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Artificial intelligence and information systems capabilities for supply chain resilience: A study in the South African fast-moving consumer goods industry

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Background: Fast-moving consumer goods (FMCG) supply chains have become increasingly exposed to disruptions during and after the coronavirus disease 2019 (COVID-19) pandemic. The industry is vulnerable to supply chain disruptions due to unstable commodity markets and demand volatility. Artificial intelligence (AI) and information systems as technology enablers provide capabilities that can improve supply chain resilience to recover from a disruption. However, FMCG firms are slow with digital transformation and often do not leverage the capabilities of AI and information systems to improve their supply chain resilience.

Objectives: The purpose of this generic qualitative study was to determine how AI and information systems capabilities can be leveraged to improve supply chain resilience in the South African FMCG industry.

Method: This study employed purposive sampling methods to identify 12 FMCG manufacturers and retailers that participated in this study. Semi-structured interviews were used to collect data. A thematic analysis approach was followed to analyse the data.

Results: Supply chain integration, automation, monitoring and analytical capabilities of AI and information systems should be considered when designing post-COVID-19 supply chains to deal with increased complexity. Furthermore, supply chain resilience is enhanced by having AI and information systems capabilities such as information sharing, planning and predictive capabilities and decision-making capabilities. This study identified internal and external organisational driving factors, such as reducing costs and competitive factors, leading to the adoption of AI or information systems.

Conclusion: This study creates awareness of the value-adding benefits of AI and information systems that improve supply chain resilience.

Contribution: This study expands on existing literature by identifying various capabilities of AI and information systems that improve FMCG manufacturers' and retailers' supply chain resilience in a developing country context.

Keywords: artificial intelligence; information systems; supply chain resilience; disruption; fast-moving consumer goods; generic qualitative research; South Africa.

Introduction

The world is changing at a rapid pace, becoming more globalised while technological advancements are impacting all facets of human life (Grinin, Grinin & Korotayev 2024:2). The future of business appears much different as firms transform to remain competitive in a digital environment while being exposed to many disruptions (Nasiri et al. 2020:1). Firms are constantly looking for ways to mitigate the detrimental effects that large-scale disruptions can have on their supply chains. The coronavirus disease 2019 (COVID-19) pandemic has led to volatility in the South African fast-moving consumer goods (FMCG) industry (Weber 2021:4). Fast-moving consumer goods retailers struggled to receive goods from global suppliers, could not reach certain customers, and struggled to match demand with available supply, constantly dealing with the bullwhip effect (Modgil, Singh & Hannibal 2021:3). These firms realised the need for more resilient supply chains (Modgil et al. 2021:3). To survive in uncertain business conditions, firms needed to change their business models and response strategies (Weber 2021:5). When disruptions occur,

the importance of supply chains is highlighted, and unrealistic expectations are placed on traditional supply chains to provide effective responses (Varzandeh, Farahbod & Zhu 2016:1). Artificial intelligence (AI) and information systems, as technology enablers, have capabilities to improve supply chain resilience, which facilitates supply chains' ability to respond more effectively to disruptions.

Artificial intelligence is applicable in the field of supply chain risk management; therefore, AI is an important technology enabler to consider for supply chain resilience (Riahi et al. 2021:12). Gupta et al. (2021:1–11) explored how AI and information systems capabilities can be leveraged to cope with supply chain disruptions, whereas Belhadi et al. (2021:1–4) examined the direct and indirect effects of AI when faced with supply chain uncertainty. Wooderson (2022:1–14) assessed how firms used resilience capabilities when faced with disruptions, and found that quick decision-making technologies contribute to higher supply chain resilience.

Artificial intelligence and information systems allow firms to monitor supply chain events, which facilitates better decision-making (Al-Talib et al. 2020:753). Supply chain resilience combines proactive capabilities that ensure preparedness towards disruptions and reactive capabilities that facilitate efficient responses, allowing the supply chain to return to its normal state of operations after it has been disrupted (Datta 2017:7). Artificial intelligence possesses capabilities that FMCG manufacturers and retailers can apply throughout their supply chains. Artificial intelligence is a combination of technologies that can interpret the data, learn from the data, and act in a manner that resembles human intelligence (Guzman & Lewis 2020:72).

Resilient supply chains require high volumes of data, and information systems have the capabilities to process this data. Information systems are combinations of hardware and software, that transform data inputs into valuable outputs that can be used to increase visibility and control, both internally and between supply chain partners (Gu, Yang & Huo 2021:9). Fast-moving consumer goods retailers require a vast variety of data to incorporate omni-channel and e-commerce distribution into their current business models. Therefore, the adoption of information systems has become increasingly important (Weber & Badenhorst-Weiss 2018:2). Fast-moving consumer goods manufacturers experience pressure to deliver goods to retail stores cost-effectively and often experience many supply chain disruptions owing to the constant introduction of new technologies (Reza 2020:27; Vijayalakshmi & Gurumoorthy 2019:699). Fast-moving consumer goods manufacturers and retailers can leverage AI capabilities for better demand prediction (Tarallo et al. 2019:738). Information systems gather, process, store and distribute information that can be used to coordinate business activities (Herath & Wijenayake 2019:465).

Numerous studies explored how supply chain resilience can be improved with the adoption of AI and information systems, especially in times of disruption (Gupta et al. 2021:1–11; Ivanov 2021:1–11; Kopanaki 2022:1–19; Modgil et al. 2021:1–43). However, few studies have primarily focused on FMCG manufacturers and retailers, as many firms in this industry have experienced various challenges incorporating AI and information systems into their supply chains (Tarai 2020:6515–6517). Fast-moving consumer goods firms have not fully valued the capabilities of AI and information systems and have been slow with digital transformation (Nozari, Szmelter-Jarosz & Ghahremani-Nahr 2022:2). Fast-moving consumer goods manufacturers and retailers in South Africa often operate in extreme business environments, exposed to many disruptions. These factors are driving FMCG firms to improve their supply chain resilience (Neboh & Mbhele 2020:16).

Modgil et al. (2021:1–43) explored how AI capabilities can be leveraged to improve supply chain resilience in a developed country, which represents an important gap as this study did not focus on a developing country and omitted the factors that are driving firms to the adoption of AI. South Africa faces digital implementation challenges, such as the lack of industry-specific guidelines and low digital skill levels (Agrawal, Narain & Ullah 2019:298). This suggests that there are opportunities to improve supply chain resilience in the South African FMCG industry. Therefore, it would be beneficial to study the adoption of AI and information systems capabilities as an approach to facilitate supply chain resilience, as many studies have rather focused on other approaches such as supply chain design and risk management to improve supply chain resilience (Agigi, Niemann & Kotze 2016:11). Consequently, Modgil et al. (2021:32) recommend that future research explore how AI and information systems can be leveraged to respond effectively to disruptions.

The goal of this generic qualitative study is to explore the role of AI and information systems capabilities to improve supply chain resilience in the South African FMCG industry. This study also explores what AI and information systems capabilities should be considered when designing and executing post-COVID-19 supply chains and what factors are driving FMCG manufacturers and retailers to adopt AI and information systems capabilities into their supply chains. Semi-structured interviews were conducted with industry participants who are involved with such technology enablers.

