Kurdish Studies
Jan 2024
Volume: 12, No: 1, pp. 713-728
ISSN: 2051-4883 (Print) | ISSN 2051-4891 (Online)
www.KurdishStudies.net

Received: October 2023 Accepted: December 2023
DOI: https://doi.org/10.58262/ks.v12i1.045

The Potential Impact of Blockchain Technology on Integration, Agility, and Collaboration in Supply Chain Performance is the Focus of an Empirical Study Conducted Within the Industries of Oman and Pakistan

Shahzad Ahmad Khan[1], Ibrahim Rashid Al Shamsi[2], Syed Zeshan Haider[3]

Abstract

As the global economy continues to evolve, supply chain management has become increasingly complex due to factors such as globalization and the 4th industrial revolution. In this dynamic environment, there is need of agility and collaboration between the supply chain processes to achieve the supply chain excellence. The purpose of this study is to investigate how the implementation of Blockchain Technology can revolutionize the way integration, agility, and collaboration within supply chain operations. By examining real-world scenarios and gathering data from manufacturing industry, supply chain practitioners in Oman and Pakistan, this study aims to provide empirical evidence of the profound impact of Blockchain Technology. It explores how this technology acts as a catalyst, enabling seamless integration of supply chain processes, enhancing the agility to adapt to rapid market changes, and fostering collaborative relationships among stakeholders. Data were collected from 220 respondents working in the manufacturing industry's supply chain practices in Oman and Pakistan, using a convenient sampling technique. Demographic analysis, factor loading, correlation analysis, and regression analysis were conducted on the variables using SPSS and Smart PLS tools. The research findings indicate that Supply Chain Agility, Supply Chain Integration, and Supply Chain Collaboration are directly and positively related to Supply Chain Performance. Our study demonstrates that blockchain technology can enhance supply chain agility, integration, and collaboration, indirectly improving overall supply chain performance. It contributes to both practitioners and researchers in the field, adding value to academic research and assisting supply chain managers in adopting Blockchain Technology. This adoption, in turn, can lead to improved supply chain performance.

Keywords: *Supply Chain Agility, Supply Chain Integration, Supply Chain Collaboration,Blockchain Technology, Supply Chain Performance*

Introduction

Supply chain performance can be greatly enhanced by technology, as its integration fosters collaboration among partners and instills agility in the processes. Beyond technological innovations, the financial structure also plays a crucial role in supply chain performance. Nowadays, technology can augment businesses by facilitating product delivery to clients, granting a competitive edge that ultimately boosts supply chain performance. Research has

[1] University of Buraimi-COB , shahzad@uob.edu.om
[2] University of Buraimi-COB , ibrahim.r@uob.edu.om
[3] Bahria University Islamabad , haider97@ymail.com

shown that all businesses need to address similar requirements for improved supply chain performance (Sheel & Nath, 2019).

Technological advancements such as the Internet of Things and Information Technology establish connectivity among supply chain partners, thereby increasing their collaboration (F. Li, Nucciarelli, Roden, Graham, & Control, 2016). Supply chain managers recognize the potential of solving problems through the implementation of Information and Communication Technology (ICT) (Nandi, Nandi, Moya, & Kaynak, 2020). The world is undergoing a transformation from traditional supply chain management methods due to the fourth industrial revolution (Satoglu, Ustundag, Cevikcan, & Durmusoglu, 2018). The supply chain encompasses processes from raw material procurement to final product delivery to consumers, necessitating industry-wide improvements to enhance efficiency and profitability (Gohil, Thakker, & Applications, 2021a). Technology can render these complex processes more agile and resilient (Cole, Stevenson, & Aitken, 2019a). Technological adaptation in the supply chain is just as critical as in other industries (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007).

