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The mediating role of supply chain digitization in the relationship between supply chain agility and operational performance

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This study investigates the mediating role of supply chain digitization in the relationship between supply chain agility and operational performance. To test the study hypothesis, a survey questionnaire was distributed to 320 respondents occupying different managerial positions at pharmaceutical manufacturing companies in Jordan. However, 285 questionnaires were retrieved, of which 17 were excluded for their invalidity. Thus, only 268 questionnaires were found to be valid for statistical analysis. The results show There is a relationship that is statistically significant between supply chain agility and operational performance; there is an impact of supply chain agility on supply chain digitization; there is an impact of supply chain digitization on operational performance; and there is no significant mediating role of supply chain digitization in the relationship between supply chain agility and operational performance. The study concludes by emphasizing the importance of supply chain agility in enhancing the operational performance and supply digitization of pharmaceutical manufacturing companies in Jordan. The study recommends other researchers conduct further studies on how digitalization, information systems, and technology may improve supply chain agility, examine the ideas of responsiveness and resilience in agile supply chains, and recognize how these factors might be balanced by businesses to attain the best possible operational performance.

1. Introduction

Because existing industrial markets have globalized and pierced international boundaries, today's corporate world has produced tighter market competition. Simultaneously, to survive and maintain a sustainable competitive edge in this global market, organizations must recognize emerging digital technologies that can be utilized to establish a new business model. In today's competitive world, how manufacturing activities are carried out has compelled organizations to adopt modern manufacturing technologies such as 3D printing, quick prototyping, and the usage of the Internet of Things for information and analysis. In this competitive and volatile climate, the goal of every firm is to provide the consumer with the correct product quality, quantity, and pricing at the best possible time.

Digitalization refers to “the increasing penetration of digital technologies in society with the associated changes in the connection of individuals and their behavior” (Gimpel & Roglinger et al., 2015). Supply chain digitization aims to make the supply chain more efficient, agile, and responsive by enabling real-time inventory tracking and monitoring, reducing lead times, optimizing production processes, improving demand forecasting, enhancing supplier collaboration, and increasing visibility and transparency across the supply chain (Büyüközkan & Göçer,2018). Hoberg et al. (2015, p. 6) define supply chain digitization as utilizing cutting-edge digital technologies to alter conventional methods of (1) carrying out supply chain

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planning and execution tasks, (2) corresponding with various supply chain participants, and (3) enabling new corporate business models is the definition of digital supply chain management. A comprehensive organizational change process that touches every aspect of the internal and external supply network is also necessary to develop a mature digital supply chain management level.

Overall, supply chain digitization is critical for businesses to remain competitive in today's business market. When customers expect rapid and reliable delivery, supply chain interruptions can have serious ramifications for corporate operations and profitability. The ability of a supply chain to adjust rapidly and effectively to changes in demand, supply, or market conditions is referred to as supply chain agility. It is a critical aspect of supply chain management as it enables companies to adapt to changing customer preferences, supply chain disruptions, and market landscape shifts (Agrawal & Narain,2018). According to Goldman et al. (1995), agility is a dynamic, context-specific, and aggressive change that embraces and pursues growth, success, profits, market share, and customers. Gligor and Holcomb (2012) contend that an agile organization can quickly satisfy customer orders, can introduce new products frequently and promptly, and can speedily get into and out of strategic alliances with its trading partners. According to the studies of Liu et al. (2021) and Hallikas et al. (2021). Supply chain digitization can significantly impact the operational performance of manufacturing companies, By increasing transparency, enhancing efficiency, boosting adaptability, and enhancing collaboration, manufacturers can reduce costs, boost productivity, and respond more swiftly to shifting market demands.

2. Statement of the Problem

Digital transformation transforms essential industries into a business model that relies on digital technologies to innovate products and services and provide new channels to achieve unprecedented levels of performance efficiency. As a result, digital transformation saves time and money, increases flexibility and efficiency in production processes and data processing, takes advantage of artificial intelligence technologies, improves quality, streamlines procedures, and opens up opportunities to deliver innovative and creative services that were previously unavailable. Recent technological advancements, exemplified by the Industrial Revolution 4.0, have necessitated the digitization of supply chains and logistics in general. In the new business environment, only businesses that can anticipate and embrace change will survive. Market share will be lost by businesses in industries that do not adapt to the new laws of the game, the change of a supply and logistics chain from an old model to a digital one necessitates meticulous planning. The benefit of achieving this transition is openness to worldwide business, where the possibilities rise exponentially and proportionally with the capability of the available work team (Marmolejo & Saucedo, 2020; Liotine,2019).