This study is guided by the following research questions:

1. What AI and information systems capabilities should be considered when designing and executing post-COVID-19 supply chains?
2. How can AI and information systems capabilities be leveraged to improve supply chain resilience?
3. What factors are driving FMCG manufacturers and retailers to adopt AI and information systems capabilities into their supply chains?

This study contributes to existing literature by identifying the specific capabilities of AI and information systems that South African FMCG manufacturers and retailers consider

important in post-COVID-19 supply chains as well as capabilities of these technology enablers that improve supply chain resilience. This study also makes a practical contribution to FMCG industry managers, as it highlights the capabilities of AI and information systems that can be leveraged to improve supply chain resilience.

Literature review

Overview of the South African fast-moving consumer goods industry

The FMCG industry is one of the largest industries in the world and can be described as rapid and agile in nature (Agigi et al. 2016:3). Allied Market Research (2019) reported that the global FMCG industry is on a stable growth curve and that the industry is projected to achieve a compound annual growth rate (CAGR) of 5.4% by 2025. Fast-moving consumer goods products have a short shelf life and are produced in high volumes that are quickly sold to satisfy the daily or near-daily needs of end consumers (Reza 2020:27). These products can also be purchased at a low cost and are easily accessible to end consumers. The South African FMCG industry is experiencing various market trends, such as changing consumer mindsets as consumers strive to adopt a healthier lifestyle and the increased attention of consumers to purchasing sustainable and eco-friendly products (Ho 2021). Consumers are increasingly prioritising value-for-money products and reducing expenditure on high-priced items. This shift is driven by a decrease in disposable income, leading consumers to actively seek money-saving strategies and optimise their spending habits (Ho 2021). The FMCG industry has witnessed a significant shift towards convenience, prompting the need for innovative adaptations to meet evolving consumer demands.

Despite its well-developed status, the FMCG industry in South Africa grapples with various challenges, including fluctuating demand levels and shifting consumer preferences. Since the start of the COVID-19 pandemic, many countries' borders have been closed, and FMCG firms have struggled to receive products sourced globally. Dierker et al. (2022) also report that a worldwide container shortage has a significant impact on global trade. More recent disruptions that have also significantly impacted the South African FMCG industry are the floods in KwaZulu-Natal, which affected the Durban port, resulting in increased lead times and delayed manufacturing processes for FMCG products (Bulbulia 2022). The Russian invasion of Ukraine also increased commodity prices, and many FMCG firms could not receive products from suppliers in those countries (Businesstech 2022). As a result of intensified disruptions and the frequency of disruptions occurring, FMCG firms have to be better prepared to withstand these disruptions with a more resilient supply chain.

Supply chain resilience

The concept of supply chain resilience has gained increased attention due to the frequent occurrence of disruptions and the unpredictability of the business environment (Pettit, Croxton & Fiksel 2019:56). Disruptions significantly affect the smooth operation of supply chains, and can have huge economic impacts on all firms (Mubarik et al. 2021:713).

Supply chain resilience encompasses the capability of a supply chain to respond to disruptions and recover from a disruption in an effective manner (Tukamuhabwa et al. 2015:5592). Kopanaki (2022:5) defines resilient supply chains as supply chains that have the capabilities to reduce vulnerability to disruptions. Tukamuhabwa et al. (2015:5592) state that resilient supply chains have better responsive capabilities and capabilities that facilitate a supply chain's operations returning to a state of normality. Agigi et al. (2016:4) explain that flexibility, redundancy and visibility are crucial elements of supply chain resilience. Resilient supply chains can adapt to changing environments and absorb unpredictable events easier. Supply chain resilience also improves a firm's proactive capability, which ensures preparedness for disruptions (Altay et al. 2018:1161). Supply chain resilience can be a source of competitive advantage if a firm can continue its normal operations in times of disruption, and firms with resilient supply chains will survive in extreme conditions and ensure that they can continue delivering products to their customers (Magagula, Meyer & Niemann 2020:66). Artificial intelligence enhances a firm's supply chain visibility through advanced data analytics and machine learning, making it an attractive option to improve supply chain resilience by enabling real-time monitoring, predictive analytics, and agile decision-making in response to dynamic market conditions (Ivanov 2021:5).

Artificial intelligence capabilities

Artificial intelligence is a combination of integrated systems that has the capability to perform tasks that usually resemble human intelligence (Pournader et al. 2021:2). Artificial intelligence has gained attention due to the availability of big data and the analytical power of modern-day computing systems (Haenlein & Kaplan 2019:5). Artificial intelligence has the capabilities to interact with and make sense of a variety of data, learn from the data, and also possess numerous decision-making capabilities (Pournader et al. 2021:2). Many firms have not exploited these capabilities but are increasing their efforts to integrate this technology enabler into their supply chains.

Disruptions such as the COVID-19 pandemic have spiked the demand for certain products and stagnated the demand for other products (Modgil et al. 2021:2). Many FMCG firms have found themselves in situations where they either overstock or understock products. Artificial intelligence capabilities have improved manual, traditional and statistical forecasting methods (Tarallo et al. 2019:739). Accurate demand forecasting and prediction are crucial in times of disruption, as firms need to know what resources to acquire to respond to fluctuating demand levels. Fast-moving consumer goods firms also sell products with short life cycles, and the seasonality of many products as well as the frequent introductions of promotions can influence demand forecasts (Kehayov, Holder & Koch 2022:1214). Fast-moving

consumer goods manufacturers and retailers generate high volumes of data through all their transactions and operate with many market uncertainties, which makes demand forecasting even more challenging. Artificial intelligence and machine learning capabilities can improve a firm's predictive capabilities (Modgil et al. 2021:7). These technologies have the capability to apply algorithms to the data, to learn from the data, and to uncover patterns in the data (Aamer, Eka Yani & Alan Priyatna 2020:2). Artificial intelligence has the capability to process high volumes and different varieties of data and convert them into meaningful insights.

Fast-moving consumer goods manufacturers and retailers sell thousands of products, all with different stock keeping units, and poor inventory management can put firms in a disadvantaged position, especially in such a competitive industry (Nemtajela & Mbohwa 2017:699). Artificial intelligence and machine learning have capabilities to update stock levels in real time and remove tedious stock counting activities (Lingam 2018:2282). Warehouse management and resource utilisation can also be assessed through AI capabilities (Riahi et al. 2021:1). Artificial intelligence increases visibility, transparency and collaboration between supply chain partners and distributes information instantly to all the relevant role players (Lingam 2018:2282).

Natural and man-made disruptions place pressure on supply chains and often push them near their breaking point. Many firms have started sourcing products globally and have incorporated e-commerce channels into their business models, which makes them even more vulnerable to disruptions (Dutta et al. 2019:349). A very important capability of AI includes the technology enabler's ability to predict, identify and assess possible risks and disruptions (Kehayov et al. 2022:1214). This capability therefore ensures that firms can proactively prepare for disruptions.

