Identifying the Factors Influencing AI Adoption in Supply Chain Management to Resolve Supply Chain Disruptions

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Abstract

This research aims to identify the factors influencing AI adoption in supply chain to resolve supply chain disruptions. It is undeniable that the adoption of AI in the supply chain could be essential to resolve supply chain disruptions. Supply chain disruptions could be defined as unexpected events such as earthquakes, the COVID-19 pandemic, and the Suez Canal crisis. To promote the adoption of AI in supply chain management and leverage its benefits, it is important to investigate the factors influencing AI adoption in supply chain to resolve supply chain disruptions. This research explores the multifaceted dynamics of adopting artificial intelligence (AI) in supply chain management through the lens of the Technology-Organization-Environment (TOE) framework. Drawing from a comprehensive review of existing literature, the study identifies critical factors influencing AI adoption across three key contexts: technological, organizational, and environmental. Within the technological context, compatibility and complexity emerge as pivotal factors, facilitating seamless integration of AI with existing systems while addressing implementation challenges through comprehensive training and user-friendly interfaces. Organizational factors, particularly top management support, are found to play a decisive role in driving AI initiatives by ensuring strategic alignment, resource allocation, and fostering an innovation-friendly culture. The study

underscores the significance of governmental regulations and support mechanisms in creating an enabling environment for AI adoption, enhancing clarity, reducing compliance risks, and incentivizing investment in AI technologies. Managerial implications highlight the importance of organizational readiness, cultural alignment, and strategic planning in leveraging AI to enhance supply chain resilience and competitive advantage. By strategically navigating these factors, organizations can optimize AI adoption efforts, thereby enhancing operational efficiencies, decision-making capabilities, and overall supply chain performance. In conclusion, this research contributes a nuanced understanding of AI adoption in supply chain management, offering actionable insights for businesses to effectively integrate AI technologies and navigate the complexities of the digital transformation era.

Keywords: Artificial Intelligence, Supply Chain Management, Toe Framework, Adoption, Supply Chain Disruption.

Introduction
Background of the Study
With the increasing global economic activities and its complexity, the supply chain increases its importance in streamlining business operations and on-time delivery of goods and services. Supply chain management is vital to streamlining the business process, saving financial costs, and increasing profit. However, supply chain management is unavoidable to face challenges like the disruptions caused by unexpected events when natural disasters, political instability, economic fluctuations, and pandemics strike. The famous events that become a hot topic recently could be the Suez Canal crisis, the COVID-19 pandemic, and earthquakes which highlighted the fragility and vulnerabilities of the global supply chain. This may lead to operational inefficiencies, financial losses, and impacts on customer satisfaction. With this, it is undeniable the urgency to find a solution to enhance the adoption and Artificial Intelligence (AI) in supply chain management and improve its resilience.

Supply chain disruption
A supply chain disruption happens when there is an event disrupting the production, sale, or distribution of products. Supply chain disruptions include but are not limited to natural disasters, regional conflicts, and pandemics (Arena, 2024). In 2011, the earthquake and tsunami in Japan significantly disrupted Japanese automaker operations including Toyota, causing a shortage of essential components and a halt in production of over 150,000 vehicles initially (Ineak, 2023). The COVID-19 pandemic has impacted global supply chains significantly, indicating an urgent need for innovative disruption management strategies, which are actively developed and disseminated through numerous scientific articles (Moosavi et al., 2022). Supply chain disruption caused by the COVID-19 pandemic results in a prolonged shortage of various products from personal protective equipment like face masks and sanitizer to semiconductors (Cohen & Tang, 2024). On 23 March 2021, the blockage of the Suez Canal caused traffic jams on both the Canal of the Mediterranean and the Red Sea and caused a loss of revenue in the range of USD 100 million (Notteboom et al., 2024).

Artificial Intelligence in Supply Chain
Artificial Intelligence (AI), which was first introduced in 1950 is a transformative technology that revolutionizes supply chain management. For instance, technologies such as machine learning, deep learning, predictive analytics, and automation can provide better insights, improve operations, enhance efficiency and productivity, improve customer satisfaction, and

streamline the decision-making process. One firm could anticipate the disruption more effectively with the help of AI implementation, which could predict and respond swiftly to ensure continuity of operations. In response to unexpected events, leveraging IoT and Artificial Intelligence enhances the visibility of inventory levels, enabling swift responses to supply chain disruptions in real-time. For example, AI tools gather data such as order records, inventory levels, fast-moving products, and seasonal peak sales. Big data allows algorithms to detect abnormal changes in demand and supply for specific products and conduct simulations to analyse potential solutions.

The adoption of AI in supply chain management might encounter challenges. Various studies are conducted to investigate the factors influencing AI adoption in supply chain to resolve supply chain disruptions. For example, Merhi and Harfouche (2023) constructed a conception model using the TOE framework in their paper and indicated that technology is a crucial category for implementing AI successfully. From the perspective of the organization, challenges like top management support, organization readiness, and organization size might be the stopper affecting AI adoption in supply chain management. In terms of environmental factors, external or competitive pressure, partner support or readiness, and government support or regulations and laws could be the challenges.

Research Problem

The complexity and globalization of the supply chain have been more susceptible to disruptions that impact business operations and economic stability significantly. Technological advancements in Artificial Intelligence (AI) are undeniably increasing supply chain resilience and efficiency. However, the adoption of AI technologies in supply chain management is facing numerous obstacles and the implementation is slow, especially during the supply chain disruptions caused by the COVID-19 pandemic and the Suez Canal crisis. To fully utilize the benefits of AI adoption in supply chain management, it is critical to understand the factors influencing AI adoption in supply chain to resolve supply chain disruptions. By identifying the determinants of AI adoptions in supply chain management using the TOE framework which analyses from the perspective of technology, organizations, and environmental factors. By understanding the factors, the study could provide insight to effectively counter the challenges of generalizing the AI adoption in the industry, which could ultimately robust the performance and enhancement in supply chain management.

Research Objectives

This Research is to Study the Objectives Below.
1. To identify the factors influencing AI adoption in supply chain management to resolve supply chain disruptions from the perspective of the technology, organizations, and environment.

