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Optimizing Supply Chain Resilience and Agility in Ghanaian Manufacturing Industries: A Framework for Integrating Local Logistics Providers.

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ABSTRACT:

Pandemics, technological advancements, and geopolitical tensions have caused great disruption in global supply chains and pose growing challenges to manufacturing firms in developing countries. In Ghana, the lack of infrastructure or infrastructure-related activities means firms are unable to survive disruptions and react effectively to changes in the market. Although supply chain resilience and agility have been identified as major strategic goals, there is little information on how these factors interact in the context of manufacturing in Ghana, and even less on the role local logistics providers play in these relationships. This research sought to examine the role of local logistics providers in the supply chain resilience and agility of Ghanaian manufacturing.

The frameworks of these two theories are used together in this paper. Dynamic Capabilities Theory explains how firms gain competitive advantage by detecting disruptions, seizing opportunities, and shifting resources. Resilience, on the one hand, can absorb shocks, and agility, on the other, can respond to shocks. Contingency Theory, on the other hand, argues that resilience has impact on agility based on the firm's operations. In the Ghanaian context, logistics integration — defined as the coordination, information sharing, and collaborative alignment between manufacturers and logistics service providers — is theorized as the key contextual moderator that strengthens or constrains the resilience–agility relationship.

In this study, a quantitative design is adopted with structured questionnaires distributed to 81 purposively sampled supply chain and logistics professionals across four firms in the Greater Accra Region, Ghana, and analyzed using PLS-SEM. Findings from the data collected reveal a significant positive relationship between supply chain resilience and agility, with logistics integration meaningfully moderating that relationship. It highlights that firms with solid logistics partnerships demonstrate stronger coordination and greater operational flexibility. The study recommended that Ghanaian manufacturing firms integrate real- time information sharing, joint decision-making, and structured collaboration into their supply chain governance framework.

KEYWORDS: supply chain resilience, supply chain agility, integrated logistics capabilities, supply chain collaboration, Ghanaian manufacturing sector

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Abbreviations

SCR: Supply Chain Resilience

SCA: Supply Chain Agility

LI: Logistics Integration

LSP: Logistics Service Providers

DCT: Dynamic Capabilities Theory

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1 Introduction

1.1 Background to the study

Pandemics, war conflicts, and rapid technological advancements are disrupting global supply chains, compelling many businesses, especially in developing countries like Ghana, to halt production and, in some cases, permanently shut down (Ayam, 2023; Dadson, 2023; Ali, Ho & Papadopoulos, 2025). As a result, for any operational business, supply chain resilience, which is the ability of operations to return to their original state after a disturbance with minimum effect on operations, is critical (Aslam et al., 2020; Hamidu et al., 2024; Calvo et al., 2020; Akrofi et al., 2023). But, supply chain resilience alone would not be enough to make a business competitive due to changing trends, hence the need for supply chain agility (Gligor et al., 2019; Ladeira et al., 2021), which is the ability for the supply chain to respond quickly to changes. Considering the poor infrastructural and logistics systems in the manufacturing sector in Ghana (Essuman et al., 2023; Yawson & Yamoah, 2022), supply chain resilience and agility, therefore, become a need for businesses to be responsive and prevent collapse. It is against this background that this research study basically stems from the essential need to promote the supply chain resilience and agility through logistics, which ties resilience and agility to a more firmed robust supply chain.

Supply chain agility refers to the firm's ability to sense, decide, and respond to environmental changes and disruptions (Eckstein et al., 2015; Yamin et al., 2024). Supply chain agility complements supply chain resilience by promoting proactive manoeuvrability and adaptiveness towards uncertainties (Dubey et al., 2014; Tarigan et al., 2021). Ghana's manufacturing industry has become less agile in the supply chain due to increased supply disruptions, transport challenges, and over-reliance on imports (Dadson, 2023; Ayam, 2023). To remain agile in the supply chain, firms must collaborate more with domestic logistics firms since they have a wider contextual knowledge and operational insight (Al Doghan & Sundram, 2023; Mandal et al., 2017). Collaborating with the local logistics industry enhances the firms' coordination, visibility, and

responsiveness to supply chain change (Song et al., 2022; Faroq et al., 2024). Data-driven logistics practices could also enhance the speedier forecasting, inventory, and delivery lead times in the supply chain (Mahama et al., 2024; Lohmer et al., 2022). Ghanaian manufacturing firms' quality systems need more resilience.

The future of business is that of continuous, rather than intermittent, disruption. To stay in business, the company's business model must adjust to the changing landscape. As the world is increasingly fragmented, systemic disruptions are driving companies to revisit their supply chains (Aslam et al., 2020; Gligor et al., 2019). Given Ghana's current infrastructure and logistics industry, it will be hard for the country's manufacturers to break through the bottlenecks (Dadson, 2023; Ayam, 2023). Resilience enables recovery from shocks, whereas agility helps to adjust to the new realities (Eckstein et al., 2015; Calvo et al., 2020). When resilience and agility are integrated, they form an elastic system that enables absorption of shocks and grabs opportunities (Mandal et al., 2017; Song et al., 2022). The interdependence between agility and resilience makes logistics integration a critical enabler that connects the two capabilities as one system that adjusts to the dynamics of supply chain conditions.

The logistics integration facilitates interdependence through the seamless flow of information, materials, and processes between supply chain partners (Abdalla, 2021; Dağdeviren & Erturgut, 2024). It promotes collaboration, joint decision-making, and instant coordination between manufacturers and logistics service providers (Aggrey et al., 2022; Gligor & Holcomb, 2012). Logistics integration can help Ghana's manufacturing sector overcome the fragmented logistics that are inhibiting its performance by coordinating operations, aligning objectives, and increasing agility (Farooq et al., 2024; Song et al., 2022). By linking strategic and tactical approaches, integrated logistics enables resilience to evolve from a responsive function to a proactive competitive strategy, fostering continuity, agility, and competitiveness for manufacturers in Ghana (Tarigan et al., 2021; Mandal et al., 2016).

1.2 Research Gaps

Table 1: Research gaps on Resilience and Agility in Supply Chain and logistics integration within Ghana.

Keywords	Scope	Database Type	Hint Count	Essential Parameters, Scope, and Gap
"Supply chain resilience AND agility in developing countries"	2010–2024	Google Scholar	35	There is a vast body of literature that spans the globe; however, there is very little focus specifically on Ghana. Although resilience-agility frameworks have been developed, they have not been adjusted to reflect the infrastructural and institutional weaknesses of developing economies. It also seems there is a need for the simultaneous operationalization of both constructs.
"Logistics integration AND manufacturing firms in Ghana"	2010–2024	Scopus	22	This shows the lack of attention in the literature on this topic. Few research studies have been centered on using logistics integration to improve performance, and all of them are limited to the agri-business sector and health sector. The identified gap in this literature is to investigate the role of LSP in translating resilience into agility.
"Manufacturing supply chain disruptions in Ghana"	2010–2024	Scopus	12	Confirms persistent issues: unstable infrastructure, limited technology adoption, and weak partner collaboration. A gap exists in the absence of empirically grounded models showing how logistics integration moderates resilience–agility outcomes.

1.3 Problem Statement, Research Question, and Objectives

Problem Statement

In an unstable and ever-changing setting, it is evident that there is a strong requirement for a resilient and agile supply chain (Essuman et al. 2023). Global crises such as pandemics, political disputes, and technological advancements have shown wide gaps in the supply chain systems. However, this matter is exacerbated in developing countries with the lack of a robust supply chain system (Al Doghan & Sundram, 2023). Currently, Ghana's manufacturing industry faces challenges with erratic infrastructure, lack of integrated logistics, and uncontrollable external factors (Ayam, 2023; Dadson, 2023). Researchers studied innovation in agricultural supply chains (Aggrey et al. 2022) and the health care supply chain (Akrofi et al. 2023). Yet, there is very little understanding of how one can simultaneously build resilience and agility into the supply chains (refer to Table 1). This paper seeks to fill that gap.

Most importantly, emergence of resilient and agile supply chains is a source of competitive advantage. To be relevant, Ghanaian manufacturing firms should be able to respond to even unexpected situations, which they can achieve through logistics provider firms. Collaboration will result in better coordination, more responsiveness, and lesser supply chain risk (Hamidu et al., 2024; Yawson & Yamoah, 2022). Integration improves the quality of decision-making of firms and their ability to perform in delivering as scheduled. It creates trust and flexibility in operations. In Ghana, this is lacking. The inability of firms to collaborate deprives them of the ability to bounce back effectively and seize opportunities. Hence, logistics integration is a prelude to resilience and agility.

Technological advancement will also play a crucial role in the ongoing featured transformation (Mahama et al., 2024). New technologies such as artificial intelligence and blockchain have a major influence on the ways organizations are fostering transparency, collaboration, and service provision (Mahama et al., 2024; Lohmer et al., 2022). Through these technologies, visibility and interaction are facilitated, and anticipatory decision-making is improved. Adequate use of these technologies will inject

more proactivity into the supply chain, leading to diminished reactivity. In Ghana, technological deployment is verging on the low side, owing to companies finding it challenging to apply the technologies due to high costs of application and unavailability of the required skills (Ayam, 2023; Dadson, 2023). Thus, businesses overly rely on manual and traditional mechanisms and have difficulties competing in a fast-changing world. There is a strong need to bridge the gap through technology applications for the deployment of resilient and agile supply chain systems.

The scholarly discussion around resilience and agility is gradually growing (Essuman et al., 2023). Scholars have identified sustainability, innovation, and digitalization as vehicles to make supply chains more robust (Akrofi et al., 2023; Dadson, 2023). Unfortunately, evidence from a Ghanaian context is rare. Most of the scholars' proposed solutions are in environments where sustainability abounds (Akrofi et al., 2023; Dadson, 2023); however, the absence of the issue of how the dynamics of resilience-agility work when local logistics innovation is observed. Evidently, firms are assisted by logistics integration to lessen risks with strengthened predictive and information sharing capabilities and improvement in capabilities to coordinate recovery. Firms become more flexible with resilience, agility, and logistics integration, which help promote the continuation of current operations in difficult situations. This has the implication that resilience and agility, though they need to be incorporated with corporate goals, will still be separate and different goals (Yawson Yamoah, 2022).

To bridge this gap, the study aims to create conceptual framework involving how manufacturing firms in Ghana can develop local logistics partnerships to attain resilience, agility, and sustained competitive performance.

Research Question

To what extent does the involvement of local logistics services providers mediate the impact of supply chain resilience on supply chain agility, with regards to Ghana Manufacturing Industries?

Research Objectives

Specifically, the study seeks;

i. To examine the relationship between supply chain resilience and supply chain agility.
ii. To analyse the role of local logistics service providers in the performance of the supply chain.
iii. To explore the moderating effect of logistic integration on the relationship between supply chain resilience and agility.
iv. To propose and show a methodology of integrating logistics partnerships to achieve manufacturing supply chain resilience and agility.

1.4 Definitions and Scope of the Study

Supply Chain Resilience

Supply chain resilience refers to the capacity of a supply chain to anticipate, absorb, and recover from disruptions (Ponomarov & Holcomb, 2009). Supply chain resilience can also refer to the firms' ability to maintain normal operations in the face of disruptions (e.g., lack of supplies, delays in transportation, or crises) (Ovadia, 2006). Supply chain resilience in this study focuses on managing disruption in manufacturing and logistics relationships in Ghana but not supply chain redesign or macroeconomic resilience. Firm-level responses are addressed rather than industry-wide or policy-driven resilience models as resilience is complex and multi-faceted (Ivanov, 2020).

Supply Chain Agility

Supply chain agility (SCA) is the ability of supply chains to quickly react to changes in markets, customer demands, and unexpected disruptions (Aslam et al., 2020). It includes the ability to detect changes in the environment, make quick decisions, and adjust resources (Tarigan et al., 2021). For this study, supply chain agility is specifically concerned with manufacturers' responsiveness to changes in demand and supply in Ghana. This research does not address digital agility, such as artificial intelligence-driven

forecasting. Instead, it focuses on practical agility capabilities observed among local firms and their logistics partners.

Integrated Logistics Capabilities

Integrated logistics capabilities refer to coordinated logistics efforts of firms that help the flow of materials, information, and resources (Esper et al., 2007). These capabilities also involve coordination between supply chain actors to make the supply chain run smoothly and to reduce inefficiencies. The study is restricted to the integration of manufacturing firms and logistics service providers in Ghana and does not cover supply chain digitization or global logistics integration. On top of that, this research studies operations such as transport, warehouse, and sharing of information without discussing highly sophisticated technological integrations because of the costs and infrastructure issues prevalent in Ghana (Song et al., 2022).

Supply Chain Collaboration

Supply chain collaboration means a coordinated set of interactions among supply chain partners that involve information sharing, decision making, and goal setting (Cao and Zhang, 2011; Cao et al., 2016). Collaboration improves mutual performance and enhances inter-organizational relationships. This study explains collaboration as the collaborative relationships between manufacturing companies and logistics service providers in Ghana and does not include informal or ad hoc networks of suppliers, distributors, or international partners. For clarity in assessing these partnerships, this study only investigates formal collaboration as opposed to informal or ad hoc interactions, allowing for transparent outcomes.

Ghanaian Manufacturing Sector

The Ghanaian manufacturing sector includes companies that produce finished or semi-finished goods for domestic use and export. It is a major contributor to the national economy, and helps create jobs, industrialisation, and development. The sector faces challenges like limited infrastructure, import dependency, and inefficiencies in logistics.

