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The Role of IoT-Driven Supply Chain Integration in Enhancing Supply Chain Performance and Organizational Outcomes

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ABSTRACT

Businesses in emerging economies like Pakistan need to improve their supply chains to stay competitive in a world market that has become more globalized. One of the most challenging aspects to master is Supply Chain Integration (SCI). The term means that customers and suppliers have to work together. Using Internet of Things (IoT) technologies in the supply chain could improve its visibility, efficiency, and adaptability. These improvements would lead to better performance in the supply chain and the organization as a whole.This research looks at how the Internet of Things (IoT) affects operations in the supply chain, focusing on how it changes different parts of its performance and integration in Pakistan. The study looks into how IoT affects the visibility, efficiency, flexibility, and resources of the supply chain, as well as how these things affect its output and performance. This study looks at how Customer Integration and Supplier Integration affect the relationship between IoT adoption and Supply Chain Performance, as well as how it affects Organizational Performance as a whole.The study uses survey data from Pakistani companies that have implemented IoT-based solutions in their supply chains. The study then employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the connections between the various constructs. The findings show that using IoT greatly enhances Supply Chain Integration, leading to greater visibility, efficiency, and flexibility, all of which have a positive effect on Supply Chain Performance. Customer Integration and Supplier Integration also play a role in the connection between IoT and Supply Chain Performance. Improving the supply chain directly improves the performance of the organization.Pakistani businesses that want to use IoT to make their supply chains more efficient can learn a lot from this study, both in terms of theory and practice. This study explains the main things that affect the performance of supply chains. This paper helps us understand how the Internet of Things can be used to improve supply chains and help businesses succeed in emerging economies.

Keywords: *Internet of Things; supply chain integration; supply chain performance; customer integration; supplier integration; organizational performance*

INTRODUCTION

Supply chain management should employ new technologies in the era of Industry 4.0 to be ahead of the competitors and enhance the overall performance of the company. The Internet of Things (IoT) is quite a significant aid to digitalizing the supply chains. The Inter net of Things (IoT) allows providing you with real-time data, easing the sharing of your data, and learning more. This simplifies the operation of businesses, saves them money, and allows businesses to meet the needs of the customers faster. The world is increasingly becoming global thereby businesses are continually seeking options to outdo their competitors. The inclusion of the Internet of Things (IoT) in the normal supply chain processes of

companies could help them work more efficiently and provide their customers with more value in entirely new ways.

Supply chain integration (SCI) is one of the greatest concepts that result in effective supply chains. SCI refers to the process of ensuring that all the members of the supply chain are collaborating as well as knowing what they are doing. These components include buying, making, shipping, and helping the customers. These involve individuals who are employees of the firm and those who are not.IoT technology facilitates conversation between buyers, sellers and manufacturers in the supply chains. According to Fatorachian and Kazemi (2021), with Industry 4.0 technologies, such as the Internet of Things (IoT), it is far easier to have different supply chain components linked. This enables the firms to utilize their resources effectively and save them.

The fact that the IoT has the potential to make Supply Chain Performance (SCP) improve is one of the most positive aspects of it. High SCP implies supply chain is fast and efficient working. IoT can also assist businesses to monitor their assets in real time, maintain a better stock, and deliver things to customers more quickly. This simplifies the process and also conserves funds. Rejikumar et al. (2019) claim that the ease of information sharing, plan making, and collaboration among people in the supply chain is promoted by IoT technologies. This is because when it happens, it is easier to save money, be flexible, and make customers happy. The IoT also offers easier view of supply chain which is useful to managers in tracking the amount of stock they have, the flow of products, and their shipping. By having full knowledge of the way they conduct business companies are better placed to make better decisions, harness their resources and make their supply chain more flexible. All these things are causing them to do better.

Many companies have been successful and thriving due to the Internet of Things (IoT). According to Tiwari (2021), implementation of IoT technology in the management of the supply chain not only increases the functionality of the chain, but also the functionality of the entire company. Some of these skills include the need to meet the needs of the market in a timely manner, provide improved customer service, and saving of money. The IoT (Internet of Things) has enhanced a workable supply chain. In this manner, businesses are likely to satisfy their customers more effectively, save money and earn more money. In case a business is equipped with the system of IoT, De Vass, Shee, and Miah (2018) assert that it performs significantly better, as they could now use the real-time data to make things run more efficiently and make better choices.

There are certain issues with IoT technology. Many companies are also unaware of the use of IoT in their supply chains. Some of these issues are technical such as ensuring that information is secure and that various systems are able to communicate. Others are concerned with how the business operates such as the managers who are not willing to make changes and lack of skilled workers. According to Mashat et al. (2024), Internet of Things cannot be always used due to technology and social challenges. This is most crucial in the locations where the individual does not possess a lot of cash. Many companies are also struggling to integrate their outdated systems with IoT technology. This is quite useful in the areas where the infrastructure has already been established and is not intended to be used with new digital tools. These issues should be resolved before IoT can be efficiently applied in a supply chain.

Supply chains come with certain negative issues when they are supported by IoT. According to Kittipanya-ngam and Tan (2020), the companies can integrate with the Internet of Things (IoT) to save in amount, turning their supply chains more versatile, and dispose of their inventory faster. When enterprises implement IoT in their supply networks, they may easily transform to satisfy the customers and learn more about their customers. Customers such as the speed at which the company has become nowadays, hence they will continue to revisit it. Long-run, it is good to the business.

Resource-Based View (RBV)

The Resource-Based View (RBV) is a great idea that shows how businesses may obtain and keep an edge over their competitors by making the most of the resources they already have. Barney said in 1991 that a business's resources might be either physical (like buildings and tools) or intangible (such people, technology, and intellectual property). RBV claims that a corporation can do better and stay ahead of the competition if its resources are valuable, uncommon, hard to copy, and hard to replace. RBV is a part of Supply Chain Management (SCM) that studies how companies can use their own resources to improve their own performance, the performance of the supply chain, and the integration of the supply chain.

IoT solutions that help businesses get the most out of their supply chain resources let them watch, track, and judge things in real time. IoT connects things, devices, and systems in the real world so that data can move freely. This makes it easier to see what's going on in the supply chain. Using IoT technologies to make things better inside their own company can help businesses stay ahead of the competition. For example, they may make their supply chains faster, easier to adapt, and better at responding to changes. They might also be able to work better with their customers and suppliers.

The Internet of Things (IoT) can help them improve their supply chains. Fatorachian and Kazemi (2021) say that the Internet of Things (IoT) and other Industry 4.0 technologies can help businesses make their supply chains more open and adaptable. These are needed to meet client requests, get things to them fast, and keep operations functioning smoothly. These improvements have made it easier for companies to get what they need and adjust to changes in the market. This helps them accomplish better in business. RBV shows that IoT can help a business's supply chain perform better than its competitors'.

They argue that the Internet of Things (IoT) can help firms better plan and connect their supply chain activities. This is a part of Supply Chain Integration. IoT makes it easy to share and move data, which can help the supply chain function together. People who work in and out of enterprises agree that the Internet of Things (IoT) makes it easy for them to chat, connect, and work together. Integrating the supply chain (SCI) is now easy.

A business should think about how to strengthen its Supply Chain Integration and get more out of its technology in order to boost both its Supply Chain Performance (SCP) and its Organisational Performance (OP). One way to achieve this is with RBV. The Internet of Things (IoT) helps businesses remain ahead of the competition in a market that is continually evolving. It accomplishes this by enhancing supply networks.

Organizational Capabilities Theory

Organisational Capabilities Theory (OCT) is premised on Resource-Based View (RBV). Firms can improve when they demonstrate to their employees how to improve things.

According to OCT, no organisation can rely on its resources only to achieve success. It must also understand how to master the utilization of those tools in order to improve and become better. Businesses are able to achieve more when they communicate with individuals who do not work on their behalf, exchange experience and stay much better informed about their own tasks. As an illustration, they are able to deploy IoT technologies in their supply chain.

Internet of Things (IoT) allows spreading information, staying in touch with relationships and doing several jobs simultaneously with no difficulties. These are all good business gifts. The IoT enables companies to transmit data immediately, and this enhances Supply Chain Integration (SCI). There will be increased ease of dealing with customers, suppliers, and distributors today. Bharadwaj (2000) argues that you should combine ICT capabilities such as IoT with other assets such as people, money, and supplier networks to ensure improved Supply Chain Performance (SCP).

Dynamic capabilities have become an important component of the organisational planning of work. Due to this reason, a business may be able to move, shift and consolidate its resources to satisfy the new needs. Companies that desire the Internet of Things to make them grow must keep transforming their way of doing things. Dynamic companies are able to easily adapt to the market changes, meet the demands of the new customers and run their businesses more effectively. Haddud et al. (2017) assert that organisations that are well prepared to adapt are in a better position to manage the emerging challenges when they employ Internet of Things and incorporate new technologies into their supply chains.

Businesses can also use IoT to put things into place since it makes them deal with individuals who are not members of the company. According to a study carried out by Setiawan et al. (2023), the IoT technologies facilitate customer supplier collaboration. Due to this, the supply chain can change directions easier and better accomplish their work. They can collaborate more at home and workplace when they incorporate IoT. This is highly essential in ensuring that the supply chain and the company work more effectively.

