

IMPACT OF IOT CAPABILITIES AND SUPPLIER INTEGRATION ON SUPPLY CHAIN MANAGEMENT PERFORMANCE: ROLE OF INTERNAL INTEGRATION

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Abstract: *This study attempts to investigate the function of internal integration as a mediator between Internet of Things (IoT) capabilities and supplier integration for supply chain management performance in Pakistan's textile industry. Utilizing a questionnaire instrument derived from previous research to collect primary data. To evaluate the proposed hypothesis, the collected data are analysed in SmartPLS version 3 using statistical tests such as confirmatory factor analysis and structural equation modelling. The findings of this study confirmed the full mediation effect of internal integration on the supply chain management performance of the textile industry in Pakistan. The study reveals, contrary to popular belief, that IoT-enabled supplier and external integration have a greater impact on supply chain performance than IoT-enabled internal integration, and that textile managers should priorities establishing internal integration within their internal functions before pursuing external integration with customers or suppliers.*

Keywords: *IoT Capabilities; Supplier Integration; Supply Chain Management Performance; Internal Integration*

INTRODUCTION

The level of connectivity and smooth operation between various supply chain components is referred to as supply chain integration (Helo & Hao et al., 2019). Along with the coordination of logistics and information flows, this also entails the integration of suppliers, manufacturers, distributors, and retailers. The efficiency, prices, and responsiveness to consumer demand may all be enhanced with effective supply chain integration. Contrarily, supply chain performance describes how successfully a supply network satisfies consumer demands while balancing costs and profits (Wagner, 2021). This covers measurements of product quality, lead times, inventory levels, on-time delivery, and customer satisfaction. Increased customer loyalty, superior financial results, and a competitive edge in the market may all result from a high supply chain performance (Muchaendepi et al., 2019). The effectiveness of the supply chain may be significantly impacted by supply chain integration. Information may flow more rapidly and correctly when multiple supply chain components are connected, which enables more effective planning and coordination. Reduced lead times, greater inventory control, and a better capacity to adapt to changes in consumer demand are possible outcomes of this. Integration of the supply chain may also aid in identifying and reducing supply chain risks (Munir et al., 2020). Companies may better predict possible delays and take action to lessen their effect by having improved insight into supplier performance and inventory levels. This may increase the supply chain's overall resilience



and guarantee that consumers keep getting the goods and services they need (Trabucchi & De Giovanni, 2021). There is a strong relationship between supply chain success and integration. Prioritizing supply chain integration may help businesses improve supply chain performance, which can enhance their financial standing and provide them a competitive edge (Piprani, et al., 2020). By enhancing the effectiveness, accuracy, and speed of communication and data sharing within and between supply chain participants, information, and communication technology (ICT) may have an important impact on supply chain performance (Liu et al., 2021; Chen et al., 2021). ICT can provide real-time insight into supply chain processes, enabling businesses to follow the flow of products and raw materials, keep track of inventory levels, and spot possible hiccups or bottlenecks (Ahmed et al., 2022). Since businesses can swiftly adjust to changes in consumer demand or supply chain circumstances, this may help to shorten lead times and enhance overall supply chain responsiveness. ICT can make it easier for supply chain participants to collaborate and coordinate (Madhani, 2021). For instance, real-time communication between suppliers, manufacturers, and distributors may be made possible via cloud-based platforms and data analytics tools. For instance, supply chain partners may share data automatically thanks to electronic data interchange (EDI), which eliminates the need for human data input and lowers the possibility of mistakes. This may increase the effectiveness of the supply chain and lower the price of data input and processing. ICT can provide real-time visibility, cooperation, and data sharing amongst supply chain participants, which can significantly improve supply chain performance (Ghazal & Alzoubi, 2021). Businesses that invest in ICT solutions may enhance the operation of their supply chains, which can result in greater customer satisfaction ratings, more revenue, and an advantage in the market (Balakrishnan & Ramanathan, 2021; Karaman, 2020).

Although there is a growing amount of literature on the advantages of IoT and supplier integration in supply chain management (Rebelo et al., 2022; Ben-Daya et al., 2020; Rejeb et al., 2020) But, more empirical study is required to comprehend the unique constraints and possibilities encountered by supply chains in Pakistan's textile sector. The literature on the role of internal integration in allowing the advantages of IoT and supplier integration in the context of the textile industry in Pakistan may also be lacking (Rehman et al., 2023). Internal integration is a term used to describe how well-coordinated and collaboratively distinct corporate departments are. While the advantages of external integration with suppliers are widely established, less emphasis has been paid to the function of internal integration in allowing these advantages. Investigating the part that internal integration plays in allowing the advantages of IoT and supplier integration on supply chain management performance in the Pakistan textile sector might fill a possible research need. For Pakistani textile sector supply chain managers aiming to enhance their supply chain management procedures and attain more efficiency and competitiveness, this study may provide helpful insights (Khan et al., 2022).