Research Questions

This Research Aims to Study the Research Questions Below.
1. What are the key factors in terms of technology influencing the adoption of AI technologies in supply chain management?
2. What are the key factors in terms of organizations influencing the adoption of AI technologies in supply chain management?
3. What are the key factors in terms of the environment influencing the adoption of AI technologies in supply chain management?

Litterature Review
Theoretical Foundation
The TOE framework was designed to study the adoption of new technologies at an organizational level (Tornatzky & Fleischer, 1990). The TOE framework consists of three dimensions - technological, organizational, and environmental that explore the factors affecting an organization's intention to adopt a technology. As per past studies, this framework has proven to be effective as many researchers have employed this framework in their technology adoption in organizations' research.

The technological context focuses on the characteristics and other aspects of technology, the organizational context focuses on the organization's internal challenges and resources to adopt the technology, and the environmental context focuses on the external issues that impact the organization's business (Chiu et al., 2017). Since this framework has received theoretical and empirical support, it is considered appropriate to study the adoption and implementation of a technology in an organization. In a technological context, the technology's features will determine if it can benefit the organization in terms of process improvement. It's compatible with current legacy systems used by the organizations and if there will be any complexity and security-related issues during the adoption process. Examples of technological factors are relative advantage, compatibility, complexity, technology cost, and many others that relate to the technology.

In an organizational context, the organization's characteristics, resources, and the willingness of organizations including its employees to adapt to innovative technologies and accept the change in the process is crucial to support the technology adoption process. Examples of organizational factors are organization readiness, firm size, top management support, Firm's IT Resources, financial support, and other elements related to organizations.

In an environmental context, the external factors are beyond organizations' control. These factors influence an organization's business operations. Examples of environmental factors such as government support, competitive pressure, business partner pressure, etc.

Factors Influence AI Adoption In SCM
Compatibility
According to Chittipaka et al. (2023), compatibility can be defined as how well a certain technology can be integrated with the adopter's previous practices, existing qualities as well as present needs. In simpler terms, compatibility refers to the degree to which a certain technology is compatible with the business's existing values, experience, and needs (Badghish & Soomro, 2024). Generally, it is believed that when it comes to embracing an innovation, there is a positive linkage between compatibility and intention (Molopa, 2023). For example, in the realm of blockchain technologies for supply chain management, compatibility has also been highlighted to be a crucial factor where higher compatibility will lead to higher adoption intention (Chittipaka et al., 2023). Dora et al. (2022) also highlighted how when it comes to AI adoption in the food supply chain to help with managing food safety challenges, quality challenges, and wastage, compatibility has been regarded as one of the crucial technological factors influencing the adoption success. This is because according to Badghish and Soomro (2024), businesses will be more inclined to adopt AI when they view that the technology is compatible and meets their work requirements and innovation prerequisites. Understanding this, it can be said that technology compatibility plays a critical role in influencing adoption intention success. Therefore, like findings from Merhi and Harfouche (2023) businesses would

need to ensure that their AI systems are compatible with their existing systems and processes to ensure the implementation success.

Complexity

According to Guan et al. (2023), complexity can be defined as the degree to which an innovation is seen as being difficult to understand or use. Generally, technological complexity involves challenges in learning and comprehending new technologies, and it is generally accepted that complexity negatively impacts innovation adoption (Badghish & Soomro, 2024). Furthermore, companies often hesitate to adopt a technology if its complexity confuses users (Guan et al., 2023). For example, in the realm of AI, the complexity of AI solutions may come from having a multitude of tools and technologies required for implementation, the need for both structured and unstructured data, and enablers such as cloud computing (Paul et al., 2022) and if managers find the technology complicated to implement and understand, they will have a higher tendency to avoid adopting it within their firms (Badghish & Soomro, 2024). In addition, technological innovations generally require employees to learn new skills, which can lead to resistance to change and further increase technological complexity (Wael AL-khatib, 2023). As such, it can be said that generally, the complexity of technology will have a negative effect on a firm's intention to adopt AI in Supply Chain Management.

Security

Security can be defined as the protection of data or networks from damage (Merhi & Harfouche, 2023). In digital supply chains, the security and privacy of an organization are at risk of being compromised through hacking, unauthorized access to sensitive information, and dissemination of inaccurate data (Shahzad et al., 2024). As such, researchers have highlighted the essential role that security and privacy have in the adoption and implementation of AI when it comes to supply chains (Merhi & Harfouche, 2023) as security concerns can be a significant inhibitor of behavioral intention (Shahzad et al., 2024). One reason for such could be due to the fact that security tends to remain the most concerning factor for organizations as many feel that the data they share might get destroyed or tampered (Baral et al., 2023). This is further supported by Kalaitzi and Tsolakis (2022) who have highlighted that companies tend to be more concerned about data confidentiality, and the corporate viability and image will be affected when data breaches occur. As a result, these concerns will create a lack of trust and confidence among the technology providers and the organization (Baral et al., 2023). As such, it can be said that security will have a negative influence on AI adoption intention in supply chain management.

Relative Advantage

According to Guan et al. (2023), relative advantage can be defined as the degree to which an innovation can be seen as offering greater benefits that comes from using the innovation in comparison to the previous existing technology and generally is a crucial factor in increasing a firm's receptiveness to new technology (wael AL-khatib, 2023). In fact, findings from Chittipaka et al. (2023) have shown that relative advantage plays a significant role in enhancing productivity and performance, particularly with the adoption of blockchain technology. This advantage is generally evaluated based on time savings, effort reduction, profit increases, cost reduction, and production enhancements (Baral et al., 2023). Similarly in the realm of AI, the implementation of AI can help with cutting costs, saving time, boosting economic profitability, and improving operational excellence which would make these new

technologies more appealing (Mukherjee et al., 2024). For instance, AI can enhance reverse logistics by improving processes such as sorting, disassembling items, remanufacturing components, and recycling materials (Mukherjee et al., 2024). Furthermore, organizations would tend to adopt technologies that promise better performance and higher financial returns and hence, it can be said that there is a positive correlation between relative advantage and innovation adoption (Badghish & Soomro, 2024). Furthermore, their findings highlighted how relative advantages of AI can help with increasing SMEs' willingness to adopt it to enhance their reputation and corporate image. Similarly, the use of big data analytics and AI offers significant benefits through speed and accuracy, making these technologies superior to their current counterparts (wael AL-khatib, 2023). As such it can be said that the greater the relative advantage, the faster the adoption process of AI in supply chain management.