It expands upon the theory of Organisational Capabilities by considering how the Internet of Things (IoT) may enhance the inner and outer capabilities of a company. As an example, it can assist it in making superior decisions, information exchange, and merge processes. It can also enable it to conduct business with consumers and suppliers in a better manner. The developers of the idea believe that the Internet of Things (IoT) can allow organisations to achieve greater results and work in a more efficient manner overall.

The Internet of Things (IoT) in Supply Chain Management

The IoT is an emerging technology that is transforming the game as it enables companies within the supply chain to gather, transmit, and analyse real-time data. One of the sources of valuable information to businesses that can be obtained through IoT devices is RFID tags, sensors, and GPS trackers. This information can assist companies to perform activities such as tracking inventories, production, logistic and customer administration plans. According to De Vass et al. (2018), Supply Chain Visibility (SCV) is enhanced by the Internet of Things (IoT), as it helps the firms to monitor their products, inventory, and logistics in real time.

IoT provides businesses with the right information that is up-to-date and accurate, which allows businesses to plan on how to produce, track their inventories and make smart decisions concerning the manner in which to utilize their resources. According to Shafique et al. (2018), Supply Chain Efficiency (SCE) is improved in terms of speed, lead times reduction, and minimisation of the risk of stock shortages by the Internet of Things (IoT). As noted in one of the studies conducted by Kittipanya-ngam and Tan (2020), the Internet of Things (IoT) is also used by businesses to monitor their goods and materials in transit through the stock chain. This facilitates easier response to market changes so as to expand the supply chain.

The IoT is also useful in the supply chain planning and working together. The Internet of Things (IoT) can make customers, suppliers, and distributors get access to information in real time. This aids them to co-exist and communicate. The better people collaborate, the better is the Supply Chain Performance and Integration (SCI). According to Lee et al. (2022), Internet of Things (IoT) facilitates the cooperation of the enterprises among themselves and beyond the building premises. It improves the entire supply chain.

IoT technologies do not always lend themselves to use, however. It should have systems able to communicate with each other and secure data. The companies also have to determine how to integrate new technology in their outdated supply chain systems. Haddud et al. (2017) believe that businesses do not desire to adopt the IoT because it is risky, costly, and difficult to use. Issues that may arise when using IoT have a few downsides, although the advantages are much greater in comparison with the

issues. The Internet of Things (IoT) can be used to ensure that companies make their Supply Chain Performance and their Organisational Performance better. Thus, the businesses can be superior to their competitors.The IoT will help businesses to plan their production, monitor their inventories, and make wise choices about how to spend their money. According to Shafique et al. (2018), Internet of Things (IoT) improves Supply Chain Efficiency (SCE) by shortening the duration of various processes, decreasing the lead time, and preventing the possibility of shortages. According to a study conducted by Kittipanya-ngam and Tan (2020), the Internet of Things (IoT) can also assist the business to track their goods and materials as they travel along the stock chain. This simplifies adopting market changes and broadening of supply chain.

The IoT also assists individuals in the supply chain in coordinating their effort and planning their work. Internet of Things (IoT) allows real-time information to customers, suppliers and distributors. This would assist them in socializing and communicating. As individuals collaborate more, Supply Chain Performance and Integration (SCI) improve. According to Lee et al. (2022), the Internet of Things (IoT) can facilitate business collaboration, both internally and beyond the premises of their own establishments. It helps in making the entire supply chain effective.

However, there is no guarantee that the usage of IoT technologies is always straightforward. The systems must be capable of communicating with one another as well as securing data. Firms should also learn to implement new technology to their old supply chain systems. According to Haddud et al., (2017), companies are not willing to adopt the IoT since it is dangerous, expensive, and not easy to operate. Although there are certain issues that may arise during the use of IoT, the advantages are far larger as compared to the issues. Internet of Things (IoT) is capable of supporting the businesses to enhance their Supply Chain Performance and their Organisational Performance. Hence, they are superior to others.

This study focuses on how Internet of Things (IoT) influences Organisational Performance (OP), Supply Chain Performance (SCP), and Supply Chain Integration (SCI). The addition of IoT technologies to the supply chains can help businesses to save money, act more efficiently, and satisfy their customers. This gives them a good ground to remain successful in the market over an extended time.

Supply Chain Integration (SCI)

Supply Chain Integration (SCI) can be defined as the extent to which a firm engages in a partnership with its internal and external stakeholders, including suppliers and customers, in order to promote the smooth flow of goods, services, information and finances along the full supply chain. Integration of all these flows is crucial in the attainment of operational efficiency and improvement of the overall supply chain performance.

Supply Chain Integration is more efficient in the environment of the IoT adoption where organizations can use real-time information and connected systems which connect the internal processes of the organizations with their external suppliers of the supply chain. RFID, Wireless Sensor Networks (WSN) and GPS are IoT-enabled technologies that enhance integration through offering more visibility and automation in supply chains. Such technologies allow to synchronize and monitor products, orders, and inventory at different points of the supply chain, which contributes to improved collaboration and minimizes inefficiencies.

The meaning of strategic alliance in this scenario is the relationship involving organisations, suppliers and customers which consists of sharing of information and joints in developing resources that are important. Digital supply chain integration tries to be even more enhanced by such technologies as artificial intelligence (AI), cloud computing, and IoT because those might allow companies to respond to changes more swiftly, cut costs, and improve responsiveness. The investing of these state-of-the-art

technologies not only streamlines the operations of the supply chain of the firm but also preconditions a long-term payback in terms of revenue and business value.

To attain high internal integration, companies need to respond to the dynamic customer demands. The effectiveness of the alignment of organisational practices, processes, and behaviours is what defines this integration, where various departments and functions of a firm are made to work in a cooperative, coordinated, and synchronised fashion. By making available the data on the other end of the supply chain in the same platforms, the business is able to monitor the process remotely, make informed decisions and carry actions smoothly in their operations.

There are a lot of problems that need to be fixed before IoT can be used to help with Supply Chain Integration (SCI). One of the biggest problems is that it's hard to connect IoT devices to infrastructure that's already in place. It can be hard for businesses to get their old systems to work with new IoT technologies when they need to connect different platforms and data sources. Haddud et al. (2017) talk about the problems that come up when you try to combine IoT with modern supply chain technology. Businesses need to make sure that all of their different systems can easily share information and talk to each other.

Price is another big issue. How much will it cost to run? The first price to pay for IoT can be high. To do this, the necessary infrastructure must be built and sensors, gadgets, and software must be bought. Large companies may find it tougher to connect to the Internet of Things (IoT) because of these fees. The costs may be higher at first, but the long-term benefits, such as lower costs, better visibility, and more efficient processes, can make up for them. When companies use the Internet of Things (IoT) to improve Supply Chain Integration, Lee et al. (2022) say they can make a lot of money. This leads to better customer service, faster delivery times, and lower costs for running the business.

This research will look at how the use of IoT affects Supply Chain Integration (SCI) and how that affects Supply Chain Performance (SCP). The study's goal is to find out what role IoT plays in making it easier for sellers, customers, and logistics partners to work together. This will help us understand how adopting IoT can improve Supply Chain Performance.

The IoT and Supply Chain Integration

A supply chain is a networked system starting with the supply of materials up to manufacturing process, sales and distribution to the end-users. It is an added value process which combines flow of physical goods and essential information and financial data within the supply chain. The susceptibility of Internet of Things (IoT) in improving Supply Chain Integration has been heavily acknowledged as it has allowed real-time data gathering and communication among the organizations and these are vital in improving visibility and decision making in the supply chain.

Abdel-Basset et al. (2020) state that the use of the IoT improves inventory management, which allows real-time monitoring of the supply chain and enhances transparency in the logistics sector. IoT has been used to offer a digital thread linking disparate entities in the supply chain by real-time data capture of connected devices and makes it possible to coordinate decision-making and synchronized actions. Such dynamic information flow does not only increase operational efficiency but also Supply Chain Performance, especially in the speed, accuracy and flexibility.

The integration of IoT into business architecture converts the traditional data as useful corporate services, which has greater openness, data re-use, and responsiveness to change in the supply chain owing to the open-ended framework that it offers. The fact that IoT can enhance data sharing and real-time communication is what makes it a decisive prerequisite of Supply Chain Integration as it can optimize both internal integration (within the firm) and external integration (with suppliers, customers, and other stakeholders). This is in line with the organizational capabilities theory which posits that internal integration may play an important role in determining the level of external integration.

IoT allows cooperative planning and prediction and promotes closer partnerships between partners throughout the supply chain by ensuring an enhanced information exchange. This is because it can automate the decision-making process, Radio Frequency Identification (RFID) tags, wireless sensor networks (WSN), and mobile applications help in creating an efficient and responsive supply chain that is capable of responding swiftly to new demands and problems.

These opportunities notwithstanding, employing the IoT comes with some challenges, including resistance to the technology owing to the management ignorance of the potential benefits of applying the technology. The outlooks of many organizations towards full implementation of IoT are color-coded by their fears of the upfront cost, complexity of the technology, and high level of expertise. Nevertheless, the possibilities of the better Supply Chain Efficiency and Organizational Performance due to the enhancement of integration and the use of data in decision-making are enormous. According to Haddud et al. (2020), these issues are vital to the capability of organizations to use the full potential of the IoT in their supply chain management.