Theoretical Framework and Hypothesis development

An organization's resources, talents, and knowledge, as well as how to employ them to gain a competitive edge, are the subject of organizational capacity theory, a management theory (Lee, & Yoo, 2019). According to the concept, a company's success is dependent on its capacity to gradually increase these qualities (Kopp et al., 2021). The two basic kinds of an organization's capabilities, according to organizational capability theory, are dynamic capabilities and routine capabilities (Linde et al., 2021). Routine capabilities relate to the organization's capacity to carry out its fundamental business operations successfully and efficiently, while dynamic capabilities refer to the organization's ability to adapt and react to changing market circumstances. According to organizational capability theory, creating a portfolio of dynamic and routine skills that are in line with the organization's strategy and business model is the key to creating a competitive edge (Mahdi & Nassar, 2021). A mix of internal development, acquisition, and strategic alliances may be used to build these competencies. The idea of flexibility states that organizational capacities change throughout time rather than being constant. To stay competitive, an organization's capabilities must evolve along with the business environment (Contreras et al., 2020). As a result, long-term success depends on the capacity of organizational skills to continuously expand and change. Strategic



management, organizational development, and innovation management are just a few of the areas where organizational capacity theory has been used. For managers, it offers a helpful framework for comprehending how their organization's capabilities contribute to their competitive advantage and how they may enhance and utilize these skills to accomplish their strategic objectives (Duchek et al., 2020).

Hypothesis Development

IoT capabilities

The performance of the supply chain may be significantly impacted by IoT (Internet of Things) capabilities (Saengchai & Jermsittiparsert, 2019). Companies may get real-time data on supply chain activities by using IoT sensors and devices, allowing them to keep track of inventory levels, follow the flow of products, and spot possible bottlenecks or interruptions (Sharma et al., 2023). Due to the ability of businesses to react swiftly to changes in consumer demand or supply chain circumstances, real-time visibility may assist shorten lead times and increase overall supply chain responsiveness. Additionally, by giving supply chain managers precise and timely information, IoT may facilitate more effective and efficient decision-making (Nayal et al., 2022; Khanfar et al., 2021). IoT systems can automatically detect trends and insights in supply chain data by using analytics and machine learning capabilities. This enables managers to make data-driven choices and improve the operation of the supply chain. The communication and coordination amongst supply chain participants may also be facilitated by IoT (Jimenez-Jimenez et al., 2019). IoT devices, for instance, may provide real-time communication between manufacturers, distributors, and suppliers, enabling them to exchange information, coordinate production schedules, and improve logistical operations. Consequently, the supply chain may operate more cost-effectively, use resources more effectively, and perform better overall (Zhao et al., 2023). Implementing IoT capabilities in the supply chain, however, may be difficult due to issues including the requirement for new systems and infrastructure to support IoT devices as well as the possibility of security and privacy issues. For businesses to handle IoT-enabled supply chains successfully, new skills and competences may be required (Esmailian et al., 2020). Generally, by providing real-time visibility, cooperation, and data sharing amongst supply chain partners, the integration of IoT capabilities in the supply chain has the potential to greatly enhance performance. To make sure that the adoption of IoT is in line with their strategic objectives and will provide them a competitive edge in the market, businesses must carefully weigh the possible advantages and difficulties (Pappas et al., 2021; Aslam et al., 2020).

H1a: IoT capabilities positively related to supply chain management performance.

H1b: IoT capabilities positively related to internal integration.

Supplier Integration

The practice of closely working with suppliers to increase the efficacy and efficiency of the supply chain is known as supplier integration (Sriyakul et al., 2019). Sharing information, synchronizing production plans, and collaborating to spot and fix any supply chain bottlenecks and interruptions may all be part of this. By enhancing responsiveness, lowering lead times, and boosting supply chain effectiveness, supplier integration may have a substantial influence on the performance of the supply chain (Al-Zaqeba et al., 2022). Companies may acquire real-time insight into supplier performance by collaborating closely with suppliers, which enables them to react rapidly to changes in demand or supply chain circumstances (Mak et al., 2021). Additionally, by optimizing production schedules and ensuring that suppliers have the tools and skills needed to satisfy client demands, supplier integration may assist to raise product quality and lower costs (Helo & Hao 2022). Companies may also lower supply chain risk and improve overall supply chain stability by establishing long-term partnerships with important suppliers. However, adopting supplier integration may also be difficult since it requires good tools for cooperation and communication and there is a chance that there will be disputes or conflicts with suppliers (Annosi, et al., 2021). Additionally, it takes time for both sides to create a high degree of trust and commitment necessary for supplier integration (Zhang et al., 2020).