The introduction of blockchain technology enhances business interactions and networking between parties, subsequently improving their performance (Urbach, Drews, & Ross, 2017). Information and Communication Technology resources can promote integration among supply chain members by facilitating the timely sharing of high-quality information for efficient resource allocation (B. Huo, Zhang, Zhao, & Management, 2015). Information Communication Technology has the potential to revolutionize supply chain performance (Abeyratne, Monfared, & Technology, 2016b) by providing essential tools for cooperation among supply chain members (G. Li, Yang, Sun, & Sohal, 2009b). Introducing and implementing technology in business can meet customer demands and spur innovation, ultimately contributing to the achievement of business goals (Schuetz & Venkatesh, 2020). This, in turn, enhances the capacity to deliver services effectively (Nadeem, Abedin, Cerpa, & Chew, 2018). The adoption of technology can also reduce the cost of supply chain processes (Manupati et al., 2020). Practitioners adopting blockchain technology are confident in its ability to enhance supply chain performance (Sheel & Nath, 2019). Blockchain's integration notably amplifies collaboration among supply chain partners at various process levels, enabling product tracking and transaction accuracy (M. Mubarik, Mubarak, & sustainability, 2020).

Blockchain technology has heralded the onset of the fourth industrial revolution (Frank, Dalenogare, & Ayala, 2019). It verifies and shares transactional data across various nodes of parties, thereby enhancing the flow of information within the supply chain and ingeniously transforming the supply chain industry (Tapscott & Tapscott, 2016). Manufacturers can now easily organize logistics to ensure timely product deliveries to customers. Through IoT-generated reports and information, product locations can be tracked and shared with customers, thereby managing operational and financial risks transparently through Information Technology (Tapscott & Tapscott, 2016). Information technology aids in storing transaction information, financial product reports, and client contracts, systematically calculating financial risks (Wang, Wu, Chen, Evans, & Journal, 2020b). In today's landscape, supply chain processes are growing increasingly complex due to the demands for technological integration in SCM. Addressing this market demand and effectively enhancing supply chain performance has become a pressing issue in supply chain management (M. Mubarik et al., 2020). The COVID-19 pandemic has significantly impacted industries, including supply chains struggling to meet new customer demands, prompting the need for comprehensive strategies and policy innovations (Cuong, T. H., & Tien, N. H., 2022). The automation of business processes through Information Technology has resolved payment and logistics issues in SCM (Fatorachian, Kazemi, & Control, 2021). Information Technology plays a crucial role in supply chain performance, with the integration of ICT serving to enhance overall performance (Fatorachian, Kazemi, & Control, 2021). Obtaining accurate and sufficient information about products sourced from third parties has been a substantial challenge in the modern supply chain (Abeyratne et al., 2016b). The complexity of managing multiple factors in the supply chain has made it increasingly difficult to uphold records with proper traceability and transparency, especially within traditional business models. Over the past decade, the use of technology in SCM has risen significantly. Traditional issues in supply chain management, such as determining what information to share with customers, are effectively addressed through technology integration, which ensures the sharing of quality and timely information (M. S. Mubarik, Naghavi, Mubarak, & Review, 2019). In the traditional supply chain, delays in payments, goods deliveries, and invoicing stem from poorly integrated systems (S. Kamble, Gunasekaran, & Arha, 2019a). The main objectives of the study are to investigate the evidence of using Blockchain technology in the supply chain integration, collaboration, and agility processes across various industries in Oman and Pakistan. The study aims to determine whether the utilization of Blockchain technology leads to an improvement in supply chain performance.

Literature Review

Supply Chain Integration

Integration refers to the coordinated and interconnected flow of materials and information to clients, involving multiple organizations working together within the supply chain. This collaboration simplifies the delivery of goods and services to customers (Lai, Ngai, & Cheng, 2004b). The adoption of technology in supply chain performance is crucial for achieving industry leadership (Craighead et al., 2007). While many studies have focused on various applications of blockchain in business, we focus on the utilization of information technology within the supply chain. Integration of information and communication technology enhances collaboration by facilitating transparent information flow and traceability of goods in transit (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016).

Blockchain inherently possesses the capability to integrate production processes with the delivery of finished goods to clients, improving access to reliable data. This integration is challenging using traditional supply chain procedures but is easily achieved through blockchain's shared digital ledger (Joshi, 2017). It empowers firms to generate more accurate demand forecasts for goods production based on sales and inventory management, thereby avoiding unexpected inventory costs due to changing market conditions (Ivanov, Dolgui, & Sokolov, 2019).

