

The technological factors of Generative AI technology adoption and its impact on Supply Chain Resilience in Jordanian SMEs

Naseem Mohammad Twaissi¹, Ayman Wael AL-Khatib², Khalid Mohammed Abdrabbo³

¹Department of Business Administration, Al-Hussein Bin Talal University, Ma'an, Jordan

²Business Faculty, Middle East University, Amman, Jordan

n.twaissi@ahu.edu.jo, invaymanwk55@gmail.com, Khalid.m.AbedRabbo@ahu.edu.jo

Abstract. The aim of this study is to investigate the technological factors of the adoption of generative AI technology and its impact on Supply Chain resilience in small and medium enterprises (SMEs) in Jordan. This study also aimed at examining the impact of adopting generative AI technology in the Technology Organization Environment Framework (TOE) framework. In order to achieve these objectives, a questionnaire of 20 items was developed and distributed to the study sample made up of managers or owners of SMEs. 225 valid questionnaires were obtained for analysis. The results of the analysis revealed an acceptance of all hypotheses. Further, technological factors had a positive effect on G-AI technology adoption. In addition, adopting G-AI technology helps enhance the level of supply chain resilience. This study had a set of theoretical and practical implications that would improve the level of adoption of G-AI technology and enhance supply chain management practices.

Keywords: Technological factors; Generative artificial intelligence adoption; Supply chain resilience.

1. Introduction

The rapid advancements in artificial intelligence has given rise to a more sophisticated technology known as generative AI (Mondal et al., 2023). This innovation enables users to directly interact with systems, such as chatbots (Sharma et al., 2022), thus enhancing the user experience (Dwivedi et al., 2023a) and by creating novel and diverse content (Korzynski et al., 2023) Generative AI can create content in various formats, including text, images, videos, and presentations (Prasad Agrawal, 2023). ChatGPT is one of the most widely recognized applications of this technology (Keiper et al., 2023). According to a US survey Generative Artificial Intelligence is used by 39 percent of the US population aged 18 to 64 and 24 percent of US workers (Blick et al., 2024).

The current literature on generative AI highlights its potential to transform the business landscape by enhancing efficiency, productivity, and marketing (Dwivedi et al., 2023a). However, the novelty and uncertainty surrounding this technology has caused confusion regarding its application (Burger et al., 2023). Generative AI can help in introducing new innovations that are both radical which require major change, or innovations that include minor improvements (Bilgram & Laarmann, 2023; Ritala et al., 2023; Akter et al., 2023). Generative AI includes business application for business management and finance. This technology will reduce the duplication of tasks and allow workers to focus on tasks that add value (Bi, 2023). Generative AI can independently generate new content including text, images and video (Lv, 2023).

Managers of supply chains require support to avoid any delay or disruptions in the chain, Generative AI technology can create innovative transformative proactive solutions to enhance and support the resilience of supply chains (Maghroor et al., 2024). Further, Generative AI technology advance decision making can be a defense against disruptions in the supply chain because there is an almost instant adaptation to changing conditions in the market (Shekhar et al., 2024). Generative AI technology can be used to improve the evaluation of supply chain operations and will enhance a number of issues including: efficiency, accuracy, resilience and will make the operations more effective (Jackson et al., 2024).

The adoption of Generative AI by companies leads to a clear improvement in all of the activities of the supply chain (Wamba et al., 2023). Further, the adoption of Generative AI by firms can lead to improved customer service, minimization of company costs, and efficacy in the overall operations (Wamba et al., 2023). Generative AI has the potential for a positive and transformative effect on all areas of an organization (Yanderpalli, 2023).

AI generative adoption also has some negative aspects that will need to be dealt with. AI generative has both negative and positive results. The negative aspects of AI generative include the following: there are currently no monitoring and regulating generative AI, the quality of generative AI needs improvements, the problem of deep fake content, confusion because of incorrect information about generative AI, algorithm bias, job losses resulting from this new technology, invasion of privacy issues, and weakening of ethics (Watch, et al., 2023). Several studies regarding AI technology contradict each other including in areas such as ethics (Sohail et al., 2023). Further, generative AI suffers from serious potential ethical issues in areas such as privacy, data protection, deep fakes which could potentially create serious problems (Al-kfairy et al., 2024)

Generative AI technology is a big step from existing AI technology, this technology possesses capabilities not found in other AI technology such as, Large Language Models (LLMs), the ability to create language that is natural. Generative AI also has capabilities to advance teaching and learning process (Giannakos et al., 2024).