In this modern period marked by a complex and dynamic environment as well as a competitive corporate marketplace, digitization has evolved as a new phenomenon that has touched many parts of life around the world. More than 90% of internet users have already completed online transactions and approximately 40% of businesses have used advanced big data analytics technologies. Furthermore, by 2020, there will be 26 billion 'things' connected to the 'Internet of Things.' (Hung 2017). Many global supply systems are unprepared for the future we are entering. As a result, supply chain managers must shift their focus from cost-cutting to enabling innovative processes and making organizations more connected and flexible to create value across the enterprise. Every day, new digital technologies emerge, with the potential to disrupt practically all aspects of old corporate procedures (Agrawal & Narain,2018). Cybersecurity threats, high implementation costs, integration hurdles, technological reliance, and diminished human interaction are just some of the possible downsides of digitizing the supply chain. To make sure the advantages of digitization outweigh the disadvantages, these concerns must be properly evaluated and resolved. Modern manufacturing organizations are adopting agility to respond rapidly to unanticipated changes in the competitive business environment. To achieve agility, supply chain managers must swiftly modify their supply chain strategies and operations to respond quickly and effectively to volatile markets and associated uncertainties. However, it is clear that a rapid change in the supply chain is expensive, and that achieving agility frequently necessitates sacrificing efficiency (Teece, 2016). Therefore, this study seeks to answer the following questions:

1. What is the relationship between supply chain agility and operational performance?
   1.1 What is the relationship between dynamic sensing and operational performance?
   1.2 What is the relationship between dynamic flexibility and operational performance?
   1.3 What is the relationship between dynamic speed and operational performance?
2. What is the relationship between supply chain agility and supply chain digitization?
3. What is the relationship between supply chain digitization and operational performance?
4. What is the mediating role of supply chain digitization in the relationship between supply chain agility and operational performance?

3. Theoretical Background and hypothesis development

3.1 Supply chain agility (SCA) and operational performance (OP)

According to Christopher (2000), agility is a capability that makes it easier for a company's structure, logistic process, and information system to function. According to Goldman (1995), SCA is necessary for businesses to fulfill their customers' requirements. According to Gligor et al. (2013), the agility that pertains to SC needs to pursue distinct roles including attentiveness, decisiveness, swiftness, flexibility, and accessibility. The roots of the idea behind agile supply chains can be traced back to flexible manufacturing systems (FMS), which is why Christopher (2000) considers flexibility to be one of the most important characteristics of an agile supply chain. Agility has been recognized as a dominating driver of competition that supports an organization throughout times of changing and uncertain environmental conditions (Gligor et al., 2013; Goldman, 1995; Tseng & Lin, 2011). This has been the case for quite some time. On the other hand, according to Tseng and Lin (2011), it is impossible for businesses to continue existing in the 21st century without incorporating agility into the SC process. According to the findings of a study that was carried out by Nazempour, R., Yang, J., and Waheed, A. (2020), to investigate the connection between SC agility and operational performance in Iran's three different industries. The findings provided insights into SC agility and concluded that firms with a higher level of agility could be more customer-focused compared to organizations with a lower level of agility. In addition, it has been concluded that agility in SC operations plays an important part in the delivery of the product in an effective, timely, and efficient manner.

A study by Um, J. (2017) investigated the impact of supply chain agility on customer service, differentiation, and business performance, the findings indicate that supply chain agility positively influences customer service and differentiation. Nonetheless, it does not directly impact business performance; rather, greater business performance can be achieved and mediated through enhanced customer service and differentiation, supply chain agility, and supply chain digitization. Akhtar et al. (2022) believe that digitization and supply chain agility are two connected ideas that can significantly influence one another. The advantages of supply chain digitalization can be considerably increased by supply chain agility. There are many ways in which supply chain agility can contribute to cost performance. It makes it possible for businesses to handle supply chain disruptions in a seamless and cost-efficient manner (Blome et al. 2013), which is important because interruptions are key cost concerns for global supply chains (Hendricks and Singhal 2005). According to Christopher (2000), companies with agile supply chains are better able to synchronize supply and demand, which lowers the costs of inventory and transportation. As a result of fewer stock-keeping variants and volume-oriented economies of scale, postponement can result in decreased costs associated with inventory, production, and transportation (Christopher 2000; Lee 2004). As a result, the first hypothesis is as follows:

H_{01}: *There is no relationship between supply chain agility and operational performance.*

3.2 Supply chain agility (SCA) and supply chain digitization (SCD)

Both supply chain agility and digitization are critical components of a contemporary supply chain. The ability of a supply chain to adjust rapidly and efficiently to changes in market demand or other external circumstances is referred to as supply chain agility. The use of technology to increase the efficiency and effectiveness of supply chain operations is referred to as digitization. Supply chain agility has the potential to significantly improve supply chain digitization. An agile supply chain is better suited to deal with the rapid changes and disruptions brought about by digitization. For example, in today's fast-changing business climate, an agile supply chain can quickly adopt new technology and respond to changes in consumer behavior. Furthermore, an agile supply chain can assist in identifying areas where digitization can be most effective. An agile supply chain may more quickly identify areas where technology can be leveraged to optimize processes, cut costs, and improve customer experience by being adaptable and responsive. This can aid in directing digitalization efforts to areas where they will have the greatest impact. A dynamic business environment necessitates the development of supply chain capabilities that emphasize prompt delivery to reduce lead times, cut costs, and prioritize customer satisfaction. To meet these needs, organizations must prioritize greater flexibility and supply chain agility (Chan et al. 2017). Puriwat and Tripopsakul's recent study (2021) discovered that organizational agility has a positive correlation to open innovation adoption. Digitalization helps enterprises facilitate reconfiguring their internal and external resources to recover from the dynamic environment, thus, the ability to respond quickly to unpredictable changes in markets and the natural environment (Zhao et al., 2023). This means that organizational agility and open innovation configurations may help to explain why business model innovation levels fluctuate. Christopher (2000) also shows that agile supply chains are intrinsically digitally enabled SC strategies and that agility implies the introduction of digitization processes.