Artificial intelligence can conduct environmental scanning by learning from the environment and processing external data (Aboutorab et al. 2022:110). After scanning the external environment, AI can also create timely alerts so that the relevant personnel can respond in time (Aboutorab et al. 2022:110). Artificial intelligence capabilities can also be used to view the supply chain holistically, including all suppliers, channel partners and intermediaries. This network planning and mapping capability allows AI technologies to assess how supply chain partners are performing and what areas of the supply chain are most vulnerable to disruptions. The magnitude of modern-day disruptions and the frequency of occurrence have also driven firms to solve problems in their supply chains with the analytical capabilities of AI (Gupta et al. 2021:6). Artificial intelligence offers many problem-solving capabilities that can provide solutions in real time and facilitate faster and more accurate decision-making (Gupta et al. 2021:7). Artificial intelligence and robotics also have the capabilities to facilitate the automation of many time-consuming tasks, which increases the efficiency of the supply chain (Lingam 2018:2282). Many administrative tasks, such as invoicing and after-sales service, can be managed by AI (Modgil et al. 2021:15). Artificial intelligence also has the capability to personalise customer experiences by gathering data about customers' purchase histories and behaviours (Arco et al. 2019:102).

Information systems capabilities

In supply chain management, the flow of accurate information is just as important as the flow of goods and finances, and information systems are crucial as they facilitate the flow of information throughout the supply chain (Daneshvar Kakhki & Gargeya 2019:5318). Many traditional supply chains operate in isolation, with different links being disconnected from each other due to limited information sharing (Khan et al. 2021:2). Digital enabled supply chains, which are more effective than traditional supply chains, require a large amount of information sharing (Khan et al. 2021:1).

Information systems are the collection of hardware and software used at the operational, infrastructural and strategic levels (Modgil & Sharma 2017:657). Information systems act as coordinating mechanisms that connect all organisational departments and links within the supply chain and facilitate better communication between all the different role players (Astuty et al. 2021:117). Furthermore, information systems report data, which is necessary to direct activities to a firm's employees (Astuty et al. 2021:117). By leveraging the capabilities of information systems, better, faster and more accurate decisions can be made (Hasan 2018:15). Information systems also enhance decision-making processes as they automatically transform data inputs into valuable and meaningful outputs that can be used when making decisions, also known as decision support systems (Kumar 2020:185).

An important capability of information systems is their ability to integrate with other systems (Gupta et al. 2021:2). Information systems can integrate with a firm's transaction handling systems, warehouse management systems and transportation management systems. An enterprise resource planning (ERP) system, which is a type of information system, integrates a firm's information systems into one overall system and connects all segments within a firm to improve visibility (Oghazi et al. 2018:175). Information systems capabilities streamline many supply chain processes, such as receiving, warehousing, delivery and transaction handling (Modgil & Sharma 2017:657–660). Most firms rely on some sort of information system to handle customer transactions to increase the speed and reliability of the process (Daneshvar Kakhki & Gargeya 2019:5318). E-commerce operations are also supported by an information system. Large volumes of data are generated as goods move through the supply chain, and information systems capabilities can provide real-time information regarding a firm's inventory and delivery to customers (Tarigan, Jiputra & Siagian 2021:49). Information systems capabilities also ensure better preparedness for disruptions, as supply chain partners

will have access to more accurate information (Gupta et al. 2021:1). Disruptive events also impact consumer behaviour, which increases the demand for certain products. Information systems capabilities can be used to improve planning activities, which creates a more accurate forecast of total demand (Daneshvar Kakhki & Gargeya 2019:5323).

Artificial intelligence and information systems capabilities for supply chain resilience

A disruption such as the COVID-19 pandemic has created the need for a higher level of supply chain resilience, which has led many firms to adopt innovative technology enablers, such as AI and information systems (Ivanov 2021:1).

A major capability of AI, and specifically information systems that improve supply chain resilience, is the ability to provide visibility throughout the supply chain. Supply chain visibility is crucial for any supply chain that attempts to withstand possible disruptions (Ivanov 2021:2). Ivanov (2021:2) states that digital technologies that create visibility can improve supply chain resilience in two ways. Firstly, real-time information that is shared can be used to predict disruptions and develop contingency plans. Secondly, if visibility is created, supply chains will know where to deploy resources that could facilitate recovery.

Artificial intelligence and information systems also foster higher levels of collaboration between supply chain partners because they can easily share information with all relevant role players (Al-Talib et al. 2020:752). Many risks can be reduced by good communication because it reduces uncertainties (Dubey et al. 2021:113). Collaboration also creates synergistic responses to disruptions, which are more effective than individual parts of the supply chain attempting to deal with a disruption (Camarinha-Matos et al. 2019:23). Hence, supply chain resilience is improved, as combined efforts will allow a supply chain to return to a state of normality much easier. Firms must make a vast variety of decisions and solve many problems that influence their supply chain.

Artificial intelligence and information systems can facilitate better decision-making and solve problems more accurately than manual methods can (Gupta et al. 2021:7). These technology enablers will also ensure faster responses, which is crucial, especially in times of disruption. Information sharing enhances a supply chain's flexibility and responsiveness and allows firms to evaluate possible alternatives needed for decision-making (Brusset & Teller 2017:61). Supply chain flexibility, facilitated by AI and information systems capabilities, can improve supply chain resilience, as AI can automate many decision-making processes. Information systems can also facilitate real-time and informed decision-making by processing data quickly and accurately. Many firms face frequent supply chain disruptions and have to be flexible enough to identify, assess and select appropriate suppliers to ensure the continuity of supply, and AI capabilities can be leveraged to facilitate the process of supplier selection (Soleimani 2018:89).

Drivers for the adoption of artificial intelligence and information systems capabilities

Fast-moving consumer goods manufacturers and retailers are adopting AI and information systems to remain competitive and avoid losing market share (Reza 2020:24). Traditional business models have often become outdated, and industry success often depends on a firm's ability to be completely data-driven. A data-driven firm places emphasis on data analytics and bases all decision-making on the interpretation of such data (Gökalp et al. 2021:2).

Fast-moving consumer goods manufacturers and retailers are constantly looking for ways to attract new customers, extend their reach, and create more value for their customers; therefore, they are including multichannel and omni-channel strategies in their business models. The implementation process of a seamless omni-channel offering is extremely complex due to all the different data requirements (Akturk, Ketzenberg & Heim 2018:16). Firms will struggle to offer an omni-channel strategy without digital integration and information sharing (Pereira & Frazzon 2021:1). Information systems facilitate customer activities across multiple business segments, in brick-and-mortar stores and online.

Profit margins in the FMCG industry are extremely thin, and customers are price-sensitive, prompting firms to implement AI and information systems capabilities to help with cost reduction. Information systems can reduce many paper-based transactions, resulting in lower costs (Modgil & Sharma 2017:669). Better inventory and warehouse management can be facilitated through AI capabilities, which also reduce costs significantly (Praveen et al. 2020:866).

Customers have also become more demanding and expect personalised offerings, which AI can provide. The need for increased efficiency in supply chains also drives firms to leverage technology enablers and information systems that support FMCG manufacturers and retailers to handle high volumes of customer and supplier transactions. Firms also need a constant flow of information throughout the supply chain, which can be facilitated by information systems (Fu et al. 2022:3). Better decision-making opportunities drive firms to adopt AI and information systems, as these systems can generate quality outputs and faster solutions (Kumar 2020:185; Tarafdar & Qrunfleh 2017:8).

