The effect of supply chain digitalisation on a firm's performance

Abstract

Purpose - Based on the Resource-Based View (RBV) theory, this study examines how supply chain digitalisation affects firms' performance by enabling firms to build supply chain agility and innovation capability.

Design/methodology/approach - Drawing from the dataset of 271 firms in the United Arab Emirates (UAE), we used structural equation modelling to validate the models. Mediation and moderation analyses were performed to test the research hypotheses.

Findings – The results suggest a positive correlation between supply chain digitalisation and a company's performance, fully mediated by both supply chain agility and innovation capability. The interplay between supply chain agility and innovation capability has the potential to result in unfavourable outcomes for a firm's performance. These results provide valuable insights into supply chain management during digital transformation.

Originality/value- The study advances the extant research on the antecedents of a firm's performance by incorporating supply chain digitalisation and mediating mechanisms of supply chain agility and innovation capability that serve as a conduit between supply chain digitalisation and a firm's performance based on RBV.

Keywords: supply chain digitalisation, supply chain agility, innovation capability, performance

1 Introduction

Supply chain digitalisation refers to the use of digital technologies and tools in supply chain operations. It is relatively new (Seyedghorban et al., 2020); however, it has attracted growing attention in industry and academia (Seyedghorban et al., 2020, Shashi et al., 2020,

Holmström et al., 2019). The adoption of digital technologies, supply chain agility and innovation capability to improve supply chain operations has become an important trend post-COVID-19 (Seyedghorban et al., 2020, Wang et al., 2020a, Wang and Wang, 2023). Besides, the Fourth Industrial Revolution (Industry 4.0) drives the use of digital technologies, such as the blockchain, Artificial Intelligence, the Internet of Things, and ERP systems, etc. in organisations (Ivanov et al., 2019, Beier et al., 2020), and an increasing number of companies are recognising that digital technology plays a vital role in supply chain operations (Holmström et al., 2019). However, it is unclear how digital technologies affect corporate performance (Bharadwaj, 2000, Li et al., 2020), as technology alone is not enough to improve performance because successful performance improvement is a multifaceted endeavour that involves various elements beyond technologies (Wang et al., 2021, Wang et al., 2023a). Li et al. (2023) stress that building digital supply chains to incorporate both internal and external resources is increasingly recognized as a crucial strategy. Technology has always profoundly impacted all business operations (Bharadwaj, 2000, Li et al., 2020). Technology is a double-edged sword, it may cause both positive and negative consequences. This question has generated much debate over the past decade, previous studies have yielded mixed results (Bharadwaj, 2000, Li et al., 2020). In addition, limited empirical research has been conducted to explore the underlying mechanisms through which supply chain digitalisation impacts a firm's performance (Seyedghorban et al., 2020).

The need to understand the mechanism between supply chain digitalisation and performance has led to a void in the current literature (Girod et al., 2023, Holmström et al., 2019, Wang and Wang, 2023). Our study seeks to fill this gap by considering supply chain agility and innovation capability and the mechanisms underlying the effects of supply chain digitalisation on a firm's performance. This is because agility and innovation are two critical factors that can significantly impact business performance, especially in today's rapidly evolving and competitive business landscape, where consumer expectations, technology, and market trends can change rapidly, organisations that prioritise agility and innovation are better equipped to thrive (Teece et al., 2016). These qualities enable businesses to seize opportunities, overcome challenges, and maintain a competitive edge, ultimately driving improved business performance and sustainable growth (Wang and Wang, 2023). As such we examine the mediating effect of supply chain agility and innovation capability on the relationship between supply chain digitalisation and firms' performance. Furthermore, given both agility and innovation are paramount strategic resources, firms may pursue both simultaneously. In this

regard, we will examine the potential synergistic effect between agility and innovation in enhancing firms' performance.

We collected empirical evidence in the UAE, one of the most progressive countries in developments such as artificial intelligence, biopharma and digitised healthcare (Gibbins, 2022). As per the UAE government report, the UAE's digital economy contributes 9.7 per cent to the GDP in 2022. UAE government aims to increase the digital economy's contribution to the country's gross domestic product (GDP) from 9.7% as of April 2022, to 19.4% in the next decade, effectively doubling its current share. The UAE has made significant strides in technological advancement, and the establishment of a highly resilient digital economy requires a focus on four critical priorities. These priorities include promoting inclusive connectivity, fostering sustainability, facilitating the development of local skills, and advancing industrial digitalisation (SDG, 2017). This study also supports and contributes to digitalisation and innovation in the UAE.

Our research indicates that supply chain digitalisation can have a beneficial impact on a company's performance by enhancing both supply chain agility and innovation capability. To be more precise, the relationship between supply chain digitalisation and firm performance is fully mediated by supply chain agility and innovation capability. This contributes to both supply chain digitalisation and supply chain management literature in terms of a new conceptual framework that integrates supply chain digitalisation concepts with supply chain agility and innovation capability. This could provide a fresh perspective on how digitalisation impacts performance through various capabilities post-COVID-19. The revelation of a synergistic effect between agility and innovation in our study holds significant implications for both academics and practitioners. In the context of the research model where supply chain agility and innovation capability serve as mediators, the interaction between supply chain agility, and innovation capability can potentially lead to negative outcomes for a firm's performance. Our study has presented empirical evidence to substantiate this observation. The empirical research offers valuable insights into the practical implications of supply chain digitalisation.