Several theories have gained popularity and acceptance by researchers who studied the adoption of artificial intelligence (Agarwal, 2023). The Diffusion of Innovation (DOI) theory and the Technology-Organization-Environment (TOE) framework are the most frequently applied at the organizational level (Iranmanesh et al., 2023; Hashimy et al., 2023). DOI theory focuses on technological and organizational

aspects that facilitate innovation diffusion in organizations (Rogers, 2003) TOE theory expands this scope to include environmental factors that influence technology adoption (Baig et al., 2023). Environmental factors are highly predictive of adoption decisions (Agarwal, 2023).

TOE theory is considered the most comprehensive and detailed in analyzing both the internal and external factors of organizations that work to directly or indirectly influence management decisions in the adoption of new technology (Sharma et al., 2022). Research in information systems and innovation have emphasized the significance of these internal and external factors in predicting technology adoption (Baig et al., 2023). TOE theory devotes its efforts to discovering the contexts that can most influence managers when making technology adoption decisions (Sharma et al., 2023) However, this theory can be used at the organizational level and not at the individual level (Polisetty et al., 2023). It is essential to understand this distinction when adopting new technology.

According to TOE theory, there needs to be a better understanding of organizational and environment factors when SMEs' adopt AI technology (Sharma et al., 2022). These factors can enhance the adoption of AI technology, as revealed by empirical evidence (Prasad Agrawal, 2023; Chen et al., 2022; Rjab et al., 2023; Ali Abbasi et al., 2022). Studies that were conducted within the context of SMEs need further research through the TOE model in order to reach more conclusive results about the effect of these factors (organizational and environmental) on the decision to adopt artificial intelligence technology and in particular generative AI (Prasad Agrawal, 2023).

The capability of supply chains that possess the adaptive capacity that enables them to prepare and respond to threats in the business environment is called supply chain resilience. Through this capacity, companies can prepare for any threat in the business environment (Al-Khatib and Ramayah, 2023) Companies can then choose the best solutions and respond to these problems and return to the initial situation before the crises occurred (Belhadi et al., 2024).

This study investigates the direct influence of technological factors on the adoption of generative AI. It also seeks to assess the direct impact of adopting generative AI on supply chain resilience in the manufacturing SMEs sector in Jordan.

2. The drivers of generative AI adoption through the TOE framework

Empirical studies highlighted the significance of generative AI in addressing business challenges (Korzynski et al., 2023), and improving operational efficiency (Burger et al., 2023), in addition to fostering innovation and creativity within organizations (Bilgram & Laarmann, 2023). However, there is limited empirical evidence on SMEs who are the most likely to adopt generative AI technology. Generative AI refers to technology that uses deep learning models and neural algorithms to produce creative content similar to human-generated outputs, such as images and text (Ratten & Jones, 2023). Generative AI relies on cognitive frameworks (Mondal et al., 2023) to generate interactive content that meets user needs (Dwivedi et al., 2023b).

Generative artificial intelligence has many distinctive characteristics that distinguish it from other technologies. This type of technology is distinguished by its ability to create new content that is characterized by creativity. Further, this content is distinctive and did not previously existed (Budhwar et al., 2023). In addition, this technology is able to analyze data and extract new insights that helps managers.

Generative AI has received considerable attention in recent months, particularly with the launch of ChatGPT, which has revolutionized artificial intelligence (Budhwar et al., 2023). Applications such as ChatGPT can generate creative content including presentations, text, images, and video and making them applicable across various fields of knowledge, especially business (Prasad Agrawal, 2023; Bahoo et al., 2023). This technology aids in developing innovative solutions for routine and complex problems (Sharma et al., 2022) This technology also accelerates innovation by reducing research and development costs (Bilgram & Laarmann, 2023). Additionally, generative AI has enhanced customer

service (Gursoy et al., 2022), and productivity (Dwivedi et al., 2023b). Generative AI also has enhanced marketing capabilities through more precise ad targeting and market research (Paul et al., 2023). The full potential that generative AI has to improve business processes is not yet clear (Ritala et al., 2023). Researchers however expect its usage to increase across organizational activities (Prasad Agrawal, 2023).

