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Supply Chain Visibility and Customer Satisfaction: The Moderating Role of Technology Adoption

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Abstract

Supply chain visibility (SCV) has become increasingly important for organisations seeking to enhance operational efficiency and deliver superior customer experiences. However, in emerging economies such as Ghana, persistent information gaps, fragmented supply chain systems, delivery inefficiencies, and uneven digital capabilities may limit how visibility translates into improved customer outcomes. Despite growing scholarly attention to SCV and technology adoption (TA), empirical evidence remains limited on whether TA strengthens the relationship between supply chain visibility and customer satisfaction (CS) in the Ghanaian business context. Drawing on the Resource-Based View (RBV) and the Technology–Organisation–Environment (TOE) framework, this study examines how supply chain visibility affects customer satisfaction. It investigates the moderating role of technology adoption in this relationship.

A quantitative explanatory research design was employed, using a cross-sectional survey of supply chain managers, logistics officers, and information technology executives in Ghana's manufacturing, retail, and logistics sectors. Data were collected from 372 respondents using a structured questionnaire measured on a five-point Likert scale. The data were analysed using descriptive statistics, correlation analysis, and regression-based moderation analysis with IBM SPSS Statistics Version 26 and Hayes' PROCESS Macro (Model 1).

The findings indicate that supply chain visibility has a significant positive effect on customer satisfaction. Furthermore, technology adoption significantly strengthens the positive relationship between supply chain visibility and customer satisfaction, suggesting that firms with stronger technological capabilities are better positioned to convert supply chain information into timely decisions, responsive service delivery, and improved customer experiences. The study contributes to the literature by showing that supply chain visibility is not merely an information-sharing mechanism but a strategic capability whose value depends partly on firms' technological capacity to process and use supply chain information effectively.

The findings extend the Resource-Based View by highlighting technology adoption as a capability-enabling mechanism that enhances the value of organisational resources. Practically,

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the study recommends that Ghanaian firms integrate supply chain visibility initiatives with appropriate digital technologies, real-time information systems, and data-driven decision-making capabilities. Policymakers should similarly promote digital infrastructure, technological accessibility, and supportive institutional conditions to accelerate supply chain digitalisation. The study provides important implications for improving customer satisfaction and sustainable competitive performance in emerging-market supply chains.

Keywords: *Supply Chain Visibility; Technology Adoption; Customer Satisfaction; Technology–Organisation–Environment; Resource-Based View; Ghana; Supply Chain Digitalisation.*

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1.0 INTRODUCTION

1.1 Background of the Study

Customer satisfaction has become a critical strategic outcome for firms operating in increasingly competitive and digitally interconnected markets. Beyond reflecting customers' evaluations of products and service experiences, customer satisfaction influences customer loyalty, repeat patronage, relationship quality, and long-term firm performance (Agyabeng-Mensah & Ahenkorah, 2019; Obiri-Yeboah et al., 2025). In supply chain-intensive industries, customer satisfaction depends heavily on firms' ability to deliver reliably, provide accurate information, ensure product availability, respond promptly, and maintain consistent service quality (Baah et al., 2022). Consequently, supply chain capabilities that help firms anticipate disruptions, coordinate activities, and respond quickly to customer requirements have become increasingly important to competitive performance.

One such capability is supply chain visibility (SCV), the extent to which firms and their supply chain partners can access timely, accurate, and relevant information on inventory, orders, product movements, and delivery commitments (Gunasekaran et al., 2020). Visibility enables firms to identify disruptions, monitor supply chain activities, coordinate interorganizational processes, and respond to changing customer requirements (Dharmapalan et al., 2021). Recent empirical evidence further suggests that increased visibility can reduce information gaps and improve supply chain responsiveness and customer-oriented outcomes (Baah et al., 2022; Saqib & Zhang, 2021). In the Ghanaian context, where firms continue to face logistical inefficiencies, delivery delays, fragmented information systems, and difficulties coordinating supply chain activities, improved visibility may be an important mechanism for enhancing customer experiences (Attatsi, 2022; Boateng, 2024).

However, supply chain visibility does not necessarily guarantee superior customer satisfaction. Visibility generates information, but its value depends on an organisation's capacity to capture, integrate, analyse, and translate it into timely decisions and operational responses (Wamba et al., 2020; Queiroz & Wamba, 2021). This distinction matters in emerging economies, where firms may face uneven access to digital infrastructure, technological capabilities, and skilled personnel (Boateng, 2024; Mwaura & Noor, 2025). Thus, SCV effectiveness may depend on complementary organisational capabilities that enable firms to transform information into customer value. Technology adoption (TA) represents one such complementary capability.

The adoption of technologies such as cloud computing, Internet of Things (IoT) applications, blockchain, artificial intelligence, analytics, enterprise systems, and automated tracking mechanisms can increase the speed, accuracy, integration, and usability of supply chain information (Queiroz & Wamba, 2021; V et al., 2024). Recent research indicates that digital technologies can strengthen visibility by improving information integration, real-time monitoring, traceability, and analytical capabilities (V et al., 2024; Guo et al., 2024). Technology can therefore

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amplify visibility's value by enabling firms to convert dispersed supply chain information into actionable intelligence.

The relationship between SCV and customer satisfaction is therefore not simply direct but technology-contingent. Firms with high visibility but limited technological capability may have extensive information but cannot process it efficiently or act on it promptly. Conversely, firms with appropriate technological capabilities can extract greater value from visibility by integrating information across supply chain functions, speeding decisions, reducing errors, and enhancing responsiveness (Wamba et al., 2020; Queiroz & Wamba, 2021).

Recent evidence also shows that technology adoption can directly contribute to customer satisfaction by improving supply chain processes and responsiveness (Saad et al., 2024). This suggests that technology adoption may serve as a boundary condition, determining the extent to which supply chain visibility translates into customer satisfaction. This argument aligns with the Resource-Based View (RBV), which proposes that firms can achieve sustained competitive advantage by effectively deploying valuable, rare, difficult-to-imitate, and non-substitutable resources and capabilities (Barney, 1991; Barney et al., 2011). From this perspective, SCV can be an information-based organisational capability, while technology adoption is a complementary capability that enhances the firm's ability to exploit that information's value.

The argument also aligns with the Technology–Organisation–Environment (TOE) framework, which explains technology adoption through the interaction of technological, organisational, and environmental conditions (Tornatzky & Fleischer, 1990; Baker, 2012). In emerging-market environments, technological infrastructure, organisational readiness, and environmental conditions may shape how firms adopt and effectively use digital technologies. Thus, integrating RBV and TOE provides a theoretically richer explanation of why visibility may produce different customer outcomes across firms with different levels of technological capability. This theoretical argument is particularly relevant to Ghana, where digital transformation is reshaping supply chain practices while firms continue to operate within an environment characterised by infrastructure limitations, fragmented data systems, and varying levels of technological capability (Boateng, 2024; Mwaura & Noor, 2025). Existing Ghanaian research has examined visibility, collaboration, technology adoption, and supply chain performance, but these streams have largely been studied independently (Baah et al., 2022; Attatsi, 2022).

Consequently, limited empirical attention has been given to whether technology adoption changes the strength of the relationship between SCV and customer satisfaction. Recent evidence reinforces the importance of investigating this interaction. For example, research on supply chain digitalisation shows that digital capabilities can enhance visibility and, in turn, improve supply chain performance (2024). Similarly, studies of technology adoption and customer satisfaction in emerging-market settings suggest that technology can improve customer outcomes by enhancing organisational responsiveness and service processes (Saad et al., 2024). Nevertheless, research has not yet sufficiently examined whether technology adoption moderates the SCV–customer satisfaction relationship, particularly in Ghanaian supply chains.

Accordingly, this study conceptualises SCV as an information-based strategic capability and technology adoption as a complementary capability that enables firms to convert visibility into customer value. Rather than assuming visibility automatically produces customer satisfaction, the study proposes that the strength of this relationship depends partly on the firm's available technological capabilities. This perspective provides a theoretically grounded explanation of when and under what conditions supply chain visibility is most likely to enhance customer satisfaction.

1.2 Problem Statement

Customer satisfaction increasingly matters to organisational competitiveness because customers expect reliable deliveries, timely information, product availability, and responsive service (Agyabeng-Mensah & Ahenkorah, 2019; Baah et al., 2022). Nevertheless, supply chain inefficiencies continue to undermine these expectations in Ghana. Delivery delays, fragmented information, inadequate tracking capabilities, and weak coordination can reduce supply chain responsiveness and ultimately contribute to unsatisfactory customer experiences (Lawrence &

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Mupa, 2024; Mwaura & Noor, 2025). The literature identifies supply chain visibility as a key mechanism for addressing these challenges because timely, accurate information enables firms to monitor supply chain activities, identify disruptions, and respond to customer requirements (Gunasekaran et al., 2020; Saqib & Zhang, 2021). Despite these potential benefits, an important conceptual problem remains unresolved. Visibility provides access to information, but access alone does not ensure firms can create customer value from it.

Organisations must possess the technological capability to integrate, process, interpret, and act upon supply chain information (Wamba et al., 2020; Queiroz & Wamba, 2021). Consequently, firms with comparable visibility levels may achieve different customer satisfaction outcomes because of differences in their technological capabilities. Previous international studies have shown that digital technologies, blockchain, IoT, and supply chain digitalisation improve transparency, traceability, coordination, and supply chain performance (Queiroz & Wamba, 2021; Akhavan & Philsoophian, 2023; Guo et al., 2024). However, much of this evidence comes from more technologically developed contexts, where digital infrastructure and technological readiness may differ substantially from those in emerging economies.

