



EFFECT OF SUPPLY CHAIN DIGITIZATION ON OPERATIONAL EFFICIENCY AND CUSTOMER SERVICE

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Abstract

Digitization of supply chain is currently a strategic requirement in organizations that are keen on improving operational efficiency and customer services in an extremely competitive business environment. The firms will be capable of enhancing the transparency, coordination, and responsiveness of the supply chain operations using digital technologies, such as cloud computing, Internet of Things (IoT), artificial intelligence (AI), and big data analytics. The paper examines the effects of supply chain digitalization on the performance of customer service and operational efficiency. The research methodology employed in quantitative research was a survey data, which is a measure of customer perceptions in terms of reliability, responsiveness, assurance, communication, security and quality of fulfillment by using a structured questionnaire with Likert scale questions. Indicators of operational efficiency such as the order cycle time, logistics efficiency and cost reduction were considered by relying on secondary data. Descriptive statistics and statistical software such as excel in data analysis were used in the statistical process. As per the results, digitization of supply chain has enormous influence on operations effectiveness in that it reduces lead times, enhances coordination, and eases decision-making. In addition, digitization facilitates the improvement of customer service performance by responsiveness, reliability, and transparency of services. The paper supports the significance of digital integration in contemporary supply chains and offers managerial implications of how organizations can use digital technologies to gain sustainable competitive advantage.

Keywords: Supply Chain Digitization, Operational Efficiency, Digital Transformation, Customer Satisfaction, Digital Supply Chain Performance

1. Introduction

The current business world has undergone a radical change in supply chain management with the rapidly evolving technology and increasing complexity of the market. The present business world that organizations are undertaking is highly competitive and dynamic and efficiency, responsiveness and customer satisfaction are the major determinants of success. The old supply chains that were forced to contend with a large number of manual operations, separated communication and limited operation visibility could no longer be used to serve the current business requirements. The constantly increasing globalization and the requirements and expectations of the customers evolving, the companies have to accommodate the new and technology oriented approaches that render the supply chain operations more efficient, flexible and transparent. In this respect, the supply chain digitalization has emerged as one of the most significant strategic initiatives, which can assist an organization in improving its performance in the operations and retain its competitive advantage in the digital era.



Supply chain digitization is the process that involves the use of sophisticated digital technologies in the supply chain operations to promote coordination, visibility, and decision-making possibilities. It entails converting the traditional functions of the supply chain like procurement, production planning, inventory management, logistics and customer service, into integrated and data-oriented systems. Through the use of digital technologies, organizations can align all activities in the supply chain and facilitate a free flow of information to all the stakeholders and as a result minimize inefficiencies and enhance overall performance.

There is a plethora of digital technologies that are instrumental in the digitization of supply chains. Artificial intelligence (AI), big data analytics, cloud computing, blockchain, and the Internet of Things (IoT) are technologies that have greatly improved the capacity of the organization to handle complicated supply chain networks. Big data analytics enables companies to handle big amounts of data and come up with insights to make better forecasts and decisions. The IoT devices enable real-time monitoring of goods and shipments, which injects greater visibility in the supply chain operations. Cloud computing can facilitate the effective sharing and cooperation of data amongst the supply chain partners, whereas blockchain technology can provide the transparency, safety, and tracking of transactions. These technologies will be used together in order to develop smart and digitization supply chains.

One of the most significant advantages of the process is the effect of the supply chain digitization on the operational efficiency. Digitally enabled supply chains help organizations to automate their daily operations and optimize an inventory, minimizing lead times and maximizing resource utilization. The constant access to data and improved analytics can make it possible to monitor the operations and eliminate inefficiencies. This has enabled it to enhance production planning by firms, better logistics coordination as well as cost reduction without affecting the reliability in operations.