In a paper aiming at identifying and assessing various key success factors (CSFs) that may improve the effectiveness of a digital supply chain, it was established that the following enhanced the success of a digital supply chain: Strategies for Sales and Operations Planning, Strategic Sourcing Techniques, Smart Manufacturing Processes, and Warehouse Management. Choudhury et al., (2021). Accessibility of real-time information in supply and demand is important for the agile supply chain to respond to changing markets. There are some implicit benefits of digital technology for agile supply chains, such as speed, visibility, cost optimization, real-time inventory, and scalability (Yerpude et al. 2023)

Supply chain professionals should be aware that supply chain digitization heavily depends on their workforce's preparedness to transition to an agile workforce that is familiar with the supply chain digitization processes in place. Due to technological improvements that may affect their primary supply chain processes, this agile workforce must be able to quickly change their supply chain performance. (Varshney, & Varshney, 2020).

Strategically aligning and integrating cross-functional digital infrastructure and capabilities is critical for creating agility because it allows for the identification of market opportunities and the acquisition of the resources required to capitalize on these opportunities. (Tallon and Pinsonneault, 2011), Firms must constantly examine all emerging applications of digital technology, as well as consistently expand and leverage existing digital capabilities, to obtain the agility required to effectively tackle a more turbulent and complex future. (Akhtar et al., 2019; Barlette and Baillette, 2020).

Scholars also believe that digital skills are a result of an organization's agility. (Nwankpa and Merhout, 2020). Furthermore, academics regard an organization's agility as a critical firm lever for developing an effective digital company mindset. (Warner and Wäger, 2019) and for successfully exploiting emerging digital technologies such as BDA, cloud computing, blockchain, and IoT (Brenner, 2018; Vial, 2019). Dehgani and Navimipour (2019) assert that information technology-based system integration, digital knowledge and skill, and digital platforms in supply chain networks increase business efficiency, effectiveness, and supply chain agility.

In general, supply chain agility and digitization are closely linked. An agile supply chain is better equipped to face the challenges of digitization, and digitization can help the supply chain become more agile. To remain competitive in today's swiftly changing business environment, companies should focus on enhancing both supply chain agility and digitization capabilities. As a result, the first hypothesis is as follows:

H_{02}: *There is no relationship between supply chain agility and supply chain digitization.*

3.3 Supply chain digitization (SCD) and operational performance (OP)

Bartezzaghi and Turco (1989) stated that operational performance is made up of the real results of the operation strategies used. These results are affected by the operating conditions and show the internal properties of a manufacturing system. Lu et al. (2018) stated that operational performance is a key factor in the total performance of the supply chain, which is usually the result of many factors and factors that help the system work. Without a doubt, operational performance is an important part of many performance evaluation methods in use today (Ebrahimi,2015; Yu et al., 2014), based on a previous study carried out by Wong et al. (2011) and Tracey et al. (1999), quality, productivity, and cost have been chosen as the performance factors. Digitization creates superior benefits for companies and has received a lot of attention from companies around the world (Attaran, 2020), Büyüközkan and Göçer (2018) and Zhang and Sakurai (2020) state that DSC is a technology system based on excellent collaboration and communication capabilities for hardware, software, and digital networks. All of them are used to support and synchronize interactions between organizations by making services more valuable, accessible, and affordable in a way that is consistent, agile, and effective results, Wong et al. (2020) conclude that the application of DSC has a positive effect on BP. Based on Bughin et al. (2018) studies, many digital technologies help improve the supply chain of any industry, such as Big Data, the Internet of Things, Blockchain, Cloud Computing systems, Artificial Intelligence, Man-Machine Learning, and many more applications, On the other end of the spectrum, researchers have cautioned about the problems and difficulties digitization may create. For example, Hazen et al. (2014) contended that with the development of digitization, data generation becomes inexpensive and simple. As a result, an abundance of low-quality data is generated, adding difficulties and costs to manage, store, and retrieve that data. Meier (2016) identified seven digital technology trends in supply chain management that include: mobility, Big Data, Cloud Computing, social media, predictive analytics, the Internet of Things, and 3D printing.

- Mobile Technology

The idea of mobile supply chain management first attracted attention more than ten years ago as a means of reducing costs and enhancing corporate performance. (Eng, 2006). The use of mobile applications in supply chains has increased operational efficiencies and given firms better traceability of their processes and products. (Tseng et al., 2011;Ngai et al., 2011).

- Big data

Big Data is seen as a key resource for helping businesses gain a competitive edge through the discovery of new information, the presentation of added value, and the development of new goods, services, and markets. (Kopanakis et al., 2016).

- Cloud Computing

Cloud Computing is described as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Grzybowska et al., 2014, p.37).

- Internal Social Media

Internal Social Media, as a term, first emerged at a conference in 2004 (O’Reilly, 2007). Internal social media is a platform or website run by a business that enables users (company employees) to set up personal profiles and engage with one another. Access to such social media platforms is restricted to members/employees of this company (Buettner, 2015).

- Internet of Things

The integration of many physical objectives into the Internet of Things enables them to communicate with one another without the need for human-to-human or human-to-computer interaction. Data is transferred via a network and over the Internet to assist organizations in achieving some beneficial goals (Ahlmeyer & Chircu, 2016).