Consequently, the extent to which technology-enabled visibility translates into customer satisfaction under resource-constrained conditions remains insufficiently understood. African research has increasingly examined supply chain visibility and digital technologies, including their implications for operational performance and customer experience (Mwaura & Noor, 2025; Moleme et al., 2024). However, the evidence remains fragmented and frequently focuses on individual technologies, particular industries, or direct relationships between technology and performance. Limited attention has been given to whether technology adoption may alter the strength of the relationship between visibility and customer satisfaction.

The Ghanaian literature presents a similar limitation. Existing studies have examined supply chain visibility, collaboration, technology adoption, and digital transformation, with evidence suggesting that these capabilities can improve transparency, traceability, coordination, and performance (Baah et al., 2022; Boateng, 2024). However, these studies largely examine the constructs independently and offer limited empirical evidence on how they interact to explain customer satisfaction.

Moreover, the literature offers insufficient guidance on when supply chain visibility is more or less likely to generate customer value. Three interrelated gaps therefore emerge. First, a contextual gap remains, as empirical evidence on the SCV–customer satisfaction relationship is limited in emerging-market supply chains such as Ghana (Boateng, 2024). Second, a theoretical gap remains because existing studies do not sufficiently explain the complementary capabilities through which visibility is transformed into customer value. Third, an empirical gap remains because few studies have explicitly tested technology adoption as a moderator of the relationship between SCV and customer satisfaction.

Addressing these gaps matters because treating SCV and technology adoption as independent drivers may overlook their mutually reinforcing value. Recent research demonstrates that digitalisation can strengthen visibility and supply chain performance (2024), while technology adoption has also been shown to improve customer satisfaction in emerging-market contexts (Saad et al., 2024). However, these findings do not establish whether technology adoption strengthens the specific relationship between supply chain visibility and customer satisfaction.

The present study therefore examines the effect of SCV on customer satisfaction and tests whether technology adoption strengthens this relationship among firms in Ghana's manufacturing, retail, and logistics sectors. The study therefore shifts the focus from whether visibility improves customer satisfaction to when and under what technological conditions visibility creates greater customer value. This boundary-condition perspective provides a stronger theoretical basis for understanding the performance implications of SCV in emerging-market environments. The study seeks to answer the following research questions:

1. What effect does supply chain visibility have on customer satisfaction among firms in Ghana?

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2. What effect does technology adoption have on customer satisfaction among firms in Ghana?
3. Does technology adoption moderate the relationship between supply chain visibility and customer satisfaction?

The study draws on the Resource-Based View (RBV) and the Technology–Organisation–Environment (TOE) framework. RBV suggests that firms achieve competitive advantage by possessing and effectively deploying valuable, difficult-to-imitate resources and capabilities (Barney, 1991; Barney et al., 2011). In this study, SCV is conceptualised as an information-based capability that provides firms with access to critical supply chain information. However, the value of this capability depends on the firm's ability to exploit the information generated. Technology adoption is therefore conceptualised as a complementary capability that enables firms to integrate, analyse, and act upon supply chain information.

The TOE framework complements the RBV by explaining how technological characteristics, organisational readiness, and environmental conditions influence technology adoption and utilisation (Tornatzky & Fleischer, 1990; Baker, 2012). Integrating these perspectives suggests that SCV and technology adoption should not be viewed as independent resources. Instead, technology adoption can determine how much customer value SCV generates. The study consequently contributes to the literature by positioning technology adoption as a boundary condition in the relationship between an information-based supply chain capability and customer satisfaction. This perspective aligns with emerging evidence that digital technologies can enhance supply chain visibility, information integration, and supply chain performance (V et al., 2024; Guo et al., 2024).

2.0 MATERIALS AND METHODS

2.1 Resource-Based View (RBV) Theory

The Resource-Based View (RBV), principally advanced by Barney (1991), explains firm performance and sustained competitive advantage through resources and capabilities that are valuable, rare, difficult to imitate, and non-substitutable. Rather than attributing superior performance primarily to favourable external market conditions, RBV argues that firms achieve and sustain competitive advantage by acquiring, developing, combining, and effectively deploying strategic resources. These resources may include physical assets, technological infrastructure, organisational processes, human expertise, knowledge, and relational capabilities. In supply chain management, the RBV perspective is particularly useful because competitive performance increasingly depends not only on physical assets but also on firms' ability to generate, share, interpret, and exploit information across supply chain partners.

In this study, Supply Chain Visibility (SCV) is conceptualised as a key knowledge-based organisational capability through which firms obtain timely, accurate, and relevant information about supply chain activities. Visibility enables organisations to monitor inventory, track orders and deliveries, identify disruptions, coordinate activities, and respond to changes in customer requirements. Thus, SCV extends beyond mere information availability; it represents an organisational capability to transform distributed supply chain information into actionable knowledge. This interpretation aligns with the RBV proposition that resources create competitive value when organisations effectively integrate them into processes and deploy them to improve decision-making and operational responsiveness (Barney, 1991; Dubey, Gunasekaran, & Childe, 2019).

SCV's strategic relevance stems from its ability to reduce information asymmetry and uncertainty across supply chain processes. Firms with stronger visibility capabilities are better positioned to identify demand changes, monitor inventory positions, anticipate potential disruptions, and coordinate responses among supply chain actors. Gunasekaran, Papadopoulos, and Dubey (2020) argue that enhanced visibility helps organisations obtain timely information and respond more quickly to changing operating conditions. From an RBV perspective, therefore, information visibility becomes strategically valuable when it enables firms to make faster and more accurate decisions than competitors with less developed information capabilities. Consequently, the relationship between SCV and customer satisfaction can be understood

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through the value-creating function of organisational resources. Customers increasingly evaluate firms based on the reliability, speed, transparency, and consistency of service delivery. Visibility allows firms to provide more accurate information about product availability, order status, delivery schedules, and potential disruptions. These capabilities can improve service reliability and reduce delivery uncertainty, thereby strengthening customer confidence and satisfaction. Baah et al. (2022) similarly suggest that supply chain visibility enhances organisational agility, operational coordination, and responsiveness to customer requirements. Conversely, inadequate visibility may contribute to communication failures, delivery delays, inventory problems, and inconsistent service experiences, all of which can negatively affect customer satisfaction.

However, RBV also recognises that possessing a resource does not automatically generate competitive advantage. A resource's value depends on how effectively it integrates with complementary organisational resources and capabilities. This consideration is especially important when adopting technology. Contemporary supply chains increasingly rely on technologies such as enterprise resource planning systems, Internet of Things (IoT) applications, blockchain, artificial intelligence, cloud computing, and advanced data analytics to collect, integrate, process, and disseminate supply chain information. Wamba and Queiroz (2022) emphasise that digital technologies can enhance the value derived from organisational resources by facilitating real-time information exchange, monitoring, and predictive analysis. Technology therefore provides an enabling infrastructure through which visibility can be converted into operational and customer value.

Technology adoption is consequently conceptualised in this study not simply as an independent organisational resource but as an enabling capability that strengthens the deployment and utilisation of SCV. When firms adopt appropriate technologies, they can integrate information generated across different supply chain stages and make it available to relevant decision-makers in real time. This increases the accuracy, timeliness, accessibility, and usability of supply chain information. Akhavan and Philsoophian (2023) argue that technology adoption can reinforce the relationship between visibility and performance by improving information quality, operational transparency, and collaboration among supply chain actors. From the RBV perspective, the strategic value therefore lies not in technology alone, but in the firm's ability to combine technology with visibility-related knowledge and processes in ways that competitors may find difficult to replicate.

The interaction between SCV and technology adoption can further be explained through the VRIN characteristics of strategic resources. First, technology enhances the value of visibility by enabling firms to transform supply chain data into actionable insights that support faster decision-making and improved customer responsiveness. Second, technology-enabled visibility may become rare when firms have sophisticated digital infrastructures, analytics capabilities, and integrated information systems that competitors do not widely possess. Third, the combined capability may be difficult to imitate because its effectiveness depends not only on acquiring technology but also on firm-specific processes, accumulated knowledge, employee competencies, data quality, supplier relationships, and organisational routines. Finally, the combination may be relatively non-substitutable when integrated, as real-time visibility provides a distinctive capability to coordinate complex supply chain activities and respond to customers. Thus, competitive advantage is likely to arise from the configuration and effective deployment of complementary resources rather than from technology or visibility in isolation (Barney, 1991).

The RBV perspective also provides a basis for understanding customer satisfaction as an outcome of resource deployment. Customer satisfaction reflects customers' evaluations of whether a firm's products and services meet or exceed their expectations. Firms that possess and effectively deploy information-based and technology-enabled capabilities can anticipate customer requirements, provide accurate information, improve delivery reliability, and resolve service problems more rapidly. Agyabeng-Mensah and Ahenkorah (2019) highlight the importance of information sharing and coordination in improving supply chain responsiveness, while Queiroz and Wamba (2021) demonstrate the importance of technology-enabled visibility for improving transparency and responsiveness in supply chain processes. These mechanisms logically explain why firms with superior visibility and technology capabilities may achieve higher

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levels of customer satisfaction. The RBV further emphasises resource complementarity. Resources can generate greater value when they are combined in ways that create capabilities that cannot be achieved through individual resources operating independently. In the present study, SCV gives firms access to supply chain information, while technology adoption provides the infrastructure and analytical capability needed to process, integrate, and use that information effectively. Together, they can enable real-time monitoring, predictive decision-making, improved coordination, and rapid responses to customer needs. This combination may therefore constitute a higher-order organisational capability that strengthens SCV's effect on customer satisfaction.