The digitized supply chains have become even more demanded with the accelerated rate of e-commerce and online platforms. The modern consumers are in search of faster delivery, appropriate tracking of their orders, effective communication, and hassle-free shopping. In order to fulfill these expectations, organizations have to build agile, responsive and customer-centric supply chains. The digital supply chain technologies can be used to address these needs by offering a chance to make orders efficiently, monitor them in real time, and enhance the communication process during the delivery.

The digitization of supply chains can expand the abilities of customer care significantly in addition to operations. Digital systems aid organizations to provide reliable, responsive and transparent services on the basis of enhanced communication, predictive analytics and automated processes. The capabilities will facilitate the firms to respond to customer demands and changes in the marketplace in the fast way, and this will improve the quality of services and the customer satisfaction. As the concept of customer experience emerges as one of the competitive advantages, digital supply chains are starting to take center-stage in the realization of quality service outcomes.

Despite the fact that digitization of supply chains is emerging as a significant concern, the literature is biased to discuss the impact of the digitization in a limited scope. The majority of the research is conducted by only taking into consideration one factor either operational efficiency or customer service without considering the interdependence that exists between the two. However, the two related end results of the performance of a supply chain are efficiency in operations and customer satisfaction. Therefore, their net impacts are supposed to be comprehended.



2. Literature Review

Digitization of supply chains has become an important field of concern in modern supply chain management studies because of its ability to improve operational effectiveness and the performance of customer services. The adoption of digital technologies including the big data analytics, Internet of Things (IoT), cloud computing, blockchain, and Industry 4.0 tools have allowed organizations to enhance visibility, coordination, responsiveness, and overall supply chain operations [1], [6], [29]. These technologies make it possible to convert conventional supply chains into smart, data-driven systems that are able to react effectively to the dynamics in the market.

The initial studies focused on the changing interdependence of supply chain players due to digitization. Vendrell-Herrero et al. [1] revealed that digitization and servitization transform supply chain relationships by allowing them to be more connected and integrated in terms of services. There is a considerable amount of literature that creates a meaningful correlation between supply chain digitization and operational efficiency. Wang et al. [2] discovered that the digitization of the supply chain can greatly increase the efficiency of logistics and improve the competitiveness of industrial companies by making the coordination and decision-making process faster. On the same note, Srinivasan et al. [3] established that digitalization of manufacturing SMEs in India results in a better operational efficiency achieved by higher integration, transparency, and responsiveness. The results can be especially applied to the emerging economies, in which the digital adoption can substantially improve the performance of the supply chain.

Digital transformation has also been found to enhance effectiveness of the supply chain through strengthening of process integration and elimination of inefficiencies. Ghate et al. [5] found that digital transformation leads to greater efficiency and effectiveness through the coordination and data-driven decision-making. Xu [15] also highlighted the fact that with digital transformation and standardized processes, operational efficiency is also increased as variability decreases and process control is also improved. These papers indicate that digitization is a contributor to efficiency in both the form of automation and the form of systematic process enhancement.

The direct association between supply chain digitalization and operational performance has been studied in a number of empirical studies. According to the study by Aninda and Karyani [8], the implementation of digitalization enhances the operational performance by decreasing delays, minimizing errors, and increasing the degree of coordination. Similar results were obtained by Saryatmo and Sukhotu [25], who noted that digital supply chains have a positive impact on the performance of operations, which supports the role of the accuracy of information and the synchronization of processes. Al-Tera et al. [26] went ahead to expand this evidence by showing that digitalization improves organizational performance by increasing operational efficiency and integration of information. All these studies point to operational efficiency as one of the key results of digital transformation.

Supply chain digitization logistics dimension has also been well researched. According to Nagy et al. [14], more digitalization of the logistics industry enhances visibility and operational performance, but there are still difficulties in implementation. Ben-Daya et al. [18] also emphasized the use of IoT in facilitating real-time tracing and monitoring in the supply chains networks. These results are consistent with the rest of the literature on Industry 4.0, which



postulates that connected systems improve control of processes and decrease uncertainty in logistics operations [17], [19], [29].

