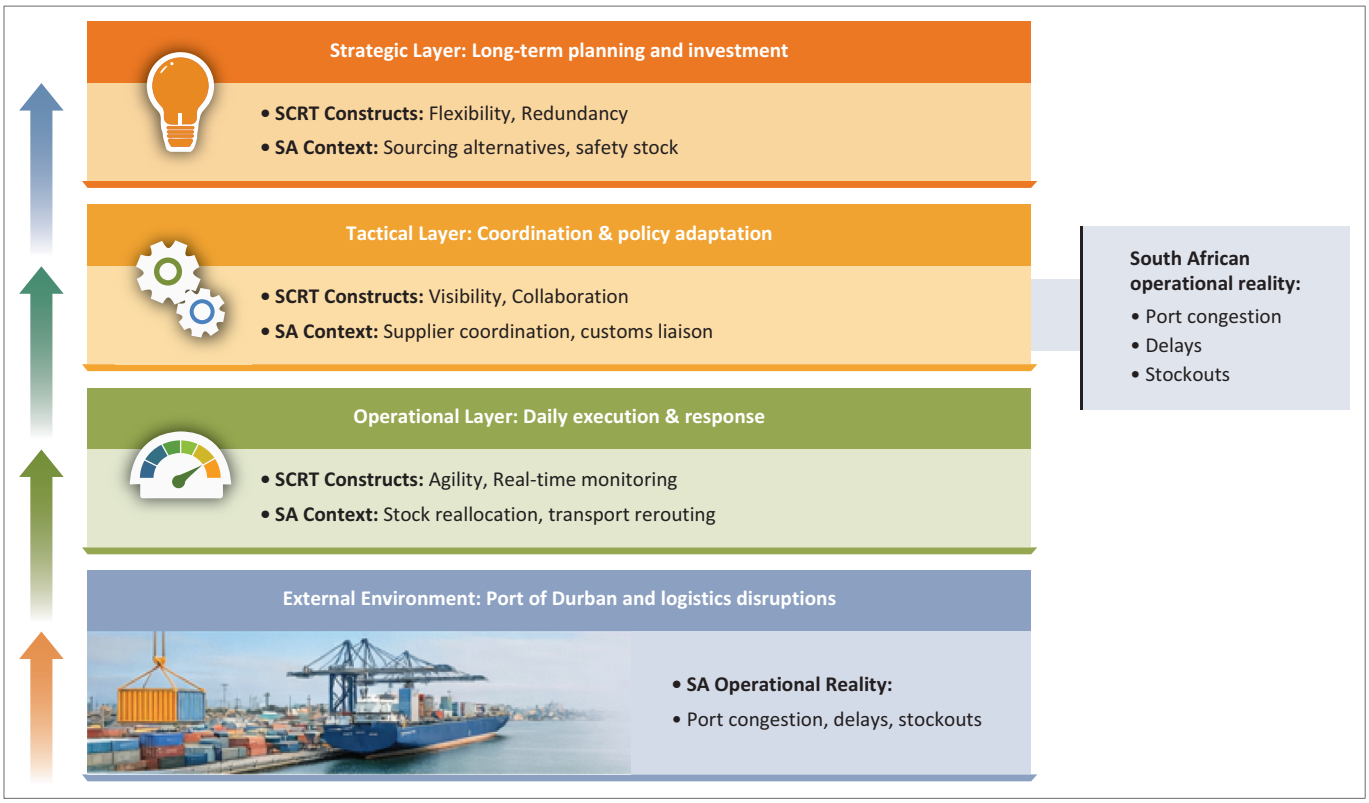


FIGURE 2: Layered model of resilience applied to South African retail.

of South African retail firms directly impacted by port congestion, providing practical insights into operational resilience under disruption.

Analytical rigour and validity

A critical lens aligns theoretical ideas with empirical practices, assessing normative prescriptions in relation to actual behaviours. Using more than one source of literature and real-world examples makes the results more reliable. Although it lacks quantitative confirmation, this approach enables in-depth theoretical analysis tailored to the challenges of South African logistics.