Table 1: Relevant Studies on IoT Adoption and Supply Chain Integration

Study	Year	Country	Research Focus	Key Constructs	Key Findings
De Vass et al.	2018	Australia	IoT adoption and its impact on supply chain performance	IoT, Supply Chain Integration, Performance	IoT adoption enhances supply chain integration, improving performance metrics.
Shafique et al.	2018	Pakistan	IoT capabilities in green supply chain practices	IoT, Supply Chain Integration, Supply Chain Output	IoT adoption improves resource management and green supply chain practices.
Kittipanya-ngam & Tan	2020	Thailand	Digitalization in food supply chains through IoT	IoT, Supply Chain Visibility, Supply Chain Performance	IoT improves supply chain visibility and performance in food industries.
Oubrahim et al.	2023	Morocco	Impact of digital transformation on supply chain integration	Digitalization, Supply Chain Integration, Performance	Digital transformation through IoT enhances supply chain integration, driving performance.
Lee et al.	2022	Malaysia	Impact of IoT on organizational performance	IoT, Supply Chain Performance, Organizational Performance	IoT enhances supply chain performance and indirectly improves organizational performance.

Setiawan et al.	2023	Indonesia	Supply chain resilience and digitalization	IoT, Supply Chain Flexibility, Performance	Digitalization with IoT enhances resilience, flexibility, and overall performance.
Haddud et al.	2017	UK	IoT adoption challenges and opportunities	IoT, Supply Chain Integration, Supply Chain Efficiency	Many firms underutilize IoT due to lack of awareness and integration challenges.
Rajaguru & Matanda	2019	Australia	Supply chain integration and competitive advantage	Supply Chain Integration, Competitive Advantage, Performance	Higher levels of integration improve operational efficiency, leading to competitive advantage.

Supply Chain Integration and Supply Chain Performance

Supply Chain Performance (SCP) is a rational approach that is applied to measure the efficiency and effectiveness of the supply chain activities. Performance measurement also plays a vital role in businesses to ascertain the success of their supply chain as well as where they can get better. Performance measurement of supply chain is however a subjective process since various stakeholders might have a different interpretation of performance indicators. Regardless, a question of the supply chain performance is necessary to determine the areas that need improvement and provide feedback to upper management to make decisions.

With the age of digital transformation, organizations are moving towards external adoption of digital technologies including Machine Learning (ML), the Internet of Things (IoT), Big Data, and Blockchain to improve its supply chain and its operations. The application of these technologies enables the firms to understand supply chain processes more, achieve efficiency and add value to the supply chain. One of its enablers, especially the IoT, is used to enhance Supply Chain Integration (SCI) by enabling smooth communication, collaboration, and exchange of data among various parties of the supply chain.

The supply chain integration increases effectiveness by allowing different systems and individuals to work together and coordinate their efforts. IoT is an important aspect of this since it helps in ensuring a smooth and steady flow of data between the suppliers, distributors, retailers, and other partners in the supply chain. Consequently, it is possible to optimize the supply chain regarding efficiency in the operation of the supply chain, the quality of the products, flexibility, reliability of delivery, and the overall experience of the customer.

Supply Chain Integration is a consequence of the desire of a company to incorporate both the internal operations and the external forces in the operation. This is a process that links everyone involved including the suppliers and the customers so that whatever the finished product is made it reaches the end customer in the most efficient way. Supply Chain Integration therefore is a competitive parameter to businesses because it has a direct influence to the performance of the business in the market.

Philsoophian et al. (2020) examined 259 articles and came to the conclusion that close collaboration between suppliers and customers can help companies to become more resilient. Supply chain improvement achieved through better supplier- customer relationship, business processes and competent employees results in cost reduction, better quality of products and increased demand. Another aspect that was emphasized by Siagian et al. (2021) is that supply chain integration in the

industrial sector of Indonesia enhances organizational performance, especially when internal and external sharing of product information and production plans is done in detail.

In addition, it has been demonstrated that Supply Chain Integration is improved with the assistance of digital technologies like the IoT that subsequently improves the Supply Chain Performance. Oubrahim et al. (2020) also showed that digital transformation (DT) has a positive impact on Supply Chain Integration (SCI) and the overall sustainable supply chain performance (OSSCP), and SCI mediates the relationship between digital transformation and supply chain performance.

The IoT also improves the collaboration of people and the systems in terms of their work, supply chain planning, and analysis of the obtained information. The IoT-based Supply Chain Integration is beneficial in increasing the visibility of a product, providing real-time tracking opportunities, and boosting collaboration that also leads to improved supply chain performance. As an example, De Vass et al. (2018) discovered that IoT capabilities in Australian retail companies have a positive and significant influence on supply chain-related process integration, which, in turn, enhances supply chain and organizational performance. In a similar manner, Shafique et al. (2019) had discovered that the IoT enhances integration of supply chain by ensuring improved supplier and customer integration that consequently results in green supply chain performances.

IoT, Supply Chain Integration and Supply Chain Performance

Due to the constant development of supply chain management (SCM), old approaches are becoming less and less suitable in terms of solving the rising demand of efficiency, flexibility, and responsiveness. Businesses are today looking to new avenues of streamlining their supply chain operations and remain competitive. Internet of Things (IoT) technologies in the SCM are essential in boosting Supply Chain Integration (SCI), Supply Chain Performance (SCP), and Organizational Performance (OP).

The IoT has become a central part of Supply Chain Integration in that it is able to offer real-time information and facilitate smooth communication between various stakeholders throughout the supply chain. Supply Chain Visibility is made possible through IoT technologies (RFID, sensors, and GPS) to help companies trace and monitor products, inventory, and assets throughout all supply chain stages. This real-time data sharing will have the internal processes highly coordinated and external partners (suppliers and customers) informed resulting in a more co-ordinated and effective supply chain.

Besides enhancing Supply Chain Integration, the IoT also has an important contribution to Supply Chain Performance. By automating operations and enhancing the sharing of information and decision-making, firms are better placed to increase their operational efficiency, minimize lead times, and achieve customer satisfaction. Through the harmonization of IoT technologies, organizations will be able to streamline their production timetable, enhance inventory control, and logistics, which leads to enhanced Supply Chain Efficiency and enhanced overall Supply Chain Performance.

Further, the IoT allows the businesses to enhance Supply Chain Flexibility through offering more responsive reactions to shifts in the market conditions. Real-time information gathering and tracking supply chain operations allow businesses to adjust to the changing customer needs and supply chain upsets more efficiently. Supply Chain Integration, therefore, improves Supply Chain Performance, having been driven by the IoT, and in the end, Organizational Performance.

A study conducted by Sinaga et al. (2021) revealed that Supply Chain Integration has a positive effect on Organizational Performance especially when companies exchange information on their products details and production plans with and outside their businesses. Likewise, Setiawan et al. (2020) established that the introduction of digital technologies like the IoT into supply chains results in more effective operations, energy-saving, and the overall performance of the supply chain, which positively affects the Organizational Performance.

Supply Chain Performance, Supply Chain Integration and Organizational Performance

In the contemporary competitive environment, the competitive point has shifted away to the individual companies and onto the whole supply chains. Consequently, the issue of Supply Chain Performance (SCP) improvement has become a significant determinant of securing a competitive advantage and Organizational Performance (OP). Supply Chain Integration (SCI) is instrumental in this dynamism because it facilitates collaboration among different supply chain organisations, including suppliers, manufacturers, and distributors.

The efficiency of the processes of the supply chain is not the only factor that defines the performance of supply chain; also the degree of integration between the internal functions (within the organization) and the external partners (customers and suppliers) are the factors that determine the supply chain performance. Internet of Things (IoT) technologies have gained more significance in this regard. The IoT enables real time data gathering, tracking and communication thus increasing Supply Chain Integration and overall Supply Chain Performance.

Companies that successfully incorporate their supply chain operations can streamline their operations, lower their costs and become more responsive to market fluctuations. IoT-based technologies in the form of RFID, sensors, and GPS can lead to the more effective Supply Chain Visibility that will enable tracking inventory production and delivery in real-time. Such visibility helps businesses to make sound decisions within a short period of time, to optimise the utilization of resources, to make deliveries on time all of which is directly related to Supply Chain Efficiency and Organizational Performance.

Besides, Supply Chain Integration is not just about efficiency in operations, it is also an important factor in the competitive position of an organization. With the help of IoT and digital technologies, integrated supply chains offer a solid platform that would enable achieving higher flexibility, higher levels of customer satisfaction, and Supply Chain Responsiveness. Sinaga et al. (2021) have also found that the more Supply Chain Integration, the better organizational performance, especially when there is the open exchange of information and plans of production between suppliers, manufacturers, and customers.

Moreover, Setiawan et al. (2020) discovered that digitalization, such as the introduction of the IoT technologies into the supply chains, leads to the improvement of the operational performance and energy consumption, which, in turn, contributes to the improvement of the Organizational Performance. Since IoT assists in the realization of Supply Chain Integration, it will allow the firms to enhance the Supply Chain Performance, which will result in improved operational performance and organizational performance in the long run.

Integration of IoT also leads to Supply Chain Flexibility since it offers real time information that enables firms to adapt to unforeseen events in demand or supply chain disruptions. The more firms implement the IoT technologies, the more efficient their ability to adjust and react to market change will be, which will further contribute to enhancing the Supply Chain Performance and Organizational Performance.