This study focuses on manufacturing firms in the Greater Accra Region and industrial zones. It also focuses on formal manufacturing firms, including no informal or small-scale unregistered businesses. The study also focuses on operational and logistical aspects of manufacturing rather than policy, financial, or macroeconomic issues which are relevant to the sector.

1.5 Structure of the Study

There are five chapters within this study.

Chapter one discusses background to the study, research gaps, problem statement, question of the study, objectives of the study, definitions and scope of the study, and the structure of the study.

In chapter two, a literature review on supply chain resilience, supply chain agility, and logistics integration is presented in line with manufacturing industries in Ghana. Dynamic Capabilities Theory and Contingency Theory are also discussed in this chapter. Plus, this chapter also contains the conceptual framework.

Chapter Three discusses the conceptual framework and hypotheses development, research methodology, research design, data collection, population, sampling method, sample size, reliability and validity, data analysis, rationale for selected research methodology, operational definitions of the study variables, and ethical considerations.

The demographic findings, descriptive statistics, validity and reliability results, correlation analysis, hypothesis testing, and the study's results are explained throughout Chapter Four.

Chapter Five summarizes the findings, offers recommendations, presents theoretical and policy implications, and suggests further studies.

2 Literature Review

This chapter reviews literature on the resilience of supply chain, supply chain agility, and logistics integration in manufacturing industries of Ghana. The review of relevant literature and theory is not carried out separately, but rather related literature and theory are discussed together to form the theoretical literature. Dynamic Capabilities Theory and Contingency Theory are discussed along with the core constructs to link the ability of firms to adapt and respond to align their supply chain strategies in a turbulent environment (Teece, 2007; Donaldson, 2001). The research gap is identified in this approach, as well as the interrelationship of the variables that are the subject of the study, to arrive at the conceptual framework.

2.1 Supply Chain Resilience Within Ghanaian Manufacturing Industries

Conceptualizing supply chain resilience in the manufacturing environment of Ghana is critical, given the infrastructural, supply, and institutional issues manufacturing firms face (Gligor et al., 2019; Aslam et al., 2020). In this section, the uses the definition of resilience from Chapter One as a starting point and aim to explore the meaning of resilience through the local interaction between manufacturing and logistics.

However, in developing countries like Ghana with high levels of environmental uncertainty and resource constraints, viewing resilience from a disaster-based narrative might not be the most appropriate, and firms should learn to adapt and absorb shocks while learning from the experiences (Kpessa-Whyte, 2017; Ayam, 2023). Firms that develop organizational learning and experience-based decision-making processes will be better poised to convert disruptions and challenges into opportunities for improvement and innovation (Mandal et al., 2016; Aslam et al., 2020). This is also characteristic of the main constructs of the Dynamic Capabilities Theory, where it emphasizes the ability of firms to sustain their position in the competitive environment by sensing any disruptions, quickly seizing the opportunities, and reconfiguring their internal and external resources accordingly (Teece, 2007). Hence, in the Ghanaian manufacturing context, firm resilience

should embody the ability to continuously adapt to disruptions and challenges by learning from experiences and collaborating with the business networks (Pratondo et al., 2021).

The manufacturer and logistics providers' inter-organizational relationship, i.e., trust, coordination, etc., can increase the resilience based on several empirical studies (Ladeira et al., 2021; Eckstein et al., 2015) in terms of the increased flow of information and faster responses to any disruptions. But, these resilience strategies are highly dependent on the scenario, such as better infrastructure or institutional support, etc. (Dadson, 2023). In line with Contingency Theory, there is no one-size-fits-all approach towards resilience; rather, the appropriateness of fit between organizational strategies and environmental factors is dependent on it (Donaldson, 2001).

Plus, resilience is becoming a necessary condition to avoid risk and disruption, enabling the production system to continue smoothly and efficiently, thus providing a competitive edge (Mandal et al., 2017; Song et al., 2022). Manufacturing companies that operate adaptive mechanisms, such as flexible sourcing, responsive logistics, and collaboration, can perform effectively despite supply chain disruptions (Tarigan et al., 2021). In this regard, supply chain resilience in Ghanaian manufacturing industries should be considered a context-specific dynamic capability that evolves according to environmental conditions, organizational learning, and collaborative relationships (Farooq et al., 2024).

2.2 Supply Chain Agility Within Ghanaian Manufacturing Industries

In Ghana's manufacturing industry, supply chain agility is defined as the ability of a firm to swiftly and effectively react to changing market conditions, demand, and uncertainty (Gligor & Holcomb, 2012; Aslam et al., 2020). In this description, agility is novel and vital in the firm and logistics relationship, not in technological advancement.

In contexts characterized by volatility and infrastructural limitations, agility is crucial in maintaining performance (Hsieh et al., 2023; Yamin et al., 2024). Agility can be achieved through quick decision-making, flexible resource mobilization, and efficient logistics (Tarigan et al., 2021; Dubey et al., 2014). Manufacturing firms, guided by Dynamic Capabilities Theory, locate changes in the environment and alter their modus operandi accordingly (Teece, 2007). Manufacturing firms in Ghana show this agility by flexing production schedules, logistics order routing, and quick responses to customers' requests (Yawson & Yamoah, 2022).

Information dissemination and collaboration enable firms to become agile (Mahama et al., 2024; Farooq et al., 2024). Those business entities that collaborate with logistics partners enjoy enhanced visibility and therefore increased agility to cope with sudden changes and disruptions (Lohmer et al., 2022). In general, agility is conditional to the infrastructure, technology, and market (Ayam, 2023; Dadson, 2023). Contingency Theory (Donaldson, 2001) states that environmental conditions need to shape organizational strategies in achieving agility. In Ghana, where there is a scarcity of resources, agility enables firms to make the most of the resources and innovate to overcome challenges.

Both flexibility and agility are complementary to resilience, focusing on rapid and proactive responses where resilience is on recovery and continuity (Aslam et al., 2020) to improve supply chain performance (Calvo et al., 2020). In this research, supply chain agility is defined as dynamic behavior based on context that will enable manufacturing firms to effectively and rapidly respond to environmental changes.

2.3 Logistics Integration in the Context of Ghanaian Manufacturing Industries

Logistics integration (Liaison, coordination and connection of logistics activities of manufacturing companies and logistic service providers) is a term that was coined in

Ghana to address the integration of logistics across manufacturing companies and logistic service providers for improved efficiency, visibility, and response (Abdalla, 2021; Dadeviren & Erturgut, 2024). As stated in Chapter One, this paper only addresses operational integration, rather than digital or global supply chains.

Logistics integration helps firms synchronize transportation, warehousing, and information flow, improving service delivery (Song et al., 2022; Tarigan et al., 2021) and enables decision-making and timely responses to disruptions and market changes (Farooq et al., 2024). Logistics integration, in theory, is an aspect of Dynamic Capabilities Theory where the ability to reorganize resources and processes across boundaries is an important component (Teece, 2007).

The integration of logistics also enhances the trust, collaboration, and shared goals between organizations (Mandal et al., 2017). These characteristics can improve supply chain performance and help teams respond to environmental conditions in a coordinated manner (Pratondo et al., 2021). The efficiency of logistics integration can depend on the technology, organizational strength, and ability of partners (Dadson, 2023). This is consistent with the theories of Contingency Theory that stress the need to link logistics integration to the environment (Donaldson, 2001).

But more significantly, the integration of logistics is an intermediate between resilience and agility. The combination of information flow and coordination allows firms to act faster upon disruptions (agility) and recover quickly and sustain continuity (resilience) (Gligor & Holcomb, 2012; Hsieh et al., 2023). In the case of the manufacturing sector in

Ghana, where logistics inefficiencies are common, the integration of logistics is an enabler of both.

Integrated logistics is thus seen as a strategic and context-sensitive capability that helps to integrate logistics processes and relationships so that it improves the efficiency, responsiveness, and adaptiveness of supply chains (Mahama et al., 2024).

2.4 Conceptual Framework

The Conceptual framework reveals a link between supply chain resilience and supply chain agility of manufacturing sectors in Ghana, with logistic integration playing a moderating role. By definition, resilience is the capacity of an organization to absorb and react to disruptions in its supply chain. In the manufacturing context of Ghana, where there is poor infrastructure, supply uncertainty, and institutional challenges, resilience should not be viewed as the ability to react to unforeseen events, but rather the ability of firms to be proactive about challenges. A firm that is resilient can foresee potential disruptions, absorb shocks, and reconfigure its operations without major losses in its performance indicators. Resilience is paramount to attaining high levels of responsiveness (agility) and competitiveness.

The figure below suggests that there is a moderator rather than a direct relationship between resilience and agility. It indicates a more thorough understanding of the supply chain dynamics. Logistics integration increases information sharing, activity coordination, and goal congruence between manufacturing firms and logistics service providers and,

in turn, increases the path of resilience turning into agility. Without proper logistics integration, resilient firms may still struggle to respond quickly due to lack of coordination and fragmented logistics processes. On the other hand, in tight logistics integration, the resilience that emerged from the resilient firm becomes channeled into quick and flexible responses, ultimately resulting in increased agility. This moderating variable indicates that the effect of resilience on agility is conditional, not automatic.

The framework draws on Dynamic Capabilities Theory to explain how firms become resilient and agile. The theory provides an explanation of how firms learn to be resilient and agile. It hinges on the three processes of sensing opportunities, seizing those opportunities, and reconfiguring resources. Manufacturing firms in Ghana face uncertainties and constraints with regard to their environment. Being able to sense disruptions will allow firms to anticipate risk, the ability to seize opportunities will allow immediate decision-making, and the ability to reconfigure resources will allow firms to adapt their operations and logistics. These dynamic abilities underpin supply chain resilience and enable firms to move towards agility. Resiliency and agility are not static in nature but evolved capabilities through learning and adapting.

To add context-sensitivity to the relationships among these variables, the framework incorporates Contingency Theory. Contingency Theory posits that there is no single right way to do business, but only the best combination of capabilities and environment. This is especially important for the manufacturing sector in Ghana where infrastructure, technology and support are not always constants. The framework illustrates this by

showing that logistics integration and supply chain agility are contextually sensitive. Specifically, logistics integration can be made successful or not if the logistics partners are reliable and support infrastructure is available. Achieving agility depends on the extent to which firms can adapt their strategies to the external environment. This theory adds to the notion that both resilience and agility are dependent upon situational fit.

A third important feature of the framework is its explicit reference to the Ghanaian manufacturing context. This contextualization helps us understand how resilience, logistics integration, and agility relate to each other in the context of the study. The framework acknowledges that firms have limited technological development, high costs of logistics, and poor supply chain processes. As a result, adaptation, coordination, and alignment are critical to firms' survival and success. By contextualizing the framework, the explanation of efficacy is improved, and makes it more applicable in real-life settings rather than theoretically abstract settings.

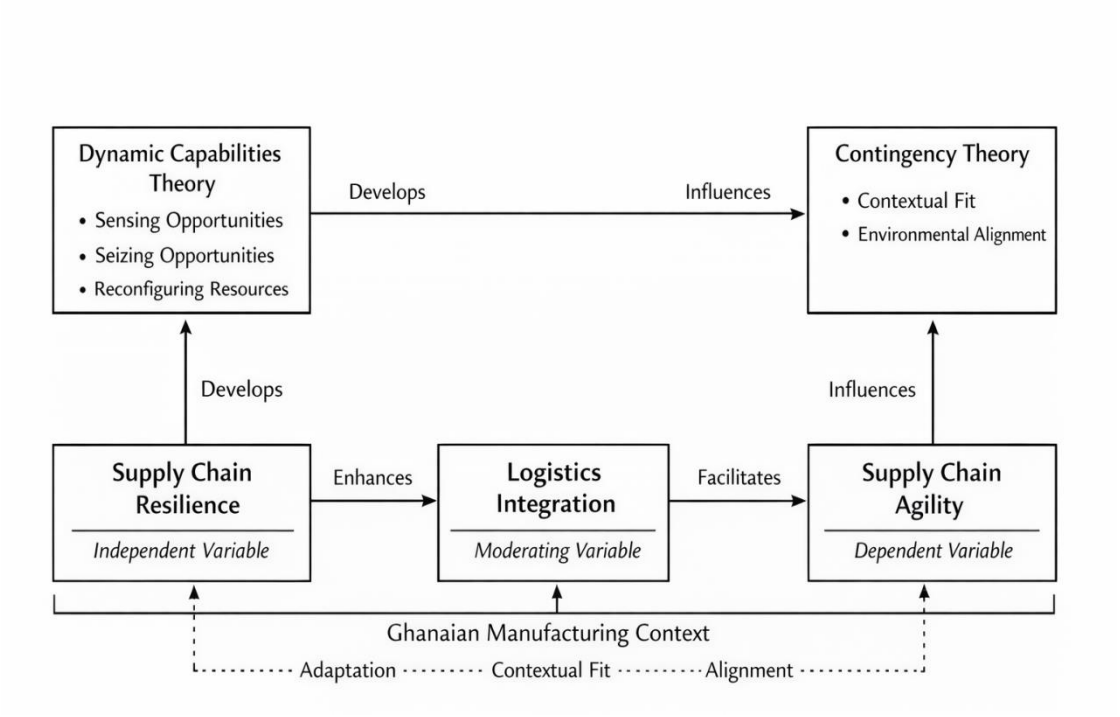

Figure 1. Conceptual Framework (Researcher's Construct, 2026)

3 Methodology

This chapter describes the research approach used to investigate the relationship between supply chain resilience (SCR), supply chain agility (SCA), and logistics integration (LI) in the manufacturing industries of Ghana, specifically Accra and its industries. As noted in the research onion, this research considers the research philosophy, research approach, research design, research strategy, time horizon, data collection, data analysis, and ethical considerations following Saunders et al. (2019), to ensure alignment between the theoretical approach, hypotheses, and research questions in this research.