The adoption of generative AI by managers in companies, particularly SMEs, has recently become a key area of interest for researchers and practitioners (Prasad Agrawal, 2023; Sharma et al., 2022). Understanding both regulatory and non-regulatory factors that affect generative AI adoption is crucial for enabling businesses to embrace this technology. The Technology-Organization-Environment (TOE) framework has proven effective in measuring and predicting managers' adoption decisions for new technologies such as big data (Bakici et al., 2021), artificial intelligence (Fu et al., 2023), blockchain (Chittipaka et al., 2022; Tseng et al., 2023), and cloud computing (Muhic et al., 2023). Research suggests that technological, organizational, and environmental factors all influence technology adoption within companies.

The TOE framework provides a comprehensive approach to understanding managers' decisions regarding new technology adoption (Baig et al., 2023). The technological context includes physical and technical aspects, such as the compatibility of the technology with a company's environment and culture (Agarwal, 2023), as well as its ease of use, perceived benefits (Horani et al., 2023), and confidentiality concerns (Muhic et al., 2023). The organizational context focuses on the internal capabilities of a company, including management support and organizational readiness, which both influence technology adoption (Tseng et al., 2023; Prasad Agrawal, 2023). However, financial constraints and limited resources can act as barriers (Horani et al., 2023). The environmental context encompasses external factors beyond the company's control, such as competitive pressures, customer demands, vendor support, market volatility, and governmental regulations (Polisetty et al., 2023; Iranmanesh et al., 2023).

2.1. The technological context

Managers' belief in the importance of new technology in improving business and driving operational efficiency can motivate them to adopt new technology (Chittipaka et al., 2022). When managers have belief that the technology to be adopted can achieve new perceived benefits that differ from previous technology will enhance motivation and inclination towards accepting new technology (Tseng et al., 2023). Relative advantage can be described as the sum of perceptions that managers recognize of the ability of new technology to provide new advantages that are not familiar with previous technology (Fu et al., 2023). Innovation or new technology has to develop business efficiency better than previous technology (Baig et al., 2023). This will then lead to management and employees to adopt new technology and harness it in work activities (Waqar and Paracha, 2023). It was also confirmed through observations and results found in the literature (Sharma et al., 2023; Fu et al., 2023) that the recognition of management and employees of the importance of artificial intelligence technology will enhance the ability to adopt. Therefore, the awareness of managers and employees of the expected benefits of this technology, which are represented in improving production, creating new innovations, and generating new creative content used to support decisions (Merhi and Harfouche, 2023), will enhance the managers' view towards facilitating the process of adopting artificial intelligence technology and generative AI technology. Therefore, the awareness of SME managers of the importance of generative AI technology and its relative advantages will lead to the pursuit of adopting generative-AI, and therefore the following hypothesis was formulated.

H1: The higher the level of the perceived relative advantages of generative AI within manufacturing SMEs, the higher the degree of adoption.

From the perspective of DOI theory, the more complex the new technology the less likely to be adopted (Rogers, 2003). Technological complexity may alienate workers from using technology and increase

their resistance (Ali et al., 2023). In contrast, a technology that has less complexity will be more likely to be adopted by managers and workers because the simpler procedures, process and methods of use will make the use of the new technology more enjoyable and more exciting thus achieving the highest possible benefits from this technology (Waqar and Paracha, 2023). Although artificial intelligence technology is characterized by technological complexity (Merhi and Harfouche, 2023) due to its reliance on complex algorithms and intelligent neural networks, generative-AI technology is characterized by ease of use due to its reliance on chatbots (Sharma et al., 2022). This makes it easier for users to use with this technology (Alsharhan et al., 2023). Most of the existing literature (Merhi and Harfouche, 2023; Sharma et al., 2022; Waqar and Paracha, 2023) emphasized the importance of technological complexity as a negative factor in reducing senior management's tendencies to adopt and apply technology, generative-AI technology provides smart platforms capable of simulating human patterns thus making it one of the easiest technologies to apply. The fact that generative-AI technology does not require high technical skills and high intellectual or physical skills has made it a technology capable of quickly entering business field (Dwivedi et al., 2023a) and is widely used by all organizational levels. This was confirmed by the results of (Sharma et al., 2022) which considered that the absence of the technological complexity element in generative-AI technology will contribute significantly to increasing the tendency of SMEs management to adopt and apply generative-AI technology. Based on the previous discussion, the following hypothesis was formulated

H2: The higher the level of the technological complexity of generative AI within manufacturing SMEs, the lower the degree of adoption.