This resource-complementarity argument is particularly relevant in emerging-market contexts such as Ghana, where information fragmentation, infrastructure limitations, logistics inefficiencies, and uneven digitalisation levels may affect supply chain operations. The strategic challenge for firms is therefore not merely to acquire digital technologies but to develop the organisational capabilities required to integrate these technologies into supply chain processes. Attatsi (2022) emphasises the importance of institutional and governance conditions in determining how organisations utilise technological and information resources. Similarly, evidence from Ghana suggests that technology-enabled supply chain practices can improve transparency, traceability, and service delivery performance (Boateng, 2024; Fekpe & Fiagbey, 2021).

Applying RBV to the Ghanaian context therefore suggests that firms that develop and integrate supply chain visibility and technology capabilities can build stronger mechanisms for creating customer value. Such firms can differentiate themselves through more reliable delivery, more accurate information, greater transparency, and faster responses to customer requirements. Lawrence and Mupa (2024) similarly indicate that advanced supply chain technologies can strengthen organisational performance and competitiveness. Accordingly, RBV provides a theoretically grounded explanation for why differences in firms' internal capabilities may result in differences in customer satisfaction outcomes.

Importantly, the RBV perspective provides the theoretical justification for examining technology adoption as a moderator in the relationship between SCV and customer satisfaction. If SCV is a valuable organisational capability, its effect on customer satisfaction should depend partly on the firm's ability to deploy complementary technological resources. Firms with relatively high levels of technology adoption are expected to extract greater value from visibility because digital technologies facilitate the collection, integration, analysis, and dissemination of supply chain information. Conversely, when technology adoption is limited, slow information processing, fragmented systems, and limited analytical capacity may constrain the benefits of visibility. The RBV therefore suggests that technology adoption can strengthen the conversion of SCV into customer-oriented performance outcomes.

Overall, RBV provides a strong theoretical foundation for this study because it explains how firms can derive competitive and customer-related benefits from strategically deploying internal resources and capabilities. SCV is a valuable information-based capability, while technology adoption provides complementary infrastructure and organisational capabilities that can enhance the use of visibility. Effective integration enables firms to turn supply chain information into timely decisions, operational responsiveness, and superior customer experiences. Consequently, the theory supports the proposition that technology adoption strengthens the positive relationship between SCV and customer satisfaction.

2.2 Technology–Organisation–Environment (TOE) Framework

Although RBV explains how internal resources and capabilities can generate superior performance, it offers limited insight into the contextual conditions that influence firms' decisions to adopt and use technology. To address this limitation, the present study complements RBV with the Technology–Organisation–Environment (TOE) framework developed by Tornatzky and Fleischer (1990). The TOE framework proposes that organisational adoption and implementation of technological innovations are shaped by three interrelated contexts: the technological context, the organisational context, and the environmental context. This framework

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is particularly appropriate for the present study because technology adoption is central to explaining how firms develop and utilise supply chain visibility capabilities. The technological context concerns the characteristics and availability of technologies relevant to the organisation, including their relative advantages, compatibility, complexity, and technological readiness. In supply chain management, technologies such as ERP systems, IoT, blockchain, cloud platforms, artificial intelligence, and data analytics can influence how well firms can capture and share supply chain information. Technologies compatible with existing organisational systems and perceived to offer clear operational benefits are more likely to be adopted and used effectively. Liu, Prajogo, and Oke (2016) and Gunasekaran et al. (2020) show that information and technology capabilities strengthen supply chain visibility and operational responsiveness.

The technological context is therefore directly relevant to the SCV–customer satisfaction relationship. Technology can increase the speed and accuracy with which supply chain information is collected and communicated. For example, real-time tracking technologies can provide shipment status information, while integrated information systems can connect inventory, procurement, logistics, and customer-service functions. Such capabilities can reduce information delays and improve firms' ability to respond to customer inquiries and service requirements. Consequently, the TOE framework helps explain the organisational conditions under which technology adoption becomes feasible and capable of generating supply chain benefits.

The organisational context refers to internal characteristics that influence technology adoption, including organisational size, management support, employee competence, financial resources, organisational readiness, and existing technological infrastructure. Technology adoption requires more than access to technological solutions; organisations must possess the managerial commitment, human capabilities, financial capacity, and internal processes necessary to implement and sustain them. In Ghanaian firms, managerial support and employee competence matter especially because the effectiveness of digital supply chain technologies depends on users' ability to integrate them into established operational processes (Boateng, 2024; Fekpe & Fiagbey, 2021).

Organisational readiness also influences whether firms can translate technology adoption into improved visibility and customer outcomes. A firm may have advanced technology but fail to realise its potential if employees lack the required skills, managers do not support digital transformation, or organisational processes remain fragmented. The TOE framework therefore complements RBV by recognising that internal organisational conditions shape how organisations adopt, integrate, and use technology effectively. This distinction matters because merely possessing technology should not automatically be interpreted as evidence of effective technology-enabled visibility.

The environmental context captures external forces that influence technology adoption, including competitive pressure, customer expectations, regulatory requirements, industry characteristics, supplier relationships, and institutional conditions. Contemporary customers increasingly expect accurate information, timely delivery, transparency, and responsive service. These expectations can encourage firms to adopt digital technologies that improve visibility and service performance. Similarly, competitive pressure can motivate firms to adopt technologies that enable them to match or exceed competitors' supply chain capabilities.

In the Ghanaian business environment, environmental factors may be particularly influential because firms operate within an evolving digital ecosystem characterised by increasing technological diffusion, changing customer expectations, institutional reforms, and growing competitive pressures. Attatsi (2022) highlights the importance of institutional conditions in shaping firms' capacity to exploit technological and information resources. Lawrence and Mupa (2024) likewise emphasise the contribution of advanced supply chain technologies to organisational competitiveness. These conditions provide an important contextual explanation for why firms differ in their levels of technology adoption. The TOE framework therefore complements the RBV in a theoretically meaningful manner. RBV focuses on how firms leverage valuable internal resources and capabilities to generate performance advantages. In contrast, TOE explains why firms adopt, integrate, and use technologies under

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specific technological, organisational, and environmental conditions. This theoretical complementarity is important because SCV and technology adoption are not developed or deployed in isolation. Their effectiveness depends on firms' available technological infrastructure, internal organisational readiness, managerial support, employee competencies, and external pressures.

For the present study, TOE consequently provides the contextual foundation for understanding technology adoption, while RBV explains the performance implications of combining technology with supply chain visibility. The integrated perspective suggests that firms first need favourable technological, organisational, and environmental conditions to adopt and use digital technologies effectively. Once adopted and embedded in organisational routines, these technologies can enhance the strategic value of SCV by improving the quality, integration, timeliness, and accessibility of information. This capability enables firms to respond more effectively to customer requirements and ultimately improve customer satisfaction.

The combination of RBV and TOE is therefore particularly appropriate for investigating the relationship between SCV, technology adoption, and customer satisfaction among firms in Ghana. RBV establishes the strategic logic that visibility and technology-enabled information capabilities can constitute valuable organisational resources, while TOE explains the contextual factors that facilitate or constrain technology adoption. Together, the two perspectives provide a more comprehensive theoretical explanation of how Ghanaian firms can transform supply chain information and digital technologies into customer-oriented value and competitive advantage.

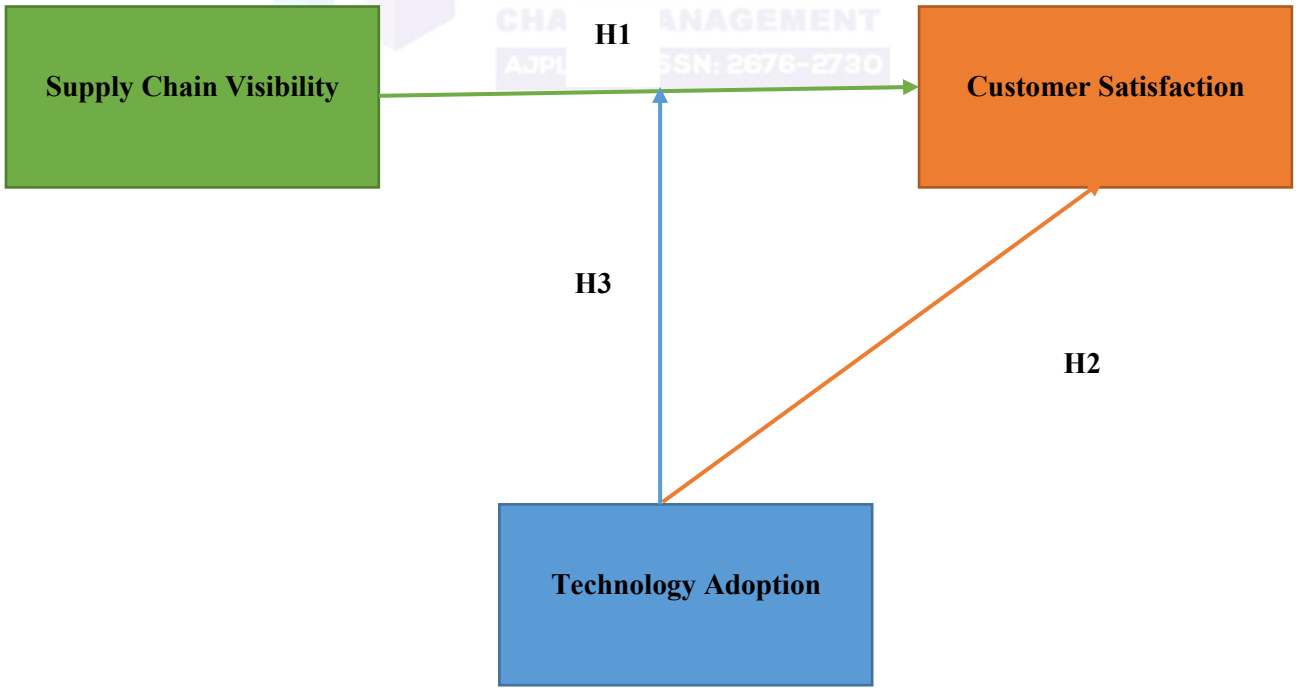


Figure 1 Conceptual Framework

2.3 Hypothesis Development

2.3.1 Relationship between Supply Chain Visibility and Customer Satisfaction

Supply chain visibility (SCV) has increasingly emerged as a critical organisational capability for enhancing customer-oriented performance. SCV refers to the extent to which firms

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can obtain, integrate, share, and utilise timely, accurate, and relevant information concerning inventory, orders, shipments, demand, and other operational activities across the supply network (Gunasekaran, Papadopoulos, & Dubey, 2020). Customer satisfaction (CS), by contrast, reflects customers' overall evaluation of how well a firm's products or services meet or exceed their expectations. Theoretically, the relationship between SCV and CS is premised on the argument that improved access to supply chain information enables firms to deliver more reliable, responsive, and transparent services. Consequently, SCV can serve as an important organisational mechanism through which firms translate supply chain information and coordination into superior customer experiences.