H2a: Supplier integration positively related to supply chain management performance.



H2b: Supplier integration positively related to internal integration.

Mediating Role Internal Integration

In order to increase the efficacy and efficiency of the supply chain, a process known as internal integration involves aligning and integrating internal operations and departments inside a business (Siagian et al., 2021). This might include integrating processes like purchasing, production, shipping, and sales as well as creating standard measurements and objectives for all these processes. Internal integration may significantly affect the performance of the supply chain by enhancing coordination, cutting down on lead times, and boosting supply chain effectiveness (Azadegan et al., 2020). Companies may enhance their awareness of their entire supply chain performance and pinpoint opportunities for improvement by harmonizing internal departments and activities. Internal integration may also assist to save costs and enhance product quality by streamlining production schedules and ensuring that internal operations have the tools and resources needed to satisfy client demands (Wong et al., 2020). Companies may increase responsibility and decision-making while also improving supply chain management by creating a consistent set of objectives and KPIs across internal operations (Kazancoglu et al., 2021). The necessity for efficient tools for communication and cooperation as well as the possibility for internal functions and departments to be resistant to change are obstacles that might arise when implementing internal integration, however. Furthermore, internal integration calls for a high degree of cooperation and dedication from all departments and roles, which might be challenging in certain businesses (Ganbold et al., 2021). Internal integration is a crucial element of supply chain management that may greatly enhance performance. Companies may enhance coordination, save costs, and boost customer satisfaction by aligning internal divisions and operations (Zhu et al., 2022; Ganbold et al., 2021).

H3a: Internal integration mediates the relationship between IoT capabilities and supply chain management performance.

H3b: Internal integration mediates the relationship between supplier integration and supply chain management performance.

METHODOLOGY

Procedure

This study examined the mediating effects of internal integration between IoT capabilities and supplier integration on supply chain management performance using a cross-sectional research design. The researcher oversees the development of data collection instruments, such as questionnaires and interview procedures, and the selection of the appropriate sample size and sampling technique for the collection of primary data. The researcher then collects the data directly from the subjects or sources. In the present study, textile managers from Pakistani textile corporations provided most of the data. A sample of 260 individuals was selected using a non-probability sampling method that included convenience sampling and snowball sampling procedures. Throughout the data collection period, which held from January to March, respondents were contacted and asked to participate in a face-to-face survey. Participants were contacted beforehand in order to schedule an interview. The investigation was conducted in accordance with moral and legal standards. Each participant gave informed consent, and their identities and confidentiality were protected. The study's findings were presented without any information that could be used to identify individual participants. A created and utilized standard questionnaire was used to collect data from participants.

Measurements

IoT capabilities as independent variable is adopted from the research De Vass et al., (2018). Items are "To measure supply chain activities, processes and its environmental conditions, to help control supply chain processes remotely and to provide real-time information to optimize supply chain activities".

Supplier integration as the independent variable is taken from the study of Lee et al., (2016). Items are “Improve information exchange with our suppliers, improve strategic partnerships with our suppliers and improve our receiving processes for delivered goods”.

Internal integration as a mediating variable is adopted from the research from study of Wong et al., (2017). Items are “accurately plan and adopt internal processes in collaboration with cross-functional teams, make and adopt demand forecasts in collaboration with cross-functional teams and Improve real-time communication and linkage among all internal functions”.

Supply chain management performance as the dependent variable is taken from research of De Vass et al., (2018). Research items are “Improve perfect order fulfilment (deliveries with no errors, Reduce the total supply chain management cost and Improve value-added productivity (sales per employee)”.

Statistical Tool

Structural equation modeling (SEM) was used to evaluate the survey data and test the assumptions (Breitsohl et al., 2019). SEM version 3 was used to analyze the data. A statistical technique used to examine difficult associations among several variables is structural equation modeling (SEM) (Grotzinger et al., 2019). SEM use path analysis to test hypotheses regarding correlations between variables and incorporates both confirmatory and exploratory factor analysis. In SEM, a model of potential associations between latent and observable variables is specified, and the model is compared to the data.