The rationale for the chosen methods is to capture both resilience and agility, which prior empirical studies have described as complementary capabilities to achieve in dynamic environments (Aslam et al., 2020; Gligor et al., 2019), where integration mechanisms enhance both constructs by fostering better coordination and response (Tarigan et al., 2021; Ladeira et al., 2021). With the manufacturing industry's infrastructural and institutional situations in Ghana, it becomes imperative to follow a systematic quantitative approach to gain the measurable relationship and test the assumptions (Dadson, 2023; Ayam, 2023).

3.1 Conceptual Model and Development of Hypothesis

The conceptual framework developed in Chapter Two guided this empirical study of causal relationships among supply chain resilience, supply chain agility, and logistics integration. It was developed using the Dynamic Capabilities Theory and Contingency Theory to explain how firms created adaptive capabilities and how contextual factors influenced the effectiveness of these capabilities.

Dynamic capabilities theory asserts that organizations can gain competitive advantage by sensing environmental shifts, seizing opportunities as they arise, and reconfiguring

resources to match (Teece, 2007). From this vantage point, a firm's supply chain resilience was its capability to absorb and recover from disruptions, while its supply chain agility was its capability to respond quickly and proactively to supply chain conditions, where resilience can be considered a prerequisite to agility (Aslam et al., 2020; Gligor et al., 2019).

Empirically, scholars supported the resilient supply chain relationship with agility in terms of flexible resources, redundancy, and a proactive response to uncertainty (Dubey et al., 2014; Ladeira et al., 2021) and flexibility (a component of agility) in operations (Tarigan et al., 2021; Eckstein et al., 2015). Plus, in a turbulent environment like Ghana's manufacturing sector, developing a resilience capability would bode well for manufacturing firms to transform disruption into productive change (Hsieh et al., 2023; Pratondo et al., 2021).

Based on these theoretical and empirical considerations, the paper sought to test the hypothesis below:

H1: Supply chain resilience will have a significant positive effect on supply chain agility.

Besides the direct influence, the study also explored the moderating impact of contingency within logistics integration. Contingency Theory refers to the matching of an organization's internal features to external circumstances for effective operations (Lawrence & Lorsch, 1967). Hence, the logistics integration element acted as a contingency factor to further complement or limit the influence of resilience on agility.

The integration of logistics enhanced the coordination, visibility, and exchange of information among partners in the supply chain, enabling rapid and coordinated responses to any disruptions (Mandal et al., 2016; Song et al., 2022). A high level of integration among firms would help the use of resilience capabilities to gain agility via real-time communication and coordinated decision-making (Farooq et al., 2024; Tarigan

et al., 2021). Hence, a low level of integration would impede this relationship (Gligor & Holcomb, 2012).

In the literature, empirical findings supported that logistics integration improved collaboration and operational alignment, which in turn enhanced the resilience–agility connection (Abdalla, 2021; Dağdeviren & Erturgut, 2024); hence, logistics integration was considered in this study to moderate the relationship.

Hence, the hypothesis stated below was evaluated.

H2: Logistics integration will significantly moderate the relationship between supply chain resilience and supply chain agility, such that the relationship will be stronger at higher levels of logistics integration.

3.2 Research Approach and Design

In addition, this research also examined the influence of contingency through logistics integration, where Contingency Theory states that the fit between a firm's internal capabilities and its external environment determines the effectiveness of organizational performance (Lawrence & Lorsch, 1967). Here, logistics integration was the contingency factor that either augmented or limited the impact of resilience to generate agility.

Logistics integration improved coordination, visibility, and information exchange among supply chain partners, enabling a speedy and synchronized response to disruptions in the supply chain (Mandal et al., 2016; Song et al., 2022). On top of that, high levels of integration helped the firms to use their resilience capabilities effectively to achieve agility through real-time communication and coordinated decision-making (Farooq et al., 2024; Tarigan et al., 2021). Low integration degraded the relationship due to disintegrated processes and delayed information exchange (Gligor & Holcomb, 2012).

Empirical evidence confirmed that logistics integration strengthened the resilience–agility linkage by facilitating collaboration and operational alignment (Abdalla, 2021; Dağdeviren & Erturgut, 2024). Thus, logistics integration was modeled as a moderating variable in this study.

3.3 Data Collection and Target Population

This study used a questionnaire to collect data for this study. According to Monette et al. (2011), questionnaires are useful instruments for quantitative research because they provide uniform responses and help statistical analysis. In this study, the questionnaire was designed following other studies to measure constructs in the supply chain context by using validated scales from previous studies (Gligor et al., 2019; Tarigan et al., 2021). The questionnaires were administered in person, and the respondents' answers were treated confidentially and voluntarily (Creswell, 2017). A questionnaire structure is shown in Table 3.1.

Table 2. Questionnaire Structure.

Section	Construct	Number of Items	Source
A	Demographic Characteristics	5	Researcher’s construct (2026)
B	Supply Chain Resilience	6	Lin, Y., Pang, G., Duan, K., Luo, J., Wang, S., & Qu, J. (2024)
C	Supply Chain Agility	5	Jum'a, L., Zighan, S., & Alkalha, Z. (2025)
D	Logistics Integration	4	Prajogo, D., & Olhager, J. (2012)

The study's population comprised employees in supply chain, logistics, or operations in Ghana's Greater Accra Region and its industrial zones, as well as personnel from third-party logistics providers. The respondents were those engaged in supply chain and disruption management.

The study was centered on four major companies – two manufacturing and two logistics firms – Erium Ghana Limited, Master Pack Ghana Limited (manufacturing firms); Amaris Logistics, and Africa Global Logistics (logistics firms). These firms had substantial presence in Tema and Accra, two of the most important centers of manufacturing and logistics in Ghana.

Within the Greater Accra and Tema industrial region, Erium Ghana Limited is said to employ between 180–220 staff in production, warehousing, and supply chain tasks (Ghana Investment Promotion Centre, 2022; Association of Ghana Industries, 2023). Master Pack Ghana Limited (another major manufacturer of packaging and industrial materials) has between 300–400 employees in manufacturing, inventory management, and distribution in the region (AGI, 2023; Master Pack Group, 2022). Africa Global Logistics (formerly Bolloré Transport & Logistics) has about 150–200 employees in freight forwarding, port operations, and integrated logistics services in the Tema and Accra corridors (Bolloré Transport & Logistics Ghana, 2022; AGI, 2023). Amaris Logistics is reported to have approximately 100–150 employees that handle transportation, last-mile delivery, and warehouse operations (GIPC, 2022; Ghana Logistics Market Report, 2023). These third-party logistics providers add credibility to this study, as it indicates that logistics integration is measured from both the manufacturing and logistics sides (Tarigan et al., 2021; Ladeira et al., 2021).

Table 3. Population of Selected Study Areas.

Company	Total Workforce (Region-Specific)	Estimated % of Experts (Top/Middle Level)	Targeted Population (N)	Source
Erium Ghana Limited	200	12%	24	GIPC (2022); AGI (2023)
Master Pack Ghana Limited	350	12%	42	AGI (2023); Master Pack Group (2022)
Africa Global Logistics	175	12%	21	Bolloré Transport & Logistics Ghana (2022); AGI (2023)

Amaris Logistics	125	12%	15	GIPC (2022); Ghana Logistics Market Report (2023)
Total	**850**	—	**102**	—

3.4 Sampling Technique and Sample Size

The sampling strategy was purposive, providing access to participants knowledgeable and experienced in the topic. This approach is appropriate when conducting studies where the specific expertise and context are required (Saunders et al., 2019).

The sample size was drawn from employees in the supply chain, logistics, and operations departments of the four firms (Erium Ghana Limited, Master Pack Ghana Limited, Africa Global Logistics, and Amaris Logistics) located in the Greater Accra Region and Tema Industrial Area of Ghana, major hubs for manufacturing and logistics.

Though there were 850 employees in total across the firms selected, the study specifically focused on those who held leading positions in supply chain and logistics operations. These included supply chain and logistics managers, operations managers, procurement heads, and senior supervisors. These individuals were expected to possess strategic and operational expertise that could provide reliable insights into supply chain resilience, agility, and logistics integration. On average, around 12% of the total workforce typically held leadership or decision-making positions, yielding a targeted population of 102 respondents.

Sample size was determined according to Krejcie and Morgan (1970), who developed a table for determining the sample size from a finite population at 95% confidence level and 5% error margin. The table suggests sampling 81 respondents, where the number of population is 100 respondents.

From each of the four selected firms, 81 respondents were sampled in proportion to the size of that firm's population. Purposive sampling was employed in selecting the sample. Table 3.3 depicts the sample size distribution and proportions.

Table 4. Study Size and Proportion.

Organization	Target Population (N)	Proportion (%)	Sample Size (n ≈ 81)
Erium Ghana Limited	24	23.5%	19
Master Pack Ghana Limited	42	41.2%	33
Africa Global Logistics	21	20.6%	17
Amaris Logistics	15	14.7%	12
Total	**102**	**100%**	**81**

The sampling frame and sample population included 102 experts from the selected firms with knowledge about strategic and tactical decision-making. Of this sample, a statistically appropriate sample size of about 81 respondents was identified using the Krejcie and Morgan (1970) table (see Appendix II). These answers ensured that the study was conducted by skilled respondents with statistical rigor and representativeness.

3.5 Validity and Reliability

The measurement model (HLS-SEM, 2017) was employed to examine the validity and reliability of the constructs' measures in the context of PLS-SEM (Hair et al., 2017).

Content validity was achieved by adapting the previously validated measures to fit the research context (Gligor et al., 2019; Aslam et al., 2020). A panel of experts evaluated the measurement items for clarity, relevance, and appropriateness. The construct validity was evaluated through convergent validity and discriminant validity. Convergent validity was evaluated with factor loadings and Average Variance Extracted (AVE) thresholds of 0.70 and 0.50, respectively (Hair et al., 2017). Discriminant validity was assessed using the Fornell–Larcker criterion and HTMT

Reliability was tested using Cronbach's alpha and composite reliability (CR), with 0.70 or higher demonstrating internal consistency (Hair et al., 2017). Note: The measurements are listed in Table 4.

Table 5. Measurement Model Assessment Criteria.

Measure	**Threshold**	**Purpose**
Factor Loadings	≥ 0.70	Indicator reliability
Cronbach's Alpha	≥ 0.70	Internal consistency
Composite Reliability	≥ 0.70	Construct reliability
AVE	≥ 0.50	Convergent validity
HTMT	≤ 0.85	Discriminant validity

These procedures ensured that the constructs of SCR, SCA, and LI are appropriately and consistently measured to bolster the results' credibility.

3.6 Data Analysis

The data analysis was performed with two applications (SPSS and SmartPLS) to ensure maximum statistical validity.

Screening, coding, and descriptive statistics were carried out using IBM SPSS Version 26. This phase of the analysis provided information on the survey participants and identified any potential problems in the data to be used in further analysis. Correlation analysis was employed to explore the pattern of relationships among variables.

Second, PLS-SEM analysis was done using SmartPLS, Version 4. This analysis enables one to perform PLS-SEM in models with latent constructs and moderators (Hair et al., 2017). PLS-SEM is a suitable analysis in this study as a result of its small sample sizes and non-normal distributions.

Generally, the analysis followed this sequence:

1. Evaluation of Measurement Models: reliability and validity (factor loadings, AVE, CR).
2. Structural Model Assessment – look at path coefficients and R2.

3. Bootstrapping – testing the significance of hypotheses using resampling techniques.

4. Moderation analysis – to test for moderation effect of logistics integration on the relationship between SCR and SCA.

Table 6. Hypotheses and Analytical Techniques.

Hypothesis	**Relationship**	**Analysis Technique**
H1	SCR → SCA	Path Analysis (PLS-SEM)
H2	SCR × LI → SCA	Moderation Analysis (PLS-SEM)

These analyses established the link between the theoretical propositions and the testing of the hypotheses of this study.

3.7 Justification of Methodological Choices

For the Ghanaian manufacturing system, supply chain operations can be affected by structural, uncertainty, and resource constraints (Dadson, 2023; Ayam, 2023). This study's approach to measurement of these issues was quantitative, allowing to model the complexities, as well as the interdependence among constructs.

In order to integrate Dynamic Capabilities Theory (DCT) and Contingency Theory (CT), an analytical approach that accounts for a causal relationship as well as a moderation effect of the relationship is needed. So, the analysis adopted provides a powerful framework for understanding how resilience can translate into agility at different levels of logistics integration.

3.8 Measurement of Study Construct

In this section, the study's three constructs, supply chain resilience (SCR), supply chain agility (SCA), and logistics integration (LI), have been developed using scales adopted from previous valid and reliable empirical studies. The study attempted to measure a

latent supply chain capability from several measures following best practice in quantitative research and structural equation modelling (Hair et al., 2017).

To achieve the consistency and completeness of the measures, each construct was measured on a multi-item Likert scale for preparedness, flexibility, responsiveness, and coordination (Aslam et al., 2020; Gligor et al., 2019). I adapted the measures from other studies to improve content validity and generalizability of the findings across contexts.