Secondary sources were included if they were published between 2013 and 2024, focused on inventory resilience or SCRT and provided relevance to South African retail or port operations. *Excluded* sources were geographically irrelevant or pre-2013 without enduring theoretical value. Data synthesis followed a thematic approach, with cross-comparison between literature and illustrative case reports (industry publications, news reports, government data). Case studies were selected to represent different firm sizes and supply chain configurations within the Durban port context, enabling triangulation of findings.

Findings and discussion

This section synthesises conceptual analysis with case-based illustrations to examine how inventory strategies and resilience theory manifest in South African retail under chronic port disruption.

Inventory strategy under disruption: Redundancy as a strategic lever

Repeated disruptions at the Port of Durban have triggered a shift from lean, centralised, JIT systems to strategies incorporating deliberate redundancy (Du Plessis et al. 2022; Vhumbunu 2021). Measures include increased safety stock, multi-echelon positioning and decentralised distribution centres to improve buffer stock (Sheffi & Rice 2005).

'A logistics director noted: "Holding more stock is expensive, but running out during peak season was devastating"'. Proactive stock positioning in inland warehouses allowed some firms to sustain fulfilment despite a 3-week clearance delay (Hirsch et al. 2024). Successful approaches applied redundancy selectively, prioritising high-margin or high-velocity SKUs, guided by simulations and scenario planning (Ivanov & Das 2020; Tsolakis et al. 2023).

However, SMEs faced challenges implementing adaptive redundancy as a result of limited capacity and weak supply node visibility (Magagula et al. 2020). While cost remains a concern, many now view inventory as a strategic continuity asset, aligning with resilience theory's emphasis on preparedness over efficiency (Pettit et al. 2019). SMEs often lack financial resources, digital infrastructure and logistics capacity to implement full SCRT-based strategies. Adaptations include reliance on selective redundancy, simplified ICT tools and collaborative arrangements with larger firms or local transport providers.

These adjustments allow SMEs to achieve partial resilience while acknowledging resource limitations and operational constraints.

Evaluating supply chain resilience theory in practice

The supply chain resilience theory's focus on redundancy, visibility and collaboration (Blos et al. 2012; Ponomarov & Holcomb 2009) is relevant but constrained by emerging market realities, including infrastructural decay and institutional volatility (Ngcobo & Naudé 2022).

Key limitations include the assumption that firms can easily reconfigure supply chains, difficult in contexts with poor rail links, congested secondary ports and fragmented logistics (Weber & Badenhorst-Weiss 2018). Digital integration is also hampered by unreliable ICT and siloed data. One executive called full visibility 'ideal but utopian' under current conditions (Hirsch et al. 2024).

Resilient firms adapted SCRT locally by creating micro-resilience units, categories, regions or supplier-specific cells able to function and recover independently (Christopher & Peck 2004; Ivanov 2021). This modular approach favours strategic segmentation over wholesale reconfiguration.

Supply chain resilience theory's emphasis on iterative learning was validated: firms that endured COVID-19 lockdowns and 2021 unrest had stronger contingency planning and faster recoveries (Dubey et al. 2021). Lessons from past crises were embedded into operations, confirming resilience as an evolving capability (Taleb 2012).

Table 1 maps SCRT constructs to South African operational realities.

Literature review basis

With over a decade (2013–2024) of peer-reviewed research considered, the literature review synthesises key contributions on inventory strategy and supply chain resilience in disruption-prone logistics, with emphasis on visibility, redundancy and agility. Sources include: *The Journal of Transport and Supply Chain Management*, *Acta Commercii*, *The International Journal of Logistics Management*, and *MIT Sloan Management Review*.

The review targeted empirical studies, SCRT-based frameworks and conceptual works on visibility, redundancy, agility and collaboration; outdated or geographically irrelevant works were excluded. From 21 selected papers, four constructs emerged as foundational to inventory resilience, agility, collaboration, visibility and redundancy, mapped to SCRT's readiness, response and recovery phases.

TABLE 1: Supply chain resilience theory construct, SA operational adaptation and examples.