- 3D printing

Due to recent developments in technology, 3D printing technologies have gained widespread attention from experts, practitioners, academics, and the general public. (Flores Ituarte et al., 2016). It is anticipated that 3D printing will revolutionize how products are created, produced, and delivered (Khajavi et al., 2014).

An agile supply chain strategy aims to respond swiftly and successfully to customers' constantly changing needs (Huang et al., 2002; Christopher and Towill, 2002; Lin et al., 2006). An agile strategy employs a “wait-and-see” approach to demand, not committing to products until demand becomes known (Goldsby et al., 2006).

H_{03}: *There is no relationship between supply chain digitization and operational performance.*

Based on the previous statements and arguments the researcher proposes to test the following main hypothesis;

H_{04}: *There is no mediating role of supply chain digitization in the relationship between supply chain agility and operational performance.*

Based on what has been stated, the study’s conceptual framework was developed as shown in Fig (1).

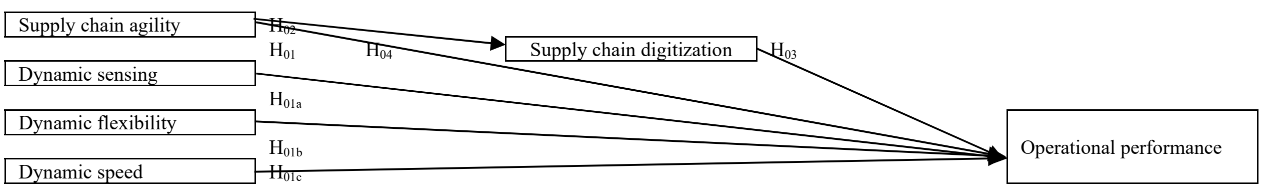

Fig. 1. The conceptual Framework of the study

4. Research methodology

This study examines the mediating role of supply chain digitization in the relationship between supply chain agility and operational performance. Using a self-administered questionnaire, data were collected from managerial employees working in the pharmaceutical sector in Jordan. Morgan's (Kotrlik & Higgins, 2001) sampling guidelines were followed to determine the sample size for this study. Consequently, purposive sampling was used to acquire data from the study's respondents. The data was collected from 285 respondents using a questionnaire as the primary data collection instrument.

Table 1
Distribution of study respondents according to personal characteristics

		Frequency	Percent
Gender	Male	175	65.3
	Female	93	34.7
	Total	268	100.0
Social status	Married	190	70.9
	Single	67	25.0
	Divorced	6	2.2
	Widowed	5	1.9
	Total	268	100.0
Age	Less than 30 years old	43	16.0
	30- less than 40	70	26.1
	40 – less than 50	90	33.6
	Above 50	65	24.3
	Total	268	100.0
Job title	Manager	55	20.5
	Assistant Manager	68	25.4
	Supervisor	122	45.5
	Others	23	8.6
	Total	268	100.0
Number of years of experience in the Company	Less than 5 yrs	65	24.3
	5- less than 10yrs	80	29.9
	10 – less than 15yrs	68	25.4
	More than 15 yrs	55	20.5
	Total	268	100.0

The research instrument was developed based on the following studies: The items of supply chain agility (SCA) were adapted from (Li et al., 2009), the items of supply chain digitization (SCD) were adapted from (Raman et al., 2018; Schoenherr et al., 2015; Cegielski et al., 2012; Ben-Daya et al., 2017; Merlino and Sproge, 2017), and the items of operational performance (Green Jr. et al., 2011; Zhu et al., 2008). The questionnaire consisted of three major sections: the first section consisted of a cover letter; the second section contained closed-ended demographic questions about the manufacturing company and respondent characteristics; and the third section was made up of questions regarding the research variables, the independent, mediating, and dependent variables. The questionnaires were distributed to 320 respondents. However, 285 questionnaires were retrieved, of which 17 were excluded for their invalidity. Thus, only 268 questionnaires were found to be valid for statistical analysis. To measure the respondents' answers, a five-point Likert scale questionnaire was adopted. Table 1 shows the distribution of the study sample members according to the personal variables.

4.1 Data sources and collection method

The information and data required by the study were obtained through two main sources: secondary sources, which included books and periodicals related to the search topic and the online information available on the subject, and primary sources through a questionnaire developed for this purpose. To measure the level of the respondents' answers on questionnaire items, the research adopted the five-point Likert scale from (1–5), respectively, where 5 means strongly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagree. Their answers were interpreted based on the following: The arithmetic mean of 1–2.33 means low agreement, 2.34–3.66 means average agreement, and 3.67–5 is considered high disagreement.

4.2 Reliability of the Study Instrument

The principle of reliability refers to the degree of stability and consistency of answers related to a given scale. It is customary for researchers to measure the reliability level of the scale by figuring out the extent of the internal consistency, which is done by determining the value of Cronbach's alpha coefficient. Table No. 2 shows that all the Cronbach's alpha values are greater than 0.6 (Hair Jr. et al., 2011). Therefore, we conclude that the scale adopted in this study has an acceptable level of reliability.