The rest of the paper is structured as follows: Sections 2 and 3 offer the theoretical foundation and the development of hypotheses. Section 4 outlines the research methodology, encompassing details on research sampling and the instruments used. In Section 5, the empirical data analysis and results are presented. The concluding sections explore the implications of the findings, wrap up the paper with reflections on research limitations, and suggest potential avenues for future research.

2 Theoretical background

2.1 Resource-based view

RBV is a key player in supply chain digitalisation research (Seyedghorban et al., 2020). RBV provides a theoretical framework to assess potential factors that can be utilised to gain a competitive advantage. RBV suggests that a company's resources and capabilities are the key drivers of its competitive advantage (Wernerfelt, 1984), by leveraging its valuable, rare, and irreplaceable resources to develop unique and valuable capabilities that are difficult for competitors to imitate, consequently, a company can establish a sustainable competitive advantage (Barney, 1991). Based on RBV, technology is considered a valuable and important resource in the framework, particularly if it is unique or difficult for competitors to replicate (Teece et al., 1997, Porter, 1985).

Capability refers to an organisational ability to assemble, integrate, and deploy valued resources (Bharadwaj, 2000, Wang, 2016). In this study, supply chain agility and innovation capability are viewed as dynamic capabilities, the development of robust dynamic capabilities is crucial for cultivating the organisational operational capabilities needed to improve performance (Geyi et al., 2020, Teece et al., 2016, Wang, 2016). This approach regards the company as a collection of resources and highlights the existence of resource heterogeneity within the organisation (Barney, 1991). Digitalisation enhances the value of agility and innovation by providing real-time data, insights, and automation that enable faster decision-making, better customer understanding, and more efficient processes. Supply chain digitalisation can make agility and innovation even rarer by integrating technology into these supply chain processes, creating a competitive edge for organisations that effectively adopt digital tools. The successful integration of supply chain digital tools and strategies requires not only technical implementation but also a strategic alignment with organisational goals. This integration can be difficult for competitors to duplicate precisely.

Our study establishes the connections between supply chain digitalisation, supply chain agility, innovation capability, and a firm's performance within the framework of RBV. A firm's performance refers to the overall effectiveness, efficiency, and success of a business entity in achieving its strategic objectives and delivering value to its stakeholders (Wang et al., 2023b). It is a firm-level performance and encompasses various dimensions, including financial metrics, i.e., profitability, Return on Investment (ROI), operational efficiency, i.e., Cycle time, inventory turnover, customer satisfaction, market share, etc. The stakeholder approach suggests that firms must balance a multiplicity of stakeholders' interests that can affect or are

affected by the achievement of an organisation's objectives (Freeman et al., 2010, Wang et al., 2023b). Strong firm performance indicates that the company is effectively utilising its resources, generating profits, satisfying customers, and maintaining a competitive position/reputation within its industry.

2.2 Supply Chain Digitalisation

Supply chain digitalisation is currently in its nascent phases of advancement. (Seyedghorban et al., 2020). Discussion about supply chain digitalisation is scattered in the literature. Hartley and Sawaya (2019) discuss digital technologies including robotic process automation, artificial intelligence, machine learning and blockchain in supply chain processes. Wang et al. (2019) explore how blockchain technology is expected to impact future supply chain practices and policies. Kittipanya-ngam and Tan (2020) examine how digitalisation is transforming the food supply chain, enabling it to become more interconnected, streamlined, and adaptable to customer demands and regulatory standards. Ivanov et al. (2018) argue that digitalisation is one of the innovative flexibility drivers. Son et al. (2021) explore a potential downside of supply chain digitalisation. Strandhagen et al. (2022) demonstrate that digital technologies can influence performance in the shipbuilding industry. Sarkis et al. (2021) offer a contemplative analysis of the significance of both traditional and emerging digitalization and information technologies in advancing environmental sustainability within supply chains. Digital technologies can bring many benefits to supply chain operations. Supply chain digitalisation can help companies improve efficiency, increase supply chain visibility, enable supply chain agility and improve sustainability (Hartley and Sawaya, 2019, Strandhagen et al., 2022, Shashi et al., 2020, Sarkis et al., 2021).

In this study, supply chain digitalisation refers to integrating digital technologies across various areas of supply chain management (Hartley and Sawaya, 2019, Son et al., 2021). Supply chain digitalisation encompasses the utilisation of diverse technologies like cloud computing, Internet of Things (IoT) sensors, robotics, blockchain, artificial intelligence, and data analytics. These technologies work together to optimize processes, enhance decision-making, and foster improved communication among stakeholders. This, in turn, facilitates the seamless flow of physical goods, information, and cash within the supply chain. Henderson and Venkatraman (1993) argue that organisations must consider strategic alignment to realise value through information technology. Digitalisation also can be viewed as a digital transformation (Hartley and Sawaya, 2019). Son et al. (2021) stress that supply chain

digitalisation offers firms opportunities to increase revenue or innovation. Seyedghorban et al. (2020) emphasise that supply chain digitalisation can increase information availability, optimise logistics, and improve supply chain visibility and transparency through integration and collaboration. Supply chain agility, which allows firms to respond quickly to changes, may be viewed as a catalyst or mechanism in digital transformation.