H_1: *Supply chain integration has a positive impact on Supply chain performance.*

Supply Chain Agility

Agility within the context of supply chain refers to the ability to swiftly respond to changes in the market that occur in the short term, effectively addressing short-term challenges and converting them into opportunities (Swafford, Ghosh, & Murthy, 2008a). In the early 21st century, rapid market and customer demand changes have affected various aspects of business, including technological advancements, advertising competition, and procedural innovations (Lin, Chiu, & Chu, 2006). This necessitates the revision of business procedures and the intelligent adoption of new business approaches (Sharifi & Zhang, 1999). Agility can be defined as the prompt response to market changes, particularly customer demand, and the incorporation of process innovations through technology to enhance customer satisfaction (Sharp, Irani, & Desai, 1999). Research suggests that the agility to adapt to ICT is a crucial element in increasing supply chain performance (Shiralkar, Bongale, Kumar, Kotecha, & Prakash, 2021).

The implementation of agility in the supply chain contributes to global competitiveness and improved performance. It allows firms to eliminate non-value-added activities, thereby efficiently delivering less costly goods to customers, which provides a competitive advantage (Bottani & Applications, 2009). Such agility is both rare and valuable, granting a superior market advantage through long-term integration (Ngai et al., 2011). Integration with information technology augments supply chain management agility, with supply chain flexibility and integration positively correlating with supply chain agility and performance (Ngai et al., 2011). Blockchain, with its distinct characteristics, stands out as one of the most influential IT-based technologies. It can be effectively utilized in supply chain technology, facilitating inter-organizational integration and delivering benefits to the supply chain (Williamson, Harrison, & Jordan, 2004). Through the integration of business processes among supply chain participants, Blockchain can help optimize operations and enhance overall performance.

H_2: *Supply chain agility has a positive impact on Supply chain performance.*

Supply Chain Collaboration

Advanced-level collaboration plays a crucial role in enhancing supply chain performance (Giannakis & Papadopoulos, 2016). This collaborative approach involves sharing information among different members of firms and facilitates joint decision-making (Liao, Hu, & Ding, 2017). Blockchain technology further amplifies collaboration within supply chain management (Wang et al., 2020a). A notable example of effective supply chain collaboration is demonstrated by Carrefour, a prominent French retail giant with numerous stores. Carrefour integrated its pure bottled milk supply system with information technology, utilizing QR codes to track data related to milk supplier quality. This collaborative effort involves stakeholders from different Carrefour stores and fosters long-term dedication among them (Soosay & Hyland, 2015a). With the rapid growth of technology and its adoption in business, along with the proliferation of e-commerce, supplier collaboration becomes essential for efficient delivery to customers and achieving mutual benefits through the sharing of expert knowledge (Rajaguru & Matanda, 2019). To make supply chain management more viable, an efficient system is required that processes information rapidly and effectively through collaborative entities (Giri & Manohar, 2021).

Blockchain-based collaborative systems facilitate the sharing of information in a readily accessible manner for all participants, allowing them to easily join a decentralized supply chain system (Cole, Stevenson, & Aitken, 2019b). This technology-enabled collaboration enhances transparency, traceability, and efficiency in supply chain operations, ultimately contributing to improved supply chain performance.

H$_3$: *Supply chain Collaboration has a has a positive impact on Supply chain performance.*

Supply Chain Performance

Supply chain management has emerged as a crucial topic within management sciences, particularly in the realm of logistics (La Londe, 1997; Ross, 1997). The supply chain encompasses processes ranging from the procurement of goods to the transformation of products into finished goods and their subsequent delivery to the final customer. Within this intricate industry, the complexity of supply chain arrangements necessitates continuous improvements in processing systems (Gohil, Thakker, & Applications, 2021b).

Globalization has introduced challenges in accessing comprehensive product information and maintaining control over various aspects of the supply chain, including product information during transit, information transparency, and product location traceability. The shared ledger feature of blockchain technology is simplifying global supply chain management, thereby enhancing performance (Saberi, Kouhizadeh, Sarkis, & Shen, 2019). The increasing inefficiencies in transactions and decreasing trust in this technology-driven era have led to the necessity of building a reliable information system to address these issues (Saberi et al., 2019).