Compatibility refers to the degree to which the organization's infrastructure, procedures, policies, and organizational structure are consistent and compatible with the introduction of new technology into the business (Iranmanesh et al., 2023). Compatibility is considered one of the most important technological factors that must be taken into account when adopting technology (Hashimy et al., 2023), defined compatibly as ability of companies to absorb new technology and introduce it into the business without difficulties which will then enhance management's tendency to adopt new technology (Prasad Agrawal, 2023). Compatibility between the organization's current systems and new technology allows greater benefit from the technological capabilities related to the new technology (Merhi and Harfouche, 2023) This will contribute to the achievement of the highest possible benefits. In addition, the organization's possession of the necessary infrastructure to absorb the new technology will contribute to reducing the potential and expected risks that may occur when the system within the company fails to absorb the new technology (Baig et al., 2023). AI technology is an advanced technology that mimics human thinking patterns (Sharma et al., 2023), this will allow companies that may suffer from the incompatibility of the current infrastructure with AI technology (Horani et al., 2023), which may lead to a tendency not to adopt AI technology.

Management in companies should conduct a periodic assessment of the compatibility of AI technology with the current systems, culture, and infrastructure in the company (Merhi and Harfouche, 2023). This will reduce the possibility missed opportunities to introduce and apply new technology within the company.

Several studies, including (Polisetty et al., 2023; Horani et al., 2023), have provided empirical evidence confirming the positive relationship between compatibility and the tendency to adopt AI technology (Prasad Agrawal, 2023; Sharma et al., 2022) also reported compatibility is necessary for adopting generative-AI technology, as companies tend to adopt the technology more if their systems and infrastructure are more compatible and consistent. Based on the previous discussion, the following hypothesis was formulated

H3: The higher the level of the perceived Compatibility of generative AI within manufacturing SMEs, the higher the degree of adoption.

One of the main technological factors in DOI theory is trialability, which refers to the degree to which a company can trial a technology or innovation before adopting it (Tiwari et al., 2023). The trialability process is based on dealing with technology on a limited and small scale (Qutaishat et al., 2023) with the aim of testing and verifying it. Literature (Ganeshkumar et al., 2023; Ali et al., 2023) have shown the importance of testing an innovation or technology before adopting it for the purpose of examining it. This will increase the confidence and reliability in the technology to be adopted (Tiwari et al., 2023). The process of trialability is important and necessary for companies before adoption (Marak et al., 2019), as employees and company managers can understand the perceived benefits or challenges they may face before actually adopting the technology on the ground (Qutaishat et al., 2023) Managers can, through trailability, understand the new technology and their needs for it, which is positively reflected in the decision to adopt the technology.

Companies face a set of challenges when adopting artificial intelligence and generative-AI technology (Rjab et al., 2023). It is therefore important before adopting this technology to work on experimenting with it and know its capabilities, which will enhance the decision to adopt.

Based on the previous discussion, the following hypothesis was formulated:

H4: The higher the level of the Trialability of generative AI within manufacturing SMEs, the higher the degree of adoption

2.2. The effect of generative AI adoption on supply chain resilience

The relationship between generative AI and supply chain resilience is a strong one according to literature (Wael Al-Khatib, 2023; Al-Khatib & Ramayah, 2023; Belhadi et al., 2024). Companies can use artificial intelligence to create predictive models, analyze data, and provide recommendations that help companies anticipate and respond to threats (Belhadi et al., 2024), thus achieving a greater response to any threat, which helps achieve goals, create competitive advantages, and reduce costs.

Based on the previous discussion, the following hypothesis was formulated:

H5: Generative AI adoption will positively associate supply chain resilience within manufacturing SMEs.