Current supply chain digitalisation literature focuses on the application of digital technologies and/or manufacturing strategies. Srai and Settanni (2019) discuss the application of digital twins in end-to-end supply chains, such as the supply chain digital twins improve supply chain transparency and trust, which would lead to increased manufacturing productivity. Kittipanya-ngam and Tan (2020) demonstrate that supply chain digitalisation transforms the food supply chain and digitalisation can improve food product traceability, safety, and sustainability. Kumar et al. (2020) develop distributed manufacturing strategies to support the digital transformation in supply chains. Wang et al. (2021) investigate the application of blockchain technology in supply chain management, the paper shows that blockchain can improve supply chain integration and collaboration.

2.3 Supply chain agility

Based on RBV, supply chain agility is a firm's capability to respond rapidly to unexpected changes and transform changes into business opportunities (Swafford et al., 2008, Teece et al., 2016, Braunscheidel and Suresh, 2009). Christopher and Towill (2001) suggest that agility encompasses more than just organisational structures, information systems, and logistics processes; it also includes mindsets. It is a capability that businesses need to cultivate across all levels, which enables them to respond quickly and effectively to changes in the market and customer demands. According to Christopher (2000), agility refers to an organisation's capacity to swiftly respond to shifts in demand, encompassing changes in both volume and variety. Gligor et al. (2015) defined supply chain agility as the capability of a firm to rapidly modify its supply chain strategies and operations, including adjustments to production and/or service capacity.

After the COVID-19 pandemic, supply chain agility is recognised as a crucial capability within the supply chain (Daneshvar Kakhki et al., 2023). Supply chain agility aids companies in decreasing lead time (Mason-Jones and Towill, 1999), enhancing collaboration (Swafford et al., 2006), managing risk (Christopher, 2000, Teece et al., 2016), enhancing sustainability (Wang and Wang, 2023). Supply chain agility enables firms to develop a fast-moving,

adaptable and robust business model, as it allows firms to address unexpected and unpredicted changes and events (Braunscheidel and Suresh, 2009, Swafford et al., 2006).

In previous studies, agility is about customer responsiveness (van Hoek et al., 2001). The inherent flexibility is the primary driver of supply chain agility (Swafford et al., 2006). Later, Teece et al. (2016) argue that although supply chain agility is costly, it is an important mechanism for achieving effective organisational management. Gligor et al. (2016) argue supply chain agility is influenced by several factors, including environmental uncertainty, supply chain orientation, and market orientation. Kim and Chai (2017) explore how supplier innovativeness affects both supply chain collaboration and agility. Geyi et al. (2020) emphasise the importance of technology as an agile enabler. Further, Wang et al. (2024) posit that supply chain agility also needs to embrace problem-solving, and firms must work closely with both internal and external stakeholders such as suppliers, employees, customers, communities, governments, etc. to quickly solve problems when an unexpected situation arises. Girod et al. (2023) argue that the relationship between agility and performance is assumed to be positive, but we currently have limited comprehensive empirical evidence to conclusively determine whether agility indeed enhances performance.

Shashi et al. (2020) suggest that supply chain agility has become a key strategy in the era of digital transformation, as supply chain agility is an important ability of the entire supply chain, including its partners, to quickly adjust the network and its operations in response to the rapidly changing and unpredictable demands of the market. In addition, technology plays a vital role in facilitating information sharing, which is crucial for supply chain agility.

Wang and Wang (2023) posit that supply chain agility is a dynamic capability, it involves the capacity to sense changes in the market or industry, seize opportunities, and transform the organisation's resources and capabilities to create and sustain a competitive advantage. Supply chain agility is essential for firms operating in rapidly changing and unpredictable environments. Supply chain agility allows companies to increase their flexibility, resilience, and adaptability when dealing with unpredictable and changing situations. As a result, this can help them maintain a competitive advantage over time.

2.4 Innovation capability

According to RBV, innovation can be seen as a capability within an organisation, as it involves the proactive utilisation of resources with new ideas to generate value (Wang, 2016). Supply chain agility and innovation capability both play a pivotal role in mitigating risks and

uncertainties and enhancing performance (Wang et al., 2020a, Braunscheidel and Suresh, 2009). To succeed in a volatile environment, a company must adopt innovation (Calantone et al., 2002). Innovation capability refers to the organisational capability to consistently convert knowledge and ideas into new products, processes, and systems (Lawson and Samson, 2001, Wang, 2016). Innovation capability also refers to the implementation or creation of technology as applied to new products, services, processes, or systems in an organisation (Lin et al., 2010, Chang and Lee, 2008).

Innovation capability stands as a unique asset within a firm (Tamayo-Torres et al., 2016). It possesses an implicit and unalterable nature, tightly linked to internal experiences and the accumulation of experimental knowledge, Guan and Ma (2003) stress that the capabilities of a firm play a crucial role in delivering and maintaining its competitive advantage, as well as in executing the entire strategic plan. Innovation is a multi-dimensional concept; it may include internal and external resources. It may contain different types of innovation capabilities, for example, Lin et al. (2010) affirm that innovation capabilities encompass product innovation, process innovation, administration innovation, marketing innovation and service innovation. Innovation may be categorised into radical and incremental innovation (Tidd and Bessant, 2021), technological innovation (Liu and Jiang, 2016) and administrative innovation (Lin et al., 2010).