The assessment development matrix (Table 7) is a table comprising the constructs, definitions, measurement sources, and items utilized in this study.

Table 7. Measure Development.

No.	Construct	Operationalization	Measure Sources	Measure Descriptions
1	Supply Chain Resilience	A multi-item Likert scale measuring the ability to prepare for, respond to, and adapt to disruptions.	Lin et al., (2024)	Includes contingency planning, flexibility in operations, redundancy of resources, rapid response to disruptions, reallocation of orders, and adaptability to market changes.
2	Supply Chain Agility	A multi-item Likert scale was utilized to evaluate the promptness of supply chain processes.	Jum'a et al. (2025)	Covers quick adaptation to design changes, cost adjustments, product improvements, rapid product introduction, and flexible production capacity.
3	Logistics Integration	Multi-item Likert scale evaluating the level of coordination between internal and external logistics activities.	Prajogo & Olhager (2012)	Includes internal logistics coordination, integration with suppliers, efficiency of distribution systems, and alignment of inbound and outbound logistics.

3.9 Ethical Consideration

Ethics play a role in the trustworthiness and acceptance of the research as well as the findings. According to Sherman (2009), researchers have an ethical obligation to adhere to standards of practice to protect participants, and researchers have a responsibility to conduct ethical research. It was with this ethical lens that I undertook this research study, including voluntary participation, informed consent, confidentiality, anonymity, and proper data storage.

The participants from the manufacturing and logistics companies in Ghana were informed about the nature, scope, and significance of the study before participating. The respondents' freedom to withdraw at any time was not compromised in any way. Prior to filling out the questionnaire, I obtained written consent from the participants to ensure they were fully aware and willing to be part of the study (Creswell, 2017).

The University's research ethics committee of Vaasa was responsible for approving this study. The research design, questionnaire instruments, and research procedures were reviewed and approved by my supervisors. To ensure the questionnaire was understandable, relevant, and appropriate, it was piloted on a few subjects selected from the population (Saunders et al., 2019) to reduce ambiguity, lessen the load, and alleviate any discomfort.

Data collection was through an interview-based questionnaire. Protection and privacy of data were considered. Participants were made aware of the study's significance and agreed to participate in the study before their participation was secured. The research, while taking place in Ghana, adhered to the principles of the General Data Protection Regulation (GDPR) to ensure greater transparency, accountability, and ethics of the process (European Union, 2016). Personal data was not sought unless absolutely necessary, and where it is sought, the purposes of the collection were clearly defined, and consent was obtained.

Anonymity and confidentiality were maintained during the study. Responses were anonymized at the time of submission to ensure that participants and organizations could not be identified in the data set or in the report. Names, names of companies, or contact information were not attached to responses at the time of analysis or reporting so that participants could freely respond without concern of being exposed or having their organizations' repercussions.

In addition, strict storage and access controls on data were implemented to ensure ethical compliance. Data was limited in access, and data were not shared with unauthorized third parties (including firms that participated). Data were used only for academic purposes, and were not repurposed without additional consent.

As defined by the University of Vaasa guidelines and research ethics protocols, collected data were held securely for a period of time after study completion for verification and academic use. After that period, all collected data were destroyed to prevent unauthorized access and misuse.

Table 8. Ethical Compliance Checklist.

Ethical Principle	Implementation in Study
Voluntary Participation	Participants were made to freely choose to participate and may request to end it at any time.
Informed Consent	Informed consent was required before starting the questionnaire
Confidentiality	Responses were confidential
Anonymity	No identifiable information was collected or linked to responses.
Ethical Approval	The study was reviewed and approved by academic supervisors (University of Vaasa).
Data Protection	The study complied with GDPR principles for data handling and privacy.
Data Storage	Data was stored in password-protected and encrypted systems.
Access Control	Access was limited to researchers and authorized supervisors only.
Data Retention & Disposal	Data was securely stored for a defined period and permanently deleted afterward.
Pilot Testing	The questionnaire was pre-tested to ensure clarity and minimize risk to participants.

4 Data Presentation, Analysis, and Discussion

Analysis and discussion of the data collected are presented in this chapter in relation to the study's objectives and questions. The response rate of participation, respondents' demographic data, and the descriptive and inferential statistical tests used are presented. An interpretation of the results with reference to the literature and the research theory is provided.

4.1 Response Rate

An overall count of 81 questionnaires was distributed to a total of 81 respondents. All 81 surveys were retrieved, making up 100% response rate, which is acceptable in quantitative research studies and representative of the study population. Responses to the questionnaires are shown in Table 9.

Table 9. Response Rate of Questionnaire (Field Survey, 2026).

Questionnaires Distributed	Questionnaires Returned	Response Rate
81	81	100%

4.2 Demographic Information

Table 10 below displays the demographic characteristics of the study respondents.

Table 10. Demographic Information of the Study (Field Survey, 2026).

		Frequency	**%**
Gender	Female	34	42.0%
	Male	47	58.0%
Ages	Below 30yrs	31	38.3%
	30-40yrs	43	53.1%
	41-50yrs	5	6.2%
	51-60yrs	2	2.5%
Education	SSCE/WASSCE	9	11.1%
	Diploma	17	21.0%
	First Degree	39	48.1%
	Master's Degree	16	19.8%
Staff Category	Lower Level	0	0.0%
	Middle Level	70	89.7%
	Upper Level	8	10.3%
Work Experience	< 2yrs	25	30.9%
	2-7yrs	45	55.6%
	8-13yrs	6	7.4%
	14-19yrs	4	4.9%
	> 19yrs	1	1.2%
Total		**81**	**100%**

The sample is predominantly male (58.0%), which suggests slightly higher percentages of males in the institutions studied. In terms of age, the respondents are overwhelmingly young and in the working-age population, with over 91% under 40 (a young demographic).

Respondents were highly educated, with nearly two-thirds holding tertiary degrees. Respondents also demonstrated a good grasp of supply chain resilience and adaptability across industries. Respondents mostly occupied middle management positions, with 10.3% in upper management positions and none in lower management roles. Therefore, the responses from the respondents represent the attitudes of those in operating and decision-making roles. More than half of the respondents had an experience less than

two years. Over 86% are early or middle career, which may explain their unfamiliarity with contemporary procurement practices.

4.3 Relationship Between Supply Chain Resilience and Supply Chain Agility

Investigation of the relationship between supply chain resilience and supply chain agility, using reliability test of supply chain and agility variables, descriptive statistics, and correlation was the first research objective.

4.3.1 Reliability of Supply Chain Resilience Variables

Reliability for Supply Chain Resilience (SCR) shows that Cronbach's alpha reported a result of 0.964 for 6 items (usual value is 0.70), indicating a high inter-item correlation in assessing supply chain resilience. This is presented in Table 11.

Hence, this result indicates that the scale items are homogeneous and correctly represent the construct of supply chain resilience in this research. A high value for alpha indicates that the measure has been retested and is reliable.

Table 11. Reliability Test I.

Cronbach's Alpha	No. of Items
.964	6

4.3.2 Reliability of Supply Chain Agility Variables

Similarly, the Cronbach's alpha on the Supply Chain Agility (SCA) construct was 0.961 based on 5 items, as shown in Table 12. This indicates that all the items measuring supply chain agility are represented uniformly in the construct.

Table 12. Reliability Test II.

Cronbach's Alpha	No. of Items
.961	5

Thus, both SCR and SCA constructs are extremely reliable, indicating confidence in the validity of measures used in examining supply chain resilience and agility.

Table 13. Descriptive Statistics and Correlation Coefficient for Supply Chain Resilience and Supply Chain Agility (Field Survey, 2026).

Variables	**Mean**	**SD**	**1**	**2**	
1. Supply Chain Resilience	31.6296	8.42236		.922**	
2. Supply Chain Agility	26.9259	6.31423	.922**		
****. p< 0.01 (2-tailed); *p<0.05; N=81**					

Table 13 above indicates that respondents rated resilience and agility as medium or high in their organizations. Standard deviations indicate moderately variable responses, indicating varying perceptions of resilience and agility at work between the organizations studied.

The results show a correlation between supply chain resilience and supply chain agility at r = 0.922, where p <0.01, which is significant at the 1% level.

Hypothesis 1 (H1): Supply chain resilience will significantly positively affect supply chain agility.

The results, therefore, provide strong support for this hypothesis. Accordingly, this hypothesis may be accepted. The very high positive correlation (r = 0.922) indicates that increasing supply chain resilience is accompanied by an increase in supply chain agility.

These organizations are not only better prepared to react, but also recover from disruptions. They will also be more agile, or able to respond quickly and with flexibility.

4.4 The Role of Local Logistics Providers in Strengthening Supply Chain Performance.

The second objective was to assess the impact of local logistics providers on supply chain. In the following report, the researcher discusses and analyses the impact of local logistics providers (Africa Global Logistics and Amaris Logistics) on supply chain resilience (SCR) and supply chain agility (SCA). Taking into account the responses of 36 respondents on 6 Supply Chain Resilience (SCR) and 5 Supply Chain Agility (SCA) indicators. Here are the results of the respondents (see Table 14 below).

The findings reveal that respondents generally hold the perception that local logistics service providers have the capacity to promote supply chain performance. A consensus level of 65% or above was observed on the vast majority of the statements, reflecting the critical role that local logistics service providers play in maintaining the fluidity and speed of operations.

Table 14. Supply Chain Performance of Logistic Firms (Africa Global Logistics and Amaris Logistics) (Field Survey, 2026).

Variable	Strongly Disagree	Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Agree	Strongly Agree
SCR1: Detailed Contingency Plan	0 (0.0%)	2 (5.6%)	4 (11.1%)	3 (8.3%)	8 (22.2%)	12 (33.3%)	7 (19.4%)
SCR2: Flexibility	0 (0.0%)	3 (8.3%)	5 (13.9%)	3 (8.3%)	5 (13.9%)	12 (33.3%)	8 (22.2%)
SCR3: Capacity & Availability of Assets	0 (0.0%)	3 (8.3%)	2 (5.6%)	7 (19.4%)	4 (11.1%)	14 (38.9%)	6 (16.7%)
SCR4: Immediate Action	0 (0.0%)	2 (5.6%)	1 (2.8%)	6 (16.7%)	8 (22.2%)	13 (36.1%)	6 (16.7%)
SCR5: Quick Reallocation of Orders	0 (0.0%)	2 (5.6%)	2 (5.6%)	7 (19.4%)	3 (8.3%)	12 (33.3%)	10 (27.8%)
SCR6: Ability to Deal with Market Changes	2 (5.6%)	0 (0.0%)	1 (2.8%)	7 (19.4%)	2 (5.6%)	11 (30.6%)	13 (36.1%)
SCA1: Supply Chain Quickly Adapts	0 (0.0%)	2 (5.6%)	0 (0.0%)	6 (16.7%)	8 (22.2%)	12 (33.3%)	8 (22.2%)
SCA2: Adjusts Rapidly to Variations	0 (0.0%)	1 (2.8%)	2 (5.6%)	5 (13.9%)	9 (25.0%)	11 (30.6%)	8 (22.2%)
SCA3: Prompt Product Incorporation	0 (0.0%)	2 (5.6%)	0 (0.0%)	7 (19.4%)	5 (13.9%)	15 (41.7%)	7 (19.4%)
SCA4: Introduces New Products	0 (0.0%)	2 (5.6%)	1 (2.8%)	8 (22.2%)	7 (19.4%)	9 (25.0%)	9 (25.0%)
SCA5: Adjusts Production Effectively	0 (0.0%)	2 (5.6%)	1 (2.8%)	4 (11.1%)	9 (25.0%)	11 (30.6%)	9 (25.0%)

4.4.1 Supply Chain Resilience (SCR) Performance

The results of the supply chain resilience indicate that local logistics companies have contributed to strengthening supply chains when disruptions occur. Regarding contingency plans, 74.9% of the respondents agreed that the logistics companies have a contingency plan, implying that companies like Africa Global Logistics and Amaris Logistics were perceived to have planned for disruptions, thereby maintaining the strength of supply chains.

More of the respondents agreed that the logistics companies were flexible. A low percentage of the respondents disagreed, which indicates that local logistic firms consider flexibility one of their superior points, but in reality, it may not be effective due to the available resources, operation size, or other contributing factors.

The results also show that, in general, there is a perception that logistics companies have sufficient capability and resources, but some ambiguity here indicates that these aspects are not easily seen or accessed. In contrast, response capability looks to be a distinctive attribute, where 75.0% indicated that logistics firms can respond quickly when a disruption occurs, helping to maintain continuity.

Moderate confidence is also reflected in order reallocation, although some hesitation indicates the need for better coordination and decision-making systems. Also, most respondents (72.3%) concur they can cope with market changes, indicating the adaptive capacity of logistics firms.

4.4.2 Supply Chain Agility (SCA) Performance

The findings show that local logistics service providers play an important function in enhancing supply chain agility in terms of responsiveness and short-term adaptation. There was strong agreement among respondents that supply chains supported by local

logistics providers could adapt rapidly, indicating that these supply chains are highly agile in this aspect. Related to this, respondents also agreed that supply chains supported by local logistics providers could respond quickly to fluctuating demand and other changes. Responses from all the respondents to these questions indicate that the ability to respond is an important element of supply chain agility, also, local logistics service providers are vital in facilitating supply chains to make timely adjustments. In addition, respondents agreed that the local logistics providers help products integrate smoothly and quickly into the supply chains. This indicates that local logistics providers contribute to not only efficient movement of products, but also the synchronization of processes within supply chains.