Advanced analytics and Industry 4.0 technologies play a significant role in digital supply chains. Ivanov et al. [17] opined that supply chain resilience is enhanced through digital technologies because they allow making decisions that are predictive and adaptive. According to Frank et al. [19], the Industry 4.0 technologies improve the performance of manufacturing by automating and integrating it. Queiroz et al. [29] also established the fact that digital capabilities of supply chain enhance response and coordination.

Another significant supply chain digitization aspect is big data analytics. Dubey et al. [20] discovered that big data analytics can increase the performance of the supply chain by bettering the use of information and decision making. Gunasekaran et al. [22] highlighted the role of predictive analytics in improving forecasting and operational planning. Dubey et al. [23] also added that the effectiveness of analytics capabilities depends on the organizational flexibility. A framework of big data-driven supply chain performance measurement was suggested by Kamble et al. [24], and the contributions of the analytics toward enhancing the visibility and firm performance were shown by Brinch [21] and Wamba et al. [28]. The ability of analytics to support supply chain resilience and organizational performance was also associated by Bahrami and Shokouhyar [27].

Besides the efficiency of operations, supply chain digitization also has a tremendous effect on customer service and customer satisfaction. In e-commerce, Sarjono et al. [4] established that e-supply chain management enhances customer satisfaction because it entails the combination of ordering, inventory, and delivery systems. It was reported that digital supply chain systems help to improve the quality of services and customer satisfaction based on better reliability and communication (Abdirada and Krishnan [7]). Harahap et al. [12] discovered that service digitalization enhances the performance and efficiency of operations, and customer satisfaction is a mediating variable. On the same note, Olusegun et al. [11] showed that digitalization enhances service quality and customer outcomes in the hospitality industry.

In general, the literature always demonstrates that the digitization of supply chains enhances the efficiency of operations with increased visibility, integration, access to real-time data, and predictive decision-making [2], [3], [5], [8], [15], [20], [24], [26]. It also enhances customer service by allowing a better communication process, correct order tracking and responsiveness [4], [7], [11], [12]. Nevertheless, there is still a major gap in research since the majority of the studies focus on operational efficiency and customer service independently but not in a single system [2], [4], [12], [25].

3. Research Gap

Even though the advantages of supply chain digitization have been mentioned in the previous studies, the literature has multiple gaps.

To begin with, in most cases, studies mainly look at the operational efficiency enhancement without properly looking at the customer service aspect. Second, the studies that analyze the results of customer service do not tend to analyze the indicators of operational efficiency at the same time. Third, the majority of the literature is done in developed economies and there is little empirical evidence in emerging markets like India.



Thus, it is necessary to conduct extensive research that would investigate the dual role of supply chain digitization in operational efficiency and customer service performance as a single analytical framework.

4. Research Objectives

The main objectives of this study are:

1. To analyze the impact of supply chain digitization on operational efficiency.
2. To evaluate how supply chain digitization influences customer service performance.
3. To identify key digital technologies driving improvements in operational efficiency and customer service.

5. Hypotheses

H01: Supply chain digitization has no significant combined effect on operational efficiency and customer service.

H1: Supply chain digitization significantly improves both operational efficiency and customer service.

H02: Supply chain digitization has no significant effect on operational efficiency.

H2: Supply chain digitization has a positive and significant effect on operational efficiency.

H03: Operational efficiency has no significant effect on customer service performance.

H3: Operational efficiency has a positive and significant effect on customer service performance.

6. Conceptual Framework

The conceptual model of the study is based on the relationship between supply chain digitization and organizational performance outcomes.