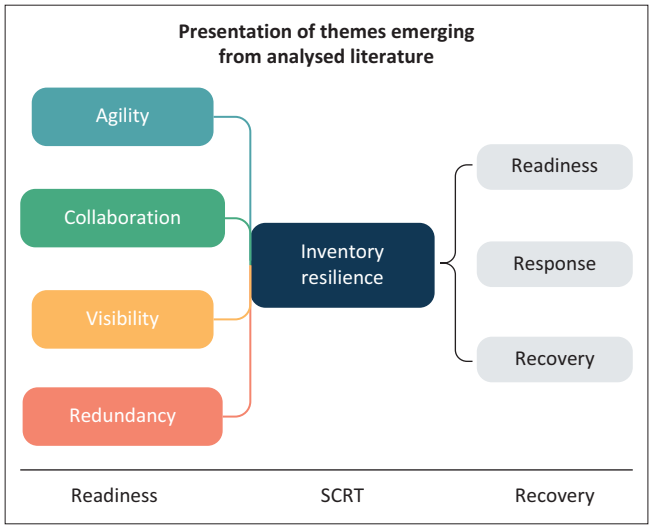
SCRT construct	Operational adaptation in SA	Example practices
Redundancy	Strategic stock buffers, multi-echelon warehouses	Inland warehousing, selective redundancy
Visibility	Real-time inventory tracking, ICT integration	AI dashboards, IoT sensors
Agility	Flexible routing and sourcing	Alternate port routes, dynamic supplier selection
Collaboration	Multi-tier partnerships	Supplier coordination, public-private contingency forums

SCRT, supply chain resilience theory; SA, South Africa; ICT, information and communication technology; IoT, internet of things.

While scholarly consensus affirms these capabilities' importance, most frameworks were designed for stable, resource-rich environments, underscoring the need for localised adaptations in fragile logistics networks like those surrounding Durban's port.

As illustrated in Figure 3, the emergent SCRT constructs and inventory resilience strategies are categorised to highlight their conceptual and practical interrelationships. The resilience capabilities of agility, collaboration, visibility and redundancy represent key organisational mechanisms that strengthen supply chain resilience. These capabilities contribute to the broader SCRT phases of readiness, response and recovery, which collectively describe how organisations prepare for, respond to and recover from supply chain disruptions (Blos, Da Silva & Wee 2018). Together, these interacting elements form the foundation of inventory resilience, enabling retailers to maintain operational continuity and mitigate the effects of disruptions such as port congestion.

Figure 4 synthesises the key themes emerging from the analysed literature and aligns them with relevant phases of SCRT. Four dominant resilience capabilities were identified: agility, collaboration, visibility and redundancy. Agility reflects the speed and flexibility with which organisations reconfigure supply chains during disruption, supporting the response phase of resilience (Christopher & Peck 2004; Ivanov & Das 2020). Collaboration emphasises inter-organisational coordination and joint resilience planning, strengthening readiness capabilities (Dubey et al. 2021; Tsolakis et al. 2023). Visibility highlights the importance of real-time information sharing and digital integration to support both readiness and response, enabling firms to



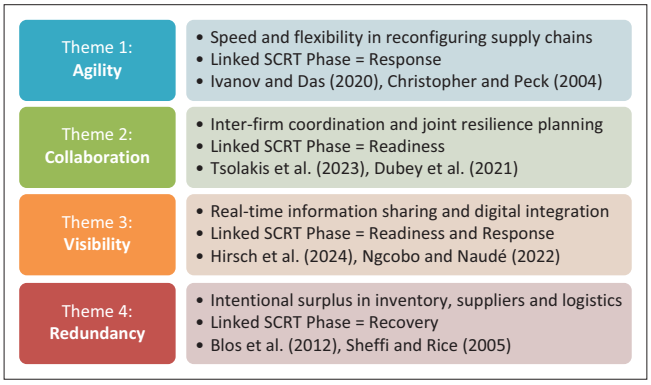
SCRT, supply chain resilience theory.

FIGURE 3: Mind map of emerging themes for Table 2.

anticipate and manage disruptions more effectively (Hirsch et al. 2024; Ngcobo & Naudé 2022). Finally, redundancy represents the intentional maintenance of surplus resources, such as additional inventory, suppliers or logistics capacity, which supports recovery by allowing organisations to restore operational stability following disruptions (Blos et al. 2012; Sheffi & Rice 2005). These themes illustrate how resilience capabilities interact across different phases of supply chain disruption management.

Together, these dimensions frame how inventory strategies should be reconfigured to mitigate the risks associated with chronic port disruptions, particularly in emerging markets like South Africa. Table 2 categorises the literature accordingly.