In addition, the relatively lower consensus and more neutral responses to new product introduction indicate another dimension on the other side. That is, although logistics providers may assist in operational processes, they may not directly contribute to agility in new product introduction. This implies that strategic agility with respect to new product development is considered to be beyond the scope of logistics firms.

In contrast, the production adjustment record reveals the greatest level of agreement, which highlights the importance of logistics services in adjusting production according to demand.

The results indicate that logistics service providers contribute primarily to operational agility, in terms of speed, responsiveness, and adjustment, rather than to strategic agility, such as innovation and product development. This distinction is important, as it denotes the strengths and limitations of the logistics contribution across the supply chain.

4.5 Moderation Effect of Logistic Integration in the relationship between Supply Chain Resilience and Supply Chain Agility.

Table 15 presents results of the hierarchical regression test to evaluate the moderating effect of logistics integration on supply chain resilience and supply chain agility. In model 1, the influence of supply chain resilience and logistics integration on supply chain agility is assessed, and in model 2, the moderating effect of the interaction term (supply chain resilience and logistics integration) is assessed.

Table 15. Hierarchical Regression Results for the Moderating Effect of Logistics Integration on the Relationship Between Supply Chain Resilience and Supply Chain Agility (Field Survey, 2026).

Model	Predictor	B	SE	β	t	p
1	Constant	-0.003	0.262	—	-0.012	.991
	SCR (Centered)	0.553	0.058	0.737	9.473	< .001
	LI (Centered)	0.277	0.098	0.219	2.815	.006
2	Constant	0.045	0.329	—	0.136	.893
	SCR (Centered)	0.555	0.059	0.740	9.363	< .001
	LI (Centered)	0.259	0.124	0.205	2.100	.039
	SCR × LI	-0.001	0.006	-0.016	-0.242	.810

Model Summary

Model	R	R^2	Adjusted R^2	SE (Estimate)	ΔR^2	F Change	df1	df2	p (ΔF)
1	0.930	0.864	0.860	2.358	0.864	247.725	2	78	< .001
2	0.930	0.864	0.859	2.373	0.000	0.058	1	77	.810

Note. SCR = Supply Chain Resilience; LI = Logistics Integration; SCR × LI = Interaction term. Dependent variable: Supply Chain Agility (centered).

Model 1 shows that supply chain resilience is a significant influencer of supply chain agility (B = 0.553, β = 0.737, p<001). As shown in the model, the resilience of supply chains is strongly associated with supply chain agility. That is, businesses with better resilient responses to disruptions that are flexible and adaptive will also be more agile at reacting to changes in the market.

Similarly, integration of logistics also impacted supply chain agility (B = 0.277, β = 0.219, p<.006). It has the potential to independently contribute to greater supply chain agility in a positive manner. Integrating logistics activities in the supply chain can contribute to greater responsiveness and adaptability.

In addition, the summary of the model indicates a high explanatory power, where 86.4% of the change in supply chain agility is explained by supply chain resilience and logistics integration, which means that these two variables may have an important impact on the agility of the companies in the study.

Model 2 added the interaction item of supply chain resilience and logistics integration to examine whether there is a moderating effect. The results show that the interaction item is not significant, indicating that supply chain resilience's relationship to supply chain agility is not significantly changed or strengthened by logistics integration. In other words, each variable's relationship with supply chain agility is independent of each other, and the relationship between supply chain resilience and supply chain agility is not moderated by logistic integration.

Inclusion of the interaction term does not improve the model fit, as the R2 without the interaction term is 0.864, which shows that the model has a strong predictive power even without the interaction term. In contrast to the above passage, this study believes that the ability of logistics integration is in use in the resilience capabilities. Resilience capability needs the flow of coordinated, integrated, and collaborative information, which is a unique feature of logistics integration. This is why the interaction term is not significant.

It is also found from the results that logistics integration is one of the two independent predictors of supply chain agility, whereas supply chain resilience is the strongest predictor of supply chain agility. Unexpectedly, the results do not support the moderating effect of logistics integration. Specifically, logistics integration does increase supply chain agility, but does not increase the relationship between supply chain

resilience and supply chain agility in the sample. There is a need for “basic” or “enabling” logistics integration to develop in the supply chain resilience/agility relationship. In other words, it is necessary to have a basic level of enabling logistics integration to strengthen the relationship between supply chain resilience and supply chain agility. Further increases in logistics integration above this level do not further reinforce the relationship between supply chain resilience and supply chain agility. A ceiling effect could exist, where after a certain point, the benefits of integration do not rise.

This implies that supply chain resilience and logistics integration can influence supply chain performance independently of each other. Unexpected occurrences, flexibility in supply chains, and adaption to market needs are driving supply chain agility, and logistics integration alone can be used to improve supply chain performance.

4.6 Developing and Validating a Framework Integrating Logistics Partnerships, Resilience, and Agility

The fourth objective was developing and testing a framework that integrates logistics partnerships for resilience and agility in manufacturing and supply chains. The assessment is the evaluation of a model of measurement (reliability and validity of constructs) and a model of structure (relationship among constructs) using SmartPLS 4. The framework is shown below (Figure 2):

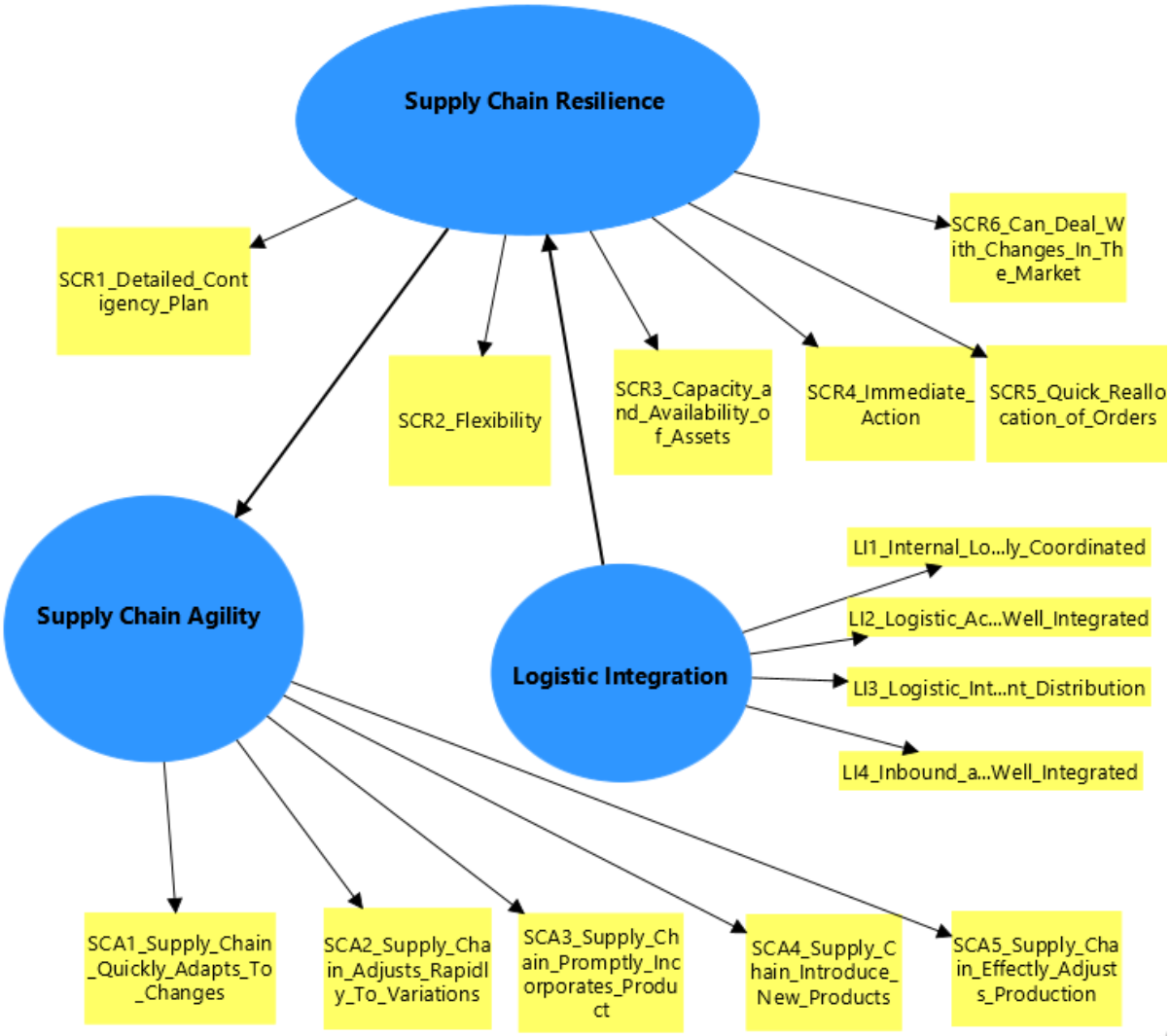

Figure 2. Framework Integrating Logistics, Resilience, and Agility (Researcher's Construct, 2026)

In this section, the framework addresses the role and effect of logistics integration, supply chain resilience, and supply chain agility in the creation of a resilient and agile manufacturing supply chain. According to the literature, logistics integration contributes to smooth flow of information and materials, as information is inbound, outbound, and distributed. The impact of logistics integration on supply chain resilience is discussed, such as contingency plans, flexibility, resources, and prompt response to disruptions. Literature examining the impact of resilience on supply chain agility is cited. Evidently, logistics integration helps to increase resilience directly while also indirectly improving agility through resilience, indicating the mediator here: resilience. Overall, the model

shows that integrated logistics systems generate robust supply chains, which help agility and responsiveness in agile manufacturing.

4.6.1 Measurement Model Results of the Framework

Reliability and validity statistics suggest that all constructs were strong. Table 16 shows the results.

Table 16. Results of Measurement Models (Field survey, 2026).

Construct	**Cronbach's Alpha**	**Composite Reliability (ρc)**	**AVE**
Logistics Integration	0.966	0.975	0.908
Supply Chain Resilience	0.965	0.972	0.852
Supply Chain Agility	0.962	0.970	0.868

The measurement model served to test reliability and validity of the three constructs of the study: Logistics Integration, Supply Chain Resilience, and Supply Chain Agility. Reliability was assessed by Cronbach's alpha and composite reliability, and validity was assessed by average variance extracted (AVE), indicator loading, and discriminant validity.

Consistency of the constructs was excellent with Cronbach's alpha from 0.962 to 0.966, well above the threshold level of 0.70. These values suggest that the items in the constructs are strongly related and measure the same attribute. Composite reliability (c) values ranged from 0.970 to 0.975, well above the recommended minimum of 0.70, suggesting that the constructs are reliably measured by the measures that significantly impact the latent variables.

All constructs are concurrently valid as the AVE for all constructs was above 0.85, well above the recommended value of 0.50, meaning this construct explains over 85% of variance in its indicator measures, indicating that the items converge on a single latent

construct. All external loadings were above the recommended 0.70 value, meaning that each item is an appropriate measure of the construct.

4.6.2 Structural Model Results

The PLS algorithm and bootstrapping revealed the following path coefficients. Table 17 reports the.

Table 17. Results of Structural Model (Field Study, 2026).

Relationship	β (Sample O)	T-Statistic	P-Value	Interpretation
Logistics Integration → Resilience	0.815	22.211	0.000	Strong, significant
Resilience → Agility	0.737	11.498	0.000	Strong, significant
Logistics Integration → Agility	0.221	3.054	0.002	Small, significant

Using the structural model, the study tested hypotheses concerning the association between Logistics Integration, Supply Chain Resilience, and Supply Chain Agility. The path coefficients, total effect, effect size, explanatory power, and total effects were calculated using the PLS technique and bootstrapping methods.

A strong and significant effect was observed for the influence of Logistics Integration on Supply Chain Resilience. This result indicated that collaboration, information sharing, and problem-solving with logistics companies enhance the resilience of manufacturing firms' supply chains. Resilience had a predictive effect on Agility, indicating that resilient firms were capable of adapting quickly to disruptions and changes in the market. The path coefficient from Logistics Integration to Agility was smaller but significant, indicating that it contributes to agility through a larger effect via resilience.

The results of the model show very high levels of explanatory power. The R^2 value of Agility is 0.866, which indicates that 86.6% of the changes in agility are explained by resilience and integration. The R^2 value of Resilience is 0.713, indicating that 71.3% of the variance in resilience is explained by integration. These values, which are well above the acceptable level of explanatory power, indicate that the model has a very high explanatory power.

Effect size analysis (f2) revealed further details about the relative importance of predictors. Logistics Integration had a very large effect on Resilience, suggesting that this predictor is critical to resilient supply chains. Resilience had a large effect on Agility, indicating that Agility plays a major role in adaptability. Integration, however, had a small effect directly on Agility. This result reflects that agility is most likely a result of integration indirectly through resilience.

Total effects analysis confirmed that Logistics Integration has a robust overall effect on Agility (0.843) through both direct and indirect pathways. Resilience's indirect effect was much larger than its direct effect, indicating that resilience acted as a mediator. In fact, it was seen that relationships are expected to improve resilience, which in turn enables agility.

Hence, these results validate the hypothesis that logistics Integration is a core ability that enhances resilience, and resilience is a driving force for agility. Integration has some effect on agility, but directly through increasing resilience. Resilience appears as the bridge between two parts of a manufacturing supply chain where integration is an enabler. The structural model supports the hypothesis to explore and validate a framework for integrating logistics partnerships to improve resilience and agility.