Table 2
Cronbach's alpha test results

Part	**dimensional**	**Cronbach's alpha**
Supply chain Agility	**Dynamic Sensing**	0.983
	Dynamic Flexibility	0.981
	Dynamic speed	0.973
	Supply chain Agility	0.987
Supply chain digitization		0.973
Operational Performance	**Quality**	0.928
	Cost	0.979
	Speed	0.975
	Reliability	0.979
	Operational Performance	0.976

4.3 Normal Distribution Test

To verify the extent to which the study data and variables follow the normal distribution, the skewness and kurtosis coefficients were used for each dimension of the study tool. Table No. 3 shows the skewness and kurtosis values for each dimension of the study tool.

Table 3
Results of Skewness and Kurtosis values test

Part	**dimensional**	**Skewness**	**Kurtosis**
Supply chain Agility	**Dynamic Sensing**	-0.974	-0.130
	Dynamic Flexibility	-0.942	-0.243
	Dynamic speed	-0.772	-0.380
	Supply chain Agility	-1.148	0.007
Supply chain digitization		-0.815	-0.130
Operational Performance	**Quality**	-0.953	-0.094
	Cost	-0.609	-0.600
	Speed	-0.737	-0.474
	Reliability	-0.737	-0.797
	Operational Performance	-0.824	-0.330

Table 3 shows that the skewness and kurtosis coefficients all range within the acceptable minimum and maximum limits of the normal distribution. The skewness values ranged (-2, 2), and the kurtosis coefficients ranged (-7, 7), which indicates that the study data follow a normal distribution; therefore, the study data are suitable for conducting the subsequent statistical analyses.

4.4 Structural honesty

Structural validity refers to the relationship of the degrees of the items on the scale to the total degree if it measures one thing, and exploratory factor analysis indicates that the components or items measure something in common, which means their structural validity. The observed factors are linear groups of possible factors, and exploratory factor analysis is also used to discover the factors into which variables can be classified by considering these factors as categories of these variables.

4.5 The results of the factor analysis in the supply chain agility dimension

The exploratory factor analysis was used to verify the structural validity of supply chain agility. Table 4 shows the rotation matrix for the items of the independent variable, supply chain agility, that were measured using 16 items.

Table 4
Matrix of orthogonal rotation of the paragraphs of the domain of Supply chain Agility

	factors		
Item	1	2	3
1	0.753		
2	0.871		
3	0.866		
4	0.878		
5		0.897	
6		0.870	
7		0.881	
8		0.892	
9		0.791	
10		0.870	
11		0.727	
12		0.868	
13			0.814
14			0.869
15			0.822
16			0.878
Determinant	0.001		
KMO	0.918		
Bartlett's Test	10239.678		
Sig.	0.00		

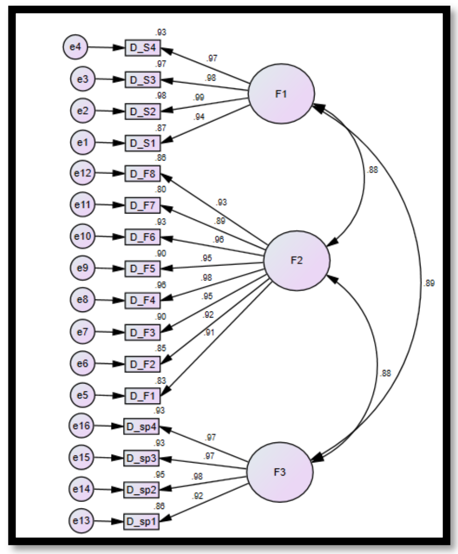

Fig. 2. Confirmative factor analysis of the variable Supply chain Agility

Table 4 shows that loadings ranged between 0.727 and 0.897, and they are all greater than the value of 0.4, as the orthogonal rotation led to the classification of the domain items into three factors. Table 4 also shows that the value of the determinant is equal to (0.005) and exceeds the value of zero, which indicates that there is no autocorrelation problem between the elements of the variable, while the value of the KMO is equal to (0.918), which exceeds (0.50). This indicates the adequacy of the study sample and its ability to give a correct result regarding the measurement of the variable. As for the value of Bartlett's Test, it amounted to (10239.678) with a significance level of (0.000), which is less than (0.05), which is an indicator of the relationship between the sub-elements for the variable.

4.6 Confirmative factor analysis of variable Supply chain Agility

The aim of using confirmatory factor analysis is to verify the validity of the proposed study model that contains the latent variable and the indicators used to measure it, or the items used in the study tool to measure this variable. The assumption of the validity of the construction is achieved if the standard regression weights are greater than 0.40. The results showed that the latent root of the independent variable amounted to (0.963), and the value of the Comparative Fit Index amounted to (0.97), which is higher than the accepted value as a minimum for these indicators, which is (0.90).

4.7 The results of the factor analysis of the domain of Supply chain digitization.

The exploratory factor analysis was used to verify the structural validity of supply chain digitization. Table 5 shows the rotation matrix for the items of the mediator variable, supply chain digitization, that were measured using nine items. Table 5 shows that loadings ranged between 0.643 and 0.964, and they are all greater than the value of 0.4, as the orthogonal rotation led to the classification of the domain items into one factor. Table 5 also shows that the value of the determinant is equal to

(0.005) and exceeds the value of zero, which indicates that there is no autocorrelation problem between the elements of the variable, while the value of the KMO is equal to (0.870), which exceeds (0.50). This indicates the adequacy of the study sample and its ability to give a correct result regarding the measurement of the variable. As for the value of Bartlett's Test, it amounted to 4791.651 with a significance level of 0.000, which is less than 0.05, which is an indicator of the relationship between the sub-elements for the variable.