Innovation culture also plays an important role in the digital transformation era (Rauniyar et al., 2023, Wang et al., 2020a). Digital technologies offer enhanced connectivity and computational capabilities, presenting immense possibilities for fostering innovation within businesses (Vial, 2019, Rauniyar et al., 2023). Seyedghorban et al. (2020) stress that technology serves as a significant catalyst for advancing innovation in supply chain digitalisation. Camison and Villar-Lopez (2014) argue that promoting organisational innovation encourages the cultivation of technological innovation capabilities and that both organisational innovation and technological capabilities can contribute to superior firm performance. Lu et al. (2020) stress that innovation enables small and medium-sized enterprises (SMEs) to attain a competitive edge and enhance both productivity and profitability. Moreover, Wang et al. (2020a) assert that firms have the potential to reduce the adverse effects of supply chain risks by cultivating innovation capabilities in a supply chain.

3 Conceptual framework and hypothesis development

We employ RBV as a theoretical lens in the research model. Digital technology is viewed as a firm's valuable resource to create organisational capabilities, which can assemble, integrate and deploy tangible, intangible and personnel-based resources (Bharadwaj, 2000), to achieve sustainable competitive advantages (Barney, 1991). The model posits interconnections between key constructs: supply chain digitalisation, supply chain agility, innovation capability, and a firm's performance. We focus on supply chain digitalisation, that is, using digital technologies to integrate and enhance supply chain processes from sourcing raw materials to final customers. A firm's performance refers to the overall corporate performance. Supply chain agility and innovation capability link the supply chain digitalisation and a firm's performance. Figure 1 displays the conceptual framework. In this section, we discuss the interrelationships among these constructs and present three main hypotheses in the study.

3.1 Mediating role of supply chain agility

Supply chain agility serves as an intermediary factor that impacts the connection between supply chain digitalisation and a company's performance. Seyedghorban et al. (2020) stress that supply chain agility is one of the important concepts in the supply chain digitalisation discipline. Technology plays a crucial role as an enabler of supply chain agility (Geyi et al., 2020). In literature, researchers posit that digital technologies may improve supply chain agility. For example, Blockchain (Kurpjuweit et al., 2021, Wang et al., 2021), cloud computing (Schniederjans et al., 2016), artificial intelligence (Dubey et al., 2022), IT (Swafford et al., 2008), Big Data (Dubey et al., 2019). The adoption of digital technologies in supply chain operations may lead to shorter lead time, and a more agile supply chain (Kurpjuweit et al., 2021). In addition, digital technologies offer different ways to enable supply chain agility, as we discussed previously, increased supply chain visibility and transparency, such as the Internet of Things, sensors, 5G and RFID can be used to provide real-time inventory data and shipment status (Mistry et al., 2020). This would allow firms to quickly identify and respond to unexpected events/changes.

Supply chain agility can be viewed as a mechanism in supply chain practices (Geyi et al., 2020). In addition, supply chain digitalisation drives supply chain agility (Seyedghorban et al., 2020). However, current literature offers little guidance on how supply chain agility impacts the firm's performance (Girod et al., 2023). According to agile strategies, the agile approach emphasises flexibility, adaptability, resilience, and continuous improvement in business operations (Gligor et al., 2019, Girod et al., 2023). In supply chain management, an agile

strategy can help companies to manage their supply chains more effectively and efficiently, as it enables firms to respond quickly to changes in demand or supply disruptions, optimize inventory levels, and improve collaboration with suppliers and customers (Christopher, 2000, Wang et al., 2024). Supply chain digitalisation plays a crucial role in enhancing the agility and responsiveness of businesses, this enables firms to bring changes and speed up problem-solving (Swafford et al., 2008, Wang et al., 2024). Moreover, supply chain agility, which is a dynamic capability, enables firms to respond quickly and effectively to sustainability-related challenges and opportunities (Wang and Wang, 2023, Geyi et al., 2020). This is particularly important in a rapidly changing business environment where sustainability issues such as climate change, social responsibility, and resource scarcity are becoming increasingly critical to business success (Seuring and Müller, 2008). Overall, supply chain digitalisation helps businesses to become more agile and responsive and lead to enhanced performance. By leveraging digital technologies and tools, businesses can transform their supply chain operations to better adapt to changes, respond to disruptions, and meet customer demands effectively. Therefore, we hypothesise:

H1: Supply chain agility mediates the association between supply chain digitalisation and a firm's performance.

3.2 Mediating role of innovation capability

Innovation capability plays a crucial role in connecting the relationship between supply chain digitalisation and a firm's overall performance. Innovation capability acts as an intermediary factor that translates the benefits and advancements brought about by supply chain digitalisation into tangible improvements in the firm's performance, i.e., operational, financial, and strategic outcomes. Essentially, a strong innovation capability enables the organisation to effectively leverage the digital tools and technologies within the supply chain to create new products, optimise processes, enhance customer experiences, and drive higher performance levels across various aspects of the business (Camison and Villar-Lopez, 2014).