Table 2 presents peer-reviewed studies mapped to SCRT phases, supporting our analytical framework. It reveals a growing empirical interest in operationalising SCRT constructs to enhance inventory resilience, particularly in disruption-prone markets. While early literature focused heavily on redundancy (e.g. Christopher & Peck 2004; Sheffi & Rice 2005), more recent work integrates visibility and agility as crucial enablers of timely response (e.g. Hirsch et al. 2024; Ivanov & Das 2020). Collaboration, though less frequently addressed, is emerging as a prerequisite for multi-tier resilience, particularly through supplier integration (Agigi et al. 2016; Tsolakis et al. 2023). Notably, few models are tailored to the South African port context, where infrastructural and institutional risks co-exist. This gap underpins the rationale for this journal article, which revisits the Blos et al. (2012) framework and proposes a modified, layered model aligned to both SCRT and local retail conditions.



SCRT, supply chain resilience theory.

FIGURE 4: Presentation of themes emerging from analysed literature.

Limitations

The findings are not widely generalisable; subsequent studies should employ empirical approaches to validate and implement recommended models. Despite this, this method fills in gaps in the literature by bringing to light the realities of developing markets that are generally ignored in conventional resilience research.

Limitations include the conceptual nature of the study, reliance on secondary sources and focus on illustrative cases rather than full-scale empirical testing. Generalisability is limited to similar emerging market contexts. Future research should pursue empirical validation, quantitative modelling of cost-resilience trade-offs, longitudinal studies on adaptive learning and investigations into SME-specific adaptation of SCRT constructs.

TABLE 2: Recent articles categorised by resilience construct and supply chain resilience theory phase.

Author(s)	Year	Title or focus area	Construct	SCRT phase	Key findings
Christopher & Peck	2004	Resilient Supply Chains	Redundancy	Readiness	Introduced foundational concepts of supply chain vulnerability and mitigation.
Sheffi & Rice	2005	Resilient Enterprises	Redundancy	Recovery	Highlighted redundancy as a protective buffer for operational continuity.
Pettit et al.	2019	SCRT Capabilities	All 4	All Phases	Developed the SCRT framework with empirical validation across sectors.
Ivanov & Das	2020	Digital Twins for Resilience	Agility	Response	Demonstrated simulation-based agile adaptation to port disruptions.
Dubey et al.	2021	Dynamic Capabilities in Food Industry	Redundancy	Readiness	Explored how redundancy can enhance adaptive capability.
Hirsch et al.	2024	AI for FMCG Resilience	Visibility	Response	Showed how real-time ICT integration improves disruption response.
Du Plessis et al.	2022	Reefer Container Imbalances	Redundancy	Recovery	Identified redundancy limitations in export-facing logistics.
Ngcobo & Naudé	2022	Sustainability in Manufacturing	Visibility	Readiness	Analysed the fragmented visibility in SA SMEs' inventory networks.
Agigi et al.	2016	Resilient Design in FMCG	Collaboration	Readiness	Emphasised cross-functional coordination in disruption planning.
Ivanov	2021	Complexity and Resilience	Agility	Response	Highlighted the reconfigurability of networks during dynamic disruptions.
Tsolakis et al.	2023	Collaboration in Agrifood Chains	Collaboration	Response	Showed that strong supplier relationships reduce lead time volatility.
Daneshvar Kakhki & Gargeya	2019	Simulation in SCM	Visibility	Response	Advocated scenario-based planning to increase inventory responsiveness.
Vhumbunu	2021	Civil Unrest & Logistics Disruption	Redundancy	Recovery	Documented the value of stockpiling after unrest-induced port closures.
Magagula et al.	2020	Disruption Practices in Retail	Agility	Response	Retailers adopt decentralised stock practices to mitigate delay risks.
Blos et al.	2012	Multi-layered Resilience Model	All 4	All Phases	Proposed a strategic-operational-tactical framework for resilience.
Wieland & Durach	2021	Critique of SCRT	All 4	All Phases	Emphasised the contextual limitations of universal SCRT applications.
Loury-Okoumba & Mafini	2018	Logistics Integration in FMCG	Visibility	Response	Identified the link between logistics visibility and retail performance.
Weber & Badenhorst-Weiss	2018	Inventory Challenges in SA	Redundancy	Recovery	Pointed to the critical role of buffer inventory in volatile logistics.
Mubarik et al.	2021	Strategic Redundancy	Redundancy	Readiness	Advocated for selective redundancy in high-margin product lines.
Taleb	2012	Antifragility	Agility	Recovery	Theorised that systems must not only survive shocks but evolve through them.
World Bank	2024	Port Performance in South Africa	Visibility	Readiness	Revealed systemic inefficiencies at Durban port impacting supply lead times.