Table 5
Matrix of orthogonal rotation of the paragraphs of the Supply chain digitization domain

	factor
Item	**1**
1	0.802
2	0.643
3	0.734
4	0.936
5	0.809
6	0.964
7	0.867
8	0.894
9	0.879
Determinant	0.008
KMO	0.870
Bartlett's Test	4791.651
Sig.	0.00

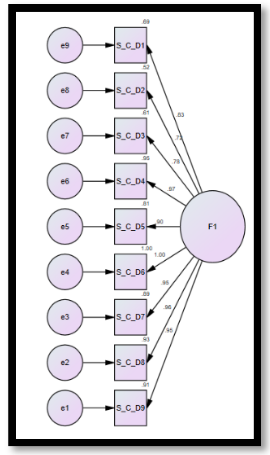

Fig. 3. Confirmative factor analysis of the variable Supply chain digitization

4.8 Confirmative factor analysis of variable Supply chain digitization

The aim of using confirmatory factor analysis is to verify the validity of the proposed study model that contains the latent variable and the indicators used to measure it, or the items used in the study tool to measure this variable. The assumption of the validity of the construction is achieved if the standard regression weights are greater than 0.40. The results showed that the latent root of the independent variable amounted to (0.935), and the value of the Comparative Fit Index amounted to (0.96), which is higher than the accepted value as a minimum for these indicators, which is (0.90).

4.9 The results of the factor analysis of the domain of Operational Performance

The exploratory factor analysis was used to verify the structural validity of the operational performance. Table 6 shows the rotation matrix for the items of the dependent variable, operational performance, that were measured using 12 items.

Table 6
Matrix of orthogonal rotation of the paragraphs of the domain of Operational Performance

	factors			
Item	**1**	**2**	**3**	**4**
1	0.811			
2	0.831			
3	0.880			
4	0.908			
5		0.913		
6		0.904		
7		0.947		
8			0.950	
9			0.937	
10				0.961
11				0.939
12				0.938
Determinant	0.001			
KMO	0.922			
Bartlett's Test	6194.997			
Sig.	0.00			

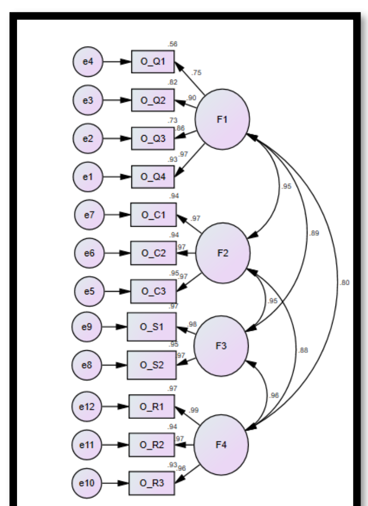

Fig. 4. Confirmative factor analysis of the variable Operational Performance

Table 6 shows that loadings ranged between 0.811 and 0.961, and they are all greater than the value of 0.4, as the orthogonal rotation led to the classification of the domain items into four factors. Table 6 also shows that the value of the determinant is equal to (0.005) and exceeds the value of zero, which indicates that there is no autocorrelation problem between the elements of the variable, while the value of the KMO is equal to (0.922), which exceeds (0.50). This indicates the adequacy of the study sample and its ability to give a correct result regarding the measurement of the variable. As for the value of Bartlett's Test, it amounted to (6194.997) with a significance level of (0.000), which is less than (0.05), which is an indicator of the relationship between the sub-elements for the variable.

4.10 Confirmatory factor analysis of variable Operational Performance

The aim of using confirmatory factor analysis is to verify the validity of the proposed study model that contains the latent variable and the indicators used to measure it, or the items used in the study tool to measure this variable. The assumption of the validity of the construction is achieved if the standard regression weights are greater than 0.40. The results showed that the latent root of the independent variable amounted to (0.944), and the value of the Comparative Fit Index amounted to (0.96), which is higher than the accepted value as a minimum for these indicators, which is (0.90).

5. Descriptive statistics and hypothesis test results

5.1 Mean and standard deviation of supply chain agility domain

Table 7 shows some descriptive results for the research variables used in this study.

Tables 7
Mean and standard deviation for domain of Supply chain agility

	Mean	Std. Deviation	Percent*	Rank	Degree
Dynamic Sensing	3.86	1.20	77.2%	1	High
Dynamic Flexibility	3.78	1.12	75.6%	2	High
Dynamic speed	3.86	1.11	77.2%	1	High
Supply chain Agility	3.82	1.09	76.4%		High

***Percent= (Mean/5)×100%**

Table 7 shows that the mean range is between 3.86 and 3.86, with the highest mean for "dynamic sensing and dynamic speed", but the lowest mean for "dynamic flexibility". The overall mean for "supply chain agility" is 3.8.