MATERIALS AND METHODS

The deductive method is one in which we use the existing theory patterns to determine whether new information in the real world is consistent with our theory patterns. The goal will be to determine the interrelations between the variables identified. Quantitative methods make use of statistics to gather and analyse data. This is a statistical technique that is used to demonstrate the relationship between two variables that can be measured. This is the reason why we check the ideas of this study with the help of logic and statistics.

This research was carried out in Pakistan, and the data collected through the research was collected among participants in terms of participation in IoT-based business and technologies in the country. Like

in the past studies, this research adopted a monoquantitative method. That is, the data was purged and analyzed statistically to determine the relationship between the study variables.

Measurement Scale

Other studies have also utilized the same tools to determine how individuals use IoT and their supply chain management. Those instruments were used in the survey to conduct this study. The studies by De Vass et al. (2018) and Haddud et al. (2017) assisted us in determining what was good and bad about the Internet of Things. These questions were employed to know what those groups believe are the advantages and disadvantages of the Internet of Things.

This research will use the measurement scales used by Huo (2012) and Rai et al (2006) in investigating Supply Chain Integration (SCI) on a unilateral scale. These scales observe the fit between the various components of the supply chain and their co-existence. The study was based on the Organisational Performance (OP) scale formulated by Lee and Azmi et al. (2022) and Zhu et al. (2012) to analyse the changes in the overall company performance once the IoT technologies are implemented.

The Supply Chain Performance (SCP) was based on the study performed by Kaliani Sundram et al. (2016) and Lee and Romzi et al. (2022). These articles talk about the most important considerations towards effective supply chain management. SCP and OP scores were selected due to the fact that they best tackled the research question despite the fact that competitive advantage (CA) is not the primary issue of the current study.

The survey was conducted through a seven-point Likert-type scale, in which an individual was required to answer questions based on the level of strongly disagree to strongly agree (see Appendix A).

Data Collection and Sampling Method

To select the IoT companies across the entire of Pakistan, we did not have to depend on chance. The snowball sample approach was employed due to the reason that there was not many in the population. It is an excellent method to connect with IoT vendors and other communities that are niche-specific. The effectiveness of a supply chain and the outcomes of a business are affected by the use of IoT. Through this method, we were able to locate and recruit individuals who would assist us to know more about this.

The survey was done using the internet, this saved cash and was not cumbersome to the individuals who were to fill it. During the tool creation, questions were screened to ensure that they were clear, and a test was conducted to get feedback. The main study did not include five middle-level Pakistani managers who worked in the other geographical locations. They read and responded to the questionnaire. Having listened to what people wanted to say, there were made some minor adjustments to make things more manageable and make everyone interpret the questions.

The survey was administered to people using Google Forms and a cover letter that contained information as to why the research was being conducted and assured the respondents of secrecy of the results.

However, ultimately, all the 143 responses were exploited and they were all correct. This implied that the research was valid and reliable, hence the findings would be robust.

The form consisted of two parts. The former enquired about the history of the business, the number of full time employees, the amount of money the business had earned last year and the type of work the business was engaged in. It was a list of questions out of an old scale that assisted in coming up with how the components of the model operated. They were in Part Two. Then it was demonstrated that the instrument was functional and the relationships were not imaginary.

DATA ANALYSIS

The data were easier to work with using SmartPLS 3 software in the form of Partial Least Squares Structural Equation Modelling (PLS-SEM). PLS-SEM does not need to be informed of the spread of data to be able to work well with small sample sizes and complex models. It is able to estimate a large number of paths and building blocks of models.

We selected PLS-SEM as a tool to establish connections between the use of the IoT, Supply Chain Integration (SCI), Supply Chain Performance (SCP) and Organizational Performance (OP). The study had two parts. Firstly, the measurement model was validated as to the true and accurate constructs. That was the second step. We had the structure model to ensure that the ideas were interlinked in the appropriate manner. The analysis of the complex relationships among the structures with the help of the PLS-SEM allowed doing it easily and rather quickly.

Analysis of Descriptions

The Internet of Things (IoT) is a disruptive technology that is gaining increasing significance in Pakistan particularly in manufacturing, logistics, and retail. Increasingly, IoT is being utilized by more and more businesses in the US to simplify supply chain management and make operations and performance of businesses easier.

This study surveyed 143 people, and all their responses could be used in the analysis. The survey participants are employed in various organizations in Pakistan implementing the use of IoT.

Demographics

Table 2 provides a short profile of the demographics of the respondents. The findings indicate the following characteristics:

- **Gender Distribution:** 66.4 out of people who responded were males and 33.6 were females. This ensured that the study was well represented with both genders.
- **Company Size:** The majority of the respondents 45.5% were employed in a company that had 51 to 500 employees. 38.4% percent of the respondents participated in companies with more than 500, and 16.1 percent in companies with less than 500 employees. This implies that there is an increasing pace in the adoption of IoT in both large and middle-size companies capable of affording to invest in such technologies.
- **Company age:** The majority of the companies that were surveyed were within the age range of 11-40: 42.6. This implies that the older businesses would be more prone to embrace the IoT and undergo a digital transformation.
- **Sales Revenue:** Approximately 80% of the surveyed companies responded that they had a sales exceeding 250 million PKR per annum. This demonstrates that most of the companies in question are large enough to afford IoT technologies.

Job Levels: The sample consisted of the many kinds of employees; it had 49.7% middle managers, 31.5% senior managers and 18.9% executives. This diversity ensures that various levels of decision-making and operational performance within organisations do not have a unified opinion on the use of the IoT.

Table 2. Demographic profile (N = 143).

Category	Frequency	Percentage
Gender (Male)	95	66.43%
Gender (Female)	48	33.57%
Company Size (50 or less)	23	16.08%
Company Size (51-500)	65	45.45%
Company Size (501 or more)	55	38.46%
Company Age (10 or less)	42	29.37%
Company Age (11-40)	61	42.66%
Company Age (40 or more)	40	27.97%
Sales Revenue (PKR < 50 million)	12	8.39%
Sales Revenue (PKR 51-250 million)	43	30.07%
Sales Revenue (PKR 251-500 million)	41	28.67%
Sales Revenue (PKR 501 million or more)	47	32.87%
Job Level (Manager)	71	49.65%
Job Level (Senior Manager)	45	31.47%
Job Level (Others)	27	18.88%

Impact and Context

The analysis took place in the environment of the gradually digital economy of Pakistan, where incorporating the IoT technologies is the key to successful business. The IoT employed in a large-scale manner in logistics and supply chain management may allow easier monitoring of data in real-time, controlling inventory, and delivering products faster. All this might make the supply chain and the organisation in general become better.

Common Method Bias

The Common Method Bias (CMB) may occur when the predictor and outcome variables of a model are collected through a similar method and the results may have bias. In this research, Common Method Bias was actually tested by evaluating the values of inner variance inflation factor (VIF). The cutoff

point of the pathological collinearity is VIF greater than 3.3. The presence of CMB is said to be free within a model when the inner VIF scores on the full collinearity test are below 3.3.

In order to identify possible Common Method Variance (CMV), a random latent marker variable method was implemented. The outer VIF showed to be below 5 and the inner VIF values were as low as between 1.45 and 2.95, which means that CMB or CMV was not a problem of any major concern in the data. As such, it may be said that Common Method Bias does not affect the validity of the results in this research.

Measurement Model

We did two things to test the reflective-formative higher-order measurement models. In the first step, the model was estimated without second-order constructs so that scores for first-order constructs could be found. In the second step, the first-order constructs were taken out of the structural model, and the construct scores were used to guess the second-order constructs.

Lower-Order Constructs

Factor loadings were used to verify the hypothesized model. The factor loadings that fell above 0.708 were regarded as acceptable since it follows over 50 percent of the variation in the indicators showing that there is sufficient item dependability. Everything and every indicator in the model passed the mark of 0.50, which validates the strength and trustworthiness of the measurement model.

Also, the Variances Inflation Factor (VIF) were checked to be sure that multicollinearity did not exist in the model. All constructs had values of VIF that were less than the threshold of 5, which proves that there was no multicollinearity.

Some of the items were dropped out of the model because of high VIFs, which might have resulted into multicollinearity. These items included:

- SCI2, SCI4, SCI5, SCI8, SCI10, SCI12, SCI15-SCI17 (Supply Chain Integration)
- OP1, OP2, OP4, OP7(Organizational Performance)
- SCP1, SCP3, SCP5, SCP6, SCP8, SCP9, SCP10-SCP14 (Supply Chain Performance)
- VIS1, VIS2, VIS4 (Visibility)
- These were dropped to minimize the impact of multicollinearity such that, the rest of the items can be used to measure the constructs.

The Alpha and Composite Reliability (CR) of the variables were used to test the internal consistency of the variables. All constructs had Cronbach's Alpha values of between 0.746 and 0.899 which is much higher than the recommended 0.70, and thus the high internal consistency of all the constructs.

The values of Composite Reliability (CR) (that measure the internal consistency of the respective constructs) were found to be between 0.837 and 0.937, significantly higher than the cut-off point of 0.70, and they assert the reliability of the constructs in the research.

In order to determine the convergent validity, the Average Variance Extracted (AVE) was computed. The values of all AVE are bigger than the expected 0.50, which means that all the constructs are able to explain a 50 per cent variance of their items and this proves convergent validity.

Table 3. Measurement model.