The need to optimise business processes and supply chains leads firms to pursue AI and information systems capabilities, as these technology enablers can optimise almost every aspect of the supply chain. When ordering materials from suppliers, an information system is needed to register the products that are purchased (Fu et al. 2022:12). When suppliers deliver products to a warehouse, information systems can facilitate the receiving process by registering the received goods, which will update inventory levels in real time. On the outbound side, a retail firm's information system can indicate that stock levels are low and that shelves should be replenished

(Yung et al. 2021:652). Firm performance often depends on the extent to which supply chain partners exchange information (Loury-Okoumba & Mafini 2018:858).

Firm and supply chain performance leads firms to adopt technology enablers and apply them in areas where performance can be optimised (Riahi et al. 2021:2). Many firms have been ill-prepared for disruptions and have realised the need to increase collaboration with suppliers. Many suppliers are situated far from firms, and collaboration can often only take place by using information systems. Disruptions have had adverse effects on many firms' supply chains, and the frequency of their occurrence drives firms to adopt technology enablers that can improve preparedness as well as responsiveness to such disruptions. The sheer volume and availability of big data and the internet of things have driven firms to transform in a digital world. Artificial intelligence and information systems have a vast variety of capabilities that can increase the resilience of the supply chains of FMCG manufacturers and retailers.

Methodology

Research design

A generic qualitative research design was used to explore the capabilities of AI and information systems for supply chain resilience. Generic qualitative research explores various participants' own attitudes, beliefs and experiences about a specific topic or problem (Jahja, Ramalu & Razimi 2021:1). The collected data therefore portrays the unique views participants have regarding the phenomenon under investigation. A generic qualitative research was most applicable for this study, as it allowed the researchers to expand on existing literature by exploring how participants experience the use of AI and information systems to improve their firms' supply chain resilience positions.

Sampling

The units of analysis in this study were the various FMCG manufacturers and retailers. The units of observation consisted of individual middle and senior managers who were employed by the FMCG manufacturers and retailers. This study used purposive sampling methods, as the researchers deliberately identified their sample according to participants, who were information-rich and could provide valuable insights into the research questions (Jahja et al. 2021:5). Criterion sampling is a type of purposive sampling technique that aims to include participants that meet very strict and predetermined eligibility criteria (Ezer & Aksüt 2021:17). Criterion sampling was used in this study at a firm and individual level. The inclusion criteria ensured that acceptable and trustworthy firms and individuals were included that were well positioned relative to the study's research questions. Firms were selected based on an inclusion criterion stating that they must operate in South Africa, must be an FMCG manufacturer or retailer, and must use AI or information systems. Individual participants were expected to be employed within FMCG manufacturing or retailing firms, hold a middle- to senior-level management position, had at least 2 years of experience, had a more strategic view regarding the use of AI and information systems, and lastly, be involved with the firm's supply chain activities. Snowball sampling was used at individual level to recruit participants through referrals from other participants (Mweshi & Sakyi 2020:191).

The researchers experienced data saturation after the 10th interview, as no new themes emerged from the data. Mwita (2022:414) defines data saturation as the point in the data collection process where sufficient data is collected and no new information emerges from the data. Two more interviews were conducted to confirm that data saturation was achieved (Constantinou, Georgiou & Perdikogianni 2017:585).

Twelve individual participants from 12 different firms participated in this study. Six participants from FMCG manufacturing firms and six participants from retailing firms were included in this study so that a balanced sample could be achieved. Details of the different participants can be found in Table 1.

Data collection

This study used a combination of face-to-face methods and information and communication technologies to conduct 12 semi-structured interviews. Face-to-face interviews were conducted where the researchers could physically reach the participants. However, online video-conferencing

TABLE 1: A profile of this study's individual participants.

Pseudonym	Job title	Firm	Gender	Duration of interview (minutes)
P1	Senior Category Manager	O1	Female	69
P2	Industrial Engineering Manager	O2	Male	28
P3	National Distribution and Customer Service Manager	O3	Male	81
P4	Supply Chain Operations Manager	O4	Male	23
P5	Senior Manager	O5	Male	33
P6	Supply Chain Director	O6	Male	31
P7	National Systems Manager	O7	Male	41
P8	Supply Chain Manager	O8	Male	44
P9	Supply Chain Executive	O9	Male	19
P10	Project and Performance Manager	O10	Male	20
P11	Warehouse and Logistics Manager	O11	Male	22
P12	Divisional Supply Chain Manager	O12	Male	23

Note: The average duration of an interview was 36 minutes.

methods were also used to overcome accessibility and time constraints, which allowed for the inclusion of participants who were geographically dispersed across South Africa and would otherwise have been excluded from the study (Saarijärvi & Bratt 2021:396). The duration of the interviews ranged from 19 to 81 min, and the average duration of the interviews was 36 min.

Semi-structured interviews provided in-depth responses, which allowed the researchers to explore the views the participants hold regarding the use of AI and information systems capabilities in their supply chains (Kallio et al. 2016:2955). Open-ended questions were presented to participants so that they could provide their own unique responses and perspectives in a flexible manner (Barrett & Twycross 2018:63). Open-ended questions provided the participants with the freedom to truly express their own thoughts and opinions. Semi-structured interviews were facilitated by a discussion guide that consisted of questions according to the study's research questions (Barrett & Twycross 2018:63). The discussion guide was pre-tested with a participant who had complied with the inclusion criteria. No major changes were made to the discussion guide after the pre-test was conducted, although certain areas were fine-tuned and enhanced to improve the quality. After the conclusion of each interview, the interviews were transcribed by the researchers.

Data analysis

Thematic analysis was used to analyse the data, which is an approach used to assign codes to the data so that patterns and themes can be identified that are relevant to this study's research questions (Castleberry & Nolen 2018:808). The researchers first coded all the transcripts by adding short descriptive tags to the relevant data extracts. Thereafter, similar codes across all the transcripts were grouped to form sub-themes and main themes. Throughout the whole process, a constant reiteration occurred where codes and themes were checked for consistency and alignment with this study's research questions. The researchers used ATLAS.ti software, which is often used for data analysis in qualitative research. ATLAS.ti allowed the researchers to use a flat coding structure and created visibility across the whole coding process (Paulus & Lester 2016:409).

Trustworthiness

In this study, the four criteria of credibility, dependability, confirmability and transferability were used to ensure trustworthiness (Connelly 2016:435). This study ensured credibility by collecting data from multiple individuals and firms in order to ensure data triangulation (Korstjens & Moser 2018:121). Dependability was confirmed by reporting all procedures and methods used, allowing any reader to determine the consistency of such methods (Johnson, Adkins & Chauvin 2020:145). In addition, the researchers kept an accurate audit trail and documented all changes. Furthermore, this study used open-ended questions that allowed participants to express their own views and transcribed the participants' responses verbatim to ensure confirmability. This study used eligibility criteria and reported on the specific data collection methods that were used to establish transferability (Shenton 2004:70).

Ethical considerations

This study was approved by the research ethics committee of University of Pretoria, Faculty of Economic and Management Sciences (No. u19062886/u18014730/2022). Prior to the interview, an informed consent form was read to all participants, which explained that their participation was voluntary and that all the information discussed would remain confidential. Every participant was also required to sign the informed consent form. Pseudonyms were used to ensure that individual participants and firms remained anonymous.