Critical questions arise concerning the current supply chain performance: Can it effectively address the challenge of delivering products and services to customers in a transparent and trustworthy manner? The integration of technology, specifically Blockchain Technology, into supply chain processes fosters transparency and collaboration, leading to improved performance (Swan, 2015). This integration significantly enhances data management within the supply chain (Köhler & Pizzol, 2020). Leveraging the shared ledger technology of blockchain, these challenges are mitigated for all partners within supply chain management through a decentralized system for global supply chain management (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016). This technological advancement provides a solution to the complexities inherent in supply chain processes and contributes to a more efficient and effective supply chain performance.

Blockchain Technology

The disruptions caused by the COVID-19 pandemic in the supply chain industry have driven the adoption of Blockchain technology to enhance performance and resilience (Shiralkar et al., 2021). In a Blockchain, data is stored in blocks across participants' nodes, with each block representing a timestamped and verified record through the blockchain network's consensus protocol, secured using public-key cryptography (Seebacher and Schuritz, 2017). This eliminates the need for a trusted central entity. The chaining of blocks via hash codes ensures immutability of information on the blockchain (Siba, Tarun, and Prakash, 2017), allowing users to trace status changes and obtain provenance information over time (Kim and Laskowski, 2018). Additionally, blockchains can execute computational logic in the form of 'smart contracts,' trusted applications installed on blockchain nodes (Androulaki et al., 2018).

Globalization has led to product manufacturing in one part of the world, material sourcing from another, and the use of finished goods in remote areas, necessitating efficient information sharing across a large logistics system. Blockchain Technology improves this information sharing and enhances supply chain performance (Mensah, Merkuryev, & Longo, 2015; Ketikidis, Koh, Dimitriadis, Gunasekaran, & Kehajova, 2008). While blockchain is often considered a general-purpose technology that enhances productivity, some authors argue that it will reshape industrial organization (Babich and Hilary, 2018; Davidson, P. de Filippi, and J.

Potts, 2018). Blockchain is characterized as an institutional technology that facilitates economic coordination (Davidson, P. de Filippi, and J. Potts, 2018).

Blockchain provides four key features that enhance integration and coordination within supply chains (Babich and Hilary, 2018):

1. Transparency: Shared ledger for aggregated information from various sources.
2. Validation: Records' immutability and consensus-based verification.
3. Automation: Execution of smart contracts based on verified blockchain information.
4. Tokenization: Creation and exchange of tokens representing claims on valuable assets.

Blockchain allows real-time sharing of information about object location and status among multiple supply chain members, leveraging sensor technology and the Internet of Things (Beck et al., 2017). This enhances data accuracy, collaborative planning, agility, execution, and risk management. Blockchain can streamline paperwork in global trade by validating freight documents, such as customs clearance (Hackius and Petersen, 2017). This technology holds the potential to revolutionize supply chain operations by improving transparency, efficiency, and coordination among various stakeholders.

H$_4$: *Blockchain Technology has a moderating effect on integration and Supply Chain Performance.*
H$_5$: *Blockchain Technology has a moderating effect on Agility and Supply Chain Performance.*
H$_6$: *Blockchain Technology has a moderating effect on collaboration and Supply Chain Performance*

Proposed Research Model

The model is designed to explore how the level of Supply Chain Integration, Supply Chain Agility, and Supply Chain Collaboration affects the overall Supply Chain Performance in the modern era. Furthermore, it examines whether the introduction of Blockchain Technology as a moderating factor enhances or alters these relationships.