Constructs	Items	Factor Loading (FA)	Variance Inflation Factor (VIF)	Cronbach's Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Customer Integration (CI)	CI2	0.761	2.502	0.899	0.902	0.587
	CI3	0.726	2.094			
	CI4	0.831	2.846			
	CI5	0.790	2.687			
	CI6	0.742	2.172			
	CI7	0.737	2.306			
	CI8	0.793	2.507			
	CI9	0.745	1.898			
Supply Chain Efficiency (EEF)	EFF1	0.827	2.521	0.912	0.914	0.694
	EFF2	0.813	2.470			
	EFF3	0.811	2.262			
	EFF4	0.871	3.168			
	EFF5	0.816	2.178			
	EFF6	0.856	2.953			
Organization Performance (OP)	OP1	0.767	2.013	0.892	0.895	0.649
	OP2	0.843	2.492			
	OP3	0.802	2.021			
	OP4	0.796	1.942			
	OP5	0.787	2.151			
	OP6	0.835	2.676			
Supply Chain Performance (SCP)	SCF1	0.815	3.455	0.944	0.944	0.578
	SCF2	0.768	3.066			
	SCF3	0.712	3.330			
	SCF4	0.804	3.325			
	SCF5	0.805	3.563			
	SCO1	0.754	3.074			
	SCO2	0.736	2.591			
	SCO5	0.767	2.560			
	SCO6	0.712	2.167			
	SCR1	0.732	2.742			
	SCR3	0.724	2.489			
	SCR4	0.782	2.946			
	SCR5	0.744	2.802			
	SCR6	0.777	2.953			
Supplier Integration (SI)	SI1	0.818	2.617	0.909	0.911	0.611
	SI10	0.736	1.888			
	SI2	0.820	3.997			
	SI3	0.741	2.092			
	SI5	0.767	2.204			

	SI7	0.728	1.959			
	SI8	0.846	4.189			
	SI9	0.790	2.293			
Supply Chain Visiblity (VIS)	VIS1	0.835	2.311	0.866	0.869	0.653
	VIS2	0.812	2.096			
	VIS4	0.728	1.553			
	VIS6	0.852	2.392			
	VIS7	0.807	2.073			

Validity of Discrimination

To test the presence of discriminant validity, we would have used not only the Heterotrait-Monotrait (HTMT) ratio (Table 4) but also the FornellLarcker criterion (Table 5).

Table 4

	CI	EFF	OP	SCP	SI	VIS
CI						
EFF	0.671					
OP	0.887	0.675				
SCP	0.929	0.816	0.921			
SI	0.907	0.690	0.862	0.885		
VIS	0.675	0.901	0.627	0.759	0.710	

According to the FornellLarcker criterion, when the square root of the average variance of each construct (AVE) exceeds the correlation of that construct with all other constructs, then there is the presence of discriminant validity. All of the constructs fulfilled this requirement as can be seen in Table 4 which indicates that they are all different.

Table 5

	CI	EFF	OP	SCP	SI	VIS
CI	0.766					
EFF	0.616	0.833				
OP	0.800	0.616	0.806			
SCP	0.860	0.761	0.853	0.760		
SI	0.824	0.634	0.779	0.823	0.782	

VIS	0.599	0.800	0.553	0.686	0.633	0.808

Higher-Order Constructs

In this paper, the higher-order constructs IoT were evaluated with the help of two lower-order constructs. We verified the outer weights, outer loadings and Variance Inflation Factor (VIF) of the higher-order constructs to ensure that they were accurate.

To validate the higher-order construct:

Outer loadings of both the IoT Benefits and IoT Challenges were strong since all the values were greater than 0.50. This indicates that all the lower-order constructs can account over 50 percent of the variance in their indicators and this indicates that the items are reliable.

They also examined the outer weights and established them to be statistically significant which proves the validity of higher-order construct.

We have checked the values of VIF to determine whether there could be collinearity. Multicollinearity was not an issue since there were no values of VIF that were greater than 5.

The conditions of higher-order construct validity were all satisfied, and we can conclude that the constructs of IoT Benefits and IoT Challenges are higher-order constructs.

Model of Structure

The structural model was the one that was used to test the relationships that existed among the constructs. The coefficient of determination or the R2 coefficient is a measure used to determine the level of prediction or fitment of the model on the data. R 2 values are between 0 and 1 and the higher the value, the better the explanatory power. The literature states that a value of R2 of 0.75, 0.50 and 0.25 would be significant, moderate, and weak respectively.

- Supply Chain Integration (SCI): R 2 = 0.643 (adjusted R 2 = 0.626).
- Performance of Supply Chain (SCP): R2 = 0.841 (adjusted R2 = 0.837).
- Organizational Performance (OP): R 2 = 0.727 (adjusted R 2 = 0.725).

These results mean that SCP has the greatest explanatory power as it has an R 2 of 0.841 that implies that it fits the construct well. The explanatory power of OP and SCI is also high; the R2 of 0.727 and 0.643, respectively.

Table 6. R-square and adjusted R-Squared.

	R-square	R-square adjusted
OP	0.727	0.725
SCP	0.841	0.837

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
OP	0.727	0.728	0.059	12.420	0.000
SCP	0.841	0.847	0.038	22.287	0.000

Figure 1: Graphical Representation for PLS-SEM

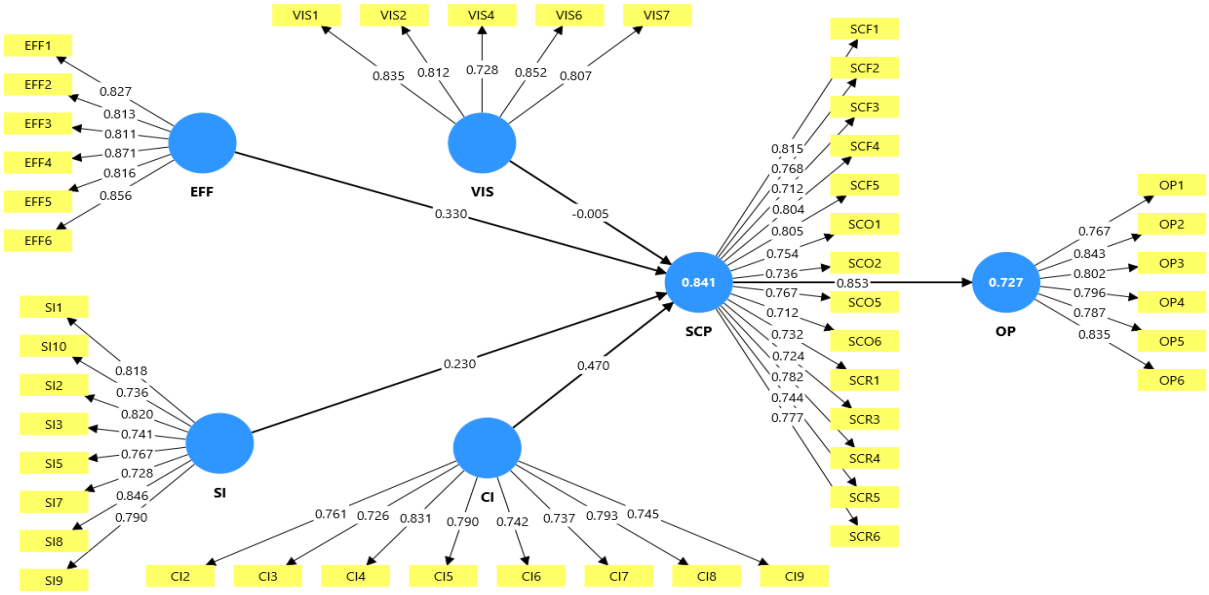
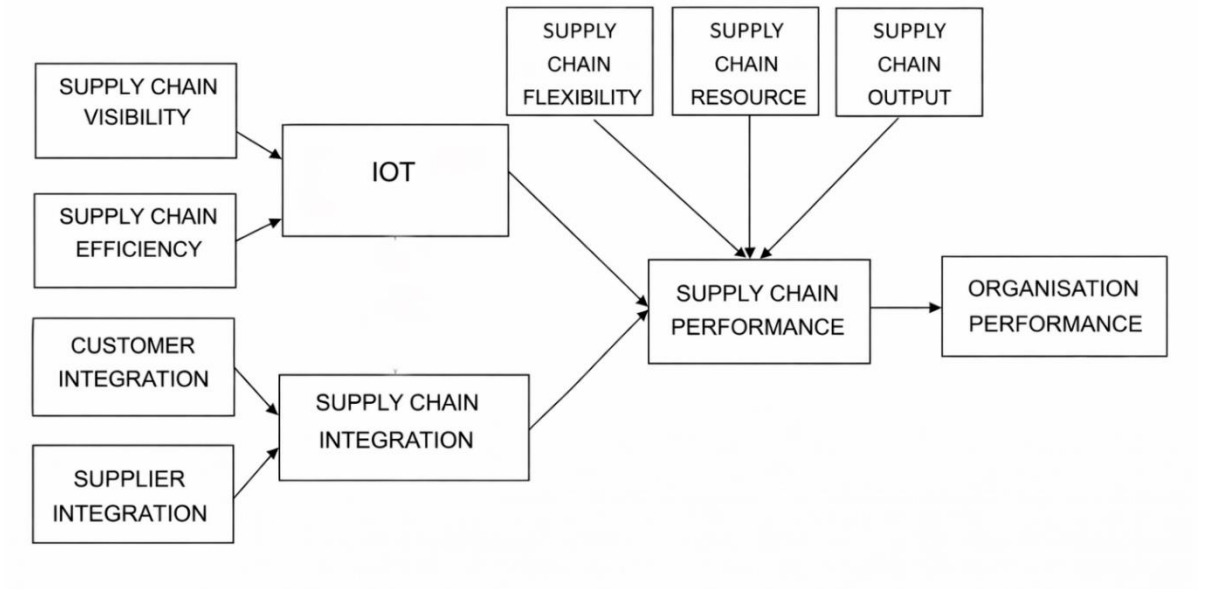