Note: Please see the full reference list of Govender, S., Mara, C.C. & Matsoso, M.L., 2026, 'Resilient retail: Transforming inventory strategies to navigate port disruptions', *Acta Commercii* 26(1), a1499. https://doi.org/10.4102/ac.v26i1.1499.

SCRT, supply chain resilience theory; FMCG, fast-moving consumer goods; SA, South Africa; ICT, information and communication technology; SME, small and medium sized enterprises.

Recommendations

Future research should focus on:

- Quantitative modelling to evaluate cost–resilience trade-offs under varying disruption scenarios (Ivanov & Das 2020).
- Digital innovations such as blockchain, IoT and advanced analytics for predictive disruption management in uneven technology adoption contexts (Daneshvar Kakhki & Gargeya 2019).
- Cross-sectoral governance mechanisms to mitigate systemic port risks (Ngcobo & Naudé 2022).
- Longitudinal case studies on post-disruption adaptive learning in South Africa (Magagula et al. 2020).

Conclusion

The present study critically analysed the reconfiguration of inventory strategies to bolster supply chain resilience in response to persistent port interruptions, specifically within the South African retail sector and the context of rising market dynamics (Agigi et al. 2016; Ngcobo & Naudé 2022). Research from both global and regional sources indicates that lean inventory models enhance cost efficiency but exhibit insufficient resilience to endure systemic disruptions, as evidenced by the situation at the Port of Durban (Du Plessis et al. 2022; Vhumbunu 2021).

Anchored on SCRT, the research examined theoretical conflicts and practical difficulties in resource-limited environments (Pettit et al. 2019; Ponomarov & Holcomb 2009). The layered resilience framework (Blos et al. 2012) was utilised to emphasise the necessity for flexible strategic, operational and tactical methodologies in the Global South (Christopher & Peck 2004).

The findings underscore redundancy as a strategic advantage, with decentralised inventories, multi-modal logistics and improved visibility as essential facilitators, bolstered by cost-effective digital solutions (Hirsch et al. 2024). Incorporating redundancy within organisational culture is essential for enduring resilience (Taleb 2012). Nonetheless, resilience must be harmonised with operational and financial sustainability (Ivanov 2021; Wieland & Durach 2021).

In addition to the theoretical insights presented, several practical implications emerge for both retailers and policymakers. Retailers should consider strengthening supply chain resilience by adopting multi-supplier sourcing strategies and maintaining strategic safety stock buffers for critical products. These measures can help mitigate the operational risks associated with prolonged port congestion and shipping delays, particularly in import-dependent retail sectors.

From a policy perspective, greater coordination between port authorities, logistics service providers and regulatory agencies could assist in reducing congestion pressures at major South African ports. Policymakers may therefore consider initiatives such as improved port scheduling systems, infrastructure investment and incentives for off-peak cargo handling to enhance overall port efficiency. Collectively, these interventions can support a more resilient retail supply chain capable of adapting to recurring disruptions within the maritime logistics environment.

In sum, a layered, context-sensitive resilience architecture is essential for South African retailers and other emerging-market firms navigating volatile global logistics (Blos et al. 2012; Du Plessis et al. 2022).

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

CRediT authorship contribution

Sajjini Govender: Conceptualisation, Methodology, Investigation, Resources, Visualisation, Writing – review and editing. Cashandra C. Mara: Supervision, Writing – review and editing. Mamorena L. Matsoso: Supervision, Writing – review and editing. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication and take responsibility for the integrity of its findings.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg and Department of Business Management Research Ethics Committee (No. [i25SOM/BM18]).

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Data availability

The authors confirm that the data supporting this study and its findings are available within the article and its listed references.

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