SCV's effect on customer satisfaction can first be explained through reduced uncertainty and improved service reliability. With timely information on inventory availability, order status, transportation activities, and delivery schedules, firms can make more accurate commitments to customers and identify potential service failures before they occur. This capability reduces information asymmetry between firms and customers and enables organisations to manage exceptions proactively. Saqib and Zhang (2021) argue that supply chain visibility improves transparency and reduces delivery disruptions, thereby strengthening customers' perceptions of reliability. From the customer's perspective, a firm's ability to provide accurate information and fulfil delivery commitments builds confidence in its service performance and contributes to satisfaction.

SCV also enhances responsiveness, which is an important mechanism linking visibility to customer satisfaction. Markets are characterised by demand fluctuations, changing customer preferences, and unexpected supply disruptions. Firms with limited visibility may respond slowly because decision-makers lack timely information about emerging changes. In contrast, highly visible firms can detect changes earlier, coordinate responses across supply chain partners, and adjust inventory, production, and logistics accordingly. Wamba and Queiroz (2022) emphasise that enhanced visibility enables firms to sense demand changes and respond more effectively to emerging supply chain conditions.

This responsiveness lets firms meet customer requirements more quickly and consistently, enhancing perceived service value and satisfaction. Another key mechanism is more accurate, transparent information. Customers increasingly expect firms to provide reliable information concerning product availability, order processing, shipment status, and expected delivery times. Inaccurate or delayed information can create discrepancies between customer expectations and actual service performance, increasing dissatisfaction. Conversely, supply chain visibility provides firms with a more comprehensive view of supply chain activities, allowing them to communicate more accurately with customers. Such transparency reduces uncertainty and facilitates better expectation management. Queiroz and Wamba (2021) demonstrate that technology-enabled visibility can improve traceability and information credibility, thereby strengthening trust-related outcomes. Accordingly, visibility can influence satisfaction not only through operational performance but also through the quality of information exchanged between firms and customers.

SCV also contributes to customer satisfaction by enhancing coordination across supply chain actors. Customer-facing performance is rarely determined by a single organisational unit; rather, it depends on the coordinated activities of suppliers, manufacturers, distributors, logistics providers, retailers, and other actors. A lack of visibility across these interfaces can lead to fragmented information, duplicated activities, stock-outs, delivery delays, and inconsistent customer service. By enabling relevant actors to access and share information, visibility supports synchronised decision-making and coordinated responses. Baah, Opoku Agyeman, and Acquah (2022) indicate that information sharing and visibility facilitate supply chain agility and collaboration, which can improve service outcomes. Thus, visibility's effect on customer satisfaction partly stems from its ability to align supply chain activities around customer requirements. The relationship is also strengthened by the role of SCV in proactive disruption management. Supply chains are exposed to disruptions arising from transportation problems, demand volatility, supplier failures, inventory shortages, and other operational uncertainties. Firms without adequate visibility may only recognise these problems after they have affected

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customers. High visibility, however, enables organisations to spot warning signals, assess potential implications, and take corrective action before disruptions become severe. Dubey, Gunasekaran, and Childe (2019) argue that visibility provides an important foundation for advanced analytics and predictive decision-making. As a result, firms can use visibility to anticipate disruptions and protect service continuity, reducing the likelihood of customer dissatisfaction.

SCV is particularly important in technology-enabled supply chains because digital technologies increase firms' capacity to convert dispersed supply chain information into actionable knowledge. Technologies such as enterprise resource planning systems, IoT, blockchain, cloud-based platforms, and data analytics can facilitate real-time data collection, information integration, tracking, and dissemination. Queiroz and Wamba (2021) highlight how blockchain-enabled visibility enhances traceability and information credibility, while Wamba and Queiroz (2022) emphasise digital technologies' role in strengthening firms' ability to sense and respond to supply chain changes. This suggests that visibility is increasingly more than simple access to information; it is an organisational capability through which firms can turn information into timely operational and customer-oriented decisions.

The Ghanaian context offers a particularly relevant setting for examining the SCV–CS relationship. Firms operating in Ghana increasingly face customer expectations for timely delivery, accurate information, product availability, and responsive service. At the same time, logistical constraints, fragmented information systems, and limited digital infrastructure may affect supply chain operations. Attatsi (2022) identifies institutional and operational conditions that can influence how effectively organisations use information and technology resources. Boateng (2024) further suggests that digital supply chain practices can enhance transparency, traceability, and service delivery, while Fekpe and Fiagbey (2021) highlight the role of information technology in improving communication accuracy and service reliability. These conditions suggest that improved visibility may substantially affect how customers evaluate firms' service performance in Ghana.

The Resource-Based View (RBV) offers a strong theoretical explanation for the expected relationship between SCV and CS. Barney (1991) argues that firms can achieve superior performance by developing and effectively deploying resources and capabilities that are valuable, rare, difficult to imitate, and non-substitutable. From this perspective, SCV is a knowledge-based organisational capability that enables firms to coordinate activities, reduce uncertainty, anticipate disruptions, and respond effectively to customer requirements. Liu, Prajogo, and Oke (2016) and Gunasekaran et al. (2020) similarly emphasise the strategic importance of information and visibility capabilities in improving supply chain performance. Firms that develop superior visibility capabilities may therefore be better positioned to deliver reliable and responsive services than firms operating with fragmented or delayed information.

Importantly, the RBV perspective suggests that visibility's performance value depends on how effectively firms embed it in organisational processes. SCV is unlikely to improve customer satisfaction merely because information is available. Rather, its value emerges when firms can interpret the information, coordinate relevant actors, make timely decisions, and implement corrective actions. This distinction strengthens the theoretical argument that SCV is an organisational capability rather than merely a technological feature. The capability to convert visibility into customer value may therefore differentiate firms that obtain substantial benefits from supply chain information from those that do not. The literature indicates that SCV can positively influence customer satisfaction through several interconnected mechanisms, including improved transparency, information accuracy, operational coordination, responsiveness, service reliability, and proactive disruption management. This relationship matters particularly in emerging-market settings such as Ghana, where supply chain uncertainties and information constraints can directly affect customer experiences. Nevertheless, the extent to which visibility translates into customer satisfaction may depend on complementary organisational and technological capabilities. This provides a basis for subsequently examining technology adoption as a moderating mechanism that may strengthen the value derived from SCV. Based on the

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theoretical arguments and empirical evidence reviewed, the study proposes the following hypothesis:

H1: Supply chain visibility is positively and significantly related to customer satisfaction.

2.3.2 Relationship between Technology Adoption and Customer Satisfaction

Technology adoption has become an increasingly important determinant of customer satisfaction as firms operate in supply chains characterised by greater complexity, information intensity, and increasingly demanding customer expectations. Technology adoption refers to the extent to which organisations acquire, implement, integrate, and effectively utilise digital technologies to support operational and strategic activities. In supply chain management, these technologies include enterprise information systems, cloud computing, the Internet of Things (IoT), blockchain, artificial intelligence, big-data analytics, digital platforms, and automated systems. Their strategic importance lies not simply in automating activities but in enabling firms to improve information quality, process efficiency, responsiveness, coordination, and service reliability.

Consequently, technology adoption can influence customer satisfaction by improving the firm's ability to deliver customer value consistently. The relationship between technology adoption and customer satisfaction can first be explained through operational efficiency and service reliability. Digital technologies automate processes, integrate information, improve demand forecasting, streamline inventory management, and coordinate logistics, reducing process variability and avoidable delays. Dubey, Gunasekaran, and Childe (2019) argue that advanced analytics and related technologies enhance firms' capacity to anticipate demand, identify operational disruptions, and improve decision-making. These capabilities help firms reduce the likelihood of stock-outs, delivery failures, and service interruptions. From the customer's perspective, more consistent service delivery reduces the gap between expected and actual performance, thereby strengthening satisfaction.

Technology adoption also improves customer satisfaction by increasing responsiveness. Today's customers increasingly expect firms to respond quickly to enquiries, order changes, delivery problems, and evolving preferences. Conventional supply chain systems may constrain responsiveness because information is fragmented across departments and supply chain partners. Digital technologies enable rapid information collection, processing, and transmission, allowing firms to identify customer requirements and respond faster. Gunasekaran, Papadopoulos, and Dubey (2020) emphasise the importance of digital technologies in improving information accessibility and organisational responsiveness. Similarly, Wamba and Queiroz (2022) contend that Industry 4.0 technologies enable firms to develop more adaptive supply chains capable of responding dynamically to changing demand conditions.