Figure 2: Graphical Representation for Conceptual model



Outer Loadings

Table 7

	CI	EFF	OP	SCP	SI	VIS
CI2	0.761					
CI3	0.726					

CI4	0.831					
CI5	0.790					
CI6	0.742					
CI7	0.737					
CI8	0.793					
CI9	0.745					
EFF1		0.827				
EFF2		0.813				
EFF3		0.811				
EFF4		0.871				
EFF5		0.816				
EFF6		0.856				
OP1			0.767			
OP2			0.843			
OP3			0.802			
OP4			0.796			
OP5			0.787			
OP6			0.835			
SCF1				0.815		
SCF2				0.768		
SCF3				0.712		
SCF4				0.804		
SCF5				0.805		
SCO1				0.754		
SCO2				0.736		
SCO5				0.767		
SCO6				0.712		

SCR1				0.732		
SCR3				0.724		
SCR4				0.782		
SCR5				0.744		
SCR6				0.777		
SI1					0.818	
SI10					0.736	
SI2					0.820	
SI3					0.741	
SI5					0.767	
SI7					0.728	
SI8					0.846	
SI9					0.790	
VIS1						0.835
VIS2						0.812
VIS4						0.728
VIS6						0.852
VIS7						0.807

Construct Reliability & Validity

Table 8

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
CI	0.899	0.902	0.919	0.587
EFF	0.912	0.914	0.931	0.694
OP	0.892	0.895	0.917	0.649
SCP	0.944	0.944	0.950	0.578
SI	0.909	0.911	0.926	0.611

VIS	0.866	0.869	0.904	0.653

DISCUSSION

Internet of things (IoT) is progressively emerging as a major source of operational effectiveness within companies across the globe, and Pakistan is not an exception. Introduction of the Internet of Things (IoT) in the supply chain management (SCM) is changing the way companies operate so that they can have improved visibility, efficiency and organizational performance. This paper sought to investigate how IoT use, Supply Chain Integration (SCI), Supply Chain Performance (SCP), and Organizational Performance (OP) relate to each other in Pakistani organizations.

The results of this paper indicate that the positive and negative effects of IoT adoption include a great influence on Supply Chain Integration. This finding is in line with other studies, including De Vass et al. (2018) and Haddud et al. (2017), that identified the application of IoT technologies in improving supply chain integration. Our results highlight the significance of adopting IoT in the concept of supply chain integration in enhancing harmony between the supply chain partners. In its turn, it assists organizations with such issues as inventory control, tracking of the products, real-time data exchange.

The beneficial effect of the IoT-based Supply Chain Integration on Supply Chain Performance is in line with previous studies. As per Lee and Romzi et al. (2022) and de Vass et al. (2018), we discovered that SCI has a strong effect on SCP. This connection highlights the importance of cooperation and information-sharing throughout the supply chain that enhances efficiency, flexibility and responsiveness to market changes. This integration is even reinforced by IoT-based digital infrastructure that supports flawless communication with suppliers and customers to streamline supply chain operations, which leads to an increased performance of operations.

In the same way, the study observed that Supply Chain Integration (SCI) has a positive impact on the Organizational Performance (OP). The findings show that better operational efficiency, cost reduction, and customer satisfaction to a greater extent are associated with SCI, which are vital in increasing the performance of an organization. This observation is consistent with Abdallah et al. (2021), who believe that SCI leads to increased cooperation and improved relations between partners of the supply chains, which gives companies an edge in the market.

The findings also indicate that there is a direct impact of IoT adoption on Supply Chain Integration with SCI mediating between the benefits of IoT and Supply Chain Performance. This finding confirms the hypothesis of partial mediation (H4) presented in the research, proposing that the advantages of the adoption of IoT become more successfully achieved in the case of the combination with supply chain integration. The positive indirect effect of IoT benefits on SCP is a factor of SCI, which has an important role to play in fulfilling the maximum value of the use of the IoT technologies.

Conversely, the adoption problems of IoT were observed to influence SCI directly in a significant manner, which confirms hypothesis H5. The indirect impact of IoT challenges on SCP via SCI was, however, also significant, which implies that, in spite of the challenges that come with the adoption of IoT, the challenges can be still counteracted by effective integration of supply chain and, therefore, the performance of the supply chain can still be improved.

Moreover, the findings of the Mediation Analysis indicate the existence of partial mediation between Supply Chain Performance (SCP) and the association between SCI and Organizational Performance (OP), which validates the hypothesis H12. This is in line with the results of Mathur et al. (2020), who also noted that SCP is a vital factor in connecting SCI to OP that leads to superior market performance and organizational achievements in general.

The mediation effect of SCI between the adoption of IoT and performance is high. This underscores the fact that the adoption of IoT technologies when combined with the supply chain operations will enhance the efficiency of the organization and make the organization achieve a competitive advantage. Similar to Boubker (2022) and Shafique et al. (2018), our findings tend to indicate that the supply chain integration using the IoT can improve the performance of the supply chain, and the results directly affect the organizational performance, particularly in competitive and dynamic markets.

Also, the observed partial mediation effects of the beneficial impact of IoT adoption on organizational performance through the supply chain integration and through the supply chain performance (H10, H12) also support the significance of integrated digital strategies in the contemporary supply chains. This finding shows that organizations can be able to accomplish greater levels of operational performance by applying IoT technologies in an integrated supply chain ecosystem.

This paper also finds out that even though the use of IoT has the potential of transforming supply chain integration and performance, it needs to address issues of data management, interoperability, and infrastructure preparedness. Since, as De Vass et al. (2018) and Haddud et al. (2017) note, the amount of data produced by IoT devices can be incredibly large, and unless there are appropriate data management systems, there can be discontinuities in supply chains. The data storage and processing capabilities have to be invested in by organizations in order to make the most out of the advantages of IoT.

To sum up, this paper provides insights on the transformational nature of IoT in the supply chain management, especially in Pakistan, whereby the incorporation of digital technologies is gaining relevance in the business survival and competitive edge. The results highlight the importance of organizations paying attention to such aspects of the supply chain integration and the use of the IoT to enhance the level of efficiency in operations and the overall success of the organization in the digital age.

CONCLUSION

The Internet of Things (IoT) is also becoming an influential technology that Pakistan is adopting to propel data-driven innovation across various sectors of the economy, such as energy, logistics, manufacturing, and retail. In the Pakistani setting, the impact of the IoT on the supply chain management (SCM) is gaining momentum, which has improved the efficiency of supply chains, the performance of operations and performance of the organization.

The paper has developed a conceptual framework to determine the influence of the adoption of IoT on the performance of an organization, specifically Supply Chain Integration (SCI). Using IoT technologies, Pakistani businesses will be able to make the supply chain more visible, manage inventory better, and improve overall operational effectiveness. The paper shows that SCI, which is driven by the use of IoT, has a positive and significant impact on the performance of the supply chain (SCP) and the organization (OP).

In this study, the researcher targeted Pakistani corporations that already implemented the IoT in their supply chains. The results of the survey were modeled with the help of the PLS-SEM (Partial Least Squares Structural Equation Modeling), which proved that the advantages and challenges associated with IoT adoption have a significant role in the supply chain integration improvement. In our study, SCI is also not only a cause of supply chain performance but an essential moderator between the adoption of IoT and organizational performance.

With respect to the first research question, the research showed that the advantages of adopting the IoT have a positive influence on SCI, which in turn positively impacts SCP and performance of the organization. This result corresponds to the findings of related research like De Vass et al. (2018) and Haddud et al. (2017), who also discovered that the adoption of IoT has a positive impact on the

integration of the supply chain. In our study, the use of IoT enabled integration is also noted to improve supply chain performance resulting in increased organizational performance.

Also, it was established that SCI mediates the relationship between IoT adoption benefits and SCP and SCP mediates the relationship between SCI and OP. The findings are consistent with those of De Vass et al. (2018) and Lee and Romzi et al. (2022) that show that IoT-facilitated integration of supply chains directly leads to an improvement in the performance of the supply chains, which subsequently leads to an improvement in the organizational performance.

Theoretical Implications

This research makes a great contribution to the literature on the supply chain integration and the adoption of the IoT. Although the literature on IoT and supply chain is relatively recent, the proposed research is essential as it empirically examines how the use of IoT affects the supply chain integration and organizational performance in Pakistan.

The paper builds on the resource based perspective and the theory of organizational capabilities by analyzing the linkages between the adoption of IoT and the integration and improvement of supply chains and operational performance. Specifically, the study highlights that SCI, which is fueled by the use of IoT offers a large competitive edge to companies because it allows the firm to make choices based on data, better inventory control, and optimization of logistics.

This research can help to understand how to use the IoT technologies to the advantage of the organization in the world that is increasingly digital by revealing SCI as one of the key intermediaries in the connection between organizational performance and the adoption of IoT. The study also tends to fill the research gaps in the literature on the mediating role of SCI in the relationship between IoT and performance, which is helpful to other organizations that want to streamline their supply chain operations.