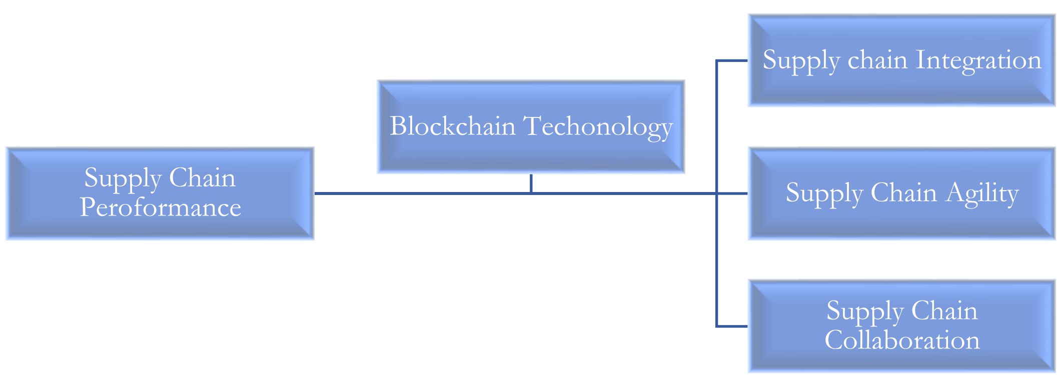

Figure 1 Research Model

Methodology

This study employs an explanatory research design and utilizes a quantitative research approach to analyze the relationships between variables, similar to the approach used by M. Mubarik et al. (2020) in their research study conducted in Oman and Pakistan. The aim is to gather precise information from the respondents. The target population for this study comprises the population associated with the research group. As Zikmund, Babin, Carr, and Griffin (2003) explain, the target population represents the group to which the research findings will be generalized. In this case, the focus is on the manufacturing industry in Oman and Pakistan, specifically on supply chain managers involved in the fourth industrial revolution. The selected firms for this study are those that are currently using or have an interest in adopting Blockchain Technology in their supply chain management. Data collection is carried out through a Nonprobability sampling technique, specifically Convenient sampling. This technique allows for the collection of data from readily available respondents, and while it may not represent the entire population, it offers practicality and feasibility (Sekaran & Bougie, 2019).

The sample size for the study is determined based on the recommendations of Uma Sekaran (2019), suggesting that a sampling selection of 30% to 40% of the population is sufficient for robust data analysis. Accordingly, data is collected from 200 to 220 participants, out of a total population of around 700 individuals working various industries, logistics companies in both countries. This approach is aligned with the principles of sampling and generalization for better understanding and applicability of the research findings (Sekaran & Bougie, 2019; M. Mubarik et al., 2020).

Data Analysis

Descriptive Statistics

Table 1. Descriptive Statistics

	Number of Respondents	Percent Responses
Gender		
Female	46	20.90%
Male	174	79.10%
Age		
18-25	27	12.25%
26-30	60	27.28%
31-35	102	46.37%
36-45	20	9.10%
45 & Above	11	5.00%
Education		
Intermediate	48	17.31%
College Graduate	126	69.71%
16-Years of Education	24	7.69%
More than 16 years of Education	10	5.29%
Management Level		
Lower Management	42	19.10%
Middle Management	166	75.45%
Top Management	12	5.45%
Professions		
Supply Chain Manager	92	41.82%
Supply Chain Supervisor	55	25.00%

Logistics Manager	51	23.18%
IT and BCT Manager	22	10.00%
Total Respondents	220	100.00%

Inferential statistics

Smart Partial Least Squares (PLS) is an effective approach for elucidating intricate relationships among different variables. It proves particularly adept at handling datasets with abnormal data distributions (Vinzi, Chin, Henseler, & Wang, 2010). The measurement model employed in this research examines how latent constructs are gauged through observable variables. The study incorporates three independent variables: Supply Chain Agility, Supply Chain Integration, and Supply Chain Collaboration, along with the dependent variable, Supply Chain Performance. Moreover, the moderating impact of Blockchain Technology is also considered within this framework. To ensure the reliability and validity of the research, Smart PLS is employed for conducting analysis on the items. This involves scrutinizing the measurement model, verifying the credibility and precision of the items' measurement, and assessing the constructs' reliability and validity. Smart PLS facilitates these analyses and assists in drawing meaningful conclusions from the gathered data.