Enhanced responsiveness can therefore improve customers' perceptions of service quality and contribute to higher satisfaction. Another key mechanism linking technology adoption to customer satisfaction is transparency and accurate information. Customers require accurate information concerning product availability, order status, delivery schedules, prices, and service processes. Inaccurate or delayed information can create uncertainty and undermine trust, even when the underlying product or service is satisfactory. Digital technologies enable firms to integrate information from multiple operational activities and provide employees and customers with more timely, accurate information. Cloud-based systems, IoT-enabled tracking, blockchain, and integrated enterprise systems can improve the visibility and traceability of transactions and physical flows. For example, Queiroz and Wamba (2021) show that blockchain-enabled supply chain applications can improve traceability and information credibility.

Such transparency reduces information asymmetry and strengthens customer confidence in the firm's ability to deliver on its promises. Technology adoption also affects customer satisfaction by enabling proactive service management. Traditional supply chain management tends to respond to disruptions after they occur, whereas digital technologies increasingly enable firms to predict and prevent service failures. Predictive analytics, artificial intelligence, and machine-learning applications can identify patterns in demand, inventory

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movements, transportation activities, and customer behaviour. Imtiaz, Hamid, and Nadarajah (2023) suggest that predictive analytics can improve firms' ability to anticipate demand fluctuations and supply disruptions before they materially affect customers.

This capability enables firms to take corrective action earlier, reducing service failures. Proactive management improves reliability and gives customers more consistent service experiences. Technology adoption also improves supply chain coordination, which is critical to customer satisfaction because customer-facing performance depends on activities across multiple supply chain actors. Suppliers, manufacturers, distributors, logistics providers, and retailers must exchange information and coordinate decisions to ensure products are available and delivered on time and to the right location.

Digital platforms facilitate information sharing and synchronisation across organisational boundaries. Baah, Acquah, and Ofori (2022) argue that digitally enabled information sharing and collaboration can improve supply chain synchronisation and service outcomes. Improved coordination can reduce duplication, communication failures, inventory imbalances, and delivery delays, thereby enhancing customer service consistency. Technology adoption's contribution to customer satisfaction extends beyond operational efficiency to customer interaction and relationship management. Digital platforms enable firms to maintain continuous communication with customers, receive feedback, provide real-time updates, and resolve complaints more efficiently. Such capabilities can make customer interactions more convenient and personalised. Baah, Opoku Agyeman, and Acquah (2022) emphasise that digitally supported coordination and information exchange can facilitate more effective responses to service problems.

Similarly, Obiri-Yeboah, Amoatey, and Ottou (2025) report that technology-enabled customer relationship management practices can strengthen responsiveness, trust, and customer satisfaction among Ghanaian SMEs. These findings indicate that technology adoption can affect satisfaction both indirectly through operational performance and directly through improved customer engagement. The empirical evidence generally supports a positive association between technology adoption and customer satisfaction. Queiroz and Wamba (2021) show that blockchain-enabled supply chain capabilities can improve transparency and traceability, strengthening trust-related customer outcomes.

Akhavan and Philsoophian (2023) similarly demonstrate that digital technologies can improve supply chain collaboration and performance. Khan, Emon, and Rahman (2024) further emphasise that Industry 4.0 technologies contribute to customer-oriented outcomes through improved operational efficiency, decision-making, and customisation. Collectively, these studies suggest that technology adoption creates multiple pathways for firms to improve customer experiences. The relationship is particularly relevant in emerging economies, where technology can help firms overcome structural inefficiencies and coordination challenges. In Ghana, fragmented information, logistical constraints, inconsistent communication, and limited process integration may affect supply chain operations. Under these conditions, technology adoption can improve transparency, coordination, traceability, and service reliability.

Boateng (2024) reports that digital technology adoption can improve transparency and traceability in Ghanaian service supply chains, while Fekpe and Fiagbey (2021) identify improvements in communication, coordination, and delivery reliability associated with information technology deployment in Ghanaian firms. These findings suggest that technology adoption may have particularly strong implications for customer satisfaction where existing operational systems are characterised by information and coordination gaps.

From the perspective of the Resource-Based View (RBV), technology adoption can be conceptualised as a strategic organisational capability when technological resources are effectively integrated with firm-specific knowledge, processes, routines, and human competencies. Barney (1991) argues that resources generate sustainable competitive advantage when they are valuable, difficult to imitate, and effectively exploited by organisations. Technology itself may be relatively accessible to competitors; however, the organisational capability to integrate technology into supply chain processes, develop employee competencies, generate high-

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quality data, and use digital information for superior decision-making may be considerably more difficult to replicate.

Thus, the customer value associated with technology adoption arises not simply from owning digital tools but from the firm's ability to deploy them effectively. This distinction is important because technology adoption should not be equated with technology acquisition. Firms may invest substantially in digital technologies but achieve limited customer benefits when implementation is poorly managed, systems are not integrated, employees lack the required competencies, or information generated by the systems is not translated into operational decisions. RBV therefore suggests that technology becomes strategically valuable when embedded in organisational routines and combined with complementary resources. Gunasekaran et al. (2020) similarly emphasise that firms derive greater value from digital technologies when they can use real-time information for operational decision-making and service improvement.

Technology adoption can also enhance customer value through personalisation and customisation. Advanced analytics and digital platforms enable firms to understand customer behaviour, identify demand patterns, and tailor products or services to individual requirements. This capability becomes increasingly important in markets where customers have diverse preferences and expect personalised experiences. Khan et al. (2024) identify customisation and improved decision-making as key customer-oriented benefits of Industry 4.0 technologies. Consequently, technology adoption can boost satisfaction not only by improving basic service reliability but also by enabling firms to deliver differentiated, customer-specific value.

The Ghanaian context reinforces the need to examine this relationship empirically. Increasing digitalisation is transforming how firms communicate with customers, manage supply chains, process transactions, and coordinate service delivery. However, differences in technological readiness, employee competence, infrastructure, and managerial commitment mean that firms may not obtain equal benefits from technology adoption. This variation provides a meaningful basis for investigating whether technology adoption is associated with differences in customer satisfaction. Evidence from Ghanaian firms and other emerging-market contexts suggests that organisations that effectively integrate technology into their operations are better positioned to improve service reliability, responsiveness, transparency, and customer engagement.

The literature provides a strong theoretical and empirical basis for expecting technology adoption to affect customer satisfaction positively. Technology enables firms to improve operational efficiency, information accuracy, transparency, responsiveness, coordination, proactive disruption management, and customer engagement. Together, these mechanisms reduce service uncertainty and improve the firm's ability to meet or exceed customer expectations. However, the strength of this relationship may depend on organisational readiness and how effectively technologies integrate into existing processes. This observation further supports the complementary application of the TOE framework, which explains the technological, organisational, and environmental conditions influencing effective technology adoption. Accordingly, based on the theoretical arguments and empirical evidence, the study proposes the following hypothesis:

H2: Technology adoption is positively and significantly related to customer satisfaction.

2.3.3 Moderating Role of Technology Adoption on the Relationship between Supply Chain Visibility and Customer Satisfaction

Although supply chain visibility (SCV) is increasingly recognised as an important determinant of customer satisfaction (CS), the extent to which visibility generates customer value may depend on the firm's technological capabilities. Supply chain visibility provides access to information concerning inventory, orders, shipments, demand, and operational conditions; however, information availability alone may not be sufficient to improve customer outcomes. Firms must possess the technological capability to capture, integrate, process, analyse, and disseminate such information promptly. Technology adoption (TA) therefore represents a

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potentially important boundary condition that determines the strength of the relationship between SCV and CS.

In this study, TA is conceptualised as a moderator because the benefits of SCV are expected to vary with the extent to which firms adopt and effectively utilise relevant digital technologies. The moderating mechanism can initially be understood in terms of information quality and timeliness. Visibility creates access to supply chain information, while technology largely determines how quickly and accurately firms can capture, integrate, and communicate that information.

Technologies such as enterprise resource planning systems, Internet of Things (IoT), cloud computing, blockchain, artificial intelligence, and advanced analytics facilitate real-time information processing across organisational and supply chain boundaries. Gunasekaran, Papadopoulos, and Dubey (2020) emphasise that digital technologies improve information accessibility, transparency, and responsiveness within supply chains. Thus, when technology adoption is high, firms can better convert visibility into timely operational decisions that improve customer-facing outcomes.

Technology adoption also moderates the transition from information visibility to actionable intelligence. SCV enables firms to observe what is happening across the supply chain, but technological capabilities determine how much of that information firms can interpret and translate into appropriate action. For example, advanced analytics and artificial intelligence allow firms to identify demand patterns, predict potential disruptions, and evaluate alternative responses. Dubey, Gunasekaran, and Childe (2019) emphasise the importance of analytics and information-processing capabilities in enabling firms to derive greater value from supply chain data.

Consequently, firms with high levels of technology adoption may be better positioned to exploit the information generated through SCV, resulting in greater improvements in service reliability, responsiveness, and customer satisfaction. Technology adoption can further strengthen the SCV–CS relationship by improving real-time monitoring and responsiveness. In highly dynamic supply chains, delays in recognising and responding to changes can result in stock-outs, delivery failures, inaccurate customer information, and service disruptions. IoT-enabled tracking systems and integrated digital platforms let firms continuously monitor supply chain activities and identify deviations from planned operations. Wamba and Queiroz (2022) argue that Industry 4.0 technologies enable organisations to sense changes in supply chain conditions and respond more adaptively. When SCV combines with these technological capabilities, firms can respond more quickly to customer requirements and disruptions, thereby strengthening visibility's positive effect on customer satisfaction.