Cost

Generally, the costs of adopting the latest technology can be said as all expenses incurred during the adoption process (Baral et al., 2023). According to (Paul et al. (2020), previous studies indicate that the perceived cost of ownership would negatively impact technology adoption, making it a crucial factor for top management when deciding whether to invest in and commit to evaluating AI technologies as implementing new technology can be expensive for many companies (Zhong & Moon, 2023). These costs include financial and human resources required for implementation (Badghish & Soomro, 2024), which may hinder the intention to adopt an innovation (Zhong & Moon, 2023). These costs are viewed as the assessment of potential losses during the adoption of new technology, continuously evaluated over time (Zhong & Moon, 2023). For example, companies that perceive higher costs relative to benefits in a supply chain analytic system are less likely to adopt it (Kalaitzi & Tsolakis, 2022). Despite the significant benefits of AI technology in pharmaceutical supply chain management, there are some challenges to its implementation, such as the privacy of sensitive data and the need for sophisticated analytics. Moreover, many pharmaceutical companies can be hesitant to invest in technology due to the associated costs and the complexity of implementation.

Top Management Support

According to Baral et al. (2023) top management support refers to the support level and resources provided by top management for technology adoption and have been highlighted as a primary predictor of organizational adoption behavior in past studies (Zhong & Moon, 2023). Being that these individuals serve as the main decision makers, the top management's involvement is essential for adopting new technology, as they are responsible for mobilizing resources and providing financial and organizational backing (wael AL-khatib, 2023). As such, top management support can be said to significantly influences a company's decisions regarding the adoption of AI technologies (Fu et al., 2023). This is because the top management shapes the vision, mission, values, and culture of the organization and hence this makes their support a critical determinant of technology adoption and implementation by fostering a supportive climate (Merhi & Harfouche, 2023). Generally, when managers provide support, they enhance the mobilization of resources, capital, and financing, thereby accelerating the pace of technology adoption (wael AL-khatib, 2023). Similarly in the context of AI adoption, top management support can also influence employees' trust in AI and reduce their resistance to change and hence serves as a fundamental enabler for AI, as it ensures the

allocation of necessary resources, while a lack of support can impede resource provision and diminish the focus on (Merhi & Harfouche, 2023). As a result, their engagement and resource allocation for new technology implementation can help send positive signals to other organizational members and educate them about the significance of adoption (Zhong & Moon, 2023). Hence, it can be said that top management support would show a positive influence on AI adoption in supply chain management.

Organization Readiness

Organizational readiness is a critical factor that ensures the availability of required resources for AI adoption (Kumar et al., 2023) and can be defined as the accessibility of the necessary organizational resources for adoption (Chatterjee et al., 2021). According to Shahzad et al. (2024), organizational readiness has two dimensions which are financial resources and information system infrastructure with financial resources generally refer to the availability of funds to install innovative technology, implement subsequent changes, and cover ongoing expenses while information system infrastructure includes advanced telecommunications and databases within departments to support the implementation of innovations (Shahzad et al., 2024). Furthermore, studies have shown that organizational readiness significantly enhances the adoption of innovative technologies (Shahzad et al., 2024). As such, a company's decision to adopt a new technology would depend on its readiness for technological infrastructure and IT-literate personnel (Kalaitzi & Tsolakis, 2022). This is because successful technology adoption requires adequate resources, knowledge, and top management support (Baral et al., 2023). Similarly, Bialas et al. (2023) highlighted a similar notion that organizational readiness would also be influenced by the presence of proficient, informed, and adequately trained personnel regarding new technologies.

Firm Size

Within the organizational context, firm size and structure significantly influence the adoption of disruptive technologies through access to financial and technical resources (Kumar et al., 2023). Previous studies have identified firm size as a crucial factor in innovation adoption (Chittipaka et al., 2023). Generally, small and medium-sized enterprises (SMEs) are often hesitant to adopt emerging technologies and alter their IT structures, processes, and work routines because they typically lack the necessary resources and knowledge (Kalaitzi & Tsolakis, 2022), larger organizations on the other hand would have more financial resources, allowing them to invest in new technologies and manage associated risks more effectively (Bialas et al., 2023). Guan et al. (2023) also highlighted similar notion by highlighting that large firms possess greater financial and technological resources than smaller firms and are better equipped to absorb the risks and costs involved in adopting new technologies.

External/Competitive Pressure

According to Merhi and Harfouche (2023), the decision to adopt and implement technologies are influenced not only by internal factors but also by external forces, which significantly impact organizational decisions, particularly regarding AI systems. Generally, competitive or external pressure can be defined as the total pressures that arise through competitors in the same industry (Wael AL-khatib, 2023). As such, when a company feels pressure from its competitors, it is more likely to integrate new technologies into its operations (Fu et al., 2023) because by adopting new technologies, they can redefine competition rules, alter internal industry structures, and find new ways to surpass their peers, thereby positioning themselves

more favourably (Zhong & Moon, 2023). On the other hand, companies that do not adopt new innovations may experience lower organizational performance and thus tend to adopt new technologies to mitigate the risk of competitive disadvantage (Zhong & Moon, 2023). This is because the pressure to maintain competitive advantage often results in companies adopting new practices (Zhong & Moon, 2023). Similarly, Paul et al. (2022) highlighted that external pressure influences Indian businesses to drive the usage and routinization of AI-based insights to remain competitive and benefit from increased collaboration with partners. Similarly, findings from Molopa (2023) highlighted that there is high frequency of respondents in their study who agree that their organization will face competitive pressure and failure to implement AI. Additionally, competitive pressure stimulates the adoption of new technology to achieve innovations and work methods that provide competitive advantages through differentiation, innovation strategies, or cost reduction (Wael AL-khatib, 2023).

