

Article

Modeling the Intricate Association between Sustainable Service Quality and Supply Chain Performance: Moderating Role of Blockchain Technology and Environmental Uncertainty

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Abstract: The growing awareness about natural resource scarcity is spreading across industries, compelling businesses to implement sustainability initiatives. The service sector, including small and medium-sized firms (SMEs) involved in logistical operations, is actively pursuing measures to achieve the expected sustainability goals. In recent years, incorporating sustainable service quality attributes (SSQAs) has become a crucial strategy for attaining competitive advantages and sustainability objectives. In this context, the current study examines sustainable service quality attributes' role in achieving sustainable supply chain performance (SSCP) and obtaining triple bottom line sustainability outcomes. Data were obtained from 295 logistics service-providing SMEs using the purposive sampling technique. The acquired data were then analyzed using the structural equation model. According to the findings, SSQAs have a positive association with SSCP. The moderating roles of blockchain technology (BT) and environmental uncertainty (EU) were significant between SSQAs and SSCP. SSCP also mediated between SSQAs, BT, and TBL. Meanwhile, EU and BT also have a significant influencing role between SSQAs and SSCP. The study adds to the body of knowledge within the domain of sustainability, by testing the unique interaction between sustainable service quality attributes and SSCP. Likewise, the use of blockchain technology as a moderator on a given relationship is empirically unique in itself. The study also provides the first of their kind findings on the subject matter in the context of 295 logistics service-providing SMEs from a developing country like Pakistan. The study's findings are helpful for managers in transforming their services by embedding the SSQAs and developing their workforce to be equipped with the knowledge and facilities necessary to achieve TBL outcomes.

Keywords: sustainable service quality attributes (SSQAs); triple bottom line (TBL); sustainable supply chain performance (SSCP); blockchain technology (BT); environmental uncertainty (EU)



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1. Introduction

Relentless industrialization and a higher pace of economic growth pose numerous obstacles to retaining competitive advantages. Businesses must carefully scrutinize their service-related attributes, considering industries are at the crossroads of exploring modern solutions to achieve sustainability challenges [1]. This requires firms to reshape their business operations strategies and include sustainability-related elements in their products or services during production [2,3]. Sustainable service quality attributes (SSQAs) encompass environmental responsibility, social accountability, and financial viability. Businesses involved in manufacturing adopt such practices in their pursuit of waste reduction, optimum resource utilization, and aligning their strategies with the people, planet, and

profit, the core principles of the triple bottom line [3]. Companies like 3M are investing millions of dollars in balancing their sustainability and profitability [4]. Logistics and supply chain organizations face continuous challenges in designing and implementing sustainable operational strategies that benefit internal and external customers and decarbonize the environment [5]. To be specific, across developing countries like Pakistan, the adoption of sustainable quality initiatives, in sync with blockchain technologies, is still in its infancy. Such a lethargic realization of the emerging reality has posed industries within the country with serious challenges, which are financial, social, and environmental in nature. Therefore, it is significant for those at the helm to realize that in the modern supply chain and logistics era, warehouse storage facilities and services that are efficient and effective are gaining recognition. They are considered key factors in gaining competitive advantages and reaching sustainability [6]. Logistics firms have started incorporating sustainability-related policies into their operations to gain competitive advantages and provide efficient and effective logistic services with lower carbon emissions and energy waste to provide improved service quality to the users [7].

In this modern era, sustainable service quality attributes facilitate fast speed, enhanced reliability, operational cost reduction, and convenient storage and delivery of goods, enhancing the firm's competitive advantage [8]. The logistics industry recognizes the increasing importance of having a measure to assess sustainable service quality attributes (SSQAs). This metric helps logistics companies provide services to their customers and serves as a tool to evaluate service quality [9]. To integrate sustainability practices into their supply chains in operations, logistics service providers (LSPs) understand the need to address issues like inefficient communication, transport delays, and ineffective carbon footprint management [10,11]. Research has shown that sustainable operational strategies significantly contribute to stakeholder satisfaction and promote supply chain performance (SSCP) [12].

Similarly, studies have demonstrated that sustainable practices play a role in achieving SSCP goals [13]. Therefore, delivering high-quality services is essential for LSPs aiming for performance in markets with customer demands [14]. Adaptability and innovation are factors for success in rapidly evolving markets. Scholars' increasing fascination with SSQAs highlights their importance [5]. The inability of SMEs operating across the developing world to adapt the stated innovations within the logistical landscape is one major reason behind the contextual and empirical formation of the given study.