RESULTS AND DISCUSSION

Reliability and Validity (Questionnaire)


For the data to be accurate and useful for testing hypotheses, reliability and validity must be established (Sürücü & MASLAKÇI, 2020). The findings of the hypothesis testing may not be accurate and may draw the wrong conclusions in the absence of trustworthy and authentic data. Therefore, prior to undertaking hypothesis testing, researchers should focus on establishing reliability and validity in their study technique (Pandey & Pandey, 2021). Any research study must have reliability and validity, which must be verified before hypothesis testing can be done. The consistency and stability of the measuring tool or data gathering technique are referred to as reliability (Mohajan, 2017). Validity describes the precision and veracity of the measuring tool or procedure used to get the data.

Researchers may decide to present both Cronbach's alpha and Composite dependability in their analysis in order to evaluate the resiliency of an investigation (Galanakis et al, 2016). The validity and accuracy of the measuring equipment or technique should also be established before performing hypothesis testing since reliability is just one component of data quality. For many research tasks, a Cronbach's alpha, and Composite Reliability of 0.70 or above are often regarded as acceptable, however higher values are recommended. All values are now larger than 0.70 (Taber, 2018). The values for Composite Reliability and Cronbach's Alpha are shown in Table 1.

In structural equation modeling (SEM), the average variance extracted (AVE) is a frequently used indicator of construct validity (Hair et al., 2021). Although this might change based on the study environment and the number of items in the scale, an AVE value of 0.50 or above can frequently be considered adequate for construct validity (Bakar et al., 2020). All values are now larger than 0.50. Table 1 include the extracted values' average variance:

Table 1
Reliability and Validity (Questionnaire)

Factors	Item SPSS coding	Items loading	Cronbach alpha value	Composite Reliability	Average Variance Extraction (AVE)
IoT capabilities	ITC1	0.889	0.882	0.927	0.809
	ITC2	0.902			
	ITC3	0.908			
Supplier integration	SI1	0.849	0.814	0.890	0.729



	SI2	0.850			
	SI3	0.862			
Internal integration	II1	0.854	0.799	0.882	0.714
	II2	0.886			
	II3	0.793			
Supply chain management performance	SCMP1	0.899	0.859	0.914	0.779
	SCMP2	0.875			
	SCMP3	0.874			

Hypotheses Testing

IoT capabilities

This research sought to investigate the connection between IoT capabilities and supply chain management performance as well as internal integration. The researchers did this by examining the effects of IoT capabilities, the independent variable, on supply chain management performance as well as internal integration. Following analysis, the findings revealed a statistically significant and favorable correlation IoT capabilities and supply chain management performance as well as internal integration. A beta value of 0.126, 0.303 and a T-value of 1.672, 4.164 which were higher than the suggested threshold of 1.96 for IoT capabilities on internal integration served as evidence for this. However, IoT capabilities did not support for supply chain management performance.

Supplier Integration

This research sought to investigate the connection between supplier integration and supply chain management performance as well as internal integration. The researchers did this by examining the effects of supplier integration, the independent variable, on supply chain management performance as well as internal integration. Following analysis, the findings revealed a statistically significant and favorable correlation supplier integration and supply chain management performance as well as internal integration. A beta value of 0.323, 0.611 and a T-value of 3.996, 9.149 which were higher than the suggested threshold of 1.96 for supplier integration on supply chain performance management as well as internal integration.

Mediating Role of Internal Integration

This research sought to investigate the mediating role of internal integration between IoT capabilities, supplier integration on supply chain management performance. The researchers did this by examining the mediating effects of internal integration, the mediating variable, on supply chain management performance. Following analysis, the findings revealed a statistically significant and favorable correlation role of internal integration for supply chain management performance. A beta value of 0.042, 0.185 and a T-value of 2.150, 3.506 which were higher than the suggested threshold of 1.96. Therefore, this study revealed the role of internal integration.

Table 2: Hypothesis Testing

Hypothesis	Value of Beta	T-Value	Remarks
1a	0.126	1.672	Not Supported
1b	0.303	4.164	Supported
2a	0.323	3.996	Supported
2b	0.611	9.149	Supported
3a	0.042	2.150	Supported
3b	0.185	3.506	Supported