Digital technologies have the potential to enhance the firm's performance. However, it is important to recognise that technology alone is not sufficient to improve overall performance. Based on RBV, technologies may influence performance through organisational capabilities (Wang, 2020). For instance, supply chain digitalisation may help improve performance by supporting traceability and reinforcing standards (Kittipanya-ngam and Tan, 2020), increasing transparency, digital connectivity, and manufacturing productivity (Srai and Settanni, 2019),

supporting sustainable sourcing (Pagell et al., 2010), optimisation of supply chain operations (Wang et al., 2020b). Innovation capability enables the advancement of digital technologies (Camison and Villar-Lopez, 2014). Digitalisation allows for greater transparency and traceability across the supply chain, which can help identify areas where performance can be improved. Innovation capability can help generate new ideas and approaches to improve performance (Wang et al., 2020a). In addition, digital technologies i.e., Blockchain, IoT, etc. optimise end-to-end supply chain operations, this may help facilitate information sharing and integrate the supply chains (Wang et al., 2021) to promote innovation capability. Meanwhile, innovation capability allows firms to exploit the information to enhance performance, and ultimately the use of digital technology may have positive impacts on performance (Beier et al., 2020). Therefore, we hypothesise the following:

H2: Innovation capability mediates the association between supply chain digitalisation and a firm's performance.

3.3 Combined effects of supply chain agility and innovation capability on performance

Supply chain agility and innovation may improve performance by enabling organisations to quickly adapt to unexpected circumstances and incorporate new ideas and approaches into their operations to achieve better performance. Agile supply chains often have shorter lead times, allowing products to reach customers faster (Wang et al., 2024). This can result in improved order fulfilment and faster response to market trends (Christopher and Towill, 2001). By enhancing the problem-solving and responsiveness of supply chain operations, Companies can leverage supply chain agility to more effectively adjust to shifting market conditions (Wang et al., 2024), and utilise innovation capability to meet new customer requirements (Wang, 2016). In addition, an organisation with strong innovation capability is able to adapt to changes, stay ahead of the competition, and meet the evolving needs of its customers and the new markets (Calantone et al., 2002). Furthermore, both supply chain agility and innovation capability can help companies identify and respond to emerging performance risks and opportunities (Christopher, 2000, Braunscheidel and Suresh, 2009, Wang et al., 2020a). Clauss et al. (2021) observed that there is a positive association between strategic agility and innovation. Agile supply chains often emphasise collaboration and communication among various stakeholders. For example, Blockchain technology can be used to optimise supply

chain integration and collaboration (Wang et al., 2021). This can help firms to improve trust and supply chain traceability to improve collaboration and communication. Furthermore, effective collaboration may enable a company to consistently generate new ideas and apply novel solutions to challenges and opportunities (Wang, 2016, Wang et al., 2023b). This also may lead to improved overall performance. Thus, supply chain agility and innovation may have a synergistic effect on performance. The following hypothesis is proposed.

H3: Supply chain agility and innovation capability produce a synergistic effect (positive interaction) on a firm's performance.

[Figure 1 here]

4 Method

4.1 Sample

A firm-level unit of analysis was designed in our research questionnaire. As mentioned before, this study selected the UAE as a research context. We collected empirical data in the UAE through an online survey in the aftermath of the COVID-19 pandemic (Feb-March 2022). The UAE has seven emirates: Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al Quwain, Ras Al Khaimah, and Fujairah. Online surveys offer a convenient and efficient method for collecting valuable information and insights from a broad audience in a timely and cost-effective manner (Bryman and Bell, 2011). Supply chain digitalisation has significant effects across industries, this research is the first to explore the effects of supply chain digitalisation on performance through supply chain agility, we did not focus on a specific industry in the study. Having said that, we include all main industries in the UAE, such as oil & gas, construction, manufacturing, transportation, trading, tourism, healthcare and finance. All sample companies were selected online through LinkedIn. We targeted the managers across seven emirates and collaborated with the industry association CIPS UAE to gather the data. Small, medium, and large companies make up the sample. Most respondents hold managerial positions in their companies. The survey distribution ceased after obtaining a sample of 50 comprehensive responses. This pause enabled us to assess the sample, identify any apparent issues with the survey design and resulting outcomes, and make essential adjustments as part of a pre-test. After confirming the

reliability of the instrument, data collection resumed. A total of 271 valid responses were recorded. This indicates about a 23% response rate in this study.

Non-response bias refers to a type of bias that can occur in research studies when individuals who do not respond to a survey or questionnaire differ in important ways from those who do respond. This can potentially impact the validity of the study's results. We followed the guidelines by Armstrong and Overton (1977) to test non-response bias in the study. The survey responses of early and late respondents were compared by an independent t-test, and we did not find any significant differences in terms of company sizes and location. The non-response bias is not a concern in the dataset.

Common method bias (CMB) refers to a type of bias that can arise in research studies when the way data is collected, rather than the constructs being measured, influences the observed relationships between variables (Podsakoff et al., 2003). In this research, we used various measures suggested by Podsakoff et al. (2012) to minimise the negative effects of CMB. For example, we conducted a pre-test to ensure survey item validity and a cover letter was offered to all participants to explain our research objectives and anonymous survey. Furthermore, Harman's single-factor test was carried out in a factor analysis to examine CMB in the study. The results indicate that no single factor can account for the majority of the variance observed in the data (>50%). Based on the analysis, CMB did not pose a threat to the validity of the study.