Achieving SSCP and TBL is full of challenges, ambiguities, and uncertainties. A dynamic environment comes with plenty of environmental uncertainties (EUs) for the companies, seriously affecting their performance [15]. Rapid technological changes, abrupt demand changes from the customers, the suppliers' performance, and competitors' actions and reactions continuously evolve and pose serious threats to the supply chain performance [15]. Developing the infrastructure that helps mitigate such uncertainties has become complementary to higher performance [16]. Companies are investing in technology to gain competitive advantages and reduce environmental uncertainties' effects [17]. Blockchain technology (BT) provides traceability and transparency throughout the supply chain [18]. Health care facilitates store and share accurate records by ensuring patients' privacy [19]. BT provides huge support in building a sustainable infrastructure, and the implementation of BT by SMEs has gained fame in recent times [20]. The main objective of BT is to provide a value system with characteristics like transparency and traceability [21]. BT is regarded as one of the most reliable elements influencing the SSCP [22].

Although there is abundant literature on the triple bottom line (TBL), a scarcity of literature that considers SSQAs as a predictor of TBL has been noticed. A recent systematic literature review on sustainable service quality has reported detailed gaps and asked researchers to conduct empirical studies to examine the sustainable service quality to achieve sustainability [23]. Only the environmental performance of logistics service providers has been examined using sustainable service quality attributes, and the study suggests investigating its relationship with economic, social, and environmental performance [5].

In a study of logistics service quality in Industry 4.0, the authors suggested conducting empirical studies to examine its impact on sustainable supply chain performance [8]. Additionally, ref. [24] highlighted that firms must be vigilant about unpredictable environments and study their influence on SSCP. A study on SMEs suggested that the implementation of BT should be closely monitored as it can affect the supply chain partners and their performances [17].

Research Questions

The current study aims to bridge the above-highlighted research gaps based on the rationale that TBL needs are fulfilled by achieving SSCP, and SSQAs are an important predictor of SSCP. In order to investigate the gaps mentioned above, a series of research questions (RQs) have been formulated:

RQ1: How do the sustainable service quality attributes construct the TBL?

RQ2: How does sustainable service quality affect sustainable supply chain performance?

RQ3: Does environmental uncertainty and implementing blockchain technology stimulate sustainable supply chain performance?

The findings of this study will assist managers in achieving the TBL by recommending that they reform their services and incorporate sustainable service quality characteristics to achieve sustainability. In the subsequent section, a comprehensive and pertinent literature review is presented. After the literature review, the research design describes the methodology, sampling, and data collection. Results and discussion of this study follow. Finally, the paper concludes with future research and limitations.

2. Underpinning Theories and Concepts

2.1. Dynamic Capabilities View (DCV)

Dynamic capability refers to an organization's capacity to integrate, develop, and reconfigure its internal and external competencies in response to ongoing environmental changes [25]. Organizations have widely used DCV as a theoretical perspective that facilitates developing capabilities and dealing with environmental uncertainties [26]. There is a plethora of research that helps to understand the significant role DCV plays in understanding how the organizations respond to the uncertainties they encounter related to the supply chain [27] and strengthen themselves against any turbulences [28,29].

DCV has been used to understand an organization's adaptability and recovery against a vulnerable and dynamic environment, particularly during the COVID-19 pandemic [27]. Alsawafi, Lemke, and Yang (2021) [30] mentioned that DCV is vital in developing capabilities to connect internal quality management with the triple bottom line. Ref. [31] utilized the DCV framework to understand the importance of dynamic service quality innovation to improve organizations' innovation performance. Hussein Ali, Gruchmann, and Melkonyan (2022) [32] used the DCV approach to evaluate how sustainable logistics service quality improves SME relationships. We believe DCV is the most practical theoretical perspective for logistics organizations to develop sustainable service quality attributes in response to challenging business environments and achieve sustainable performance. Moreover, DCV has the potential to explain the capabilities influencing the triple bottom line under environmental uncertainty with support from blockchain technology.

2.2. Sustainable Service Quality Attributes (SSQAs)

Service quality is defined as meeting the customers' expectations while delivering the services and conforming to the standards set by the customer. However, it is difficult to measure the service quality due to its traits of being perishable, heterogeneous in nature, and having inseparable aspects [33]. Tangibility, responsiveness, reliability, empathy, and assurance are the attributes the customers use to form their perception of service quality [34]. Modern technologies have driven scholars to include information and communication technology as another service quality attribute [35]. In recent times, sustainable service

quality attributes have become popular among researchers to achieve sustainability goals by including green practices with a realization of reducing the environmental impact [3,36].