Independent Variable

- Supply Chain Digitization

Dependent Variables

- Operational Efficiency
- Customer Service Performance

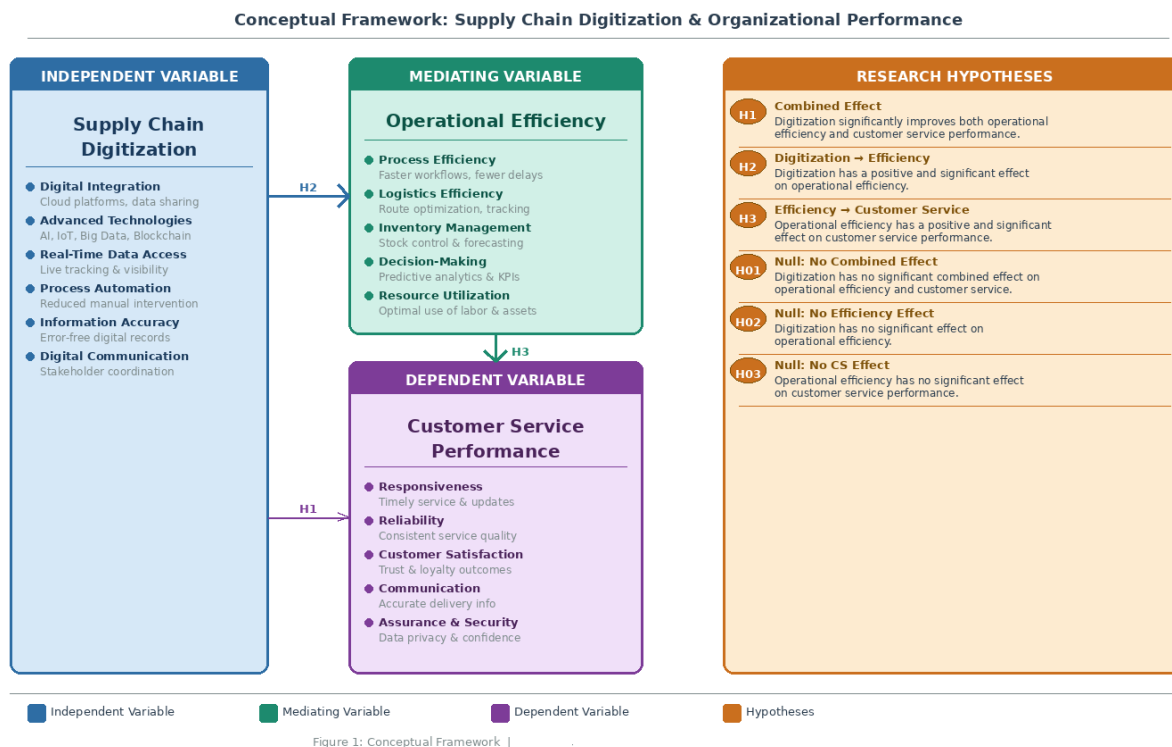
This paper aims to suggest a theoretical framework explaining how supply chain digitization, operational efficiency, and customer service performance are linked to one another. Digitization of supply chain is the independent variable that affects operational efficiency and customer service performance. Digital technologies that can be used to enhance operational processes include big data analytics, cloud platforms, and IoT that can increase coordination, data visibility, and decision-making. Digital transformation is believed to have a relationship with customer service performance through an important mediating variable known as operational efficiency. The

effectiveness of the supply chain operation enhances reliability of the delivery, minimizing lead times and increasing the processes of order fulfillment that eventually leads to customer satisfaction and quality in service provision.

Supply Chain Digitization becomes better: Accuracy of the Information, Real-time tracking, Process coordination.

Operational Efficiency is enhanced: Delivery reliability, Order accuracy, Process speed.

Customer Service Performance gets better: Satisfaction, Trust, Recommendation intention.



7. Research Methodology

Research Design

This study adopts a **quantitative research approach** using descriptive and explanatory research designs.

- **Descriptive Research:** To describe current supply chain digitization practices and customer perceptions.
- **Explanatory Research:** To examine the cause-and-effect relationship between digitization and performance outcomes.