Business Partner Support/Readiness

According to Kalaitzi and Tsolakis (2022), organizations also often rely on their trading partners to design and implement technology. For instance, a partner in a business relationship may recommend or even pressure their counterparts to adopt specific technologies (Bialas et al., 2023). Being that the global presence of supply networks and the high coordination complexity among involved actors, it is critical to streamline targets and operations (Kalaitzi & Tsolakis, 2022). Hence, partner support is external and helps to generate the innovation performance of an organization through knowledge exchange as the knowledge development of employees through their own and through the help of inputs from partners of the organization would help in the easy adoption of AI-embedded technology allowing for employees realize the usefulness of AI applications in organizations (Chatterjee et al., 2021). Furthermore, having a higher degree of data quality and integrity enables smooth sharing of data among the supply chain partners from the public data repository and would lead to a successful AI adoption in the supply chain (Kumar et al., 2023).

Government Support/ Regulation & Laws

Government support, regulations, and laws play a crucial role in influencing AI adoption within organizational supply chain management. Favourable regulations and legal frameworks can significantly enhance the adoption of AI technologies. For instance, clear regulatory guidelines reduce uncertainties and compliance risks, while supportive policies, such as grants, tax incentives, and subsidies, can lower financial barriers to AI adoption. Additionally, governments that promote data sharing and collaboration among supply chain stakeholders further enhance the effectiveness of AI solutions. The high frequency of studies emphasizing government support and regulations underscores their importance in creating a conducive environment for AI adoption. Organizations should stay informed about relevant policies and actively seek opportunities for government incentives. By aligning their AI initiatives with regulatory requirements and leveraging available support, organizations can mitigate risks and enhance the feasibility and attractiveness of AI investments

On the other hand, government support refers to the assistance provided to employees or organizations to facilitate technology transformation or implementation within firms (Badghish & Soomro, 2024). This is because companies tend to encounter difficulties complying with policies and regulations due to the large amount of unstructured data (Kalaitzi & Tsolakis, 2022) and these concerns about potential misuse or unintended consequences of AI have prompted legislation and policymaking to adapt regulations and laws to the new

conditions brought about by AI adoption and implementation (Merhi & Harfouche, 2023). Moreover, government support and policies on compliance, intellectual property, and consumer protection can help reduce ambiguity, instil confidence, and assist organizations in adopting disruptive technologies (Kumar et al., 2023). Similarly, Badghish and Soomro (2024) have also highlighted that government policies such as providing monetary incentives, scientific resources, pilot projects, and training programs can serve as a driving force for SMEs to adopt new technology and green practices and without any governmental support, no companies can adopt innovative technology in their operations (Baral et al., 2023)

Conceptual Research Framework And Hypothesis
The literature review explores the relevant literature related to this study's independent and dependent variables. T-O-E Framework was referred to develop the conceptual framework for this study. The conceptual framework which illustrated the relationship between variables is shown in Figure 1.
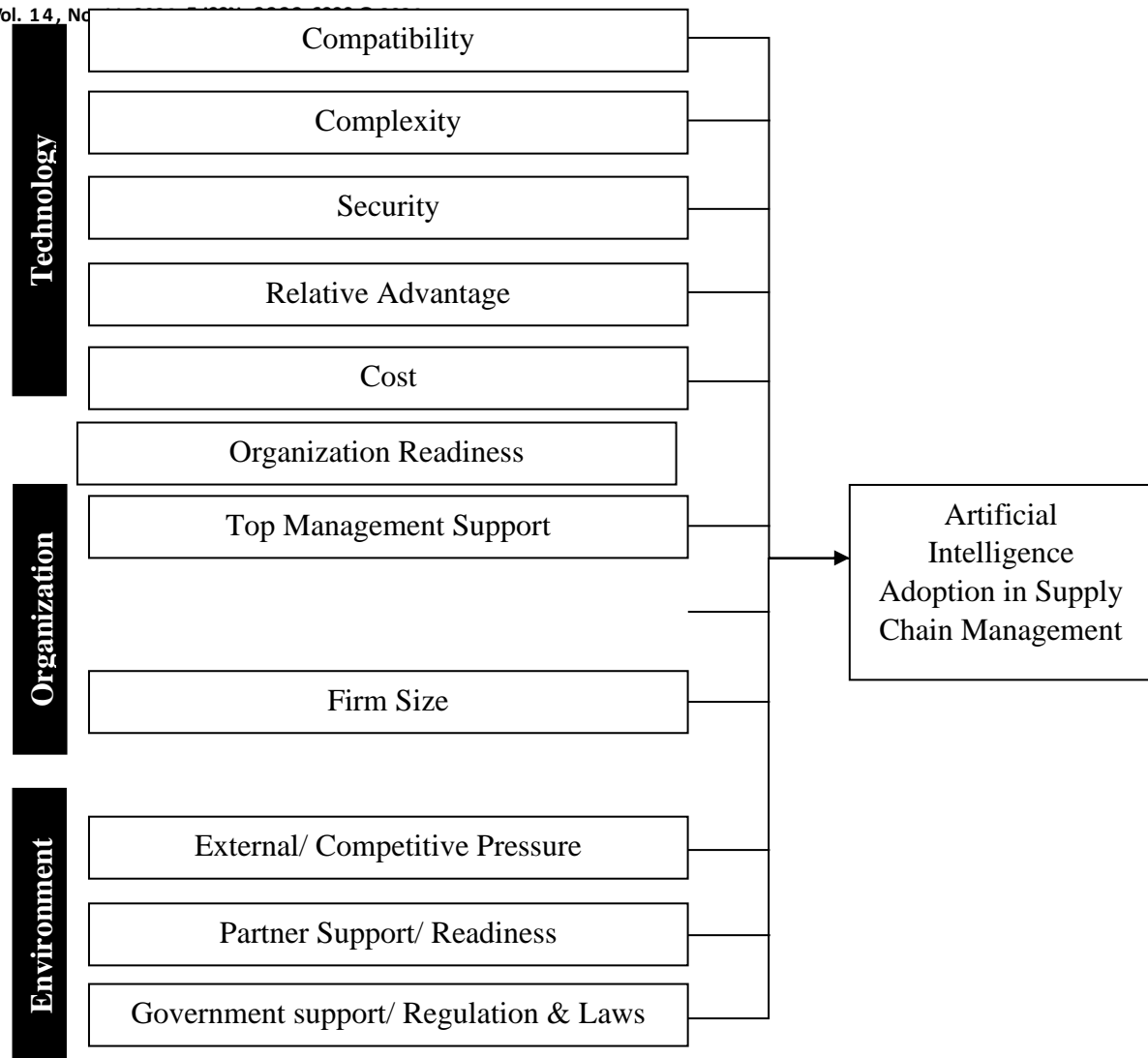
Figure 1: Research Conceptual Framework