4.2 Measurement

The validated scales were adopted for assessing supply chain agility (Wang et al., 2024), innovation capability (Wang et al., 2020a, Guan and Ma, 2003) and a firm's performance (Wang and Wang, 2023, Wang et al., 2022b). Supply chain digitalisation was derived from firms' digitalisation (Wang et al., 2022a). All scales are reflective measurements, which provide a powerful tool for analysing the concepts, offering advantages over other measurement techniques (Hair, 2010). 7-point Likert measurement scales were used to measure all constructs (1= strongly disagree, 7= strongly agree). Joshi et al. (2015) argue that a 7-point scale offers more advantages compared to other Likert scales. Further, we conducted confirmatory factor analysis (CFA) to validate the measurements in the study.

The Kaiser-Meyer-Olkin (KMO) test was used to assess sampling adequacy. The KMO test produces a score between 0 and 1, with higher scores indicating better sampling adequacy for factor analysis. A commonly used criterion suggests that a statistic above 0.80 is indicative

of adequate sampling for factor analysis. In our study, the KMO measure of sampling adequacy was found to be 0.94, which indicates satisfaction.

Bartlett's test of sphericity was conducted to assess the suitability of the data for factor analysis. This test evaluates the null hypothesis that the variables within the dataset are uncorrelated or independent, against the alternative hypothesis that they exhibit correlations or associations. Our results show that Bartlett's test was significant, suggesting that factor analysis could be a useful technique to uncover the underlying structure of the variables.

5 Analysis and results

SPSS Amos 28 was used to perform factor analysis. CFA is used in measurement models to assess the validity of a model by examining the relationships between observed variables and their underlying latent constructs (Hair, 2010). We removed the items with poor loadings. A desirable model fit is indicated by achieving values equal to or greater than 0.90 for indices like NFI, IFI, TLI, and CFI, while the RMSEA index should register a value lower than 0.08. The measurement model results indicate a good model fit: (Chi-square = 439.9 (df=147, p<.001), Chi-square/df (CMIN/DF) =2.9; NFI=0.90; IFI=0.93, TLI=0.92; CFI=0.93; RMSEA=0.086). The measurement model of supply chain digitalisation contains five items, the measurement model of supply chain agility includes six items, the measurement model of innovation capability includes five items, and the measurement model of a firm's performance contains three items (see Table 1).

5.1 Reliability and validity

It is essential to test the reliability of a model to ensure that the measurement instrument utilised in the study is producing precise and consistent results. Table 1 shows the measurement items and Cronbach α scores of scales in the study. Cronbach's alpha is a commonly used measure of internal consistency reliability, which examines the extent to which different items within a scale or questionnaire are measuring the same construct. The threshold of 0.70 demonstrates the reliability of scales (Hair, 2010). All factor loadings above 0.70.

[Table 1 here]

Table 2 indicates the reliability and validity of the measurement models. Composite Reliability (CR) is a measure of the internal consistency or reliability of the items that measure a construct. If the CR value is greater than the threshold of 0.7, it suggests that the items are measuring the same construct and that the construct has high internal consistency and reliability (Hair, 2010). Convergent validity was established by using average variance extracted (AVE), which is a measure of the amount of variance captured by the construct relative to the amount of variance due to measurement error. If the AVE value is greater than the threshold of 0.5, it indicates good convergent validity (Hair, 2010).

Discriminant validity was established by examining the correlation coefficients between the measures and comparing them to the AVE values for each construct (Fornell and Larcker, 1981). If the correlation coefficients between measures are lower than the square root of the AVE values for the constructs, it suggests that the measures are distinct from one another and are measuring different constructs (see Table 2).

Was also calculated variance inflation factor (VIF) to assess potential multicollinearity issues. VIF is a statistical measure used to assess the severity of multicollinearity in regression analysis. Multicollinearity may occur when two or more independent variables in a regression model are highly correlated with each other. This can create difficulty in determining the individual impact of each variable on the dependent variable. Our results show that all values are below the recommended conservative threshold of 5 (Kim, 2019). There is no indication of a multicollinearity issue with the measures in this study.

[Table 2 here]

5.2 Research hypotheses testing

The research hypotheses were tested by estimating a structural equation model in Amos 28. The fit indices of the structural model fall within the generally accepted thresholds (Chi-square = 439.9 (df=147, p<.001), Chi-square/df (CMIN/DF) =2.9; NFI=0.91; IFI=0.94, TLI=0.93; CFI=0.93; RMSEA=0.08) and suggest a good model fit the data. Table 3 shows the results for the structural paths. supply chain digitalisation exerts a stronger impact on innovation capability than supply chain agility does. Additionally, innovation capability slightly outweighs supply chain agility in its influence on firm performance. The firm's size was applied as a control variable for supply chain agility, innovation capability, and firm's performance; but it only had a significant effect on the firm's performance (0.18 at p<0.01).