4.6.3 Mediation Analysis

The mediation analysis was conducted to determine whether Supply Chain Resilience is a mediator between Logistics Integration and Supply Chain Agility. Resilience mediated

this relationship. The indirect effect of Logistics Integration on Agility through Resilience was strong (0.622, p <0.001), suggesting that partnerships with logistics providers contribute to agility primarily through resilience.

The indirect effect of integration and the smaller direct effect (β = 0.221) suggest that firms seeking to improve agility should prioritize resilience-building strategies in their logistics partnerships, as this is the pathway from integration to agility.

4.6.4 Moderation Analysis

The moderation test was to determine whether Logistics Integration moderates the relationship between Resilience and Agility. Hypothesis 2 predicted that in a well-integrated organization, the relationship between resilience and agility would be stronger. The results indicated that the interaction term was not significant, implying that integration was not functioning as a moderator.

This result suggests that integration is an independent predictor rather than a conditional enhancer of resilience's effect on agility, so there is always agility regardless of the level of integration. While integration is crucial in building resilience, it does not increase the link between resilience and agility once resilience is established. This finding clarifies the theoretical framework by clarifying that integration has a foundational role (building resilience) rather than an interactive role (enhancing resilience's effect on agility).

4.6.5 Model Fit & Predictive Validity

To evaluate the structural model's fit with the empirical data and its applicability to new data, the researcher conducted the model fit indices and prediction test in SmartPLS 4.

Table 18. Model Fit and Predictive Validity Results (Field Study, 2026).

Metric	Value	Threshold / Benchmark	Interpretation
SRMR	0.042	≤ 0.08	Excellent fit
NFI	0.848	≥ 0.80 acceptable; ≥ 0.90 good	Acceptable fit, close to good
PLSpredict	PLS-SEM prediction errors lower than linear regression	PLS errors < LM errors	Strong predictive relevance
Q^2 (Resilience)	Positive	> 0 indicates predictive relevance	Predictive relevance confirmed
Q^2 (Agility)	Positive	> 0 indicates predictive relevance	Predictive relevance confirmed

The value of Standardized Root Mean Square Residual (SRMR) for the model was 0.042, where the recommended value should be below 0.08. This indicates a good fit of the model with a correlation matrix, leaving very little residuals, indicating excellent credibility of the model. According to the fit indices of the Standardized Root Mean Square Residual (SRMR), the proposed relationships for logistics integration, resilience, and agility fit the data well.

The Normed Fit Index (NFI) value is 0.848, which is close to the cutoff value of 0.90, indicating a slightly less than perfect fit. The Normed Fit Index (NFI), which measures the proportionate improvement in fit when comparing the proposed model to the null model, is considered an acceptable fit index. Both the SRMR and NFI values indicate that the proposed model is suitable.

Beyond model fit assessment, PLSpredict was used to assess prediction validity. By using this function, the prediction errors of the PLSSEM model were evaluated against predictions of the linear regression benchmarks. The prediction errors of our PLSSEM model are consistently lower than those of our linear regression model, suggesting that the model has predictive relevance to predict resilience and agility in supply chains for future years beyond the sample data.

Blindfolding was also used to evaluate the predictive relevance of the model (Q^2 values). The Q^2 values for resilience and agility were found to be positive, indicating that the model has predictive relevance for these endogenous constructs. Positive Q^2 values indicate that the model is not only statistically valid but also able to explain and predict variance in key supply chain capabilities.

The combination of a good SRMR, acceptable NFI, lower prediction errors in PLSpredict, and positive Q^2 is an indication that our model is well-fitting and predictive. I have greater confidence in the model since it shows that logistics integration enhances resilience, and so agility, in a robust and useful way.

Results from this study support the theoretical premise that the model of integration–resilience-agility is well-supported. Indeed, these results suggest that firms can use this model to predict how logistics partnerships will affect resilience and agility in real-life supply chains.

The model fit indices (SRMR = 0.042, NFI = 0.848) show that the model is well specified and suitable for the data. As expected, PLSpredict produced lower levels of errors than the linear regression, and a positive Q2 indicated that the model has predictive relevance. Overall, the results show that the model is robust and able to predict supply chain resilience and agility.

4.7 Discussions

The findings of the data collected from the 81 respondents are discussed below.

4.7.1 Demographic Characteristics

Demographic profile of respondents is an important factor in interpreting the findings of this study. They reflect a male-dominated sample (58.0%), which is consistent with

other global and regional trends in supply chain and logistics. Since the physical nature of traditional logistics and the underrepresentation of women in STEM and technical fields, logistics and supply chain management have been viewed as male-centric (Tariq et al., 2023). Recent studies in emerging markets such as Nigeria and Ghana have shown that while gender diversity is improving, leadership roles and operative roles in logistics are still dominated by men (Ramakrishna et al., 2023; Wiredu et al., 2023). This gender imbalance may also affect perceptions of risk and resilience, as it appears that teams with different genders adopt different approaches to risk management, which may be critical to supply chain resilience.

Young professionals are the dominant factor, with more than 91% under the age of 40. This is a reflection of the trend for industrial modernization in sub-Saharan Africa, where a young, tech-savvy population is accelerating industry modernization (Tariq et al., 2023; Wiredu et al., 2023). They are perceived as more “digital ready” and more likely to adopt newer technologies like blockchain, AI, and tracking systems for faster supply chain agility (Manhando & Dzingirai, 2026; Opuala-Charles et al., 2026). Younger professionals are likely to more readily adapt to the fast pace of transformation in global supply chains, which may explain the high perceived agility of the survey.

In addition, the majority of the respondents are first degree holders or master degree holders, which is vital for the supply chain resilience dynamics. The majority of the respondents are educated, suggesting that they have a good understanding of the Dynamic Capabilities Theory, which is more significant for the firms' ability to adapt internal and external resources to rapidly changing circumstances (Chowdhury et al., 2024; Opuala-Charles et al., 2026). The educational attainment of the workforce shows that the firms participating in the survey have the intellectual capabilities to embrace arduous strategies such as contingency planning and asset reallocation (Opoku, 2025; Sarfo et al., 2025).

Last, is the 89.7% of middle management respondents, bringing in the perspectives of those most hands-on with the supply chain strategies. Middle managers are the harness between the objectives and reality of the supply chain, making their perceptions of resilience and agility a reflection of the reality of the business (Bag et al., 2022; Wiredu et al., 2023). The lack of lower-level staff in the sample may limit access to the failures on the ground, but it provides a clearer picture of the tactical and strategic alignment within the organizations.

4.7.2 Relationship Between Supply Chain Resilience and Supply Chain Agility

4.7.2.1 Reliability and Measurement Consistency

Supply Chain Resilience has a Cronbach's alpha of 0.964, and Supply Chain Agility has a Cronbach's alpha of 0.961. Both are considered to have "excellent" internal consistency, which is higher than 0.70 (Ramakrishna et al., 2023). Within the SCM research context, these high alphas indicate that the multi-item scales measuring these constructs are robust and that the individual items (i.e., flexibility, responsiveness, or recovery capability) are conceptually coherent.

In the context of resilience and agility, reliability plays a critical role. Resilience refers to the "ability to recover" and "preparedness" to react to disruption (Akram et al., 2024; Mubarik et al., 2021). Agility refers to the fast reaction to unanticipated transformation (Aityassine et al., 2022; Aslam et al., 2020). The stability of these variables is important for correlation and regression analysis since the relationship observed is not due to measurement error but rather reflective of the organization.

4.7.2.2 The Synergistic Link Between Supply Chain Resilience and Supply Chain Agility

The most striking result of this section is that supply chain resilience has a very strong relationship with supply chain agility (Hypothesis 1). This is consistent with the finding in Hypothesis 1 that there is a positive relationship between supply chain resilience and

supply chain agility. As a result of the strength of the relationship, it is not only a significant relationship, but also a very strong relationship. It suggests that in our studied logistics environment, these two capabilities complement each other in such a way that an improvement in one capability is related to an improvement in the other.

This result also indicates that there is very close similarity between resilience and agility for supply chain management. Resilience provides the structure and recovery for continuity in the face of disruption, whereas agility provides the speed and flexibility to respond in real time. This study indicates that resilience and agility complement each other and do not work in silos (Akram et al., 2024; Sharma et al., 2024).

Others propose that agility can help or mediate resilience as well. For instance, agile supply chains can quickly, easily, and efficiently change resources, suppliers, and distributions to accommodate disruptions (Aslam et al., 2020; Gligor et al., 2019). An agile logistics firm that can easily reroute or redistribute goods will be resilient to disruptions such as congestion in ports, fuel shortage, or geopolitical changes, especially in developing economies where infrastructure and markets are more and more volatile (Nweze, 2024).

This strong correlation indicates that, in the context of logistics, resilience and agility may have evolved more collectively, simultaneously, and commonly, such as real-time tracking and planning systems and collaborative logistics networks, both of which can perceive greater responsiveness, visibility, and coordination in the supply chain to improve resilience and agility.

However, the incredibly high correlation raises the question of possible overlap. A few scholars argue that resilience and agility both share similar characteristics in environmental scanning, decision-making, and response time (Gligor et al., 2019). Hence, respondents might not distinguish between the two when assessing their

logistics performance. What is perceived to be resilient might have some characteristics of agility and vice versa.

Accordingly, the study results are in favor of the hypothesis below:

Hypothesis 1 (H1): There is a positive relationship between supply chain resilience and supply chain agility.

The results showed firms with more resilience may also have more agility. Hence, suggesting that managers in the supply chain trying to promote those characteristics in their chains should target bringing together resilience and agility. Hence, logistics firms that desire to improve supply chain outcomes need to implement systems and processes that help responsiveness, adaptability, and recovery features since they are also implicitly and explicitly involved in enhancing supply chain performance.

4.7.3 The Role of Local Logistics Providers in Strengthening Supply Chain Performance

For local logistics providers, namely Africa Global Logistics and Amaris Logistics, the results suggest that they are seen as significant contributors to supply chain performance, functioning as "enablers." Since their agreement levels are above 65% on many measures, it is evident that they are integral parts of the regional supply chain.

4.7.3.1 Supply Chain Resilience Performance

To the contrary, 74% of respondents believe that their local logistics companies have well-established contingency plans. Supply chain preparedness is perceived as essential in the resilience of supply chains as it allows firms to plan for and respond to disruptions and ensure continuity in uncertain times (Mubarik et al., 2021). Basically, contingency planning is the ability for logistics firms to plan for response to things such as transport delays, fuel shortages, port congestion, or demand shocks. In areas where infrastructure deficits, regulatory uncertainty, and political unrest are often disrupting supply chains,

this level of preparedness is especially important. African Global Logistics is seen as stabilizing the supply chain by implementing risk-based response systems into its operations to sustain supply chain stability (Manhando & Dzingirai, 2026; Opuala-Charles et al., 2026).

For firms, contingency planning does not only have to have a Plan B. It must also have visibility that allows them to spot a disruption early and take action at the right moment. Information flows in real-time, models of predictability, and coordination mechanisms that enable decision-making in time are the key factors that affect contingency planning. Firms may have contingency plans, but their success depends on the information systems and organizations (Akram et al., 2024; Mavi et al., 2023).

Regarding the question about flexibility, 69.4% of the respondents agreed that logistics providers were flexible. But, the high percentage of disagreement (22.2%) shows that flexibility in logistics is not always perceived. Flexibility in logistics here refers to the ability of logistics firms to adjust operations, processes, and distribution plans according to changes in the market. There may have been a difference between the perception regarding contingency plans by logistics companies and actual flexibility, possibly because logistics providers in developing countries may be having difficulty in quickly adapting to changes due to limited transport capacities, inefficient infrastructure, and increasing costs. Flexibility becomes not only a strategic decision, but also a function of resources and capabilities. So, firms may be adequately prepared on paper, but underprepared on the ground when changes are necessary.

The low level of uncertainty regarding the availability and capacity of assets (19.4% unsure) adds to the concerns about the visibility and transparency of resources. While most responders rated local logistics providers as reliable, the high level of uncertainty indicates that not all locations may know what their assets are and when they are available. Uncertainty can impact decision-making and reduce confidence in the system's ability to respond to real-time disruptions.

In terms of resilience, capacity buffering, such as having redundant transport vehicles or having excess inventory, has proven to increase resilience. However, this is expensive and not practical for all logistic companies operating in resource-constrained situations (Obuseh & Obioma-Ekeanyanwu, 2026). As a result, leaner processes, while cost-effective, can lead to issues when demand spikes or when disruption strikes.

Despite good planning and contingency management by local logistics companies, the findings indicated that there was a lack of flexibility and visibility of assets in the local logistics sector. The gap must be addressed by improving supply chain transparency, real-time tracking of logistics resources, and coordination across nodes. Enhancing visibility, i.e., access to accurate and timely information on assets, stock, and operating status, is a priority to reduce uncertainty and improve resilience (Mavi et al., 2023; Mubarik et al., 2021).

4.7.3.2 Responsiveness and Adaptability

The high levels of agreement on the urgency of dealing with disruptions (75.0%) and adapting to changing market conditions (72.3%) highlight the agility of local logistics providers as they navigate the supply chain. Hence, it is not just Africa Global Logistics that responds to disruptions, but also Amaris Logistics can react effectively when faced with disruptions. The pressure of supply, travel time, or connection issues may cause fluctuations in these scenarios, where rapid response or "speed" may serve as a competitive advantage to the supply chain (Adeleye et al., 2024).