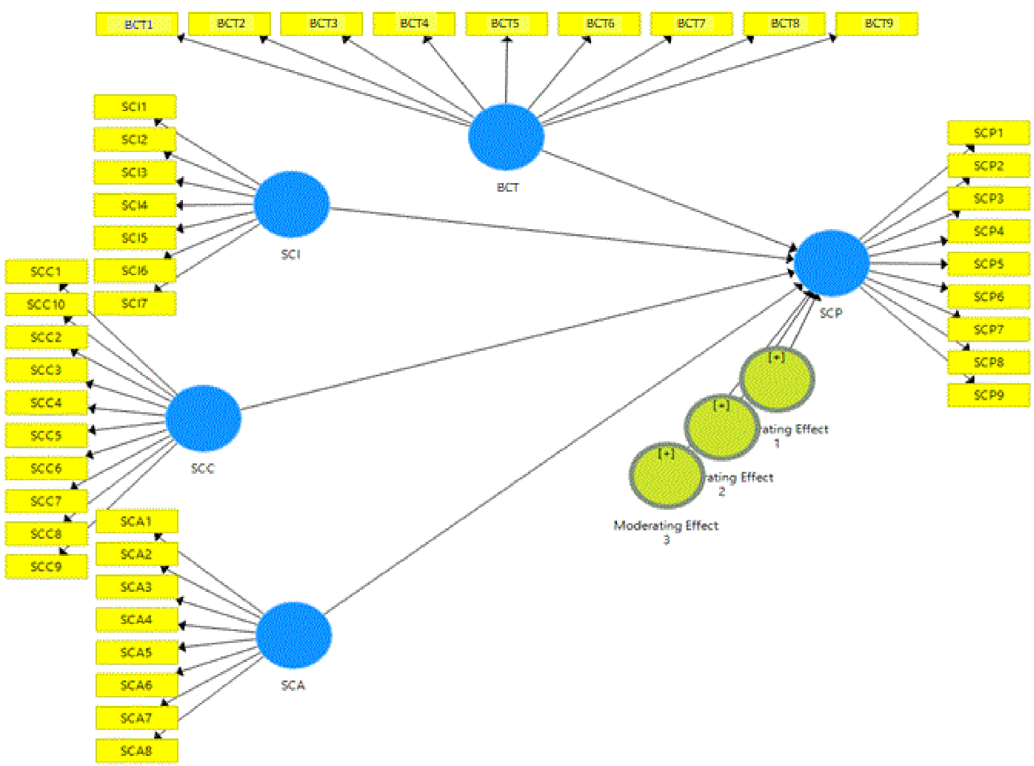

Figure 2 Measurement Model Smart PLS

Internal Consistency and Convergent Validity.

After building the required model in Smart PLS software, run the PLS Algorithm. The process is known as "Measurement model evaluation". The outer loading over .708 is encouraged, indicating that the item accounts for more than 50% of the variation in construct and that item dependability is acceptable. The values above .60 are also acceptable according to (Byrne, 2013). The results show that the majority of the values were more than .708 which is acceptable. Table 2 presents the summary of the outer loadings.

Table. 2 Outer Loading

Item Code	Factor Loading	Item Code	Factor Loading	Item Code	Factor Loading
Supply Chain Agility		Supply Chain Integration		Blockchain Technology	
SCA1	0.716	SCI1	0.737		
SCA10	0.713	SCI10	0.707	BCT1	0.766
SCA2	0.747	SCI11	0.74	BCT10	0.701
SCA3	0.761	SCI2	0.766	BCT11	0.757
SCA5	0.706	SCI3	0.695	BCT12	0.771
SCA6	0.703	SCI5	0.776	BCT2	0.72
SCA7	0.716	SCI7	0.721	BCT3	0.688
SCA9	0.74	Supply Chain Performance		BCT7	0.739
Supply Chain Collaboration		SCP1	0.737	BCT8	0.813
SCC12	0.724	SCP11	0.836	BCT9	0.752
SCC13	0.701	SCP2	0.701		
SCC14	0.692	SCP3	0.703		
SCC2	0.762	SCP4	0.696		
SCC3	0.694	SCP6	0.7		
SCC4	0.744	SCP7	0.735		
SCC5	0.741	SCP8	0.748		
SCC6	0.79	SCP9	0.79		
SCC7	0.7				
SCC8	0.723				

Correlation analysis

Originated by Karl Pearson about 1900, the correlation coefficient describes, to know the strength of the relationship between two variables the value of correlation is calculated. Designated r, it is often referred to as Pearson's r and as the Pearson product-moment correlation coefficient. The coefficient of a correlation is a numerical measure of the relationship between paired observations. The correlation is functional statistics that is widely used to find relationship between variables in research. It is a figure, which not only indicates the relationship degree between the two variables, but it also states the strength of relationship between the variables. The correlation values are recorded in the range of -1 to +1. When the value of (r) is 0, it shows that relationship between variables does not exist. When the value of (r) is positive, it indicates that increase in one variable increases the values of other variable or it causes positive change. However, in case of negative (r) value, increase in one variable decreases the value of other variable.(Lind, Marchal, & Wathen, 2017b).