[Table 3 here]

The empirical results show that supply chain digitalisation is associated positively with supply chain agility and innovation capability, and then supply chain agility and innovation capability are associated positively with the firm's performance. The findings also demonstrate the mediating effect of supply chain agility in the research model. To test our hypotheses H1 and H2, a bootstrapping method (sampling iterations n=1500) was used to analyse indirect effects (Preacher and Hayes, 2008). We find that supply chain agility is a significant mediator between supply chain digitalisation and a firm's performance (β=0.25 at p<0.01). In addition, innovation capability is a significant mediator between supply chain digitalisation and a firm's performance (β=0.24 at p<0.01). To test whether the mediating effects of both supply chain agility and innovation capability are full or partial, we added a direct path from supply chain digitalisation to the firm's performance. The result shows that the direct path between is non-significant (0.15 at p>0.05), suggesting that supply chain agility and innovation capability fully mediate the relationship between supply chain digitalisation and a firm's performance.

To better understand the role of supply chain agility and innovation capability in this model, we test the synergistic effect (positive interaction) between supply chain agility and innovation capability in predicting a firm's performance (H3). The results indicate that there is a statistically significant interaction between supply chain agility and innovation capability on a firm's performance. However, surprisingly, the sign of the interaction is negative (β=-0.09; t=2.76; p<0.01); therefore, H3 is not supported. Figure 2 shows the interaction effect. Table 4 summarises the results of the hypotheses testing.

[Figure 2 here]

[Table 4 here]

[Figure 3 here]

6 Discussion

Digitalisation has gained significant popularity, leading numerous companies to embrace it with the anticipation that it will enhance their performance (Li et al., 2023). Technology is

rapidly transforming business operations, with advancements such as artificial intelligence, blockchain, and the Internet of Things (IoT) enabling greater visibility, efficiency, and collaboration (Seyedghorban et al., 2020, Wang et al., 2020b). Most extant research regarding supply chain technologies focuses on the application of digital technologies. These technologies are being used to increase supply chain transparency, optimize supply chain operations, improve decision-making, and enhance the customer experience (Srai and Settanni, 2019, Kumar et al., 2020, Wang et al., 2021). As mentioned before, very few empirical studies were conducted to understand the underlying mechanisms of supply chain digitalisation, and agility on a firm's performance (Girod et al., 2023). Supply chain digitalisation is a new concept (Seyedghorban et al., 2020), little is known about how the use of digital technology in supply chain management can lead to a firm's performance through supply chain agility and innovation capability.

There is an argument regarding how technologies affect a firm's performance, some studies argue that technologies may have a negative impact on performance (Bharadwaj, 2000). Our results indicate that supply chain digitalisation is positively associated with a firm's performance through supply chain agility, and innovation capability, this is in line with our expectations, in addition, supply chain agility and innovation capability are directly and positively associated with a firm's performance, the results are consistent with previous research (Geyi et al., 2020, Wang and Wang, 2023, Camison and Villar-Lopez, 2014). We take a closer look at the effects of supply chain digitalisation on a firm's performance, our findings show that supply chain digitalisation can have a positive impact on profitability, market share and reputation.

Our results show that supply chain digitalisation can significantly impact a firm's performance through supply chain agility and innovation capability. However, improving performance through technology alone will prove challenging unless companies possess a well-defined goal and leverage the technology to construct distinct and valuable capabilities from the outset. For example: by leveraging digital technologies such as advanced analytics, blockchain, cloud computing, 5G, and the Internet of Things, firms have the potential to enhance their business connectivity by gathering and analysing real-time data from every stage of the end-to-end supply chain. Based on our argument, firms can intentionally gather pertinent data and subsequently utilise this information for related capacity-building efforts i.e., supply chain agility and innovation. Further, through greater supply chain agility, businesses can more effectively respond to change including internal changes, external changing market conditions, and supply chain disruptions/uncertainties (Girod et al., 2023). This can lead to a range of

benefits. As we discussed before, digital technologies may enhance traceability and transparency across the supply chain (Kittipanya-ngam and Tan, 2020), allowing businesses to more effectively monitor and manage business performance. Moreover, digital technologies can facilitate collaboration and communication within and across supply chain partners (Wang et al., 2021), enabling businesses to work together more effectively to promote performance.

The negative interaction between supply chain agility and innovation is surprising and noteworthy given both innovation and agility promote changes in business organisations in response to dynamic environment. However, at the same time, adopting both strategies would pose risks to organisations that stem from a lack of alignment, resource constraints or risk amplification. For example, the digital landscape evolves rapidly, and if the supply chain agility and innovation are not adaptable to emerging digital technologies, strategic misalignment can result in adverse effects. This discordance often manifests as conflicting priorities and challenges in allocating resources effectively. Teichert and Bouncken (2008) stress that innovation is a strategic issue which needs to be aligned internally and externally. Resource constraints could result in a situation where pursuing both supply chain agility and innovation simultaneously will strain firms' resources, including insufficient funding or a shortage of skilled personnel or expertise due to internal resource competition for agility initiatives and innovation projects (Hottenrott and Peters, 2012). Furthermore, the pursuit of agility and innovation may heighten the risk exposure of the supply chain disruptions, especially if both the demand and supply side are highly dynamic (Braunscheidel and Suresh, 2009, Fernandes and Paunov, 2015). Therefore, striking a balance and ensuring synchronisation between these elements is crucial to maximizing their synergistic potential for positive organisational performance.