Findings

This study identified three main themes that are directly related to the study's research questions. The main themes include technology enabler capabilities, artificial intelligence and information systems resilience capabilities, and drivers of technology capability adoption. In addition to the main themes, sub-themes were also identified. The findings are discussed in the following subsections and are supported by raw data extracts. Table 2 illustrates a summary of the themes and sub-themes.

Theme 1: Technology enabler capabilities

The first theme relates to research question 1 and identifies the various capabilities of AI and information systems that are considered important when designing and executing post-COVID-19 supply chains. Eight capabilities of these technology enablers were identified and categorised into four sub-themes, as follows: supply chain integration capabilities, automation capabilities, monitoring capabilities and analytical capabilities.

Supply chain integration capabilities

Nine participants mentioned that internal integration is important in a 'post-disruption' supply chain. Supply chain integration relates to the collaborative functioning of all departments within a firm as well as external integration with supply chain partners. In this category, participants indicated that it is important that internal information systems be integrated so that all the relevant role players can receive and access timely information. This role implies that information systems have the capabilities to connect to one another, which facilitates internal integration, as indicated by the following response:

> '… purely because we want the same master data, the same planning systems across Africa. So, when I am comparing sales in Africa, I am comparing it to the same master data in South Africa.' (P1, female, Senior Category Manager)

TABLE 2: Summary of themes and sub-themes.

Theme	Technology enabler capabilities (RQ1)	AI and information systems resilience capabilities (RQ2)	Drivers of technology capability adoption (RQ3)
Sub-theme	**Supply chain integration capabilities**	**Information sharing**	**External organisational drivers**
	◦ Internal integration	◦ Information sharing	◦ Competitive advantage
	◦ External integration	◦ Real time data	◦ FMCG industry characteristics
	Automation capabilities	◦ Information accuracy	**Internal organisational factors**
	◦ Supply chain automation	**Planning and predictive capabilities**	◦ Cost
	◦ Reduces complexity and human intervention	◦ Route planning	◦ Efficiency
	Monitoring capabilities	◦ Scenario planning	◦ Effectiveness
	◦ Monitors supply chain events	◦ Supply planning	◦ Data accuracy and sense making
	◦ CCTV security	◦ Demand planning	◦ Visibility
	Analytical capabilities	◦ Demand prediction	◦ Standardisation
	◦ Data analysis	◦ Disaster prediction	
	◦ Machine learning	**Decision making capabilities**	
		◦ Quick decision making	
		◦ Decision making parameters	
		◦ Emotionless decision making	
		◦ Solution generation	
		◦ Creates triggers for reaction	
		◦ Problem identification	
		◦ Informed decision making	
		Transparency and visibility	
		◦ Inventory visibility	
		◦ Reporting	
		◦ Tracking and tracing	
		Operational efficiencies capabilities	
		◦ Order-to-cash cycle management	
		◦ Consistency	
		◦ Managing supply chain activities	
		◦ Optimising truck deliveries	
		◦ Business continuity	

CCTV, closed circuit television; FMCG, fast-moving consumer goods.

However, external integration with supply chain partners is just as important, as this allows for improved collaboration, which increases the effectiveness of responses to disruptions. Four participants indicated that information systems have the capabilities to connect and integrate with supply chain partners' information systems, as indicated as follows:

> 'I think definitely there's a lot more people that focus on getting to a point where they can integrate so from our perspective there's definitely, we see a lot more vendors asking for good integration between us and that's not only to place orders but it's also to share information, you know share stock levels, be able to receive orders, passing on a lot more data between businesses, so you almost get this cross industry sharing of data that kind of helps everybody to plan a little bit better, so definitely a bigger uptake in that.' (P9, male, Supply Chain Executive)

Participants stated that internal as well as external integration of information systems is important so that all role players can have access to information. This finding is consistent with the statement by Gupta et al. (2021:2) that information systems have integration capabilities.

Automation capabilities

Four participants highlighted that AI contributes to supply chain automation. Automation capabilities refer to conducting supply chain activities with less reliance on humans. Artificial intelligence capabilities automate supply chain activities that were usually conducted manually, and automation allows activities to be conducted at a higher speed and accuracy, as indicated by a participant as follows:

> '… AI capability there to make sure there is no deviation from a perfect kind of demand plan to a perfect production plan to a perfect materials planning. That in turn will relate to basically a hundred percent effective, efficient, optimised inventory management. You know no cash flow issues, perfect inventory and then together with that obviously you've got the physical portion where investment wise, yes it will be major in terms of getting robotics and then AI in terms of the production, but also in terms of the warehousing so you now, pick locations etc. all automated etc.' (P8, male, Supply Chain Manager)

Three participants emphasised that information systems automate supply chain activities, which is apparent in the following response:

> 'Absolutely, so he is led by the arm mounted terminal on his hand, connected to RF, connected to SAP giving him instructions of what he needs to do ….' (P7, male, National Systems Manager)

Seven participants referred to the fact that AI reduces a lot of complexity and human intervention in areas such as data analysis and prediction, which allows people to focus on the more value-adding activities, as illustrated by one participant's response:

> 'AI could definitely streamline the operation and allow you to get to answers a lot quicker, with less reliance on the person.' (P6, male, Supply Chain Director)

Four participants specified that information systems also have the capabilities to reduce the amount of manual intervention required, as indicated by the following response:

> 'Well, you reduce a lot of your manual work, that people used to do, so instead of suppliers calling, or we calling suppliers to place orders or sending mails, everything is automated, so you can just put in some numbers, press enter and then the order goes through.' (P2, male, Industrial Engineering Manager)

Participants highlighted that AI and information systems capabilities automate many supply chain activities as well as reduce complexity and human intervention. This finding confirms the literature of Lingam (2018:2282), who states that automation contributes to increased efficiency. However, three participants mentioned that automation is a challenge in a developing country like South Africa, due to the existence of labour constraints and the high rate of unemployment. Therefore, it is challenging to implement AI and information systems that replace manual labour.

Monitoring capabilities

Three participants indicated that AI capabilities are used to monitor supply chain events. Monitoring capabilities refer to the ability of AI to scan the environment in which the supply chain operates and to report on events that might have a negative effect on a supply chain. In this category, participants mentioned that the capability of AI to monitor supply chain events allows firms to be better prepared to withstand a disruptive event and also allows firms to respond better to such an event, as illustrated by the following response:

> 'Also, let's reverse it now, Ukrainian war comes along, aluminum comes out of those areas that commodity became a scares resource globally and that impacted us significantly. It immediately highlighted that we needed to work with our suppliers to bring in their coils and their stock and ensure that there was sufficient supply for the South African producer.' (P1, female, Senior Category Manager)

However, one participant stated that AI built into CCTV cameras can also monitor internal activities and improve yard management operations. This participant further mentioned that the AI built into CCTV cameras can improve security and create certain alerts. This implies that AI built into CCTV cameras can facilitate preparedness and responsiveness towards disruptive events. The following quotation serves as an example:

> 'So, a massive DC coming there so from an AI perspective what we doing is we are implementing a new CCTV system and a new VMS. The cameras themselves have AI on the edge right so how we do it is we have cameras that monitor the perimeter and cameras that work throughout the DC. These cameras can do motion detecting, it can use RF technology, it can use infrared, so we can see people approaching the wall, but there is AI on the camera that says if someone is approaching the wall then alert someone.' (P7, male, National Systems Manager)

This finding is consistent with the literature of Al-Talib et al. (2020:753) and Modgil et al. (2021), which explained that AI has the capabilities to monitor supply chain events, which facilitates better decision-making and responses to disruptions.