The high proportion of strongly agree responses (36.1%) suggest that the respondents perceive their local logistics services to be extremely adaptable to change, not only to react to disruption but also to adapt to changing market conditions. This is because of their contextual intelligence and good awareness of the local industry situation, customer behavior, regulations, and local infrastructure, which enables them to make faster decisions.

This is even more important in Africa, where markets are not always predictable, or where infrastructure is not evenly developed. Whereas some multinational logistics companies may rely on standardized global procedures, local logistics companies are more present in the environment and may respond more quickly to changes. This “localized intelligence” allows these firms to respond to change quickly by routing, allocating resources, or shifting the delivery system. Local logistics companies may outperform larger, bureaucratic international players in situations where quick decision-making and flexibility are required (Opoku, 2025; Sarfo et al., 2025).

Another factor contributing to agility is that organizations are increasingly using collaboration and localized logistics ecosystems. Organizations like UPS, FedEx, and DHL have relationships with suppliers, transport providers, and customers. This enables faster communication and coordination during disruptions. In addition, the relationship factor lowers the decision-making process and improves the speed of corrective action. Finally, agility is not only technological, but also relational, based on trust, proximity, and constant interaction across the supply chain.

Some of the findings are in keeping with a growing body of research in the supply chain literature on the importance of reconfiguration to enhance agility. Flexibility in the ability to change logistics routes, mode of transport, or move stock is a sign of systemic flexibility. This is even more so as a result of the post-COVID-19 uncertainties that have hit global supply chains. Local logistics providers may be better positioned than global logistics providers to make changes efficiently (Nweze, 2024; Obuseh & Obioma-Ekeanyanwu, 2026).

Hence, the results indicate that agility across the local logistics sector is not reactive, but embedded in their business models. They can be quickly and easily adaptable to disruptions and changes in the market based on contextual knowledge, relationships, and flexibility, and provide support for the resilience and competitiveness of supply chains in volatile and structurally constrained environments.

4.7.4 The Moderating Role of Logistics Integration on the Relationship Between Supply Chain Resilience and Supply Chain Agility

Moderating effect of logistic integration on the SC resilience–SC agility relationship. This section elaborates on the direct effect of Supply Chain resilience on Supply Chain agility, followed by discussion of logistics integration as a determinant of agility independently, combined, and not combined with logistics integration.

4.7.4.1 The Direct and Dominant Effect of Supply Chain Resilience on Agility

Model 1 proves the supply chain's resilience predicts significantly supply chain agility. The increase in resilience will increase the agility of an organization. It is important in today's SCM environment because it is in a "perma-crisis" since 2020 (Akram et al., 2024; Aslam et al., 2020).

Resilience is the ability of a supply chain to bounce back (or even better, bounce forward) from a disruption (Aityassine et al., 2022; Mubarik et al., 2021). When firms invest in resilience, such as redundant suppliers, contingency plans, and visibility, they develop a safety net that allows them to take more risks and move quickly (Akram et al., 2024; Cerabona et al., 2023). The resilience variable's high beta coefficient signifies that resilience indeed drives agile supply chains. Highly resilient firms are naturally more agile because they have identified their weaknesses and those weaknesses have endowed them with the "flexibility" to respond to changes in the market (Chowdhury et al., 2024; Gligor et al., 2019).

Similarly, dynamic capacity theory advocates aligning and repositioning a firm's competencies to rapidly morphing needs (Akram et al., 2024; Opuala-Charles et al., 2026). Resilience is the ability to "re-configure", and agility is the "sensing and seizing" of opportunities (Aslam et al., 2020; Sharma et al., 2024). As cited by a few of the institutions that were spoken to, the ability to respond to disruption incentivizes the ability to respond quickly and with precision, i.e., agility (Opoku, 2025; Tufan et al., 2024).

4.7.4.2 Logistics Integration as an Independent Strategic Enabler

Logistics also appeared to be a significant predictor of agility in the supply chain. The significance of this relationship demonstrated that integration is independent of both speed and adaptability in the supply chain.

In an integrated network, there is free-flowing information between stakeholders, which can be instantaneously modified (Bag et al., 2022; Sarfo et al., 2025). For instance, when a local logistics provider like Africa Global Logistics integrates its system with the client(s) systems, the clients can easily reroute shipments or production scheduling modifications in case of delays (Manhando & Dzingirai, 2026; Opuala-Charles et al., 2026). And this flexibility would increase even without including resilience as functionalities of integration increase efficiency independently (Ramakrishna et al., 2023; Wiredu et al., 2023).

The lower value of the logistical integration found in this study compared with resilience indicates that integration is crucial, but resilience is the deciding factor for agility in this study (Mavi et al., 2023; Nweze, 2024). Considering that developing countries may have fragmented infrastructure, the “hard” factor of resilience, i.e., buffer stocks or transportation routes, may weigh more than the “soft” factor of digital or procedural integration (Adeleye et al., 2024; Opoku, 2025).

4.7.4.3 The Explanatory Power of the Combined Model

Table Model 1 summary indicated that resilience and logistic integration explained 86.4% of the variance in supply chain agility, which is a very high value for social science and management studies (Tariq et al., 2023; Wiredu et al., 2023).

This demonstrates a high level of explanatory power, which shows that in the post-pandemic era, agility is a by-product of resilience and logistics investment (Aslam et al., 2020; Nweze, 2024). Both of them need to complement each other to enhance the

organization's strength during turbulence and flexibility during market dynamics (Akram et al., 2024; Sharma et al., 2024). A recent study with an African perspective identifies supply chain success characteristics with advanced analytics and local integration (Adeleye et al., 2024; Obuseh & Obioma-Ekeanyanwu, 2026).

4.7.4.4 The Absence of a Moderating Role for Logistics Integration

The study reveals that supply chain logistics do not significantly moderate the relationship between resilience and agility. This contradicts the notion of 'integration as glue,' which states that firm capabilities' effectiveness requires them to be coordinated (Amoako Gyampah et al., 2019). In contrast, the findings indicate that resilience strongly affects agility irrespective of the degree of logistic integration.

Rooted in the Dynamic Capabilities Theory, resilience and agility as higher-order capabilities are interlinked (Akram et al., 2024). A resilient resource base that senses and withstands shocks is a prerequisite foundation for agility. Perhaps, these two capabilities are so critical to a firm's survival and competitive advantage in the churn supply markets like Africa that they crowd out other factors such as integration (Manhando & Dzingirai, 2026; Opoku, 2025). Integration, through sharing and coordination of data and information, provides 'operational efficiency', but it does not directly contribute to 'structural agility' that emerges from the resilient resource base (Alfaqiyah et al., 2025; Tukamuhabwa et al., 2021). In other words, a firm cannot use logistics to make up for a lack of resilient infrastructure. The lack of a firm supply chain base will prevent any digital and physical integration from fostering agile responses in firms (Ruel et al., 2021).

The high correlations and R2 values in this model can be explained by the nomological relevance of these constructs in disruptive situations. In an environment with high external uncertainty (e.g., Ghana), firms adapt to disasters by integrating resilience and agility into one response that can face frequent infrastructure and regulatory failures (Donkor et al., 2021; Opoku, 2025). Due to this overlap, there is a high amount of

explained variance because resilience has become the most reliable, and frequently the only predictor of a organization's capacity to respond quickly to troubles (Akram et al., 2024).

Hypothesis 2: The relationship between supply chain resilience and supply chain agility will be moderated by logistics integration, such that the relationship will be stronger when logistics integration is high.

Hence, the study rejects Hypothesis 2. In addition, the regression results reveal that the interaction term between supply chain resilience and logistics integration is not significant. This result suggests that the impact of resilience on agility is pervasive across all firms, regardless of the extent of their logistics system integration.

Some research in more stable or developed markets found that logistics integration has a significant impact on supply chain agility (Donkor et al., 2021; Opoku, 2025; Amoako-Gyampah et al., 2019). On the contrary, this study found that, in this study, the logistics integration is not an independent predictor of supply chain agility.

Theoretically, the results show that logistics integration is part of the bigger picture of the "viability" capability, where supply chain resilience provides flexibility and responsiveness in order for a firm to adapt rapidly. In other words, integration is a prerequisite for agility.

Also, for developing economies, the results indicate that, by and large, the firms tend to rely on resilience-driven agility where the ability to absorb disruption influences the performance of these firms. Here, logistics integration is only used as a complementary means to help information flow but not a requisite for strategic responsiveness (Manhando & Dzingirai, 2026; Opoku, 2025; Ruel et al., 2021).

4.7.5 Formulation and Assessment of a Conceptual Model Linking Logistics Collaboration, Supply Chain Resilience, and Agility

The preceding empirical analysis validates our research model and shows the significance of logistics integration, supply chain resilience, and supply chain agility in the manufacturing sector. This section discusses the findings in the context literature on supply chain management practices.

4.7.5.1 Validation of the Measurement Model

The reliability and validity of the constructs Logistics Integration, Supply chain resilience, and Supply Chain Agility were examined in the first phase of the analysis. Cronbach's alpha values ranging from 0.962 to 0.966 and composite reliability values from 0.970 to 0.975 suggest excellent internal consistency across all constructs, where the threshold value suggested by academics is 0.70 (Ahmed et al., 2024; Marín-García & Alfalla-Luque, 2019). The high values of the reliability coefficients and the reliability of the scales used in this research are highly consistent, indicating that the items may be accurate reflections of the true score of a latent variable with little error (Nasoontorn et al., 2023).

In addition, the average variance extracted for each construct exceeded the required value of 0.50 (Baah & Jin, 2019; Marín-García & Alfalla-Luque, 2019) by reaching 0.85, indicating that the constructs explained over 85% of the variance in the indicators, which is necessary for conducting quality empirical studies in the field of SCM (Ahmed et al., 2024). Likewise, each indicator's reliability was well above the recommended value of 0.70 (Marín-García & Alfalla-Luque, 2019; Nasoontorn et al., 2023).

4.7.5.2 The Critical Role of Logistics Integration in Building Resilience

The findings revealed a highly significant and strong path from Logistics Integration to Supply Chain Resilience. This indicates that the extent of manufacturing firms' integration with their logistics partners in collaboration, information exchange, and joint

solutions significantly drives the supply chain resilience of manufacturing firms. This finding concurs with recent studies that highlighted the importance of external integration with suppliers and logistics service providers as a fundamental measure to build resilience (Deng & Karıa, 2023; Jiang et al., 2023).

The very large effect size also indicates that logistics integration is an extremely important capability for resilience. Highly integrated firms were able to respond to logistics disruptions, such as bottlenecks and shocks in the supply, due to the global disruptions from 2020 to 2024 (Dacre et al., 2024; Tarigan et al., 2021). The value of resilience (0.713) indicates that the variance of more than 70% in the resilience capabilities is solely due to the integration, indicating that firms with logistics partnerships stand to transform in a volatile and uncertain market (Omoush, 2025).

4.7.5.3 From Resilience to Agility: The Path of Adaptability

The other finding is that Supply chain resilience significantly impacts Supply chain agility. This finding indicates the importance of Supply chain resilience as a prerequisite for Supply chain agility, where a firm needs a Supply chain Resilience capability to be agile in responding to rapid changes in the market (Aslam et al., 2020; Sharma et al., 2024). Plus, Gligor et al. noted that supply chain resilience and supply chain agility are different constructs but can share some features, i.e., flexibility and speed (Gligor et al., 2019).

Finally, this high value for agility (0.866) shows that the combined effect of logistics integration and resilience provides enough explanation for a firm’s agility. For a resilient firm, there is a bit of "slack" in the process that provides enough robustness to pivot agile activities without worrying about breaking the process (Mishra et al., 2024; Tufan et al., 2024). This result shows that resilience provides enough fuel for manufacturing firms to become truly agile in their lead times (Punchihewa, 2025; Tarigan et al., 2021).

4.7.5.4 Mediation Analysis: Resilience as the Strategic Bridge

The mediation analysis further explains how logistics integration affects agility. The results show that the direct relationship between logistics integration and agility exists, but the indirect effect through resilience is stronger, which confirms the mediation role of Supply Chain Resilience. In other words, logistics partners will not make a firm agile without first making the firm's supply chain resilient (Omoush, 2025; Punchihewa, 2025).

The above results show the significance of the bridging role of resilience. That is, collaborative practices of logistics integration (e.g., information sharing, unity in handling risks) can cultivate resilient capabilities (e.g., visibility, redundancy), which in turn can help the firm to be agile in responding to the market (Ghobakhloo et al., 2023; Mutambik, 2024). For managers, this means that instead of focusing on agility, a firm needs to secure the foundations of resilience that involve partnerships with logistics to avoid fragile agility, i.e., breaking easily when there is high speed (Deng & Karıa, 2023; Sharma et al., 2024).

4.7.5.5 The Paradox of Moderation: Why Integration Does Not Amplify Resilience's Effect

Interestingly, moderation analysis results reveal that Logistics Integration fails to moderate the relationship between resilience and agility, implying that Hypothesis 2 is rejected, and the interaction term is not significant. This gives a clearer picture of the proposed framework by emphasizing the importance of integration as an antecedent and not as a moderator (Dewi & Hermanto, 2024; Tufan et al., 2024). When a firm's integration is high, it is essential to act for building resilience, but it does not further strengthen the effect of resilience on agility.