Based on the above discussed literature, the following research framework (Figure 1) was proposed which was developed based on the T-O-E Framework. Under the Technology dimension, compatibility, complexity, security, relative advantage and cost were identified to influence AI adoption in supply chain management. Under the Organization dimension, top management support, organization readiness and firm size would influence AI adoption in supply chain management while external/competitive pressure, partner support/readiness and government support/regulation and laws will influence AI adoption in supply chain management in the Environment dimension.

The adoption of AI in Supply Chain Management is influenced by a variety of factors categorized under the Technology-Organization-Environment (TOE) framework. This discussion explains each context and why specific factors within each context were chosen, how they contribute to the importance of their respective contexts, and how these findings, based on the most frequently studied factors, can aid organizations in adopting AI in their supply chain management. By prioritizing the key factors and recommendations, organizations can enhance their AI adoption initiatives, resulting in greater supply chain efficiency and enhanced competitiveness. Ensuring alignment among technological, organizational, and environmental factors will facilitate a comprehensive approach to AI integration, optimizing potential benefits and promoting sustainable growth.

To enhance compatibility, organizations should invest in AI solutions that are designed to be compatible with their existing systems. Conducting thorough assessments of current technological infrastructures and selecting AI technologies tailored for seamless integration can minimize disruptions and facilitate smoother transitions. Additionally, addressing complexity by simplifying the adoption process through comprehensive training programs and ensuring that AI solutions have user-friendly interfaces can reduce perceived complexity. This approach helps increase acceptance and usage among employees, making AI technologies more accessible and less intimidating. By strategically focusing on compatibility and complexity, organizations will significantly improve their prospects for successful AI adoption in their supply chains. This dual approach not only ensures a smoother transition but also maximizes the potential benefits of AI technologies, ultimately leading to enhanced operational efficiency and competitive advantage.

Technology
Compatibility
In technological context, five critical factors have been identified and chosen based on a comprehensive review of past research: compatibility, complexity, security, relative advantage, and cost. Among these factors, compatibility and complexity emerges as the most frequently studied, with 9 out of 19 studies highlighting their significance within the technology context of the TOE framework (Badghish & Soomro, 2024; Chittipaka et al., 2023; Fu et al., 2023; Guan et al., 2023; Kalaitzi & Tsolakis, 2022; Merhi & Harfouche, 2023; Molopa, 2023; wael AL-khatib, 2023). This high frequency emphasizes their significant roles in the adoption process of AI within organizational supply chain management.
Compatibility stands out as a crucial technological factor, emphasizing its importance in ensuring the seamless integration of AI systems with existing technologies. High compatibility minimizes the need for extensive modifications, thereby facilitating smoother transitions and reducing operational disruptions. Organizations that prioritize compatibility can more effectively integrate AI into their supply chains, leveraging existing technological infrastructures and maximizing resource utilization. This seamless integration is essential for reducing resistance to change and ensuring that AI solutions can be effectively deployed without significant overhauls. By focusing on compatibility, organizations enhance their ability to adopt AI technologies efficiently and smoothly. Therefore, the following hypothesis is proposed by this study:
H1: The compatibility positively influences the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Complexity
Moreover, complexity reflects the perceived challenges associated with AI implementation. High complexity can act as a significant barrier to adoption due to the extensive training and substantial changes required in existing processes. Organizations that address complexity by simplifying AI technologies and providing comprehensive training programs can mitigate these barriers. This approach ensures that employees are well-equipped to utilize AI systems, facilitating smoother adoption and enhancing overall effectiveness. By focusing on reducing perceived complexity, organizations can make AI technologies more accessible and less intimidating, thereby promoting wider acceptance and utilization. The findings align with existing research that emphasizes the importance of complexity and compatibility in AI adoption for organizations. These findings suggest that organizations should prioritize

ensuring compatibility and addressing complexity to enhance AI adoption in their supply chains. By doing so, they can achieve a more integrated and user-friendly implementation, ultimately leading to more successful AI initiatives. Thus, the hypothesis proposed is:

H2: The complexity positively influences the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Security

The cyber security issue and risk factors enables businesses to identify potential barriers and facilitators to AI adoption. By proactively addressing these factors, businesses can mitigate risks associated with AI implementation and increase the likelihood of success. In today's dynamic business environment, supply chain management can greatly benefit from the integration of AI technologies to improve security and efficiency. According to Charles et al. (2023), it can greatly improve supply chain security by enabling proactive risk mitigation techniques and offering advanced threat detection capabilities. Moreover, the identification of environmental factors such as market competition and regulatory requirements helps businesses anticipate emerging opportunities and threats in the external environment, enabling them to adapt their AI adoption strategies accordingly. Massive amounts of data can be analysed in real-time by AI-powered surveillance systems, which can identify anomalies and possible security breaches before they get out of hand. Additionally, according to Elluru et al. (2017), machine learning algorithms can recognize patterns that point to fraudulent activity or malicious intent, giving organizations the ability to act quickly to stop or lessen damage can also improve cyber security by automatically detecting potential vulnerabilities, monitoring network traffic, and responding to cyber threats. This lowers the likelihood of data breaches and cyberattacks (Dubey et al., 2019). Reim et al. (2020) added that AI algorithms may gain accuracy over time by learning from past data, which would enable them to adjust to evolving threats and identify novel patterns that point to security issues. By using a proactive approach, organizations can foresee potential security threats and stop breaches before they happen. Thus, the hypothesis proposed is:

H3: The security has a positively influences on the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Relative Advantage