Analytical capabilities

Eight participants identified that AI capabilities are used for data analysis. Artificial intelligence has various analytical capabilities that can be used to process and analyse big data sets, which allows firms to arrive at meaningful conclusions as data has no meaning without the interpretation thereof. Participants mentioned that a lot of data is available and that they need AI to analyse and interpret the data. An extensive amount of data has become available in a 'post-disruption' environment, which emphasises the need for analytical capabilities. The analytical capability of AI is illustrated by the following response:

> 'So, I think data has become, it's there. It's there in abundance. It's no more about getting data now, it's about finding the right data and analysing it and humans can't do that right now. You need AI technology, to do the basics and then you get involved where you can.' (P10, male, Project and Performance Manager)

Five participants stated that information systems also have analytical capabilities that can be used to transform data inputs into valuable outputs. The analytical capabilities of information systems allow firms to derive insights from the data, as indicated by the following quotation:

> 'Like I've mentioned before you get overwhelmed with a lot of like sort of data and I call it data, because you haven't made sense of it yet. I think once you have made sense of it, it becomes information. So, there's a lot of information, basically its literally trial and error in terms of what instruments give you the best information, so you are able to make the right decisions on a daily basis.' (P6, male, Supply Chain Director)

Two participants indicated that AI has machine learning capabilities. Machine learning refers to the capability of AI to learn from historical data so that improved decisions can be made in the future. This is highlighted in the following response:

> '… basically we've gone ahead and sort-of integrated quite a fancy planning system that uses some form of artificial intelligence to learn and basically better the forecast.' (P6, male, Supply Chain Director)

These findings confirmed the literature of Gupta et al. (2021:1), which highlighted that AI and information systems possess numerous analytical capabilities, and Guzman and Lewis (2020:72), which illustrated that AI consists of machine learning capabilities.

Theme 2: Artificial intelligence and information systems resilience capabilities

The second theme relates to research question 2 and addresses the various capabilities of AI and information systems that improve FMCG manufacturers' and retailers' resilience positions. Twenty-four capabilities were identified and categorised into five sub-themes as follows: information sharing, planning and predictive capabilities, decision-making capabilities, transparency and visibility capabilities, and operational efficiencies capabilities.

Information sharing

Seven participants explained that information systems facilitate information sharing. Information sharing refers to the exchange of information within the firm and between supply chain partners. Information sharing improves supply chain resilience, as it allows supply chain partners to have access to information that can contribute to better decision-making, as is evident in the following response:

> 'We have information across our country that we can actually figure out with the different parties what's going on the different routes. To reduce your risk …' (P12, male, Divisional Supply Chain Manager)

Six participants emphasised that information systems facilitate the flow of real-time data. Information systems have the capability to share real-time data between different parties. Real-time information allows updated information to be distributed, which increases collaboration between supply chain partners. Real-time information provides the latest version of relevant information, which improves supply chain resilience as supply chain partners will have access to timely and updated information. Real-time data is also important, especially in the FMCG industry due to the fast-paced nature of the industry. This is indicated by the following response:

> 'What SAP does is and the capability of it, it gives you a total solution regarding what's going on at any given time, so it's live and that's the good thing. So, if you go into SAP now, I can see exactly what the stock level is now of a certain SKU in any depot and its real time.' (P3, male, National Distribution and Customer Service Manager)

Three participants indicated that information systems provide access to accurate information. Information accuracy is especially important in the FMCG industry, due to the complexity and high-volume nature of the industry. Accurate information forms the basis on which all employees base their decisions. If firms have accurate information, a lot of discrepancies and redundancies can be avoided, which leads to better decision-making and improves supply chain resilience: This is illustrated by the following quotation:

> 'The more information, the more accurate information and the more structured your operations are, the better your possibility is of getting it right and making the right call.' (P11, male, Warehouse and Logistics Manager)

These findings are consistent with the literature (Brusset & Teller 2017:61; Gupta et al. 2021:1; Tarigan et al. 2021:49). These studies found that information sharing, real-time data and accurate information can all increase a firm's responsiveness and resilience towards disruptions.

Planning and predictive capabilities

Three participants mentioned that AI capabilities facilitate route planning. Planning capabilities refer to a firm's proactive planning to ensure alignment throughout all processes. Artificial intelligence has numerous capabilities that allow firms to improve their proactive capabilities. Participants specified that planning activities ensure better preparedness for disruptions and allow them to direct organisational resources more efficiently. Artificial intelligence planning capabilities can be leveraged for route planning, scenario planning and demand planning. The route planning capability of AI is illustrated by the following response:

> 'There's AI inside that algorithm, there's AI that's sitting in that planning algorithm that says hang if you drive these routes now, the traffic is heavy at that time. AI makes it smarter all the time, tells you hang on you may be driving further that way but doesn't matter because you'll still to get to the because of traffic.' (P7, male, National Systems Manager)

Scenario planning is a very important capability of AI as indicated by three participants. Scenario planning allows firms to plan for different possible scenarios, as is evident in the following response:

> 'Further to that, where we might have only done two or three scenarios, now we doing 5 or 6 scenario planning's and what we are also doing is we are planning for three different scenarios at all times where previously we might have planned for one and maybe 2.' (P1, female, Senior Category Manager)

Five participants stated that AI capabilities support demand planning by analysing historical data as well as trends in demand. Demand planning is a crucial activity in the FMCG industry due to the volatility of demand. Artificial intelligence's demand planning capability is illustrated by the following response:

> 'Yes, so we use the AI capabilities for our demand planning for now and what's it called, order cycle management, so understanding what customer will order.' (P10, male, Project and Performance Manager)

Information systems also consist of various planning capabilities, including route planning, supply planning, and demand planning. Two participants mentioned that information systems are used for route planning. Participants indicated that route planning is important, as trucks need to drive the most efficient routes in order to keep fuel costs as low as possible. This is illustrated by the following response:

> 'So, if you don't have proper systems in place built or proper utilise loads, utilise your trailers properly, making sure that your routes are efficient, you're not going to buffer that type of increases ….' (P12, male, Divisional Supply Chain Manager)

One participant explained that information systems are used to conduct supply planning activities, which is illustrated by the following response:

> 'Then we have Phantom, which controls supplier demand, material planning.' (P10, male, Project and Performance Manager)

Three participants mentioned that information systems are used for demand planning, and one such response can be seen in the following quotation:

> 'Yeah no so, O7 is SAP wall to wall, so we use from ERP to demand planning ….' (P7, male, National Systems Manager)

Seven participants stated that AI capabilities are leveraged for demand prediction. Predictive capabilities can be defined as the anticipation of future events. Artificial intelligence's predictive capabilities allow firms to develop a forward view, which can improve preparedness and supply chain resilience. In this category, participants highlighted that historical data can be analysed to discover trends and patterns. Although predicted figures are not completely accurate, they do provide firms with visibility. Artificial intelligence's demand prediction capability is apparent in the following response:

> 'AI that we just have adopted now on our planning side, uhm so demand planning, statistical forecast model with the built-in AI.' (P6, male, Supply Chain Director)

Two participants indicated that AI has the capability to predict the likelihood of future disruptions. Artificial intelligence has enormous computing power, and a vast variety of data can be put into AI systems, which makes it possible for AI systems to predict the likelihood of future disruptions. If AI can predict the likelihood of future disruptions, it can significantly reduce a firm's reaction time. The following response serves as an example:

> 'I think, because you could see what happened in the past and we could see the forward view with the detail now in the systems now, we can actually look at the forward view and see whether there is going to be bumps ahead.' (P6, male, Supply Chain Director)

This corroborates the findings of previous studies that identified that these capabilities improve supply chain resilience (Daneshvar Kakhki & Gargeya 2019:5323; Kehayov et al. 2022:1214).