The moderating effect is also reflected in transparency and trust formation. Visibility can improve the availability of supply chain information, but technology can increase the credibility, traceability, and security of that information. For instance, blockchain technologies can create more transparent, auditable records of transactions and product movements. Queiroz and Wamba (2021) demonstrate the potential of blockchain-enabled supply chain applications to improve traceability and information credibility. These characteristics can strengthen customer trust in product authenticity, transaction accuracy, and delivery information. Consequently, technology adoption may enhance the relational value of SCV by transforming operational transparency into greater customer confidence and satisfaction. The empirical literature increasingly supports the argument that digital capabilities can strengthen visibility's performance implications. Akhavan and Philsoophian (2023) indicate that blockchain and other digital technologies can enhance collaboration and reduce uncertainty across supply chains. Similarly, studies of digital supply chain capabilities suggest that technology-enabled visibility can improve firms' capacity to respond to disruptions and maintain supply chain performance. The broader implication is that visibility and technology are complementary, not substitutive: visibility provides the information foundation, while technology enhances the speed, quality, and analytical value of that information.

This complementarity matters especially under the resource-based perspective. The Resource-Based View (RBV) argues that competitive advantage comes not merely from

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possessing individual resources but from a firm's ability to combine and deploy them in distinctive ways (Barney, 1991). From this perspective, SCV represents an information-based capability, while technology adoption provides complementary technological and analytical capabilities that increase the value derived from visibility. Liu, Prajogo, and Oke (2016) emphasise the strategic importance of information and technological capabilities in strengthening supply chain performance. Thus, technology adoption can be understood as a capability that enhances the productivity of another strategic capability—SCV. The RBV explanation further suggests that resource complementarity moderates this effect.

A firm with high SCV but limited technological capability may possess substantial information but lack the means to integrate and analyse it effectively. Conversely, a firm with advanced technology but weak visibility may have sophisticated systems but insufficient access to accurate and comprehensive supply chain information. The strongest customer-oriented outcomes therefore likely occur when firms combine high visibility with appropriate technological capabilities. Consequently, the interaction between SCV and TA can produce a synergistic effect in which the value of visibility increases as technological capability rises.

Technology adoption can also strengthen the SCV–CS relationship through proactive disruption management. Supply chain disruptions can quickly translate into customer dissatisfaction when firms cannot identify problems early or respond effectively. Technologies such as predictive analytics, artificial intelligence, and IoT enable firms to detect deviations and anticipate potential disruptions. Imtiaz, Hamid, and Nadarajah (2023) highlight how technology-enabled capabilities contribute to organisational responsiveness and performance. When these technologies are combined with high levels of supply chain visibility, firms can identify potential service failures earlier and initiate corrective action before customers are significantly affected. This reduces service variability and strengthens the relationship between visibility and customer satisfaction.

This moderating effect is particularly relevant in developing and emerging economies, where firms may face greater information asymmetry, infrastructural constraints, logistical uncertainty, and fragmented supply chain systems. In such environments, firms may not realise the benefits of visibility if they lack the technological infrastructure and human capabilities needed to process and use supply chain information. Evidence from Ghana indicates that digital technology adoption can improve transparency, traceability, communication, and service delivery (Boateng, 2024; Fekpe & Fiagbey, 2021). These findings suggest that technology can help firms turn visibility into more reliable customer-facing outcomes.

The Ghanaian context matters because digitalisation is increasing alongside persistent operational and infrastructural challenges. Firms may differ considerably in their levels of technological readiness, employee competence, digital infrastructure, managerial commitment, and ability to integrate new technologies into existing supply chain processes. Attatsi (2022) notes that institutional and infrastructural conditions can influence the effectiveness of technological and information resources. Similarly, Lawrence and Mupa (2024) highlight challenges associated with technological integration and supply chain development in African contexts. These conditions suggest that SCV's effect on customer satisfaction may not be uniform across firms; instead, it may depend substantially on a firm's technological capability. The Technology–Organisation–Environment (TOE) framework further complements the RBV explanation by identifying the conditions that may shape effective technology adoption. Technological compatibility and complexity affect the feasibility of implementing digital solutions, while organisational readiness, managerial support, employee competence, and financial resources shape the firm's capacity to deploy them effectively. Environmental factors, including competition, customer expectations, institutional support, and regulatory pressures, may also influence technology adoption. Consequently, the moderating role of technology adoption should be interpreted within the broader technological, organisational, and environmental context in which firms operate.

Importantly, the expected moderating effect does not imply that technology automatically improves the value of visibility. Rather, it suggests that the strength of the SCV–CS relationship depends on the level of effective technology adoption. At relatively low levels of technology

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adoption, firms may struggle to integrate visibility information, conduct real-time analysis, coordinate with supply chain partners, and respond promptly to customer requirements. As technology adoption increases, these constraints are progressively reduced, allowing firms to derive greater value from visibility. At higher levels of technological capability, firms can therefore translate visibility more effectively into timely decisions, improved coordination, proactive disruption management, transparent communication, and reliable service delivery.

This argument also addresses an important gap in the existing literature. Much of the existing research examines SCV and technology adoption as independent predictors of supply chain or customer outcomes, while comparatively less attention has been given to whether technology adoption changes the strength of the relationship between visibility and customer satisfaction, particularly within developing-country contexts. Examining this interaction is theoretically important because it moves beyond the assumption that visibility has a uniform effect across firms. Instead, it recognises that visibility's performance value may depend on the complementary technological resources and capabilities available to organisations.

The literature and theoretical perspectives reviewed provide a strong basis for proposing that technology adoption positively moderates the relationship between supply chain visibility and customer satisfaction. SCV gives firms access to timely, relevant information, while technology adoption enhances their ability to process, integrate, analyse, and act on it. The combination can improve responsiveness, transparency, coordination, disruption management, and service reliability, thereby increasing customer satisfaction. In contrast, limited technology adoption may constrain the firm's ability to convert visibility into tangible customer value. Accordingly, this study proposes the following hypothesis:

H3: Technology adoption positively moderates the relationship between supply chain visibility and customer satisfaction.

3.0 METHODOLOGY

3.1 Research Design

Research design provides the methodological architecture through which a research problem is translated into an empirically testable investigation. It specifies the procedures for data collection, measurement, analysis, and interpretation and establishes the logical alignment between the research objectives, theoretical propositions, and empirical evidence (Creswell & Creswell, 2018; Saunders, Lewis, & Thornhill, 2019). This study adopted an explanatory research design to examine the relationships among supply chain visibility (SCV), technology adoption (TA), and customer satisfaction (CS), with particular emphasis on TA's moderating effect on the SCV–CS relationship. An explanatory design was appropriate because the study was theory-driven and sought to test theoretically derived hypotheses concerning the direction and strength of relationships among the focal constructs.

Specifically, the design enabled the study to examine whether SCV significantly predicts customer satisfaction and whether this relationship varies by the level of technology adoption. Rather than merely describing existing supply chain practices, the design facilitates empirical examination of theoretically specified associations and interaction effects. This aligns with Saunders et al. (2019), who argue that explanatory research is appropriate when the purpose is to establish relationships between variables and provide evidence for why particular outcomes occur. The study employed a cross-sectional design, whereby data were collected from respondents at a single point in time.

The cross-sectional approach was appropriate for obtaining a contemporaneous assessment of firms' supply chain visibility capabilities, technology adoption, and customer satisfaction. It also enabled the researcher to collect data efficiently from respondents across different organisational and industrial settings. Nevertheless, because the data were collected at a single point in time, the study interprets causality cautiously. It frames them primarily in terms of hypothesised relationships and predictive associations rather than definitive temporal causality.

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The study adopted a quantitative research approach because its primary objective was to empirically test theoretically derived relationships using numerical data and statistical procedures. Quantitative research is particularly suitable for studies involving predefined constructs, standardised measurement instruments, hypothesis testing, and statistical estimation of relationships among variables (Creswell & Creswell, 2018; Hair et al., 2021). The quantitative approach was appropriate because SCV, TA, and CS were operationalised as measurable latent constructs using multiple indicators. The study transformed respondents' data into numerical scores and subjected them to statistical analyses to determine the magnitude, direction, and significance of the hypothesised relationships. In particular, the approach enabled the study to assess the direct effects of SCV on CS and TA on CS, as well as the interaction effect of TA on the SCV–CS relationship.

Data were collected using a structured self-administered questionnaire. Structured questionnaires are widely used in quantitative research because they provide standardised questions and response categories, thereby improving comparability across respondents and facilitating statistical analysis (Saunders et al., 2019). The questionnaire was developed based on established constructs and measurement dimensions identified from the relevant literature on supply chain visibility, technology adoption, and customer satisfaction. The instrument consisted primarily of closed-ended items measured on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

The Likert format was selected because it allows respondents to indicate the intensity of their perceptions of organisational practices and outcomes while producing data suitable for quantitative analysis. Hair et al. (2021) note that multi-item scales suit measuring latent constructs in management research because they let researchers capture different dimensions of complex organisational phenomena. The questionnaire was structured into sections corresponding to the study's major components. The introductory section stated the research purpose and assured confidentiality and voluntary participation. Subsequent sections measured SCV, TA, and CS using multiple indicators.

Demographic and organisational information was also collected to provide contextual information about the respondents and participating firms. We distributed questionnaires electronically and in hard copy, depending on respondent accessibility and organisational preference. We distributed the electronic questionnaire through platforms such as Google Forms and professional email networks, while researchers administered hard copies directly to eligible respondents where appropriate. This mixed administration mode was intended to improve coverage and accessibility across organisations and geographical locations.