Data Collection

The primary data were obtained using a structured questionnaire that was given to customers who deal with digital enabled supply chain services.



The questionnaire was made up of closed-ended questions and the measurements were based on 5-point Likert scale of strongly disagree to strongly agree.

Measurement Variables

Dimensions of customer service were: Reliability, Responsiveness, Assurance, Empathy, Fulfillment quality, Communication, Security and privacy.

The indicators of operational efficiency were acquired through the secondary sources like company reports and operational performance databases.

Sampling Technique

Non-probability convenience sampling was employed in the study.

Respondents:

Customers who utilize digitally enabled service like online shopping platforms, order tracking systems and digital delivery systems.

Sample Size:

286 respondents determined using **Slovin's formula**.

Tools for Data Analysis

The following analytical tools were used:

Descriptive statistics, Correlation analysis, Regression analysis, Excel, SPSS and Power BI.

Constructs of this research were quantified on the basis of various indicators based on other literature. Digitization of supply chains was quantified based on digital ordering system, tracking of orders, accuracy of information and digital communication items. Operational efficiency was gauged using indices like reliability in delivery, accuracy in order, coordination of logistics, and efficiency in managing inventory. Measures of customer service performance were based on responsiveness, reliability, quality of communication, and general customer satisfaction. Each item of measurement was measured on a five point Likert scale with the range of strongly disagree (1) to strongly agree (5).

Construct	Dimension	Measurement Indicators	Source
Supply Chain Digitization	Digital ordering systems	Digital technologies make it easy to place and manage orders	Adapted from [20], [22]
	Order tracking	Customers can track order status in real time	Adapted from [8], [30]
	Information accuracy	Digital systems provide accurate delivery information	Adapted from [3], [5]



	Communication	Digital tools improve coordination between stakeholders	Adapted from [4], [8]
	Error reduction	Digital communication reduces service errors	Adapted from [22]
Operational Efficiency	Delivery reliability	Orders are delivered at the promised time	Adapted from [2], [14]
	Order accuracy	Products received match customer orders	Adapted from [8]
	Logistics efficiency	Digital technologies improve logistics coordination	Adapted from [2], [15]
	Inventory management	Digital systems improve inventory visibility	Adapted from [3], [22]
Customer Service Performance	Responsiveness	Customers receive timely service updates	Adapted from [4], [12]
	Reliability	Digital systems improve service reliability	Adapted from [5], [8]
	Communication	Customers receive accurate delivery information	Adapted from [30]
	Satisfaction	Customers are satisfied with digitally enabled services	Adapted from [12]

8) Primary Data Analysis (Customer Service) Respondent Profile

The demographic features of respondents offer us the information about the nature of people utilizing digitally enabled supply chain services. The survey comprised the data of 293 participants of various ages and gender. The analysis shows that most respondents are within the younger demographic group, since digitally literate consumers have adopted digital platforms more.

Table 1: Demographic Profile of Respondents

Variable	Category	Percentage
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Gender	Male	58%
	Female	42%
Age	18–25	46%
	26–35	32%
	36–45	14%
	46+	8%

Most of them are aged between 18 and 35, which means that the most common age bracket of the respondents who use the digital services of supply chains is young and might be more at ease with such digital means.

Customer Service Variable Descriptive Statistics.

The survey was conducted on customer perceptions measured on Likert scale (1 to 5) in the following dimensions reliability, responsiveness, communication, order accuracy, delivery reliability, trust and security.

Table 2: Descriptive Statistics

Variable	Mean	Std Dev	Interpretation
Ease of placing orders	4.12	0.81	High agreement
Real-time order tracking	4.25	0.74	Very strong
Delivery reliability	3.98	0.85	Good
Communication updates	4.07	0.79	Strong
Order accuracy	3.91	0.88	Good
Data security	3.76	0.92	Moderate

The descriptive statistics are that the respondents have positive views about digital supply chain systems. The greatest average score was recorded on the real-time order tracking (Mean = 4.25), indicating that transparency and visibility in the delivery processes are important to customers. In the same way, the convenience of making digital orders scored highly in the mean (Mean = 4.12), which means that digital ordering systems enhance customer convenience.