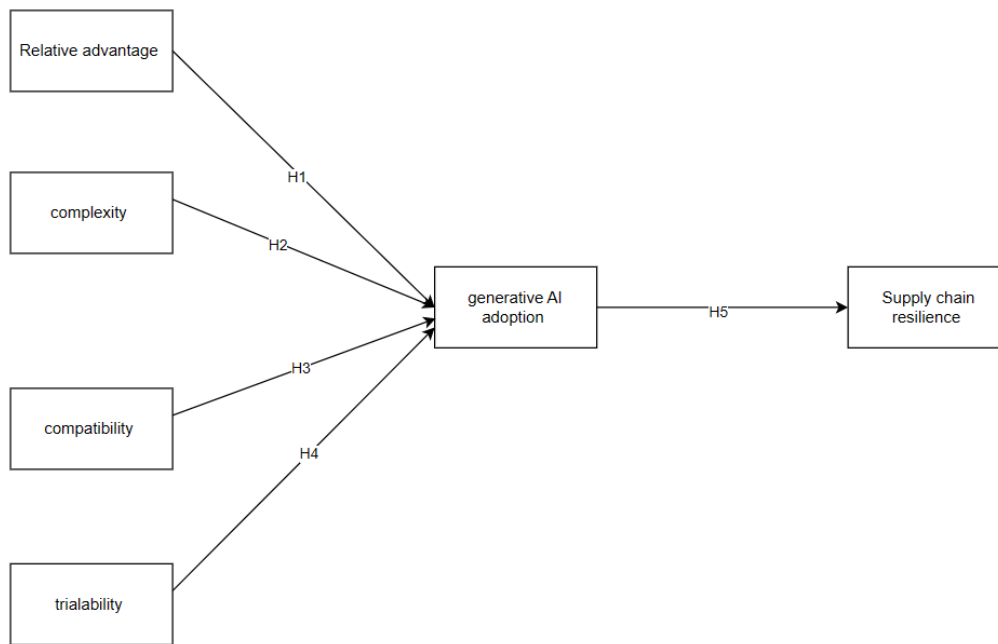


Fig.1: Research model

3. Research methods

3.1. Sampling and data collection

Jordan is recognized as one of the leading emerging countries that adopts digital technology (Wael Al-Khatib, 2023). Most businesses in Jordan are SMEs which is the reason this study focused on a sample drawn from these companies. Several studies (Al-Khatib et al., 2023) highlighted that manufacturing SMEs are a key economic sector that heavily relies on digital technologies, such as artificial intelligence, in their operations, making them an ideal focus for this research. Further, the SME sector in Jordan is responsible for many innovations regarding ways to improve the overall business environment in Jordan. In addition, knowledgeable employees in technology matters, infrastructure that is well suited for IT, the commitment of managers and positive attitude of managers about adoption of AI technology are one of the many reasons the SMEs in Jordan are rapidly adopting AI technology (Almashawreh et al., 2024).

To gather data, a non-probability purposive sampling method was employed which targeted managers or owners of manufacturing SMEs. A total of 250 questionnaires were distributed, and 220 valid responses were collected, resulting in an 88% response rate.

3.2. Questionnaire Development

The questionnaire used for data collection was designed by referring to previous studies. Items were created based on established research, resulting in a final version containing 20 items: 3 items each for relative advantage, complexity, computability, trialability, and G-AI adoption, as well as 5 items for supply chain resilience. The questionnaire was translated, and its content validity was confirmed by consulting a group of academics. Responses were measured using a five-point Likert scale.

4. Data Analysis

The data analysis was initiated by testing the measurement model for validity, reliability, and discriminant validity. The hypotheses were then tested using the structural model step (Hair et al., 2019).

4.1. The Measurement Model

The questionnaire items were assessed for convergent validity, reliability, and discriminant validity. Both Cronbach's alpha and composite reliability (CR) values exceeded the 0.70 threshold, indicating strong reliability. All item factor loadings were above the acceptable level of 0.70, and the average variance extracted (AVE) was greater than 0.50, confirming convergent validity (Hair et al., 2019). The results of these evaluations are displayed in Table 1.

Table 1. Reliability and convergent validity

Construct	Item	Factor loading	AVE	CR	α
RA		0.846	0.720	0.911	0.870
		0.887			
		0.863			
COMPLEX		0.794	0.597	0.856	0.776
		0.776			
		0.741			
COMP		0.811	0.742	0.920	0.884
		0.761			
		0.862			
TRIAL		0.881	0.617	0.865	0.794
		0.849			
		0.853			
G-AI		0.727	0.655	0.919	0.895
		0.775			
		0.813			
SCRES		0.822	0.730	0.915	0.876
		0.796			
		0.818			

		0.856			
		0.790			

Discriminant validity was then evaluated using the heterotrait-monotrait ratio (HTMT) as introduced by (Henseler et al., 2015). For discriminant validity to be accepted, the HTMT values should be less than 0.85. As shown in Table 2, all values met this criterion, confirming the presence of discriminant validity (Hair et al., 2019).