3.2 Constructs, Measures, and Sources

Constructs	Measures	Sources
Supply Chain Visibility (SCV)	Information sharing, real-time tracking, transparency, and coordination	Baah, Acquah, & Ofori (2022); Gunasekaran, Papadopoulos, & Dubey (2020)
Customer Satisfaction (CS)	Service reliability, responsiveness, delivery timeliness, and perceived trust	Agyabeng-Mensah & Ahenkorah (2019); Queiroz & Wamba (2021)
Technology Adoption (TA)	Digital integration, automation, system interoperability, and usage intensity	Liu, Prajogo, & Oke (2016); Boateng (2024)

4.0 RESULTS AND DISCUSSIONS

4.1 Preliminary Assessment of the Measurement Data

Before testing the hypothesised structural relationships, the study assessed the dataset's adequacy for multivariate analysis and the psychometric properties of the measurement instruments. The analysis involved the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity, internal consistency reliability, indicator reliability, convergent validity, discriminant validity, and common method bias. The results are presented below.

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4.1.1 Sampling Adequacy and Factorability

Table 1: KMO and Bartlett's Test

Test	**Statistic**
Kaiser–Meyer–Olkin Measure of Sampling Adequacy	0.965
Bartlett's Test of Sphericity – Approx. x^2	4969.853
df	210
Sig.	<0.001

Table 1 shows that the dataset was highly suitable for factor analysis. The KMO statistic was **0.965**, well above the commonly recommended minimum of 0.70, indicating excellent sampling adequacy. This high value suggests that the observed indicators share sufficient common variance to warrant factor extraction and construct validation. Bartlett's test of sphericity was also statistically significant, **$x^2(210) = 4969.853$, $p < 0.001$**, rejecting the null hypothesis that the correlation matrix is an identity matrix. Thus, meaningful correlations exist among the measurement indicators. Taken together, the exceptionally high KMO value and significant Bartlett's test provide strong empirical justification for proceeding with the measurement-model assessment. The results also indicate that the correlation structure among the 21 indicators is sufficiently robust for subsequent multivariate analysis.

4.2 Measurement Model Assessment

The measurement model was evaluated using Cronbach's alpha, composite reliability (CR), indicator loadings, average variance extracted (AVE), and discriminant validity. These tests assess whether the constructs of Supply Chain Visibility (SCV), Customer Satisfaction (CST), and Technology Adoption (TAD) are measured reliably and represent empirically distinct concepts.

Table 2: Reliability, Convergent Validity and Indicator Loadings

Construct	**Cronbach's α**	**Items**	**CR**	**AVE**	**√AVE**
Supply Chain Visibility	0.926	7	0.931	0.660	0.812
Customer Satisfaction	0.878	7	0.955	0.751	0.866
Technology Adoption	0.925	7	0.939	0.687	0.829

Supply Chain Visibility

Indicator	**Loading**
SCV1	0.720
SCV2	0.889
SCV3	0.785
SCV4	0.887
SCV5	0.710
SCV6	0.875
SCV7	0.798

Customer Satisfaction

Indicator	**Loading**
CST1	0.786
CST2	0.890
CST3	0.926
CST4	0.788
CST5	0.878
CST6	0.923

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CST7	0.867

Technology Adoption

Indicator	Loading
TAD1	0.875
TAD2	0.724
TAD3	0.679
TAD4	0.930
TAD5	0.910
TAD6	0.861
TAD7	0.789

4.2.1 Internal Consistency Reliability

The findings demonstrate strong internal consistency across all three constructs. Cronbach's alpha coefficients were 0.926 for SCV, 0.878 for CST, and 0.925 for TAD. Similarly, composite reliability values were 0.931, 0.955, and 0.939, respectively. These coefficients substantially exceed the conventional 0.70 benchmark, indicating satisfactory internal consistency within each construct. These results are particularly important because composite reliability provides a robust assessment of reliability in latent-variable models by accounting for individual indicator loadings. The relatively high values suggest that the indicators consistently capture their respective latent constructs and show adequate measurement precision.

4.2.2 Indicator Reliability and Convergent Validity

The indicator loadings further support measurement quality. The SCV indicators recorded loadings between 0.710 and 0.889, while the CST indicators ranged from 0.786 to 0.926. TAD indicators ranged from 0.679 to 0.930. Thus, virtually all indicators exceed the preferred 0.70 level. The TAD3 loading of 0.679 is marginally below 0.70 but remains close to the recommended threshold and is supported by the construct's strong composite reliability and AVE. Importantly, deletion of an indicator should not be based solely on its loading; theoretical relevance and the overall quality of the construct should also be considered. Therefore, retaining TAD3 is defensible, particularly given the strong reliability and convergent validity of the technology adoption construct.

Convergent validity was further established through AVE. SCV recorded an AVE of 0.660, CST recorded 0.751, and TAD recorded 0.687. All three values exceed the minimum criterion of 0.50, indicating that each construct explains more than half of the variance in its respective indicators. The evidence therefore confirms satisfactory convergent validity across the measurement model. Overall, the results indicate strong reliability, satisfactory indicator reliability, and adequate convergent validity, providing a sound basis for examining the study's proposed structural relationships.

4.3 Discriminant Validity

Discriminant validity was assessed using the **Fornell–Larcker criterion**. Under this criterion, the square root of each construct's AVE should exceed its correlations with other constructs. The results are presented in Table 3.

Table 3: Fornell–Larcker Criterion

Construct	SCV	CST	TAD
SCV	**0.812**	0.712	0.511
CST	0.712	**0.866**	0.588
TAD	0.511	0.588	**0.829**

Note: Bold diagonal values represent the square roots of AVE. Off-diagonal values represent inter-construct correlations. All reported correlations are significant at p < 0.01.

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The results provide evidence of satisfactory discriminant validity. The square root of AVE for SCV (0.812) exceeds its correlations with CST (0.712) and TAD (0.511). Similarly, the square root of AVE for CST (0.866) exceeds its correlations with SCV (0.712) and TAD (0.588). Finally, the square root of AVE for TAD (0.829) exceeds its correlations with SCV (0.511) and CST (0.588). These findings indicate that each construct shares more variance with its own indicators than with another construct's indicators.

Hence, SCV, CST, and TAD are empirically distinguishable constructs, despite their theoretical relatedness. This is particularly important for the present study because the subsequent moderation analysis requires the constructs to capture conceptually different dimensions of the proposed model.

Table 4 Hypothesis Testing and Findings

Hypothesis	Relationship	Beta	T value	P value	Remarks
H1	**SCV -> CST**	.026	16.470	.0000	**Supported**
H2	**TAD - ->CST**	.026	8.984	.0000	**Supported**
H3	**TAD * SCV - -> CST**	.0346	6.0133	.0000	**Supported**

5.0 CONCLUSIONS

5.1 Supply Chain Visibility and Customer Satisfaction

The findings strongly support H1, which proposed that supply chain visibility (SCV) has a significant positive effect on customer satisfaction (CST). The estimated relationship was statistically significant ($\beta = 0.026$, $t = 16.470$, $p < 0.001$), indicating that variations in supply chain visibility are systematically associated with customer satisfaction. Although the reported coefficient is relatively small, its statistical significance and large t-value indicate that the relationship is unlikely to be due to sampling error in the estimated model. The finding reinforces the view that visibility is an important organisational capability through which firms improve the reliability, transparency, and responsiveness of customer-facing operations. Greater visibility enables firms to obtain timely information about inventory positions, order status, transportation activities and potential disruptions.

This information reduces uncertainty and allows organisations to communicate more accurately with customers, proactively manage exceptions, and improve fulfilment reliability. Consequently, customers are more likely to perceive the firm as responsive, dependable and transparent. This finding aligns with the supply chain visibility literature, which emphasises the importance of timely, accurate information for coordination and operational responsiveness (Caridi et al., 2018; Ben-Daya et al., 2019). Caridi et al. (2018) argue that visibility lets supply chain actors monitor material and information flows and spot deviations before they escalate into major service failures. Ben-Daya et al. (2019) similarly emphasise that digital information sharing reduces information asymmetry and facilitates more effective coordination across supply chain networks.

This result is particularly relevant to emerging-market contexts such as Ghana, where information fragmentation, delivery uncertainty, and limited coordination among supply chain actors may affect supply chain operations. Under such conditions, visibility can help reduce information gaps and improve service consistency. Thus, this finding extends the visibility literature by showing that the benefits of information transparency are not limited to internal operational outcomes but can translate into customer-facing value.

This finding also aligns with the Resource-Based View (RBV) underpinning this study. From an RBV perspective, visibility can be a strategically valuable capability when firms have the organisational routines and systems to collect, integrate, and use supply chain information effectively. Visibility enables firms to anticipate operational problems, coordinate resources, and respond more effectively to customer requirements. The significant positive relationship observed in this study therefore provides empirical support for the argument that information-based capabilities can contribute to superior customer-oriented outcomes.

5.2 Technology Adoption and Customer Satisfaction

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The findings also support H2, which proposed that technology adoption (TAD) has a significant positive effect on customer satisfaction. The estimated coefficient was statistically significant ($\beta = 0.026$, $t = 8.984$, $p < 0.001$). This result indicates that organisations that adopt and use digital technologies more are more likely to report improved customer satisfaction. The finding can be explained by the capacity of digital technologies to enhance the speed, accuracy and consistency of supply chain processes.

Technologies such as enterprise resource planning (ERP), Internet of Things (IoT), artificial intelligence (AI), cloud computing and digital analytics allow firms to integrate operational information, automate routine processes and improve decision-making. These capabilities can improve order accuracy, delivery reliability, responsiveness, and customer communication. The finding is broadly consistent with the digital supply chain literature.