Reliability Test

Table 3: Reliability Analysis



Construct	Cronbach Alpha
Customer Service Performance	0.87

Interpretation:

The alpha value of 0.87 is a strong indication of internal reliability, which shows that the questionnaire items are always able to measure the customer service performance.

Correlation Analysis

Table 4: Correlation Matrix

Variable	Digitization	Customer Service
Supply Chain Digitization	1	0.63
Customer Service Performance	0.63	1

The correlation results indicate that supply chain digitization and customer service performance have a strong positive relationship ($r = 0.63$). It implies that the customer service satisfaction is associated with an increase in digital supply chain capabilities. The findings suggest that online technologies such as real-time order tracking, automatic notifications, and inbuilt communication platforms can be used to enhance service reliability and customer confidence.

Regression Analysis

Table 5: Regression Results

Dependent Variable: Customer Service Performance

Variable	Beta	Significance
Supply Chain Digitization	0.61	$p < 0.01$
R^2	Adjusted R^2	F-value
0.39	0.38	79.9

The regression findings suggest that the digitization of the supply chain positively affects the performance of customer services and this effect is statistically significant. The standardized beta coefficient ($= 0.61$) indicates a very positive impact. The model attributes the variance in customer service performance ($R^2 = 0.39$) to about 39 percent.



Hypothesis Testing

The proposed hypotheses were tested using the results of the regression analysis.

H01: The digitization of the supply chain does not have a strong impact on the operational efficiency and customer service.

The null hypothesis is rejected because the regression analysis indicates a statistically significant relationship ($p < 0.01$).

H1: Digitization of supply chains has a significant positive impact on the performance of operational efficiency and customer service.

Thus, the other hypothesis is accepted.

This implies that digital technologies are essential in the improvement of operational processes as well as customer service delivery in the contemporary supply chain systems.

FINDINGS FROM SECONDARY DATA: OPERATIONAL EFFICIENCY

The results of the secondary data analysis of the reviewed literature suggest that the digitization of the supply chain contributes greatly to the improvement of the operation of different industries in terms of efficiency. The digital technologies, including big data analytics, Internet of Things (IoT), blockchain, and cloud-based platforms, can help organizations enhance the process of their operations by providing more convenient access to data, increasing the accuracy of information, and improving the coordination of activities within the supply chain. Digital supply chains have been recorded to enhance effectiveness through quicker decision-making, reduced delays in the supply chain processes, and efficient use of resources in the supply chain operations [2], [3], [5], [8], [15], [20], [22].

Digitization of supply chains is also important in enhancing coordination and integration of supply chain partners. The supply chain provides efficient flow of information resulting in smoothed operations and enhanced responsiveness [1], [8], [9], [11]. Also, the digital integration allows organizations to coordinate procurement, production, and distribution processes in a more efficient way. On-demand access to shared information helps minimize delays in operations and increase collaboration, leading to better workflow continuity and fewer disruptions [4], [8], [11].

Digital technologies also lead to the enhancement of the efficiency of logistics and inventory management. IoT sensors, automated tracking systems, and digital logistics platforms allow tracking the shipment and transportation processes in real-time. These tools assist organizations to optimize their routes of delivery, minimize the time spent on transit, and enhance the overall performance of the organization in terms of logistics [2], [14], [18].