Practical Implications

To the businesses in Pakistan, the results of this study make an attractive call to action of implementing the IoT technologies. The irrelevance of IoT in driving supply chain integration is not solely theoretical, but a genuine opportunity that businesses leverage operational performance and the ability to retain a competitive advantage. In the modern digital economy, firms incorporating the use of IoT in their supply chain are in a better position to respond to consumer needs, better manage inventory, and enhance product traceability.

The digital infrastructure provided through the IoT enables companies to increase the visibility of their supply chains, track the movement of products, and manage the inventory in the most efficient way possible. The integration also promotes cooperation and interaction with suppliers and consumers and this gives rise to more responsive and agile supply chain performances. The results of the current research prove that the implementation of the IoT can provide supply chain partners with a variety of opportunities, such as better traceability and visibility, real-time access to the data, which contributes to the further optimization of operations.

In addition, the research urges companies to put into focus the application of IoT in their supply chain management practices to stay competitive and keep pace with the worldwide digital revolution. Companies that incorporate IoT within their supply chains will be in a better position to respond to the dynamics in the market and react fast to the needs of the customers.

Limitations and Future Research Direction

Although this research is quite informative, one should list a number of limitations. To start with, the sample was narrowed to the providers of the IoT in Pakistan, and the future research may consider enlarging the sample to include a wider supply chain partner, including suppliers, distributors, and retailers. This would provide a wider perspective of the internet of things adoption in Pakistan, and its effects on the whole supply chain.

Also, the research concentrated primarily on the benefits of IoT adoption in the domain of supply chain efficiency, visibility, and operational performance. The other possible benefits and challenges of IoT adoption that can be discussed include such aspects as data privacy, security, and integration challenges. The future studies may explore these areas to have a more detailed picture of the application of IoT in a supply chain management area.

The second weakness is that the study was cross-sectional, and therefore, the conclusions cannot be made on causal relations of the constructs. The longitudinal studies may offer a deeper understanding of the long-term effects of the adoption of the IoT on the supply chain performance and organizational success.

In spite of these constraints, this research study contributes significantly to the whole literature on the resource-based view, and organizational capabilities. It offers good evidence about how the use of IoT and supply chain integration brings competitive advantage, which eventually translates into the enhanced organizational performance.

Funding

There was no external finance in this research.

Informed Consent Statement

All the participants received informed consent as part of the questionnaire.

Data Availability Statement

In this published article, all data created or processed in the course of this study are provided.

Conflicts of Interest: The authors do not have any conflict of interest.

Appendix A

Table A. Measurement items of the scale and associated sources.

Construct	Codes	Measurement Items	Source
Internet of things (IOT)			
SUPPLY CHAIN VISIBLITY	VIS1	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of more transparency and visibility of information and material flows.	DeVass et al. Haddudet al.
	VIS2	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of Improved product tracking and traceability.	
	VIS3	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of	

		better support of e-commerce platforms through information reliability and availability	
	VIS4	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of prediction of optimal level of production by reducing overproduction and underproduction.	
	VIS5	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of facilitation of product development and commercialization.	
	VIS6	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of better integration along inter-organizational business processes.	
	VIS7	As an IoT solution provider, your customer will be able to identify supply chain visibility in terms of transparency of local and international logistics operations.	
SUPPLY CHAIN EFFICIENCY	EFF1	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of better control and management of inventories.	DeVass et al. Haddudet al.
	EFF2	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of Improved fleet and transportation management	
	EFF3	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of better predictive asset maintenance.	
	EFF4	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of production adjustments based on real-time information regarding demand and capacity availability.	
	EFF5	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of Improvement in company asset utilization and reduction in machinery loss and downtimes.	
	EFF6	As an IoT solution provider, your customer will be able to identify supply chain efficiency in terms of Improvement in just-in-time manufacturing through better production scheduling.	
SUPPLY CHAIN INTEGRATION (SCI)			
	SI1	We have been able to improve the business processes with our suppliers to Improve information exchange with our suppliers.	
	SI2	We have been able to improve the business processes with our suppliers to Establish a quick ordering of inventory from our suppliers.	
	SI3	We have been able to improve the business processes with our suppliers to Accurately plan and adopt the procurement process in collaboration with our suppliers.	

SUPPLIER INTEGRATION	SI4	We have been able to improve the business processes with our suppliers to Stabilize procurement with our suppliers.	DeVass Shee Miah 2018
	SI5	We have been able to improve the business processes with our suppliers to Share real-time demand forecasts with our suppliers.	
	SI6	We have been able to improve the business processes with our suppliers to improve strategic partnerships with our suppliers	
	SI7	We have been able to improve the business processes with our suppliers to Help suppliers improve their processes to better meet our needs.	
	SI8	We have been able to improve the business processes with our suppliers to Improve the account payable processes for suppliers.	
	SI9	We have been able to improve the business processes with our suppliers to Improve the transport/logistics processes of logistics partners to deliver orders just in time.	
	SI10	We have been able to improve the business processes with our suppliers to improve our receiving processes for delivered goods.	
CUSTOMER INTEGRATION CUSTOMER INTEGRATION	CI1	We have been able to improve the business processes with our customers to Improve the strength of linkages with our customers.	DeVass Shee Miah 2018
	CI2	We have been able to improve the business processes with our customers to improve regular contacts with our customers.	
	CI3	We have been able to improve the business processes with our customers to Improve communication with our customers on products and promotions.	
	CI4	We have been able to improve the business processes with our customers to Make and adopt demand forecasts with a real-time understanding of market trends.	
	CI5	We have been able to improve the business processes with our customers to Improve the customer shopping experience/time/ordering/customising processes	
	CI6	We have been able to improve the business processes with our customers to Accurately plan and adopt the checkout/dispatch/delivery processes through a better understanding of market trends.	
	CI7	We have been able to improve the business processes with our customers to Improve the check-out/dispatch/delivery process of goods.	
	CI8	We have been able to improve the business processes with our customers to Improve and simplify the payment receivable process from our customers.	
	CI9	We have been able to improve the business processes with our customers to Improve customer feedback process.	
SUPPLY CHAIN PERFORMANCE (SCP)			

SUPPLY CHAIN FLEXIBLITY	SCF1	As an IoT solution provider, your customer will be able to develop their supply chain processes' ability to respond to and accommodate Demand variations, such as seasonality.	DeVass et al.
	SCF2	As an IoT solution provider, your customer will be able to develop their supply chain processes' ability to respond to and accommodate Periods of poor manufacturing performance, such as machine breakdown.	
	SCF3	As an IoT solution provider, your customer will be able to develop their supply chain processes' ability to respond to and accommodate Periods of poor supplier performance.	
	SCF4	As an IoT solution provider, your customer will be able to develop their supply chain processes' ability to respond to and accommodate Periods of poor delivery performance.	
	SCF5	As an IoT solution provider, your customer will be able to develop their supply chain processes' ability to respond to and accommodate New products, new markets, or new competitors.	
SUPPLY CHAIN RESOURCE	SCR1	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Value-added productivity per employee.	
	SCR2	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Total cost of resources used.	
	SCR3	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Total cost of distribution, including transportation and handling costs.	
	SCR4	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Total cost of manufacturing, including labor, maintenance, and re-work costs	
	SCR5	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Cost associated with held inventory.	
	SCR6	As an IoT solution provider, your customer will be able to develop their organizational operations to improve Return on investment.	
SUPPLY CHAIN OUTPUT	SCO1	As an IoT solution provider, your customer will be able to improve their company's performance in Product quality.	
	SCO2	As an IoT solution provider, your customer will be able to improve their company's performance in Supply chain delivery reliability	
	SCO3	As an IoT solution provider, your customer will be able to improve their company's performance in Sales.	
	SCO4	As an IoT solution provider, your customer will be able to improve their company's performance in Manufacturing lead time.	

	SCO5	As an IoT solution provider, your customer will be able to improve their company's performance in Perfect order fulfillment (deliveries with no errors).	
	SCO6	As an IoT solution provider, your customer will be able to improve their company's performance in Customer complaints.	
ORGANISATION PERFORMANCE (OP)			
ORGANISATION PERFORMANCE	OP1	As an IoT solution provider, your customer will be able to develop their organizational operations to Improve productivity (e.g., assets, operating costs, labor costs).	Lee and Azmi et al. Zhu et al.
	OP2	As an IoT solution provider, your customer will be able to develop their organizational operations to Improve sales of existing products.	
	OP3	As an IoT solution provider, your customer will be able to develop their organizational operations to Find new revenue streams.	
	OP4	As an IoT solution provider, your customer will be able to develop their organizational operations to Save raw materials, energy, water, human, machine, and equipment costs during production processes.	
	OP5	As an IoT solution provider, your customer will be able to develop their organizational operations to Return/re-use/recycle.	
	OP6	As an IoT solution provider, your customer will be able to develop their organizational operations to Customer satisfaction.	
	OP7	As an IoT solution provider, your customer will be able to develop their organizational operations to Employee satisfaction.	