Choi et al. (2020) suggest that digital technologies facilitate operational integration and improve coordination of supply chain activities, while Ivanov and Dolgui (2021) demonstrate that digital transformation enhances the speed and quality of decision-making under operational uncertainty. Technology therefore enables firms to process information rapidly and translate it into timely operational responses.

The finding is also particularly relevant for developing economies. In contexts where firms face infrastructural constraints, fragmented information systems, and coordination challenges, digital technologies can offset some of these inefficiencies by enabling automated information exchange and improving process integration. Thus, technology adoption can improve not only internal efficiency but also the quality of interactions between firms and their customers.

From an RBV perspective, technology adoption should not be understood simply as the possession of technological assets. Instead, its strategic value derives from the organisation's ability to integrate technological resources with human skills, organisational routines, and supply chain processes. Consequently, this study's key relationship suggests that technology becomes valuable when firms develop the capability to deploy it in ways that improve customer-facing outcomes. Importantly, the finding also provides a foundation for the moderation hypothesis. If technology independently contributes to customer satisfaction, its integration with another strategic capability—supply chain visibility—may produce an even stronger customer-oriented effect. This possibility is examined under H3.

5.3 Moderating Role of Technology Adoption in the SCV–Customer Satisfaction Relationship

The third hypothesis proposed that technology adoption positively moderates the relationship between supply chain visibility and customer satisfaction. The interaction effect was statistically significant ($\beta = 0.0346$, $t = 6.0133$, $p < 0.001$), supporting H3. This finding is particularly important because it moves beyond the examination of direct effects and demonstrates that the value of supply chain visibility depends partly on the technological context within which visibility is deployed. In other words, visibility does not operate in isolation. Its contribution to customer satisfaction strengthens when firms have adequate technological capabilities to capture, integrate, analyse, and act on the information generated through visibility systems.

This finding aligns with the argument that digital technologies transform visibility from a passive information-access mechanism into an actionable organisational capability. Wieland (2020) emphasises digitalisation's role in enhancing supply chain responsiveness and adaptability, while Sweeney et al. (2018) highlight how technologies such as real-time tracking, cloud systems, and other digital platforms support supply chain information integration. When such technologies are combined with visibility capabilities, firms can detect changes in customer demand and operational conditions more rapidly and translate this information into appropriate responses.

This significant interaction effect also aligns with Dubey et al.'s (2019) argument that technological capabilities enhance organisations' ability to transform information into operational intelligence. Visibility provides information about what is happening across the supply chain, whereas technology largely determines how quickly and effectively that information can be processed and converted into action.

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Thus, combining SCV and TAD provides a stronger basis for improving customer-oriented outcomes than either capability alone. The result has important implications for firms operating in Ghana and other emerging economies. Investment in visibility infrastructure alone may not generate its full potential if firms lack the technological capacity to integrate data, automate processes and support real-time decision-making. Conversely, technology adoption without adequate supply chain visibility may also limit the availability and quality of the information required for effective decision-making. This significant interaction therefore underscores the importance of complementarity between visibility and technology.

From the RBV perspective, this finding provides particularly strong theoretical support for the study. The RBV argues that competitive value arises not simply from individual resources but from the effective combination and deployment of complementary resources and capabilities. In this case, supply chain visibility is an information-based capability, while technology adoption provides an enabling capability that allows visibility to be exploited more effectively. Their interaction therefore creates a potentially stronger source of customer value than either capability independently.

The finding also aligns with the Technology–Organisation–Environment (TOE) framework, which recognises that technological capability and organisational readiness influence the effective adoption and use of digital innovations. The results suggest that technological adoption is not merely an independent determinant of customer satisfaction but also an important contextual condition that determines how effectively firms can convert visibility into customer value.

5.4 Synthesis of Findings and Theoretical Contribution

Taken together, the findings support three interconnected relationships. First, supply chain visibility is positively associated with customer satisfaction. Second, technology adoption contributes to customer satisfaction independently. Third, and most importantly, technology adoption strengthens the positive relationship between supply chain visibility and customer satisfaction. This moderation finding represents the study's principal theoretical contribution. Existing supply chain research has frequently examined visibility and digital technologies as independent drivers of organisational performance.

The present findings suggest that their value is better understood through a complementarity perspective, in which technology enhances firms' capacity to exploit visibility. This extends the RBV. Rather than viewing SCV and technology adoption as isolated resources, the findings demonstrate that their strategic value may emerge from their interaction. Visibility generates access to information, while technology provides the infrastructure and analytical capability required to transform information into timely action. This combination enables firms to improve responsiveness, transparency, reliability and ultimately customer satisfaction.

The findings also provide empirical support for TOE's complementary role. While RBV explains why visibility and technology can constitute valuable organisational capabilities, TOE helps explain the technological and organisational conditions under which firms can effectively adopt and utilise those capabilities. Integrating the two perspectives therefore provides a more comprehensive explanation of the SCV–CST relationship.

5.6. Practical and Managerial Implications

The findings have several implications for managers and supply chain practitioners.

First, managers should treat supply chain visibility as a strategic capability.

Organisations should invest in systems that provide timely, accurate information on inventory, orders, transportation, and delivery status. Real-time tracking, integrated inventory systems and digital supply chain dashboards can improve the organisation's ability to identify disruptions and communicate accurate information to customers.

Second, technology adoption should be aligned with supply chain objectives.

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Investment in technology should not be driven solely by the desire to become digitally advanced. Managers should identify technologies that directly address operational and customer-service challenges. Firms should integrate ERP, IoT, cloud-based platforms, AI-supported analytics, and automated information-sharing systems into supply chain processes to improve responsiveness and reliability.

Third, firms should prioritise integrating technologies rather than making isolated technology investments.

The significant moderation effect indicates that technology creates greater value when it complements existing visibility capabilities. Managers should therefore focus on interoperability among ERP, inventory, logistics, customer relationship and tracking systems. Data generated from different parts of the supply chain should be integrated into a coherent information architecture.

Fourth, organisations should strengthen employees' digital capabilities.

Technology investments alone are unlikely to generate sustained value if employees lack the skills required to interpret and utilise digital information. Firms should therefore provide continuous training in data analytics, digital supply chain platforms and technology-enabled decision-making.

Fifth, firms should prioritise customer-facing visibility.

Because this study examines customer satisfaction as the outcome, firms should translate internal visibility into customer value. Customers should receive timely, accurate information about order confirmation, product availability, shipment progress, and delivery expectations. Such transparency can improve trust and reduce uncertainty.

Sixth, managers should develop integrated digital transformation strategies.

The significant interaction between SCV and TAD suggests that firms should avoid treating visibility initiatives and digital transformation as separate projects. Instead, digital transformation strategies should explicitly identify how technology can strengthen existing supply chain capabilities and generate measurable customer outcomes.

5.7. Recommendations

Based on the empirical findings, the following recommendations are proposed:

- *Invest in integrated visibility infrastructure.* Firms should deploy real-time tracking systems, inventory management platforms, digital dashboards and integrated information-sharing systems to enhance supply chain transparency.

- *Accelerate strategic technology adoption.* Organisations should prioritise technologies such as ERP, IoT, cloud computing, AI, and advanced analytics where they directly improve supply chain responsiveness and customer service.

- *Integrate technology with visibility capabilities.* Technology investments should be designed to enhance the collection, integration, analysis and utilisation of supply chain information rather than operate as standalone systems.

- *Develop digital competencies.* Firms should establish continuous training programmes to improve employees' ability to use digital technologies, interpret supply chain information and make data-driven decisions.
- *Strengthen customer-facing information systems***.** Organisations should provide customers with accurate, timely information on product availability, order status, delivery schedules, and potential disruptions.

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- *Develop organisation-wide digital transformation strategies.* Senior management should establish long-term digital strategies that align technology investments with supply chain capabilities, customer expectations, and organisational objectives.

- *Promote interoperability and data integration.* Firms should minimise information silos by ensuring procurement, inventory, logistics, customer service, and other relevant systems can exchange information seamlessly.
- *Monitor the customer outcomes of digital investments.* Managers should evaluate digital supply chain initiatives not only through operational metrics but also through customer satisfaction, trust, retention and service reliability.

5.8. Limitations and Directions for Future Research

Despite its contributions, the study has several limitations that should be acknowledged. First, the study employed a cross-sectional research design, meaning that data were collected at a single point in time. Although the statistical relationships support the proposed hypotheses, cross-sectional data establish temporal precedence less strongly than longitudinal designs. Future studies could employ longitudinal data to examine how investments in visibility and digital technologies influence customer satisfaction over time.

Second, the study relied predominantly on self-reported perceptual measures. Although the measurement assessment demonstrated satisfactory reliability and validity, perceptual responses may still be subject to respondent bias. Future research could combine survey responses with objective indicators such as delivery lead time, order fulfilment rates, inventory accuracy, complaint rates and customer retention.

Third, the study was conducted within the Ghanaian organisational context, which may limit the generalizability of the findings to other institutional and economic environments. Future research could conduct comparative studies across Ghana and other African economies, or between emerging and developed economies, to determine whether the moderating role of technology adoption remains stable across contexts.

Fourth, the study examined customer satisfaction as the principal outcome. Future research could extend the model by investigating other performance outcomes, including customer loyalty, supply chain resilience, operational performance, innovation performance and sustainability performance.

Fifth, the study focused on technology adoption as a moderator. Future research could examine whether other organisational factors, such as digital capability, organisational agility, leadership support, organisational culture, innovation capability, and supply chain collaboration, strengthen or weaken the SCV–customer satisfaction relationship.

Finally, future studies could use multi-method, multi-source research designs. Combining quantitative surveys with interviews, case studies and objective organisational data would provide a richer understanding of how firms develop visibility and technological capabilities and how these capabilities translate into superior customer outcomes.

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