5.2 Supply chain digitization

Tables 8
Mean and standard deviation for Items of Supply chain digitization

No		Mean	Std. Deviation	Percent*	Rank	Degree
1	Big data is used to improve our data quality.	4.01	1.07	80.0%	2	High
2	Our company can monitor customer interaction through real-time data analysis	3.93	1.43	78.6%	5	High
3	Our company can achieve information exchange with cloud computing	4.00	1.23	80.0%	3	High
4	Cloud technologies enhance process capability and local storage	3.92	1.14	78.6%	6	High
5	Blockchain improves the traceability of products in the supply chain.	3.89	1.07	77.8%	7	High
6	Exchange of information with customers and suppliers is easier through the application of blockchain	3.87	1.14	77.4%	8	High
7	The Internet of Things provides the linkage for all devices to the Internet associated with production processes.	4.04	1.10	80.8%	1	High
8	Robotics is used to improve production capacity	3.94	1.19	78.8%	4	High
9	Our company uses or plans to use robotics on a regular basis in the future.	3.79	1.36	75.8%	9	High
Supply chain digitization		3.93		78.6%		High

***Percent= (Mean/5)×100%**

Table 8 shows that the mean ranges between 3.79 and 4.04, with the highest mean being "The Internet of Things provides the linkage for all devices to the Internet associated with production processes", but the lowest mean being "Our company uses or plans to use robotics regularly in the future". The overall mean for "supply chain digitization is 3.9.

5.3 Operational Performance

Table 9 shows the mean range between 3.91 and 4.10, with the highest mean for "quality", but the lowest mean for "reliability". The overall mean for "operational performance is 3.91.

Tables 9
Mean and standard deviation for operational performance

	Mean	Std. Deviation	Percent*	Rank	Degree
Quality	4.10	1.08	82.0%	1	High
Cost	3.94	1.02	78.8%	2	High
Speed	3.74	1.22	74.8%	4	High
Reliability	3.75	1.32	75.0%	3	High
Operational Performance	3.91		78.2%		High

***Percent= (Mean/5)×100%**

5.4 Results of the study

5.4.1 Results of the hypothesis test of H01

H_{01}: There is no significant relationship between supply chain agility and operational performance.

1.1 There is no significant relationship between dynamic sensing and operational performance.

1.2 There is no significant relationship between dynamic flexibility and operational performance.

1.3 There is no significant relationship between dynamic speed and operational performance.

To test this hypothesis, multiple regression was applied.

Table 10
Results of Regression for the relationship between supply chain agility and operational performance

Independent variables	Beta	T	Sig.	R	R Square	F	Sig.
(Constant)		13.215	0.000	0.642	0.412	61.718	0.000
dynamic sensing	0.793	7.494	0.000				
dynamic flexibility	1.013	9.158	0.000				
dynamic speed	0.633	5.495	0.000				

According to the results of Table 10, there is a relationship that is statistically significant at sig. ($\alpha \leq 0.05$) between supply chain agility and operational performance, as the value of the correlation coefficient (R) was 0.642. It also showed a statistically significant value that indicates the degree of a statistically significant relation between supply chain agility and operational performance; the (R-square) value was (0.412), a statistically significant value in terms of both the independent variables and the dependent variable, and the (F) test value was (61.718), a statistically significant value at sig. ($\alpha \leq 0.05$). Accordingly, the alternative hypothesis is accepted.

The results related to the sub-hypotheses are:

1. There is a significant relationship between dynamic sensing and operational performance, where the values of (Beta = 0.793) and (T = 7.494) were statistically significant. Accordingly, the alternative hypothesis is accepted.
2. There is a significant relationship between dynamic flexibility and operational performance, where the values of Beta = 1.013 and T = 9.158 were statistically significant. Accordingly, the alternative hypothesis is accepted.

There is no significant relationship between dynamic speed and operational performance where the values of (Beta = 0.633) and (T = 5.495) were statistically significant. Accordingly, the alternative hypothesis is accepted.

5.4.2 Results of the H02 test

H02: There is no significant relationship between supply chain agility and supply chain digitization.

To test this hypothesis, simple regression was applied.

Table 11
Results of regression for the relationship between supply chain agility and supply chain digitization.

Independent variable	T	Beta	R Square	F	Sig.
Supply chain agility	19.523	0.767	0.589	381.162	0.00

According to the results of Table 11, there is an impact of supply chain agility on supply chain digitization. where the values of (Beta = 0.767) and (T = 19.523) were statistically significant; the (R-square) value was (0.589), a statistically significant value; therefore, the alternative second hypothesis is accepted.

5.4.3 Results of H03 test

H03: There is no significant relationship between supply chain digitization and operational performance.
To test this hypothesis, simple regression was applied.

Table 12
Results of Regression for the relationship between supply chain digitization and operational performance

Independent variable	T	Beta	R Square	F	Sig.
Supply chain digitization	16.532	0.712	0.507	273.298	0.000

According to the results of Table 12, there is an impact of supply chain digitization on operational performance. where the values of (Beta = 0.712) and (T = 16.532) were statistically significant; the (R-square) value was (0.507), a statistically significant value; therefore, the alternative third hypothesis is accepted.

5.4.4 Results of H04 test

H04: There is no significant mediating role of supply chain digitization in the relationship between supply chain agility and operational performance.

To test the hypotheses, path analysis was applied to study the relationships between the study variables.