Decision making capabilities

Two participants mentioned that AI has quick decision-making capabilities, as it can process a lot of data faster. Decision-making capabilities refer to the capability of technology enablers to process data and to make decisions based on various alternatives, as illustrated by the following response:

> 'I mean it can just get to a decision so much quicker than a person.' (P9, male, Supply Chain Executive)

One participant mentioned that AI can make decisions while considering a firm's unique criteria, as demonstrated by the following response:

> '… whereas I think AI can take all those requirements, constraints, criteria for the entire model across the world and then automate that.' (P6, male, Supply Chain Director)

Two participants indicated that AI makes decisions only based on facts, without being influenced by emotional factors, as indicated by the following response:

> 'Absolutely, I think if you've got, if you can take the emotion out of making decisions, you know then it's running numbers …' (P9, Male, Supply Chain Executive)

Two participants identified that AI can automatically generate solutions with less reliance on humans, as indicated by the following response:

> 'AI could definitely streamline the operation and allow you to get to answers a lot quicker, with less reliance on the person.' (P6, male, Supply Chain Director)

One participant specified that AI creates triggers and alerts that can direct people to make decisions, as illustrated by the following response:

> 'We are now at all times planning for three and what are the triggers the system highlights, what triggers need to be prioritised to immediately take action or which can take a bit longer to action depending on one of those three scenarios.' (P1, female, Senior Category Manager)

Four participants highlighted that AI can identify problem areas, and two participants mentioned that information systems also have such capabilities, as indicated by the following responses:

> 'So now we are going to protect ourselves and say hang on, this AI cameras are telling us hang on there's a problem.' (P7, male, National Systems Manager)

> 'I think more it's allowing us to actually see where we have shortcomings ….' (P11, male, Warehouse and Logistics Manager)

Two participants pointed out that information systems facilitate informed decision making, as indicated by the following response:

> 'Hundred percent, so if you can get better information, better decision making and then it leads you to being a lot more resilient and it has been able to make those decisions quickly as well.' (P6, male, Supply Chain Director)

Artificial intelligence and information systems' decision-making capabilities improve supply chain resilience, as decisions can be made faster and more accurately. These findings are consistent with Gupta et al. (2021:7), who stated that AI and information systems can facilitate better decision-making than manual methods. However, two participants mentioned that information systems stiffens decision making. Three participants also explained that these technology enablers are dependent on quality inputs and can provide ineffective outputs if data are not entered correctly, mostly referred to as 'garbage-in-garbage-out'.

Visibility and transparency

Four participants specified that AI provides inventory visibility, and seven participants highlighted that information systems contribute to inventory visibility. Visibility and transparency refer to the openness and sharing of information. This category includes inventory visibility, reporting, as well as tracking and tracing. Artificial intelligence and information systems have the capabilities to improve inventory visibility, which is evident in the following responses:

> 'How quick it can count, cause you just have to drive the camera along the isle and it takes images, tells you that this pallet is in this bin, this pallet is in this bin, real as we go boom-boom. So, we just drive as quick as we can drive this machine through the DC is as quick as we can count everything.' (P7, male, National Systems Manager)

> '… they need to know exactly how much inventory is in the warehouse, how much inventory suppliers can provide, available to promise and that. The information systems are critical.' (P2, male, Industrial Engineering Manager)

Four participants stated that information systems have reporting capabilities. Reporting refers to the visible display of information to assess supply chain performance. Information systems enable firms to report on various kinds of information, which increases visibility and transparency, as illustrated by the following response:

> 'Hundred percent, it's that reporting by far so it's, all these systems means garbage in terms of what they can do unless there's an interface or a dashboard where you can sort of assess you know how you doing.' (P6, male, Supply Chain Director)

Four participants mentioned that information systems consist of tracking and tracing capabilities. Tracking and tracing refer to the active monitoring of all supply chain activities. Tracking and tracing enable firms to have visibility across all activities, as indicated by the following response:

> 'So that's our system that we use, so One Network does it, so we've got mixed telematics on the truck integrated to One Network, so we know where the trucks are at any point in time, whether the backdoor is open, whether its closed.' (P7, male, National Systems Manager)

These findings corroborate the findings of Ivanov (2021:2), which state that technology enablers improve supply chain visibility and resilience.

Operational efficiencies capabilities

Two participants indicated AI, and 10 participants identified information systems as technology enablers facilitating order-to-cash cycle management. Operational efficiency capabilities refer to basic execution activities using technology enablers. These technology enablers facilitate higher efficiency when executing such activities. Artificial intelligence and information systems allow firms to handle their order-to-cash cycle process more efficiently, as illustrated by the following responses:

> 'So, the retailers have a system, a retail system that they order on to us, so we've done away with like manual ordering.' (P2, male, Industrial Engineering Manager)

> 'So, it just looks at different parts of invoicing and elements of that so that you don't go through so many different levels of people.' (P10, male, Project and Performance Manager)

One participant mentioned that AI increases efficiency as it does not become fatigued in comparison to humans, as illustrated by the following response:

> 'I mean a robot doesn't get sick, it doesn't get lazy, it is very efficient etc.' (P8, male, Supply Chain Manager)

Seven participants explained that information systems are used to manage supply chain activities. This is apparent in the following response:

> 'We use an ERP system to manage a lot of our supply chain.' (P10, male, Project and Performance Manager)

Two participants stated that information systems optimise delivery processes, as indicated by the following response:

> 'Exactly so if we route ineffectively, so when we get al.l the orders, we must put those orders onto trucks that it can fit on and drive the shortest possible route.' (P7, male, National Systems Manager)

One participant, however, mentioned that information systems can be used to ensure business continuity, as illustrated by the following response:

> '… we can actually switch on this kit and this kit allows you to want to connect all the RF devices so it does actually, it mimics that you are actually at the DC so all the kit we use to pick and all that stuff works in a remote setting. So now we can distribute stock from anywhere.' (P7, male, National Systems Manager)

These findings are consistent with Lingam (2018:2282) and Modgil and Sharma (2017:657–660), who state that AI and information systems increase supply chain efficiency.

Theme 3: Drivers of technology capability adoption

The third theme relates to research question 3 and identifies the various driving factors that are leading FMCG manufacturers and retailers to adopt AI and information systems into their supply chains. The main driving factors include external and internal organisational driving factors.