Organizations tend to adopt technologies that promise better performance, as they are constantly seeking ways to enhance efficiency, reduce costs, and gain a competitive edge. When a new technology offers clear benefits such as increased productivity or improved outcomes it becomes more attractive for organizations to integrate it into their operations. This tendency to embrace performance enhancing innovations is a key driver of technological adoption in the business world. Likewise, organizations would tend to adopt technologies that promise better performance and higher financial returns and hence, it can be said that there is a positive correlation between relative advantage and innovation adoption (Badghish & Soomro, 2024). Furthermore, their findings highlighted how relative advantages of AI can help with increasing SMEs' willingness to adopt it to enhance their reputation and corporate image. Similarly, the use of big data analytics and AI offers significant benefits through speed and accuracy, making these technologies superior to their current counterparts (wael AL-khatib, 2023). As such it can be said that the greater the relative advantage, the faster the adoption process of AI in supply chain management. Therefore, the following hypothesis is proposed by this study:

H4: The relative advantage has a positive influence on the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Cost

Some similar studies also conducted by Badghish and Soomro (2024), Kumar et al. (2023), Molopa (2023) to investigate the factors influencing adoption of AI in supply chain management. In terms of technology factors, there are essential factors impacting the adoption of AI such as compatibility complexity, security, relative advantage, and cost. Similarly, the significant investment needed to adopt AI can be a barrier, leading to reluctance in simplifying interpretations and increased sensitivity to errors and unusual occurrences, regardless of the firm's size (Badghish & Soomro, 2024). As a result, it can be said that costs play a role in influencing AI adoption intention in supply chain management. Thus, the hypothesis proposed is:

H5: The cost factor positively influences the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Organization

Top Management Support

Within the organizational context, three critical factors have been identified and chosen based on a comprehensive review of past research: top management support, organization readiness, and size. Top management support emerges as the most prominent factor, with 12 out of 19 reviewed studies highlighting its critical importance (Badghish & Soomro, 2024; Baral et al., 2023; Dora et al., 2022; Fu et al., 2023; Kumar et al., 2023; Merhi & Harfouche, 2023; Molopa, 2023; Mukherjee et al., 2024; Paul et al., 2020, 2022; wael AL-khatib, 2023; Zhong & Moon, 2023). This prevalence highlights the vital role of leadership in the successful adoption of AI technologies.

Top management support is critical for driving AI initiatives within an organization. The commitment and advocacy from senior leadership ensure that AI projects receive the necessary resources, attention, and strategic priority. Leaders who encourage AI adoption can foster an innovation-friendly culture, encourage organizational buy-in, and allocate sufficient funding and resources. Their support helps overcome resistance from various levels of the organization, ensuring that AI initiatives are aligned with overall business objectives and receive sustained focus. To secure top management support, organizations should actively engage their senior leaders in AI initiatives. Demonstrating the strategic benefits of AI adoption to top management is crucial. By highlighting how AI can drive efficiencies, enhance decision-making, and provide competitive advantages, organizations can ensure that these projects receive the necessary resources and attention. Strong leadership commitment can drive AI adoption more effectively and align projects with overall business objectives.

The frequent emphasis on top management support in the literature suggests that organizations should actively engage their senior leaders in AI initiatives. By securing strong leadership commitment, organizations can drive AI adoption more effectively, ensuring that projects are well-supported and aligned with strategic goals. Engaging top management in AI initiatives also enhances the likelihood of securing necessary investments and fostering a culture of continuous improvement and innovation. Furthermore, top management support can influence other organizational factors critical to AI adoption. Leaders can facilitate the development of necessary skills and competencies among employees through targeted training programs and professional development opportunities. They can also champion the

creation of cross-functional teams that integrate AI into various business processes, thereby promoting a more holistic approach to AI implementation.

Hence, the significant emphasis on top management support within the literature highlights its vital role in the successful adoption of AI technologies in organizational supply chains. Organizations aiming to enhance their AI capabilities should prioritize securing strong leadership commitment and fostering a supportive environment that encourages innovation and strategic alignment. Thus, the hypothesis proposed is:

H6: The top management support has a positive influence on the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Organizational Readiness

According to Shahzad et al. (2024), organizational readiness significantly enhances the adoption of innovative technologies. Hence, if an organization is not prepared to use a new system such as AI, employees may feel constrained and unable to realize the full benefits of the new technology (Chatterjee et al., 2021). As such, a higher level of organizational readiness would generally indicate sufficient resources and a greater intention to adopt new technologies (Guan et al., 2023). Therefore, the following hypothesis is proposed by this study:

H7: The Organizational readiness positively influence the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Firm Size

According to (Chittipaka et al., 2023), Previous studies have identified firm size as a crucial factor in innovation adoption Indeed, previous studies have shown that firm size significantly influences innovation adoption. Larger firms often have more resources and established processes that can facilitate the integration of new innovations. On the other hand, smaller firms might face resource constraints but can sometimes be more agile and flexible in adopting innovations. The relationship between firm size and innovation adoption can vary depending on the industry and specific context. Furthermore, Molopa (2023) also highlighted that generally, AI adoption would be more suitable for larger firms as larger firms will gain more beneficial effects from the adoption of new technology though it is also highlighted that smaller firms may also be more inclined to adopt new technologies as compared to larger firms due to their flexibility and ability to adjust quickly. Therefore, the following hypothesis is proposed by this study:

H8: The firm size and structure positively influence the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Environment
External Competitive Pressure

In the environmental context, three critical factors have been identified and chosen based on a comprehensive review of past research: external/ competitive pressure, partner support/ readiness, and government support, regulations, and laws. Among these factors, government support, regulations, and laws appear as the most frequently studied factors, with 14 out of 19 reviewed papers focusing on them (Badghish & Soomro, 2024; Baral et al., 2023; Bialas et al., 2023; Chittipaka et al., 2023; Dora et al., 2022; Fu et al., 2023; Guan et al., 2023; Kalaitzi & Tsolakis, 2022; Kumar et al., 2023; Merhi & Harfouche, 2023; Molopa, 2023; Mukherjee et al., 2024; Paul et al., 2020; Sharabati et al., 2024). This emphasis highlights the significant

impact of external regulatory environments on AI adoption in supply chain management. Furthermore, using innovative technology strengthens an organization's market position and customer relationships, enabling them to provide better service (Baral et al., 2023). As a result, it can be said that having competitive or external pressure will influence AI adoption in supply chain management positively.