REFERENCES

Fatorachian, H.; Kazemi, H. Impact of Industry 4.0 on Supply Chain Performance. Prod. Plan. Control 2021, 32, 63–81. [CrossRef] https://doi.org/10.1080/09537287.2020.1712487

Rejikumar, G.; Sreedharan, V.R.; Arunprasad, P.; Persis, J.; Sreeraj, K.M. Industry 4.0: Key Findings and Analysis from the Literature Arena. Benchmarking 2019, 26, 2514–2542. [CrossRef] https://doi.org/10.1108/BIJ-09-2018-0281

Tiwari, S. Supply Chain Integration and Industry 4.0: A Systematic Literature Review. Benchmarking 2021, 28, 990–1030. [CrossRef] https://doi.org/10.1108/BIJ-08-2020-0428

Kittipanya-ngam, P.; Tan, K.H. A Framework for Food Supply Chain Digitalization: Lessons from Thailand. Prod. Plan. Control 2020, 31, 158–172. [CrossRef] https://doi.org/10.1080/09537287.2019.1631462

De Vass, T.; Shee, H.; Miah, S. The Effect of "Internet of Things" on Supply Chain Integration and Performance: An Organisational Capability Perspective. Australas. J. Inf. Syst. 2018, 22, 1–29. [CrossRef] https://doi.org/10.3127/ajis.v22i0.1734

Mashat, R.M.; Abourokbah, S.H.; Salam, M.A. Impact of Internet of Things Adoption on Organizational Performance: A Mediating Analysis of Supply Chain Integration, Performance,

and Competitive Advantage. Sustainability 2024, 16, 2250. [CrossRef] https://doi.org/10.3390/su16062250

Hashemi, S.M.; Handayanto, E.; Masudin, I.; Zulfikarijah, F.; Jihadi, M. The Effect of Supply Chain Integration, Management Commitment, and Supply Chain Challenges on Non-profit Organizations Performance: Empirical Evidence from Afghanistan. Cogent Bus. Manag. 2022, 9, 2143008. [CrossRef]

https://doi.org/10.3390/su17219814

Ghadge, A.; Er Kara, M.; Moradlou, H.; Goswami, M. The Impact of Industry 4.0 Implementation on Supply Chains. J. Manuf. Technol. Manag. 2020, 31, 669–686. [CrossRef]

Kumar, P.; Aziz, S. Managing Supply Chain Risk with the Integration of Internet of Things in the Manufacturing Sector of Pakistan. Dutch J. Finance Manag. 2022, 5(2), 22405. [CrossRef]

Lee, K.L.; Azmi, N.A.N.; Hanaysha, J.R.; Alzoubi, H.M.; Alshurideh, M.T. The Effect of Digital Supply Chain on Organizational Performance: An Empirical Study in Malaysia Manufacturing Industry. Uncertain Supply Chain Manag. 2022, 10, 495–510. [CrossRef]

Bharadwaj, A.S. A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. MIS Q. 2000, 24, 169–196. [CrossRef]

De Vass, T.; Shee, H.; Miah, S. The Effect of 'Internet of Things' on Supply Chain Integration and Performance: An Organisational Capability Perspective. *Australas. J. Inf. Syst.* 2018, 22, 1–29. [CrossRef]

Shafique, M.N.; Rashid, A.; Bajwa, I.S.; Kazmi, R.; Khurshid, M.M.; Tahir, W.A. Effect of IoT Capabilities and Energy Consumption Behavior on Green Supply Chain Integration. *Appl. Sci.* 2018, 8, 2481. [CrossRef]

Haddud, A.; DeSouza, A.; Khare, A.; Lee, H. Examining Potential Benefits and Challenges Associated with the Internet of Things Integration in Supply Chains. *J. Manuf. Technol. Manag.* 2017, 28, 1055–1085. [CrossRef]

Rajaguru, R.; Matanda, M.J. Role of Compatibility and Supply Chain Process Integration in Facilitating Supply Chain Capabilities and Organizational Performance. *Supply Chain Manag.* 2019, 24, 315–330. [CrossRef]

Lee, K.L.; Romzi, P.N.; Hanaysha, J.R.; Alzoubi, H.M.; Alshurideh, M. Investigating the Impact of IoT on Organizational Performance in Malaysian Manufacturing Industry. *Uncertain Supply Chain Manag.* 2022, 10, 537–550. [CrossRef]

Oubrahim, I.; Sefiani, N.; Happonen, A. The Influence of Digital Transformation and Supply Chain Integration on Overall Sustainable Supply Chain Performance: An Empirical Analysis from Manufacturing Companies in Morocco. *Energies* 2023, 16, 1004. [CrossRef]

Shafique, M.N.; Khurshid, M.M.; Bajwa, I.S.; Kazmi, R.; Tahir, W.A. IoT-enabled Supply Chain Integration and its Effect on Green Performance: Evidence from Pakistani Retail Industry. *Internet Things* 2023, 24, 100982. [CrossRef]

Setiawan, H.S.; Tarigan, Z.J.H.; Siagian, H. Digitalization and Green Supply Chain Integration to Build Supply Chain Resilience toward Better Firm Competitive Advantage. *Uncertain Supply Chain Manag.* 2023, 11, 683–696. [CrossRef]

Haddud, A.; Khare, A.; Lee, H.; DeSouza, A. Internet of Things in Supply Chain: Opportunities and Challenges for Businesses in Early Industry 4.0 Context. *Oper. Supply Chain Manag.* 2021, 14, 148–161. [CrossRef]

Lee, K.L.; Azmi, N.A.N.; Hanaysha, J.R.; Alzoubi, H.M.; Alshurideh, M.T. Investigating the Impact of IoT on Organizational Performance in Malaysian Manufacturing Industry. *Uncertain Supply Chain Manag.* 2022, 10, 495–510. [CrossRef]

Haddud, A.; DeSouza, A.; Khare, A.; Lee, H. IoT Integration and Challenges in Supply Chains. *J. Manuf. Technol. Manag.* 2017, 28, 1055–1085. [CrossRef]

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). Sage Publications.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. European Business Review, 26(2), 106–121.

Ben-Daya, M., Hassini, E., & Bahroun, Z. (2022). Internet of Things and supply chain management: A conceptual framework. Operations and Supply Chain Management, 15(2), 251–268.

Li, G., Yang, H., Sun, L., & Sohal, A. S. (2009). The impact of IT implementation on supply chain integration and performance. International Journal of Production Economics, 120(1), 125–138.

Huo, B. (2012). The impact of supply chain integration on company performance. Supply Chain Management: An International Journal, 17(6), 596–610.

Mathur, B., Gupta, S., Meena, M. L., & Dangayach, G. S. (2020). Impact of supply chain practices on organizational performance with moderating effect of supply chain performance in Indian health care industry. International Journal of Supply Chain Management, 7(1), 30–41.

De Vass, T., Shee, H., & Miah, S. J. (2018). The effect of Internet of Things on supply chain integration and performance: An organizational capability perspective. Australasian Journal of Information Systems, 22, 1–29.

Haddud, A., DeSouza, A., Khare, A., & Lee, H. (2017). Examining potential benefits and challenges associated with the Internet of Things integration in supply chains. Journal of Manufacturing Technology Management, 28(8), 1055–1085.

Lee, K. L., Azmi, N. A. N., Hanaysha, J. R., Alzoubi, H. M., & Alshurideh, M. T. (2022). The effect of digital supply chain on organizational performance. Uncertain Supply Chain Management, 10, 495–510.

Abdallah, A. B., Rawadiah, O. M., & Al-Byati, W. (2021). Supply Chain Integration and Export Performance: The Mediating Role of Supply Chain Performance. International Journal of Production and Performance Management, 70, 1907–1929.

Boubker, O. (2022). The effects of information technologies on automotive supply chain and firm performance: A PLS-SEM approach. LogForum, 18, 61–75.

Shafique, M. N., Rashid, A., Bajwa, I. S., Kazmi, R., Khurshid, M. M., & Tahir, W. A. (2018). Effect of IoT capabilities and energy consumption behavior on green supply chain integration. Applied Sciences, 8, 2481.

Mathur, B., Gupta, S., Meena, M. L., & Dangayach, G. S. (2020). Impact of supply chain practices on organizational performance with moderating effect of supply chain performance in Indian health care industry. International Journal of Supply Chain Management

Yanus, E. D. S., Primiana, I., & Cahyandito, M. F. (2016). The influence of supply chain integration on company performance through competitive advantage in Indonesian pharmaceutical industry. Academy of Strategic Management Journal, 15(2), 291–300.

Taj, S., Imran, A. S., Kastrati, Z., Daudpota, S. M., Memon, R. A., & Ahmed, J. (2023). IoT-based supply chain management: A systematic literature review. Internet of Things, 24, 100982. https://doi.org/10.1016/j.iot.2023.100982

De Vass, T., Shee, H., & Miah, S. J. (2021). IoT in supply chain management: Opportunities and challenges for businesses in early Industry 4.0 context. Operations and Supply Chain Management, 14, 148–161. http://doi.org/10.31387/oscm0450293

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. MIS Quarterly, 24, 169–196.

http://doi.org/10.2307/3250983

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43, 115–135. http://doi.org/10.1007/s11747-014-0403-8

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1), 39–50.

https://doi.org/10.1177/002224378101800104

Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. International Journal of e-Collaboration, 11(4), 1–10.

http://www.igi-global.com/article/common-method-bias-in-pls-sem/132843

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review. Journal of Applied Psychology, 88(5), 879–903. https://psycnet.apa.org/fulltext/2003-08045-010.html