External organisational drivers

Four participants highlighted that competitive factors are driving them to adopt AI or information systems. External organisational drivers are factors that originate outside the firm. External organisational drivers relate to competitive factors as well as FMCG industry characteristics. In this category, participants mentioned that they are adopting AI or information systems to remain competitive. This role implies that FMCG manufacturers and retailers consider adopting AI and information systems to avoid losing market share to competitors, as indicated by the following response:

> 'Yes and everyone else is doing it right, so you can't be behind the, you'll be behind the curve otherwise.' (P7, male, National Systems Manager)

Ten participants specified that the nature of the FMCG industry is also an external driving factor. The fast-paced nature of the FMCG industry requires having access to timely information and quick decision-making; therefore, the adoption of information systems is applicable, as indicated by the following response:

> 'You'll always, people fall under pressure and I think people succumb to pressure in a fast-paced environment so having that robust system just creates that security, that you know you are within certain bounds.' (P11, male, Warehouse and Logistics Manager)

These findings are consistent with Reza (2020:24), who stated that competitiveness is a driving factor for adopting AI and information systems. However, this study also identified FMCG industry characteristics as external organisational drivers, that are also leading FMCG manufacturers and retailers to adopt them.

Internal organisational factors

Nine participants mentioned cost, seven participants highlighted efficiency, and two participants indicated effectiveness as internal organisational drivers. Internal organisational drivers are driving factors that originate within the firm. The first three drivers in this category include cost, efficiency and effectiveness, which are evident in the following responses:

> 'So, it will all be around cost and efficiencies so if there is technology that can drive down costs and provide efficiencies, they will look at it.' (P5, male, Senior Manager)

> 'So, it's more about efficiency, so you need to get more efficient and that's critical for any supply chain in the FMCG world.' (P10, male, Project and Performance Manager)

> 'I think that's key for us and the key driver is to make sure that you maintain and improve your service levels.' (P12, male, Divisional Supply Chain Manager)

Three participants indicated that the need for accurate data and analytical capabilities is driving them to adopt AI or information systems. Five participants highlighted visibility, and one participant indicated standardisation as an internal organisational driving factor.

Previous literature has identified cost, efficiency, effectiveness, analytical capabilities, visibility and standardisation as benefits of leveraging AI and information systems capabilities (Gupta et al. 2021:6; Lingam 2018:2282; Modgil & Sharma 2017:699; Oghazi et al. 2018:175; Praveen et al. 2020:866). However, this study identifies these factors as internal organisational driving factors leading to the adoption of AI and information systems.

Conclusion

Summary of findings

The aim of this study was to explore which capabilities of AI and information systems should be considered in a 'post-disruption' supply chain as these supply chains require different capabilities to adapt to the changing environment. Furthermore, the study also explored what capabilities of AI and information systems improve supply chain resilience and what driving factors are leading to the adoption of such technology enablers. This study expanded on the study of Modgil et al. (2021:1–43), with a focus on South African FMCG manufacturers and retailers.

The first research question investigated what capabilities of AI and information systems should be considered when designing and executing post-COVID-19 supply chains. All firms mentioned a variety of AI and information systems capabilities that are considered important in a 'post-disruption' supply chain, as these technology enablers have become increasingly important. The integration of information systems leading to overall supply chain integration was mentioned by almost all participants due to the significance of aligning and sharing information with supply chain partners. Artificial intelligence and information systems were identified as having automation capabilities that can increase speed and accuracy. Further, participants also highlighted that AI increases preparedness towards disruptions by monitoring supply chain events. Lastly, participants highlighted that AI and information systems have analytical capabilities so that useful conclusions can be drawn from all the available data. These capabilities were identified by participants, as 'post-disruption' supply chains often require distinctive capabilities.

The second research question explored which AI and information systems capabilities improve supply chain resilience. The first step in improving supply chain resilience is information sharing, which allows organisational silos to collapse and improves collaboration. Artificial intelligence and information systems' planning and predictive capabilities allow firms to be more proactive and ensure preparedness towards disruptions. Artificial intelligence and information systems also automate many decision-making procedures that allow firms to reach decisions quicker, and these technology enablers can make decisions by considering more variables than humans can. Artificial intelligence and information systems create visibility and transparency, which are important aspects of supply chain resilience (Ivanov 2021:2). If operations and procedures are visible within a firm, it allows all role players to prepare and make decisions based on the same information. Lastly, AI and information systems streamline many operational activities previously conducted by humans and improve the speed and accuracy thereof.

The third research question explored what factors are driving firms to adopt AI and information systems. This study identified competitiveness and the characteristics of the FMCG industry as external organisational driving factors. The FMCG industry is extremely competitive; therefore, firms are adopting AI and information systems to enhance competitiveness (Reza 2020:24). Participants also mentioned that internal organisational factors are driving them to adopt AI and information systems.

Theoretical implications

This study expands on the work of Modgil et al. (2021:1–43) as it identifies various capabilities of AI and information systems that improve supply chain resilience, from the perspective of FMCG manufacturers and retailers in a developing country like South Africa. This study also identifies the driving factors leading to the adoption of such technology enablers. The findings of this study contribute to the existing literature on the use of technology enablers such as AI and information systems to improve supply chain

resilience. The findings of this study also corroborate the findings of various previous studies conducted on this topic, as it identified numerous capabilities of AI and information systems that improve supply chain resilience (Gupta et al. 2021:1–11; Ivanov 2021:1–11; Kopanaki 2022:1–19; Modgil et al. 2021:1–43). Reza (2020:24) found that competitiveness is a factor for adopting AI and information systems. This study found that the characteristics of the FMCG industry are another external organisational driver and that internal organisational drivers also exist, which contributes to the existing literature.

Managerial implications

Supply chains constantly evolve, and often distinctive capabilities of technology enablers are required in a 'post-disruption' supply chain. This study firstly helps supply chain managers become aware of the capabilities of AI and information systems that are considered important in a 'post-disruption' supply chain. Supply chain managers should therefore pay closer attention to the capabilities that these technology enablers provide and decrease resistance to change. Supply chain resilience has become increasingly important due to the frequency of supply chain disruptions (Pettit et al. 2019:56). Firms therefore have to improve their supply chain resilience in order to remain competitive and ensure the longevity of their operations. This study secondly increases awareness among supply chain managers of the value-adding benefits AI and information systems have for improving supply chain resilience. Supply chain managers should become more acquainted with technology enablers such as AI and information systems, and recognise the impact these technology enablers can have on their firm's supply chain resilience position.

Limitations and directions for future research

Firstly, this study was conducted in a developing country where the implementation of technology enablers such as AI and information systems is often limited. It is therefore recommended that the capabilities of AI and information systems be explored in another developing country so that it can be determined if similar findings can be found. Secondly, this study was conducted in the South African FMCG industry, where many firms do not leverage AI and information systems capabilities. Future research should include other industries, so that additional knowledge can be obtained on the use of technology enablers within a resilience context. Lastly, the sample size of this study was limited as only six FMCG manufacturers and six retailers were included. Future research should focus on including a broader sample within the FMCG industry, by including distributors and wholesalers which will create a holistic perspective of the FMCG industry.

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Competing interests

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Authors' contributions

This article is based on the dissertation of K.H. and B.S. who were the main researchers. W.N. acted as the supervisor with the conceptualisation, literature review, research instrument and development of this manuscript.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Pretoria, Faculty of Economic and Management Sciences Research Ethics Committee (No. u19062886/u18014730/2022).

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Data availability

The data that support the findings of this study are available on request from the corresponding author, W.N. Data are stored according to institutional policy.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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