H9: The external competitive pressure positively influences the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Business Partner Support

Business partner support and readiness is essential for maintaining trade relations, especially when a dominant partner exists in the supply chain (Chittipaka et al., 2023). This is because even if an organization initiates the adoption of new technology, this process can be influenced by the readiness of its business partners, as system compatibility across the supply chain is crucial for seamless integration (Bialas et al., 2023) due to certain ICT technologies require cooperation with trading partners for effective use (Molopa, 2023). As such, partner support or readiness may have a significant impact on AI adoption intention and success in supply chain management. Thus, the hypothesis proposed is:

H10: The business partner positively influences the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Government Support

Government support in AI adoption for supply chain management is multifaceted. Regulatory clarity provides a stable environment in which organizations can plan and execute AI projects with confidence. Supportive government policies, including financial incentives like grants, tax breaks, and subsidies, can significantly reduce the initial investment costs associated with AI technologies. Furthermore, government initiatives that facilitate data sharing and collaboration among various supply chain stakeholders can lead to more effective and innovative AI applications.

Organizations should proactively engage with policymakers and stay abreast of evolving regulations to ensure compliance and take full advantage of available incentives. By strategically aligning their AI initiatives with government policies and leveraging the support mechanisms in place, organizations can navigate regulatory landscapes more effectively and position themselves for successful AI integration in their supply chain management systems. Therefore, the significant emphasis on government support, regulations, and laws within the literature suggests that organizations aiming to enhance their AI capabilities should prioritize understanding and navigating the regulatory environment, seeking government support, and aligning their initiatives with regulatory frameworks to mitigate risks and capitalize on opportunities for AI adoption.

Government funding and legislation play a crucial role in encouraging IT innovation (Mukherjee et al., 2024). In some instances, the regulatory environment and governmental institutions can exert more influence than market forces, impacting the adoption of innovations through the promotion of specific technologies (Bialas et al., 2023). Being that AI can be a disruptive technology, various challenges including security, privacy, and social ethics can be seen resulting in governments worldwide making significant financial investments in AI and have published national AI development policies to help overcoming these challenges (Mukherjee et al., 2024). In fact, Molopa (2023) highlighted that regulation by government entities can either impede or promote technological advancement as well as have a positive

or adverse effect on productivity. Regulation support generally includes the regulations and policies set by governments to monitor and regulate the use of new technologies, which is a fundamental factor impacting innovation diffusion (Chittipaka et al., 2023). As such, government support or regulation and laws can help to positively influence firm's adoption intention of AI in supply chain management. Thus, the hypothesis proposed is:

H11: The government support and regulations positively influence the intention of organizations to adopt Artificial Intelligence in Supply Chain Management

Methodology

The study intended to identify the factors influencing Artificial Intelligence adoption by organizations in supply chain management that can help in resolving the current ongoing global supply chain disruptions. The main demographic to focus on would be operation and supply chain management personnel, working in Malaysia manufacturing companies. This demographic is suitable for the study as it seeks to investigate the factors that influence Artificial Intelligence adoption by organizations involved in the manufacturing industry. The nature of the study focuses on technology adoption in supply chain process for organizations based in Malaysia. Organizations such as multinational companies and small medium enterprises (SME) including logistics service providers that are based in Malaysia were chosen as the unit of analysis. The study's participants were experts in the supply chain such as directors, managers, assistant managers, and specialists who work in supply chain departments such as planning, procurement, logistics and warehousing. Professionals in the supply chain were approached for the data collection since they possess a thorough understanding of the organization's technology adoption plans and are specialists in supply chain overviews. This study aimed at an organizational level where only one respondent was required from an organization.

The choice of an appropriate sample size is of utmost importance in this study. The purposive sampling approach seeks to generate a representative sample (Tashakkori & Teddlie, 2010). The minimum sample size in this investigation will be computed using G*Power. Measurements In this study, a questionnaire was chosen as the instrument for data collection. The survey will be devised in the English language and constructed using Google Forms. Afterwards, the questionnaire will distribute on multiple prominent forums and groups across various social media platforms through posts or private messages, which included a Uniform Resource Locator (URL) directing users to the website where the questionnaire was hosted. Those questions were designed so that the questionnaire can only be answered by the desired population for this study. The study will examine the research model using the partial least squares (PLS) approach of structural equation modeling. The SmartPLS Version 4.0 will be employed for this purpose.

Discussion and Conclusion

The findings of this study hold several key managerial implications for businesses aiming to leverage AI technologies in their supply chain management practices to mitigate disruptions. Firstly, decision-makers should prioritize investments in AI solutions that offer scalability and flexibility, enabling them to adapt to evolving supply chain dynamics. Additionally, fostering a culture of innovation and providing adequate training and resources are essential for enhancing organizational readiness for AI adoption. Moreover, collaboration with suppliers and partners to integrate AI technologies across the supply chain ecosystem can yield significant benefits in terms of improved visibility and coordination. Furthermore, given the

critical role of data in AI applications, organizations should focus on enhancing data quality and accessibility to maximize the effectiveness of AI-enabled decision-making. Finally, aligning AI adoption efforts with strategic objectives and regulatory requirements is crucial for ensuring long-term success and compliance. By addressing these managerial implications, businesses can unlock the full potential of AI in enhancing supply chain resilience and competitiveness in today's rapidly changing business landscape.

By applying the TOE framework to the study of AI adoption in supply chain management, businesses gain a nuanced understanding of the multifaceted factors influencing adoption decisions. This understanding empowers decision-makers to make informed choices regarding the adoption of AI solutions to address supply chain disruptions. Rather than relying on intuition or anecdotal evidence, businesses can leverage empirical insights to assess the feasibility and potential impact of AI adoption in their specific organizational context. According to Molopa (2023), the primary benefits of Industry 4.0 for the supply chain include a reduction in the time required to deliver goods to clients, a quicker response to unforeseen events, and a notable enhancement in the calibre of decision-making. Expert systems have shown to be an invaluable tool for decision-making in a variety of fields due to their capacity to provide insightful analysis and recommendations. (Sheshadri & Kumar, 2019). Unquestionably, artificial intelligence is a technological advancement that will benefit most businesses in supply chain management and logistics. Through the identification of patterns and trends, big data analytics will aid in the interpretation of the data. With the aid of decision-making algorithms, artificial intelligence will expedite the process of identifying trends and patterns (Kersting & Meyer, 2018).