Table 2. Discriminant validity: HTMT criterion

Constructs	1	2	3	4	5	6
Relative advantage						
Complexity	0.862					
Computability	0.751	0.667				
Trialability	0.842	0.856	0.767			
Generative AI adoption	0.862	0.886	0.762	0.705		
Supply chain resilience	0.759	0.699	0.578	0.708	0.725	

4.2: The Structural Model

The research’s hypotheses were evaluated through Partial Least Squares Structural Equation Modeling (PLS-SEM). The bootstrapping procedure was used to estimate the hypothesized paths (regression coefficients) by creating a random samples 5,000 times. This procedure provides a more robust estimation of regression coefficients compared to normal methods.

The analysis revealed that all variables collectively accounted for 60.6% of the variance in G-AI adoption, with an R² value of 0.606, indicating a moderately strong variance. The variance in supply chain resilience was 464%.

Hypotheses H1, H2, H3, and H4 were supported, showing that relative advantage, complexity, compatibility and trialability positively influenced G-AI adoption, and G-AI adoption positively and significantly impacted supply chain resilience. These results are summarized in Table 3.

Table 3. Structural model results

Hypothesis	Paths	Std. Beta	Std. Error.	t-value	p-value
H1	RA → G-AI	0.161	0.049	3.305	0.001
H2	COMPLEX → G-AI	0.111	0.049	2.26	0.036
H3	COMP → G-AI	0.342	0.051	6.648	0.000
H4	TRIAL → G-AI	0.133	0.044	3.005	0.003
H5	G-AI → SCR	0.317	0.040	7.941	0.000

5. Discussion

First: The results of the hypotheses testing represents that there is a strong positive effect of relative advantage in supporting G-AI adoption, as this result is consistent with the results of previous studies (Merhi & Harfouche, 2023; Sharma et al., 2022; Waqar & Paracha, 2023; Horani et al., 2023), which emphasized the importance of relative advantage in adopting artificial intelligence technology, as existing studies in literature confirmed the positive relationship between relative advantage in adopting artificial intelligence technology. By reviewing previous studies, it becomes clear that this factor has contributed sufficiently to the prediction in explaining how artificial intelligence can be adopted in this context.

Second: The results of the data analysis showed that complexity does have an effect on G-AI adoption. This result was accepted in the previous studies such as (Waqar & Paracha, 2023; Horani et al., 2023).

Third: The results of the data analysis showed that there is a strong positive effect of computability in supporting G-AI adoption, as this result is consistent with the results of previous studies such as (Sharma et al., 2022; Merhi & Harfouche, 2023; Horani et al., 2023; Prasad Agrawal, 2023) the ability of computability to explain managers' adoption of artificial intelligence technology, and thus companies are able to adopt artificial intelligence and generative-AI technology when there are significant computability emerging from facilities and infrastructure in the firm.

Fourth: The results of the data analysis showed that there is a strong positive effect of trialability in supporting G-AI adoption, as this result is consistent with the results of previous studies (Chen et al., 2022; Mikalef et al., 2022; Gupta et al., 2022), which emphasized the importance of trialability support in adopting such technologies.

By reviewing previous studies, it becomes clear that this factor has contributed sufficiently to the prediction in explaining how artificial intelligence can be adopted in this context.

Fifth: The results of the data analysis revealed that there is a strong positive effect of G-AI adoption on supply chain resilience, as this result was consistent with the results of previous studies (Wael Al-Khatib,

2023; Al-Khatib & Ramayah, 2023; Belhadi et al., 2024) where industry 4.0 technology, such as the Internet of Things and artificial intelligence, facilitate the creation of new solutions by generating creative content that helps to meet the threats and risks in the context of the supply chain (Belhadi et al., 2024).

6. implications and limitations

This study had several theoretical and managerial implications, as it was able to address the research gap of the impact of technological factors on the adoption of artificial energy technology in manufacturing SMEs, which is considered one of the important sectors that focuses heavily on the use of such technology. This technology makes it possible for managers to gain the ability to make better decisions related to adopting technology by conducting technological scanning of competitors.

This study also contributed to understanding the effect of G-AI on supply chain resilience, and therefore supply chain managers should focus more on training and acquiring knowledge on how to use such technologies to introduce new innovations in supply chains to meet the threats and risks.

Despite the importance of this study, there are a set of methodological limitations that must be taken into consideration when conducting future research. The focus of the data collection process was a self-reported measures, and therefore it would be useful to use other procedures in collecting data. Also, a specific set of independent variables that have an effect on technology adoption were used. It would be advisable in the future to study other variables, such as organizational factors. Finally, the focus was limited to manufacturing SMEs, and therefore it is worth studying other sectors, including large companies.

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