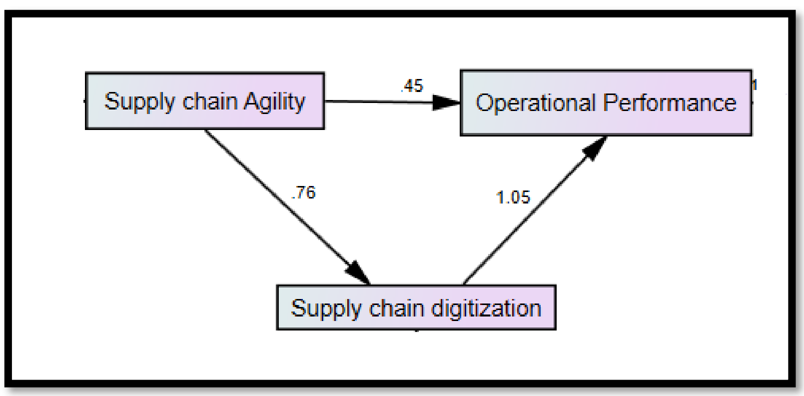

Fig. 4. Path analysis was applied to studies the relationships between the study variables

Table 13
Path analysis was applied to study the relationships between the study variables

			Estimate	S.E.	C.R.	P	Indirect Effects
Supply chain Agility	←	Supply chain digitization	.763	.039	19.560	***	0.802
Supply chain Agility	←	Operational Performance	.448	.060	7.466	***	
Supply chain digitization	←	Operational Performance	1.051	.060	17.404	***	

Table 13 shows the values of the direct and indirect effects of the relationship of the mediator variable on the relationship between the transformation of the independent and the dependent variables. By reviewing the values of the direct effects in the table, the value of the effect of the independent variable on the dependent has reached (0.448), and the value of the effect of the independent variable on the mediator has reached (0.763). The value of the direct effect of the mediator on the follower was (1.051), and these effects were expressed using the standard values, where it is noted that all the values of these effects (coefficients) were statistically significant, as they were all less than 0.05 and at the same time less than 0.001, so they were denoted by the symbol (***). This means that there is an indirect effect of the mediating variable, given that all the significance level values were statistically significant, which indicates that there are partial means of supply chain digitization (as a mediating variable) on a relationship between supply chain agility and operational performance. The fourth main hypothesis is accepted in its alternative form.

6. Conclusion of the study

The following conclusions were reached by the researcher in light of the study's findings:

- There is a relationship that is statistically significant at sig. ($\alpha \leq 0.05$) between supply chain agility and operational performance.

This means, that shorter procurement, production, and distribution lead times characterize an agile supply chain and this decrease in lead times has a direct influence on operational performance by allowing for faster responses to customer requests, reducing stockouts, and optimizing inventory levels, thus, because an agile supply chain offers the adaptability, responsiveness, and efficiency required to optimize operational procedures and adjust to changing business conditions. Sustained operational excellence is greatly influenced by the capacity to manage changes and uncertainties in the marketplace.

- There is an impact of supply chain agility on supply chain digitization.

To adapt to changing demands, agile supply chains can typically reorganize their networks, switch suppliers, or move operations to different locations, on the other hand digitizing the supply chain allows for improved monitoring of changing conditions by providing real-time data, analytics, and visibility. The supply chain can respond quickly to changes in demand because of the data that facilitates flexible decision-making.

The digitalization of the supply chain and its agility are two sides of the same coin. The supply chain's innate responsiveness and adaptability are what make it agile, but digitalization facilitates real-time visibility, data-driven decision-making, and effective cooperation by offering the tools and technology that are needed. When put together, they form a supply chain that can withstand and adapt to the challenges of today's commercially globalized world.

- There is an impact of supply chain digitization on operational performance.

The term "supply chain digitization" describes how different parts of the supply chain are made more efficient, visible, and collaborative by incorporating digital tools and technologies. Supply chain digitalization can have a profound and varied effect on performance, in conclusion, real-time visibility, data-driven decision-making, collaboration, and process optimization across the supply chain are just a few of the ways that supply chain digitalization may drastically improve operational performance. Businesses that embrace digitization and apply it well are better positioned to acquire a competitive edge and adjust to changing market conditions.

- There is no significant mediating role of supply chain digitization in the relationship between supply chain agility and operational performance.

If supply chain digitization does not play a major mediating effect, it suggests that the degree of digitization in supply chain processes has little effect on or improvement over the impact of supply chain agility on operational performance, Organizations may need to consider the practical consequences of this finding. It could imply, for instance, that merely increasing supply chain agility without placing a strong emphasis on digitization doesn't always result in a notable gain in operational performance, or vice versa.

Research results can differ, therefore it's important to remember that just because a major mediating role isn't present in one study doesn't mean that it is in all of them. The interplay among these variables may be influenced by several industry-specific variables, contextual factors, and research approaches.

7. Recommendations for future research

Future researchers are recommended to consider the following topics:

- Researchers are advised to conduct further studies on how digitalization, information systems, and technology may improve supply chain agility.

- Searching ways on how blockchain, AI, and IoT technologies support flexible supply chain operations.

- Examining the ideas of responsiveness and resilience in agile supply chains. And recognizing how these factors might be balanced by businesses to attain the best possible operational performance.

- Exploring the ways that incorporating ethical and sustainable practices into the supply chain might improve operational performance and agility.

- Investigate several tactics used by firms in their supply chain digital transformation endeavor and examine how effective these tactics are at improving overall operational performance.

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