A plausible justification for this result could be that once the firm is resilient, the ability of resilience to enable agility is intrinsic and does not need further integration to help it (Son & Kim, 2025). Hence, it suggests that a firm must first develop its integration to increase its resilience and then focus on resilience to enable agility. These findings are

vital for managers wanting to spend resources on integration and resilience, rather than looking for them to "boost" each other while implementing agile strategies (Ahad et al., 2025; Chen, 2026).

4.8 Conclusion of Discussion

Chapter four presented data and analysis of the data collected to examine the research questions and research hypotheses. In this study, the objective is to discuss the research questions, achieve the objectives, and test the proposed model to investigate the relationship between logistics integration, supply chain resilience, and supply chain agility in the manufacturing industry. The first research objective was to explore the relationship between supply chain resilience and supply chain agility. Supply chain resilience and supply chain agility are strongly related, thus, they complement each other.

In addressing the second research objective, I also discussed the local logistics providers, who play a role in enhancing the local supply chain performance through providing contingency, quick response, and adaptation to supply chains, although they have a lack of flexibility and visibility on their assets. To address the third research objective, I discussed the moderation effects of logistics integration and found that logistics integration does not significantly moderate the relationship between supply chain resilience and agility, both of which can drive independently. Finally, for the fourth research objective, I developed and tested a sound framework that incorporates logistics partnerships, resilience, and agility. I found that logistics integration is one of the main antecedents to resilience and, in turn, resilience is one of the drivers of agility. My findings show that logistics integration and resilience can work together to provide agility; hence logistics integration, resilience, and agility constitute a sequential or capability-based approach toward supply chain performance in an evolving environment. These findings prove the core of my research, fulfilling the study’s objectives.

The findings reported in this thesis began with an analysis of the response rate and demographics, which revealed a young, well-educated, and mid-level management workforce. This means that the findings reported in this thesis are based on the views of those who directly influence and implement supply chain decisions, which adds more value to the findings.

Tests of reliability and validity were used to check the validity of the measuring instrument. Since supply chain resilience and supply chain agility have a high alpha coefficient, the constructs are relatively reliable. Because there is a high degree of internal consistency, there is little chance of error in further analyses.

The table provides evidence showing a strong relationship between supply chain resilience and supply chain agility. This result confirms the main hypothesis of this study and the theoretical argument. The findings indicate that firms with higher capacity to prevent, mitigate, and recover from supply chain disturbances are also more capable of effecting an agile response to market changes. It indicates the compatibility and synergy between these two capabilities in contemporary supply chain practices.

Results from local logistics providers further supported the above finding on logistics providers' roles in facilitating resilience and agility. Respondents agreed highly on points of contingency planning, responsiveness, and adaptability, clearly indicating that local logistics providers contribute to continuity and quick responses to market changes. However, logistics providers fell short on flexibility and asset visibility, suggesting that although they are reliable, they need to improve in terms of resource assignment and visibility.

More discussion on the predictors of the variables used in this research was found from the regression results. Supply chain resilience was found to be the main predictor of supply chain agility, which highlights the role of supply chain resilience in adapting and reacting to supply chain practices. Also, logistics integration was found to have a direct

effect on supply chain agility, which means that it is a strategic skill that firms use for enhancing coordination and communication. The insignificant interaction effect indicates that the predictor logistics integration neither complements nor substitutes the effect of supply chain resilience on supply chain agility, and both of those predictors have an individual effect on the supply chain's performance.

Results of this chapter show that supply chain resilience, the most important precondition for supply chain agility, is required for agility, responsiveness, and adaptability in supply chain agility, and logistics integration helps in supporting it. The findings of this study highlight the value of resilience for organizations to cope with more turbulent and uncertain environments. On the other hand, although logistics integration does not affect the relationship between supply chain resilience and supply chain agility, it is critical to invest in logistics integration to improve coordination.

5 Summary, Conclusion, and Recommendations

In this chapter, the findings, conclusions, and recommendations for practice and policy are presented. The research aimed to explore the impact of resilience on agility in supply chain manufacturing, exploring local logistics providers and logistics integration. The results discussed in the previous chapter (chapter four) indicated a positive correlation between resilience and agility, and logistics integration plays a moderating role. This chapter summarizes these findings, consistent with the objectives of the study, and proposes some of the implications of these results.

5.1 Review of Research Objectives

The study sought to examine the relationships between supply chain resilience and supply chain agility, as well as the role of logistics integration and local logistic providers in manufacturing in Ghana. The specific objectives are to:

(i) To analyze the relationship between supply chain resilience and supply chain agility;

ii. Analyze the contribution of local logistic service providers to supply chain performance;

iii. To investigate the moderating role of logistics integration in the relationship between supply chain resilience and supply chain agility

iv. To develop and validate a framework integrating logistics partnerships to enhance supply chain resilience and supply chain agility of manufacturing supply chains.

The study employed correlation and regression analyses to examine variable interactions, while using structural equation modeling and mediation analysis to test our proposed framework. The use of these methodologies enables us to explore both the direct and indirect relationships among variables, thereby providing comprehensive evidence for our conclusions.

5.2 Summary and Synthesis of Findings

Summary and synthesis of the findings of the study are discussed below.

5.2.1 Resilience as the Core Driver of Agility

The findings indicate that, contrary to common belief, resilience to supply chain disruptions is not a factor that supports supply chain agility; rather, it is the main driver. Agility is not isolated, but is a function of adaptive processes such as disruption response, flexibility, and recovery. This view of agility as a competitive advantage has to change to one where agility is viewed as a capacity for resilience in a volatile environment, such as Ghana's manufacturing sector.

5.2.2 Logistics Integration as a Foundational Capability

Logistics integration was found to improve resilience through better coordination, collaboration, and information sharing, but its impact on agility was indirect, through resilience, rather than directly through responsiveness. This challenges the assumption that integration brings agility, suggesting that the benefits of integration must be translated into resilience.

5.2.3 Mediation Effect of Resilience on Mediation Effect of Resilience

The mediation results indicate a pattern of capabilities as Logistics Integration > Resilience > Agility. This demonstrates that firms cannot rely only on integration. Integration efforts may not lead to meaningful improvements in agility without building resilience. This finding shows that greater capability development is important, and not simply improved operations.

5.2.4 Absence of Moderating Effect: A Contradictory Insight

Contrariwise, there was no impact of logistics on resilience or agility. This is important since it rebuts some of the conventional wisdom on the role of skill integration. Logistics integration has a threshold effect, where when the level of integration is attained, further improvement does not enhance resilience-agility link. Instead, resilience and integration function independently and together.

5.2.5 Role of Local Logistics Providers

Local logistics providers were considered necessary for resilience and agility due to their contextual knowledge and responsiveness. But, the lack of visibility, adoption of technologies, or distribution of resources indicated a mismatch in capabilities and performance. This suggests that while local players might be important, their impact is thwarted by inadequacy of infrastructure and technology.

5.2.6 Validation of the Integrated Framework

Thus, the validated model supports a capability-based sequential model of supply chain performance. The model has a high power of explanation, and the relations depict the road connecting integration to resilience and agility.

5.3 Conclusions

These findings suggest several things. The first is that supply chain resilience is the most significant predictor of supply chain agility. Resilience was not only a significant predictor of agility, but it was also a positive predictor of agility. Firms that are highly resilient are in a better position to respond quickly and effectively to environmental changes.

Second, supply chain resilience and agility are closely related and complementary concepts**.** Due to the high correlation between the two, investment in resilience will lead to more agility, which is a capability view of supply chain performance.

In addition, there are two different dimensions of logistics integration that can affect supply chain performance. Logistics integration improves collaboration, information sharing, and coordination, but does not improve resilience-agility by moderation. It appears that logistics integration enhances performance by improving resilience, but not by amplifying its effects.

Both logistics integration and agility are interacted with by supply chain resilience. This is significant, since it shows that integration alone does not lead to agility; a first step in moving towards agility is to develop resilience. There is a need to build capabilities, not improve operations.

Local logistics providers are vital components of supply chain resilience and agility. Logistics providers have flexibility, adaptability, and knowledge of the local environment, making them an integral partner in providing continuous supply. Logistics providers are challenged with issues such as where their equipment is located, how available it is, and how readily resources can be used.

This study concluded that supply chain performance was multidimensional and capability-driven. Logistics integration was a stepwise and dynamic relationship between resilience and agility as tested during validation. This provides an appropriate theoretical base and practical guidance for supply chain management in uncertain conditions.

5.4 Theoretical Contribution

This paper adds to the literature on supply chains in the following three aspects.

1. It challenges the presumed benefits of logistics integration by providing counter evidence.
2. It proposed the sequential capability model to further explain integration, resilience, and agility.
3. It reports on Ghana, and will therefore contribute to the scant literature on supply chains in developing countries.

5.5 Recommendations

1. Incorporate supply chain resilience.

Firms should go beyond ad-hoc responses and implement formal resilience systems that include: Risk assessment and early warning systems, supplier diversification strategies, business continuity, and recovery plans. Outcome: Faster response to disruption and agility.

2. Implement digital logistics integration

Invest in: Real-time tracking systems, integrated logistics platforms, and data analytics for demand forecasting. Implementation: Partner with technology providers and slowly move to the technology as a company needs it.

3. Strengthen local logistics partnerships.

Develop long-term contracts with performance goals, share technologies and data, and provide joint training. Outcome: Improved service coordination and reliability.

4. Increase asset visibility and allocation.

Implement tracking technologies (e.g., GPS, warehouse systems) and distribution of logistics assets across regions. Insight: Lower costs and improved time to market.

5. Align integration with capability development.

Managers should ensure that the integration efforts are not separate from the outcomes of resilience, but linked to them.

5.6 Policy Implications of the Study

Government should:

1. Invest in digital logistics infrastructure ‘
2. Support SMEs and logistics firms in adopting technology
3. Encourage public-private partnerships in supply chain innovation
4. Improve transport infrastructure to reduce inefficiencies.

5.7 Suggestions for Future Research

Future research should:

1. Use longitudinal data to research how capabilities develop over time.
2. Examine other moderators, such as digital transformation
3. Evaluate other moderators, such as training orientation in learning.

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APPENDIX I: SURVEY QUESTIONNAIRE

Please write in Ink in the box corresponding to the statement which you think best answers the question posed. For the following questions, please select (✓) all that apply.

SECTION A: DEMOGRAPHICS AND CHARACTERISTICS OF RESPONDENTS

1. What is your gender?

(a) Female [ ] (b) Male [ ]

2. What is your age?

(a) Below 30 [ ] (b) 30 – 40 years [ ] (c) 41 – 50 years [ ]

(d) 51 – 60 years [ ]

3. What is your level of education?

(a) SSCE/WASSCE [ ] (b) Diploma [ ] (c) First Degree [ ]

(d) Master's Degree [ ]

4. What category of staff are you?

(a) Lower level [ ] (b) Middle level [ ] (c) Upper level [ ]

5. How many years have you been with the company?

(a) Less than 2 years [ ] (b) 2 – 7 years [ ] (c) 8 – 13 years [ ]

(d) 14 – 19 years [ ] (d) More than 19 years [ ]

From Section B - D: Please mark the number from 1 to 7 with the following scale that corresponds to your degree of agreement or disagreement with each statement.

1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Indifferent/Not Sure
5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree

SECTION B: SUPPLY CHAIN RESILIENCE

Statement	1	2	3	4	5	6	7
Our firm has detailed contingency plans and regularly conducts preparedness exercises and readiness inspections							
Our firm's supply chain has flexibility in sourcing, manufacturing, order fulfilment, and logistics to quickly respond to any change							
Our firm's supply chain has capacity and availability of assets (including reliable back-up utilities; redundant facilities, equipment, and labour) for sustained or continuous product flows							
Our firm takes immediate action to deal with disruptions, despite the short-term costs							
Our firm can quickly reallocate orders to alternate suppliers and reassign jobs between different production facilities							
Our firm can deal with changes in the market							

Adapted from; Lin, Y., Pang, G., Duan, K., Luo, J., Wang, S. and Qu, J., 2024. The impacts of digital and learning orientations on supply chain resilience. *Industrial Management & Data Systems*, *125*(2), pp.535-574.

SECTION C: SUPPLY CHAIN AGILITY

Statement	1	2	3	4	5	6	7
Our supply chain quickly adapts to changes in product design requirements.							
Our supply chain adjusts rapidly to variations in production and operational costs.							
Our supply chain promptly incorporates product improvements into production processes.							

Our supply chain introduces new products to the market promptly.							
Our supply chain effectively adjusts production capacity to meet demand fluctuations.							

Source Jum'a, L., Zighan, S., & Alkalha, Z. (2025). Influence of supply chain digitalization on supply chain agility, resilience, and performance: environmental dynamism as a moderator. *Journal of Manufacturing Technology Management*, *36*(4), 798-819

SECTION D: LOGISTIC INTEGRATION

Statement	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Our firm's internal logistics activities are closely coordinated.							
Our firm's logistics activities are well integrated with suppliers' logistics activities.							
Our logistics integration is characterised by excellent distribution, transportation, and warehousing facilities.							
The inbound and outbound distribution of goods with our suppliers is well integrated.							

Adapted from: Prajogo, D., & Olhager, J. (2012). The effect of supply chain information integration on logistics integration and firm performance. *Int J Prod Econ*, *135*(1), 514-522.

APPENDIX II: KREJCIE AND MORGAN TABLE

Table for Determining Sample Size of a Known Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Note: N is Population Size; S is Sample Size *Source: Krejcie & Morgan, 1970*