The contribution of Industry 4.0 technologies and advanced analytics is especially notable in the field of operation efficiency. The technologies assist in predictive analytics and automated decision-making, which enhances operational planning and responsiveness of the supply chain [17], [19], [20]. IoT technologies also help increase the visibility of operations through the possibility of real-time data collection of production systems, transport vehicles, and warehouses. This enables organizations to identify disruptions at the initial stages and streamline the operations to minimize delays and enhance efficiency [18]. The secondary data interpretation implies that the supply chain digitization enhances the efficiency of operations mainly in terms of the increased



visibility of the data, the higher level of the coordination, and the higher efficiency of decisions. The efficiency is increased in several dimensions such as logistics performance, inventory management, production planning, and resource utilization.

Moreover, the literature suggests that the advantages of supply chain digitization are not limited to the reduction of costs. Digitization enhances the speed of processes, reliability of operations and responsiveness, which is critical in keeping up with the competitive business dynamic environments [3], [5], [17], [18]. When organizations successfully combine the digital technologies with organizational capabilities and standardized processes, they tend to experience improving the operational performance in the long term [10], [13], [23].

Construct	Sub-Dimension	Variables / Indicators	Supporting References
Supply Chain Digitization	Digital Integration	Use of digital platforms, system connectivity, data sharing	[1], [6], [29], [30]
	Advanced Technologies	AI, IoT, Big Data, Blockchain adoption	[17], [18], [20], [22]
	Real-Time Data Access	Real-time tracking, live data visibility	[2], [14], [18]
	Automation	Process automation, reduced manual intervention	[5], [19]
Operational Efficiency	Process Efficiency	Reduced delays, faster processing, workflow optimization	[2], [3], [8], [15]
	Logistics Efficiency	Route optimization, delivery speed, shipment tracking	[2], [14], [18]
	Inventory Management	Stock optimization, demand forecasting accuracy	[3], [15], [22]
	Resource Utilization	Optimal use of labor, time, and assets	[5], [20], [24]
	Decision-Making Efficiency	Data-driven decisions, predictive analytics	[20], [21], [23]



	Coordination & Integration	Supplier coordination, information flow	[1], [8], [11]
	Process Standardization	Reduced variability, consistent processes	[15], [24]
	Operational Monitoring	Performance tracking, KPI monitoring	[24], [30]

Discussion

The study findings prove that supply chain digitization is essential to enhance the operations efficiency as well as customer service performance. The main data analytics shows that digitally enabled supply chain systems are more reliable, transparent, and responsive to customers than traditional supply chain processes.

The mean scores of order tracking and digital communication are high pointing out that customers appreciate transparency and real time information in supply chain services. Operationally, the secondary data analysis proves that digital technologies can make organizations streamline logistics operations, lower lead times, and enhance coordination among supply chain partners. In general, the results demonstrate that digital supply chain transformation can bring substantial value by enhancing internal operations performance and external customer service outcomes.

Research Limitations

This research has a number of limitations. To begin with, the research employed convenience sampling, and this could confine the applicability of the results. Second, survey data were used to measure customer perceptions and it can be subject to subjectivity. Third, the research was limited to the digitally enabled supply chain services of the chosen areas.

Future Research

The future studies can also consider the effects of new technologies like blockchain, artificial intelligence, and predictive analytics on the supply chain performance. There would also be beneficial longitudinal studies on the long-term effects of supply chain digitization in various industries.

Conclusion

Digitization of supply chain is now a part and parcel of the contemporary business strategy. With digital technologies incorporated into the supply chain activities, efficiency, transparency, and responsiveness are increased in the organizational processes. In this research, the authors investigated how supply chain digitalization affects operational efficiency and customer service performance. The results show that the digital transformation leads to the high quality of the work of the organization, and the level of customer service is also raised. Companies that effectively use digital supply chain technology are able to enjoy enhanced coordination, reduced delivery time, and enhanced customer satisfaction. Supply chain digitization is therefore a major source of



competitive advantage in the current digital economy. Future studies can focus on industry-related uses of supply chain digitalization and assess the potential of new technologies, including blockchain and advanced predictive analytics, in supply chain management.

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