The comprehensive analysis of technological, organizational, and environmental factors enables businesses to identify potential barriers and facilitators to AI adoption. By proactively addressing these factors, businesses can mitigate risks associated with AI implementation and increase the likelihood of success. In today's dynamic business environment, supply chain management can greatly benefit from the integration of AI technologies to improve security and efficiency. According to Charles et al. (2023), it can greatly improve supply chain security by enabling proactive risk mitigation techniques and offering advanced threat detection capabilities. Moreover, the identification of environmental factors such as market competition and regulatory requirements helps businesses anticipate emerging opportunities and threats in the external environment, enabling them to adapt their AI adoption strategies accordingly. Massive amounts of data can be analysed in real-time by AI-powered surveillance systems, which can identify anomalies and possible security breaches before they get out of hand. Additionally, according to Elluru et al. (2017), machine learning algorithms can recognize patterns that point to fraudulent activity or malicious intent, giving organizations the ability to act quickly to stop or lessen damage can also improve cyber security by automatically detecting potential vulnerabilities, monitoring network traffic, and responding to cyber threats. This lowers the likelihood of data breaches and cyberattacks (Dubey et al., 2019). Reim et al. (2020) added that AI algorithms may gain accuracy over time by learning from past data, which would enable them to adjust to evolving threats and identify novel patterns that point to security issues. By using a proactive approach, organizations can foresee potential security threats and stop breaches before they happen.

Through the examination of organizational factors such as culture, resources, and capabilities, businesses can assess their readiness for AI adoption. By fostering a culture of innovation and providing adequate resources and training, businesses can enhance their organizational readiness to embrace AI technologies effectively. Moreover, by aligning AI adoption efforts

with strategic objectives and organizational priorities, businesses can ensure that AI initiatives are integrated seamlessly into existing operations, maximizing their potential impact on supply chain resilience and performance. The advantages of AI integration include increased competitive advantage, efficiency, and security, making it a wise investment for businesses looking to prosper in a world that is becoming more digital and interconnected by the day (Farah et al., 2022). Because AI adoption in supply chain management necessitates a trifecta of technical proficiency, cultural congruence, and strategic planning, organizational readiness is essential (Issa et al., 2022).   By leveraging AI technologies to enhance supply chain resilience and agility, businesses can gain a competitive advantage in the marketplace. In today's volatile and uncertain business environment, the ability to respond quickly and effectively to supply chain disruptions is critical for maintaining customer satisfaction and market share. By adopting AI solutions that enable real-time monitoring, predictive analytics, and automated decision-making, businesses can optimize their supply chain operations and differentiate themselves from competitors. A thorough consideration of how AI can be used to support supply chains' long-term performance and competitive advantage—that is, innovation—is prompted by the technology's demonstrated ability to support decision-making in supply chains (Akter et al. 2020). Artificial intelligence (AI) applications have given businesses a competitive edge in two areas: (a) nearly 100% accurate customer demand forecasting and projection; and (b) optimizing R&D to increase manufacturing at a lower cost and higher quality. c) supporting them with the promotion (identifying the target market, determining price, defining demographics, creating the appropriate message, etc.). d) giving their clients a better experience, which is further discussed in detail in a later section (Dash et al., 2019).

By synthesizing insights from the TOE framework with empirical findings from AI adoption research, this study contributes to theory development in the field of technology adoption and innovation management. By refining existing theoretical constructs and proposing new theoretical frameworks, this study advances our understanding of the complex interplay between technological, organizational, and environmental factors shaping technology adoption decisions. This theoretical development lays the foundation for future research and informs the design of more effective strategies for promoting technology adoption and innovation in organizations.

Based on the comprehensive discussion and findings presented in the research article on AI adoption in supply chain management, several key conclusions can be drawn. First, the study emphasises the critical role of technological factors, particularly compatibility and complexity, in determining the successful integration of AI technologies into supply chains. The focus on compatibility highlights how important it is for enabling smooth integration with current systems, reducing operational disruptions, and maximising resource use. It is equally important to address complexity with thorough training and user-friendly interfaces because doing so reduces adoption barriers and improves organizational preparedness for implementing AI. The factors impacting an organization's intention to adopt technologies, such blockchain, artificial intelligence, cloud computing, etc., have been studied in various developing nations, including Malaysia, according to previous literature. In previous research, it is also found that an organization's intention to adopt is driven not only by technology but also by the way its resources are already organized and by its connections with partners, competitors, and the government.

Second, the study emphasises how important top management support is for advancing AI initiatives inside businesses. Senior leaders' advocacy and dedication are crucial in obtaining funds, developing a culture that values innovation, and coordinating AI initiatives with

important corporate objectives. In addition to overcoming opposition to change, this leadership support makes sure that AI adoption initiatives are given top priority and successfully incorporated into organizational procedures, optimising their influence on supply chain operations. The study also emphasises how important government support programs and regulatory frameworks are in influencing supply chains' adoption of AI. An environment that is favourable to AI investments is created by well-defined regulatory guidelines and policies that support them, such as financial incentives and data-sharing initiatives. By actively interacting with regulatory frameworks and utilizing government assistance, organizations can reduce adoption barriers, minimize risks, and improve the allure of AI technologies for supply chain applications.

From a managerial standpoint, the study offers useful information to companies looking to use AI technologies. To maintain competitive advantage and resilience in changing market conditions, strategies like building an innovative culture, improving organizational readiness through focused training, and coordinating AI adoption efforts with strategic objectives are crucial. Businesses can improve their ability to adopt and integrate AI technologies effectively, optimise supply chain efficiency, and position themselves for long-term success in the digital era by strategically addressing technological, organizational, and environmental factors. The results highlight the intricate interactions among variables influencing supply chain management's adoption of AI. Organizations can leverage AI technologies to drive innovation, competitive differentiation, and operational excellence in the ever-evolving business landscape of today by strategically navigating these factors.

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