The study provides several valuable contributions to supply chain digitalisation literature. Our study contributes to the understanding of the effects of supply chain digitalisation on a company's performance, specifically through the lenses of supply chain agility and innovation capability. The findings affirm the significance of implementing digital technologies in supply chains (Seyedghorban et al., 2020). Supply chain agility and innovation capability can provide businesses with the tools and capabilities needed to enhance a firm's performance, while also improving their supply chain effectiveness, resilience, innovativeness, and competitiveness. The full mediation also reveals that digitalisation-agile-innovation strategy alignment is required to effectively leverage organisational capabilities to achieve a better firm's performance. The joint influence of supply chain agility and innovation capability might lead to an adverse impact on the firm's performance. As discussed above, the adverse consequences

stem from various facets. The research provides empirical evidence to demonstrate the adverse outcome.

6.1 Theoretical implications

From RBV perspective, our study contributes to the understanding on the value of the supply chain digitalisation as organisational resource which need to be channelled through certain capabilities before the value can be appropriated to enhance firm's performance. In our study, supply chain agility and innovation are shown to be effective capabilities through which the potential of digitalisation as valuable resource can be realised. The negative interaction between supply chain agility and innovation is also noteworthy where two capabilities which appear to be congruent in their nature (characteristics) do not necessarily produce synergistic effect. Again, in light of RBV, the result challenges our understanding that usually suggests pursuing capabilities which look similar is an efficient strategy which both capabilities require similar resources. However, our results on the contrary suggest that such a strategy can be ineffective because the two strategies can end up competing the same resources within organisations.

6.2 Managerial implications

The research findings offer several practical implications for managers across industries. First, when managers decide to implement new technologies in their supply chain management, it is essential for management to identify the specific issues that require attention. Furthermore, having a well-defined vision or objective for supply chain digital transformation is crucial. This study demonstrates that supply chain digitalisation may help firms to improve their performance through organisational capabilities. Our mediating effects may imply that simply implementing new technology does not guarantee better results. The technology needs to be seamlessly integrated into existing processes, capabilities and workflows to maximise its effectiveness (Wang et al., 2021). If the technology doesn't align with how the organisation operates or isn't used to its full potential, its impact on performance may be limited or even negative. Managers should intentionally gather pertinent data generated by technologies for meaningful utilisation. This aids in constructing distinct and valuable capabilities i.e., supply chain agility and innovation capability. Second, in addition to the predetermined objectives, managers should take into account how digital technologies can facilitate the integration of supply chain agility and innovation capability, they are two important capabilities in firms.

Specifically, managers should pay attention to the adverse interaction between supply chain agility and innovation capability on a firm's performance. Lack of proper integration between innovative practices and supply chain processes may result in inefficiencies. For instance, if new product designs, new methods or technologies are not seamlessly incorporated into the supply chain operations, it can lead to delays, increased costs, and a decrease in overall performance. Third, introducing new technologies always entails change, and our research findings propose that adopting an agile approach is a suitable way for firms to attain better performance during digital transformation. In this context, managers must be mindful of uncertainties and unforeseen circumstances. Moreover, they should establish problem-solving mechanisms during the digital transformation process (Wang et al., 2024). Fourth, our research models indicate that managers should recognise the potential for the role of innovation capability in supply chain digitalisation to enhance performance. However, implementing supply chain digitalisation and innovation could come with a high cost. While researchers suggest that digital technologies and innovation can offer numerous advantages, companies should be aware of the overall cost of implementing these new technologies/ideas. Therefore, before introducing any new technologies, firms should carefully consider both the costs and benefits.

7 Conclusion

The study examines the interplay between supply chain digitalisation, supply chain agility, innovation capability and firm's performance. The findings advance the extant research on the antecedents of a firm's performance by incorporating supply chain agility and innovation capability that serve as a conduit between supply chain digitalisation and a firm's performance based on RBV. The study contains some research limitations. First, as mentioned before, this research is the first to explore the effects of supply chain digitalisation on a firm's performance through supply chain agility, we did not focus on a specific industry, which may limit the in-depth analysis in industries. However, this may inspire further research to validate the research models in different contexts. Second, due to limited research resources, we applied single-informant designs in the study, this may suffer from several problems, such as common method variance. Although we have not found common method variance in this study, multiple-source studies should be recommended to test the models in further research. Third, all sample companies were invited online, our study excluded companies without internet access in the UAE. This may limit some findings. Further research may be designed to collect data both online and offline data collection. Finally, our study discovered unexpected results - the adverse

interaction between supply chain agility and innovation capability on a firm's performance, suggesting the possibility of additional underlying mechanisms that act as a link between supply chain agility, innovation capability and a company's performance. Thus, this may provide direction for further research, the researchers could explore various underlying mechanisms to refine the research model.

Corporate social responsibility has become an increasingly important concept in business as more and more consumers, investors, and other stakeholders expect companies to operate in a socially responsible and environmentally friendly way. Digitalisation may introduce cybersecurity risks and vulnerabilities. Further supply chain digitalisation research should pay more attention to risks and corporate social responsibility activities, as companies can improve their value, strengthen stakeholder relationships, and contribute to a more sustainable and equitable future by engaging in corporate social responsibility activities. As discussed earlier, given the potentially high costs of technology investment and the potential for adverse effects on overall corporate performance (Bharadwaj, 2000), there's a call for a deeper investigation.

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