Dependent variable: Supply Chain Management Performance

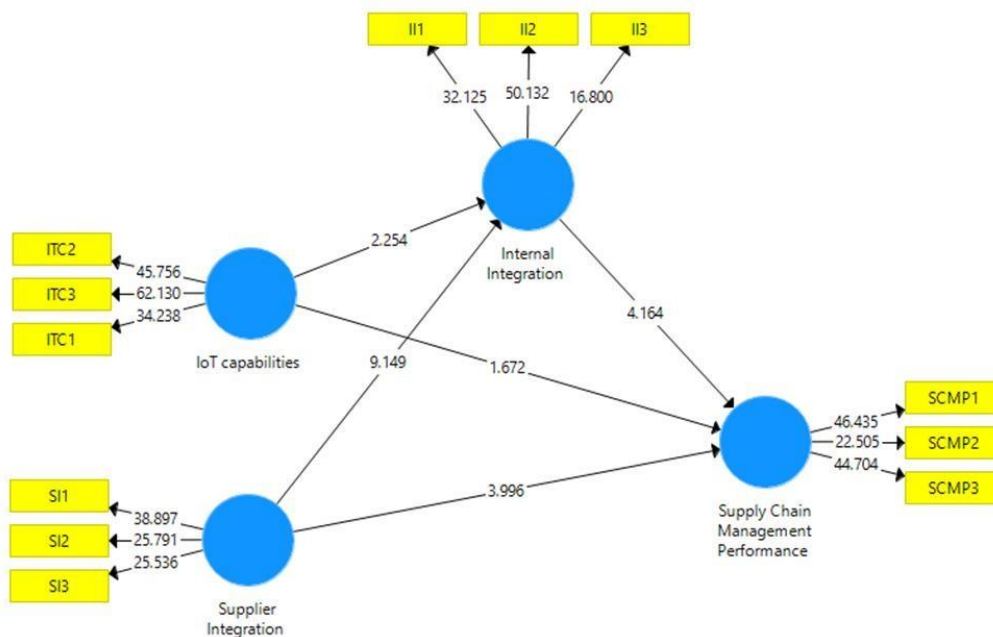


Figure 1: Structural Equation Modelling

DISCUSSION

According to the paper, for IoT-enabled supplier integration to be successful and have a positive influence on supply chain management performance, internal integration is essential (Argyropoulou et al., 2023). The research demonstrates specifically how internal integration mediates the link between IoT capabilities, supplier integration, and supply chain management performance. According to these results, businesses should prioritize internal integration before attempting external integration with suppliers (Tarigan et al., 2021; Freije et al., 2022). Internal integration entails coordinating the efforts of a company's many departments, including finance, operations, and logistics, in order to achieve shared objectives (Kaliani Sundram et al., 2018; Zhao et al., 2021). According to the reveal, organisations are better equipped to take use of IoT capabilities and supplier integration to boost supply chain management performance when they have strong internal integration (Lee et al., 2022, Cui et al., 2022). The study's results also call into question the belief that IoT-enabled internal integration is more crucial for supply chain effectiveness than IoT-enabled exterior integration with suppliers. According to the research, if internal integration is successful, IoT-enabled supplier integration may affect supply chain management performance more than IoT-enabled internal integration (Tan & Sidhu, 2022).

Managerial Implications

Contrary to popular belief, the study finds that IoT-enabled supplier and has a greater impact on supply chain performance than IoT-enabled internal integration, and that textile managers should prioritize establishing internal integration within their internal functions before pursuing external integration with customers or suppliers. This emphasizes the value of taking the whole supply chain into account, including suppliers and consumers, as opposed to merely looking at it from the textile management standpoint. Textile managers should concentrate on connecting current IoT devices with suppliers (like GPS) and consumers (like smartphones) to do this. This will allow them to collect all digital data into a single internet-based platform for sharing, interacting, and analyzing data. This strategy may increase the advantages for all partners and help achieve the objective of building a dynamic global network using the IoT platform. These results may also influence policy decisions by demonstrating that IoT investment is a wise public investment. Numerous nations, both developed and developing, have already adopted national policies for the adoption of IoT technology and committed substantial sums of money to IoT research.

Future Research direction

First off, the study's conclusions are based on the responses of textile managers, which may restrict how broadly the findings can be applied. Further investigation is required to verify the study's


findings in other situations since it's expected that managers in other sectors or areas would have different experiences and viewpoints. Second, the research ignores other possible performance-influencing elements including organisational culture and strategic planning in favor of focusing only on the effects of IoT capabilities and supplier integration. Third, the research primarily examines the function of internal integration; nevertheless, it is unknown how the performance of the supply chain may also be impacted by towards integration with consumers. The potential advantages of IoT-enabled consumer integration and how it interacts with internal and supplier integration need more study.

CONCLUDING REMARKS


With an emphasis on the function of internal integration, this study's conclusion offers insightful information on the effects of IoT capabilities and supplier integration on supply chain management performance. In order to effectively mediate the link between IoT capabilities, supplier integration, and their effects on supply chain management performance, the research emphasizes the significance of successful internal integration. According to the study's conclusions, businesses should put internal integration first before attempting outward integration with suppliers. Companies may use IoT capabilities and supplier integration to enhance supply chain management performance by coordinating various internal activities towards shared objectives.

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