Table 3 Correlation analysis

variables	Bct	sca	scc	sci	scp
Bct	1				
sca	.89	1			
scc	.921	.911	1		
sci	.896	.886	.907	1	
scp	.905	.910	.925	.907	1

The correlation table describes the relationship between the variables. The mean of all variables was calculated with the Smart PLS, by adding the considered items of affected variables only. Correlation table (Table 3) has been computed by Smart PLS which shows correlation (r) of all the considered independent Variables (Supply Chain Agility, Supply Chain Collaboration Supply Chain Integration) and moderating variable (Blockchain Technology) with dependent variable (Supply Chain performance) with their significance value (p). Blockchain Technology used as moderating variable in this study. The result in correlation table demonstrates that the Supply chain Agility, Supply Chain integration, supply chain collaboration , Blockchain technology had strong and positive relationship with supply chain performance. So, the study hypothesis was in line.

Table. 4 Regression Analysis

Hypothesis	Relationship	Standard Beta	T Value Statistics	P Values	Results
H_1	SCI -> SCP	0.189	3.675	0	Accepted
H_2	SCA -> SCP	0.32	5.397	0	Accepted
H_3	SCC -> SCP	0.349	4.678	0	Accepted
H_4	Moderating Effect of BCT with SCI -> SCP	0.161	2.108	0.036	Accepted
H_5	Moderating Effect of BCT with SCA -> SCP	0.185	2.152	0.004	Accepted
H_6	Moderating Effect of BCT with SCC -> SCP	0.102	1.194	0.233	Rejected

Table 4 presents the regression analysis outcomes, illustrating the relationships between the variables. The results indicate that Supply Chain Integration (SCI) has a positive impact on Supply Chain Performance (SCP), as evidenced by the tabulated values ($\beta = 0.189$, $p < 0.05$). The T-value of 3.675 surpasses 2, leading to the acceptance of Hypothesis 1 (H_1). Similarly, the analysis shows a positive and significant influence of Supply Chain Agility (SCA) on SCP ($\beta = 0.32$, $p < 0.05$), with a T-value of 5.397 exceeding 2. Hence, Hypothesis 2 (H_2) is accepted. Likewise, the relationship between Supply Chain Collaboration (SCC) and SCP exhibits a positive and significant impact, with the values indicating ($\beta = 0.349$, $p < 0.05$) and a T-value of 4.678 exceeding 2. Consequently, Hypothesis 3 (H_3) is accepted. The interaction between SCI and SCP in the presence of the moderating variable Blockchain Technology (BCT) reveals a positive and significant impact ($\beta = 0.185$, $p < 0.05$), with a T-value of 2.108 surpassing 2. Therefore, Hypothesis 4 (H_4) is accepted. Furthermore, the moderating effect of BCT on the relationship between SCA and SCP is evident, with a positive and significant impact ($\beta = 0.085$, $p < 0.05$) as depicted in Table 4.3. The T-value of 2.152 exceeds 2, leading to the acceptance of Hypothesis 5 (H_5). However, the analysis of SCC and SCP in the moderating impact of BCT indicates that BCT does not have a moderating impact on SCP. The values presented in the table ($\beta = 0.102$, $p > 0.05$) and a T-value of 1.194 is less than 2, leading to the rejection of Hypothesis 6 (H_6).

Our empirical findings showed that the impact of independent variables (Agility, Collaboration, Integration) on Supply Chain Performance is significant in the presence of Blockchain Technology, except for the moderating role between Supply Chain Collaboration and Supply Chain Performance. The literature review provides a 'compact and comprehensive overview of the state of knowledge in a specific research area' (Casino et al., 2020), a blockchain also supports the integration of heterogeneous traceability data recorded by the multiple involved parties. Blockchain technology further amplifies collaboration within supply chain management (Wang et al., 2020a). The concept of supply chain integration capability consisting of supply chain visibility, supply chain agility and supply chain flexibility was derived from previous studies (Wang and Jie, 2020., Williams et al., 2013). Overall, the research findings align with the original research, indicating consistency across different firms from Oman and Pakistan. Despite variations in cultural, knowledge-sharing, infrastructure, and economic conditions.

Implications

This research holds significant practical implications that can guide top management in enhancing their supply chain processes through integration with vendors, clients, and internal stakeholders. The findings of this study highlight how digitalization and innovation in Supply Chain Management (SCM) can lead to improved connectivity, efficient resource allocation, and better sharing of information, with Blockchain Technology playing a moderating role. As the fourth industrial revolution reshapes industries, this research underscores the importance for supply chain businesses to incorporate various forms of Information and Communication Technology (ICT) to optimize SCM performance. Notable examples, such as the partnership between Maersk and IBM in supply chain management, demonstrate substantial cost savings and improved efficiency through timely and accurate information sharing via Blockchain Technology integration. Pioneering companies like WEBOC, AGILITY, and MAERSK are at the forefront of revolutionizing supply chain businesses. Their implementation of highly automated IT systems not only meets client needs but also saves both time and costs, driving innovation in the industry. The successful integration of Blockchain Technology, collaboration, and agility phases requires active involvement and engagement of all stakeholders. This inclusive approach ensures realistic and achievable expectations. However, it is acknowledged that smaller organizations may face challenges, including higher integration costs, while grappling with similar issues. In conclusion, this research offers actionable insights that can empower supply chain management to adopt innovative practices, leverage technological advancements, and foster collaborative relationships to enhance overall performance and deliver tangible benefits to all stakeholders involved.

Future Research Direction

To further enhance the research framework of this thesis, additional research could delve into the intricacies of each research variable, providing more comprehensive insights. The implementation of Blockchain Technology (BCT) holds a significant impact on the operational dynamics of supply chain management (SCM). BCT introduces a practical and transformative approach, challenging traditional concepts of managing supply chains across various businesses and organizations. While existing studies do shed light on the role of BCT in SCM and its influence on operational and financial performance, there remains an avenue for future researchers to explore other Information and Communication Technologies (ICT) such as artificial intelligence, Data Science, and Enterprise Resource Planning (ERP) in the context of supply chain management and corporate settings in Oman and Pakistan's major cities. These emerging ICTs present valuable opportunities for industrial and academic researchers to conduct in-depth investigations into the relationships between these variables. Future studies could uncover intricate connections, shedding light on how these technologies interact and synergize within supply chain processes. In terms of practical recommendations for top management, this research suggests that BCT can facilitate enhanced communication between internal and external stakeholders. Additionally, it can improve inventory management through collaboration with cross-functional teams, leading to more efficient operations. Furthermore, the integration of BCT can facilitate real-time reception of customer feedback, thereby enabling businesses to be more responsive to customer needs and preferences.

By delving deeper into these areas, future researchers can contribute to a more nuanced understanding of how various technologies, including BCT, artificial intelligence, Data Science, and ERP, impact supply chain management in the dynamic business landscapes of Oman and Pakistan. This expanded knowledge base can offer actionable insights to industry leaders and decision-makers, fostering more effective and agile supply chain practices.

Conclusion

This research aimed to assess the role of Blockchain Technology (BCT) as a moderator in the context of supply chain performance, specifically in relation to Supply Chain Agility (SCA), Supply Chain Collaboration (SCC), and Supply Chain Integration (SCI). BCT has emerged as a highly promising and potentially transformative factor within Supply Chain Management (SCM). While the study observed a direct and significant relationship between SCC and SCP, this relationship was not recognized in the presence of the moderator BCT. Nonetheless, the role of BCT in enhancing supply chain performance was evident throughout the research findings. These results hold practical implications for businesses' operations and contribute to both theoretical advancements in academia and practical insights for industrial applications. The research outcomes have the potential to guide decision-making processes across businesses of varying sizes, from small to medium to large enterprises, when it comes to integrating BCT. This guidance can be particularly valuable in diagnosing challenges within the supply chain and making informed decisions to enhance performance. In the dynamic landscape of the fourth industrial revolution, business agility plays a pivotal role in meeting customer needs. Increased collaboration among organizations can streamline product reengineering processes and improve overall supply chain operations, thereby reducing working capital risks.

Ultimately, this research holds the potential to optimize supply chain operations, enhance performance, and drive innovation within the supply chain industry. Blockchain Technology is recognized as a powerful tool capable of making supply chain performance more agile and progressive, aligning with the demands of the modern era.

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