2.3. Sustainable Supply Chain Performance (SSCP)

SSCP is defined as achieving the organizational strategic sustainability goals through integrated and coordinated actions performed by all the supply chain partners on economic, environmental, and social fronts with a long-term orientation [37]. SSCP enables organizations and their partners to develop customer goodwill, make more profits, invest in social well-being, and avoid negative environmental impacts [38]. As a result, SSCP paves the way for developing the motivation and capabilities to achieve triple bottom line (TBL) performance indicators [39].

2.4. Environmental Uncertainty (EU)

EU is defined as the lack of the firm's ability to make the appropriate decisions due to unpredictable continuous environmental changes [40]. These EUs are of micro and macro levels; the micro-level EU emerges from the inside of the organization, whereas the macro-level EU emerges from the outside, and firms have very little control over these [24]. To overcome the problems arising from the EU and the firm's need for access to accurate information, they invest a lot in building a good information technology structure [41]. In a supply chain context, EU is higher due to the higher interdependence of the supply chain partners, and it becomes more complex for the managers to understand or predict the course of future events more accurately [42].

2.5. Blockchain Technology (BT)

BT is based on the electronic database that facilitates the organizations in storing and sharing transparent information by developing smart capabilities across the supply chain partners, which becomes supportive for them and increases their efficiency for a long time [43,44]. The BT supply chain partners can rely on the information stored or disseminated using these databases, even without physical and trusted interventions [45]. Therefore, BT facilitates through immutability, transparency, smart contracts, and enhanced efficiency [44,46].

2.6. Triple Bottom Line (TBL)

The concept of sustainability is abstract by nature. However, scholars have agreed that a set of performance-related objectives can be measured using the triple bottom line approach [47]. Including the TBL in the supply chain context is measured using social, economic, and environmental dimensions as performance indicators [48]. The sustainability initiatives help achieve the triple bottom line objectives [49].

2.7. Environmental Performance (EnvP)

A firm can reduce pollution and other hazardous matters and waste in the environment by minimizing the usage of energy resources [50]. Firms take environmental protection initiatives after reacting to internal and external pressure [51]. These initiatives can be proactive (when the firm itself starts following the environmental practices), reactive (when the firm reacts to comply with the governmental regulations), or consumption-driven (to overcome any customer complaint).

2.8. Economic Performance (ECP)

ECP refers to a company's capacity to reduce the costs of resources used in the production of products or services [52]. ECP develops the firm's capabilities to meet its financial needs efficiently [53]. Firms develop sustainable products or services, engage in more green practices, and seek new markets to ensure higher turnover and increase market share, sustainable growth, and economic performance.

2.9. Social Performance (SP)

SP refers to meeting the households' expectations for a long time, aiming to develop a long-term relationship with them [54]. Social performance is also known as CSR, which encompasses the ethical, legal, social, and economic perspectives that take discretionary actions to meet societal demands and expectations [37]. Accordingly, SP covers the vast domains of being socially and ethically responsible and accountable to the people around the firm like its employees, shareholders, policymakers, government agencies, members of the supply chain, customers, overall society, and most importantly, the future generation [39], and making all the efforts to ensure that it does not violate the health and safety rules, follow labor rules, and abide by human rights in pursuit of achieving higher social performance [38]. Table 1 summarizes the operational definitions of all study variables.

Table 1. Operational definitions of the variables.

Variable	Definition	Source
Sustainable service quality attributes	Meeting the customers' expectations while delivering the services and conforming to the standards set by the customer.	[34]
Sustainable supply chain performance	Achieving the organizational strategic sustainability goals through integrated and coordinated actions performed by all the supply chain partners on economic, environmental, and social fronts with a long-term orientation.	[37]
Environmental uncertainty	The lack of the firm's ability to make the appropriate decisions due to unpredictable, continuous environmental changes.	[40]
Blockchain technology	BT is based on the electronic database that facilitates the organizations in storing and sharing transparent information by developing smart capabilities across the supply chain partners, which becomes supportive for them and increases their efficiency for a long time.	[55]
Environmental performance	The firm's efforts to reduce pollution and other hazardous matters and waste in the environment by minimizing the usage of energy resources.	[50]
Economic performance	The firm's ability to reduce the costs related to resources utilized during the production process of goods or services.	[52]
Social performance	Meeting the expectations of the society, aiming to develop a long-term relationship with the social communities.	[54]

3. Theoretical Framework and Hypothesis Development

Below, Figure 1 shows the proposed framework of the current study.

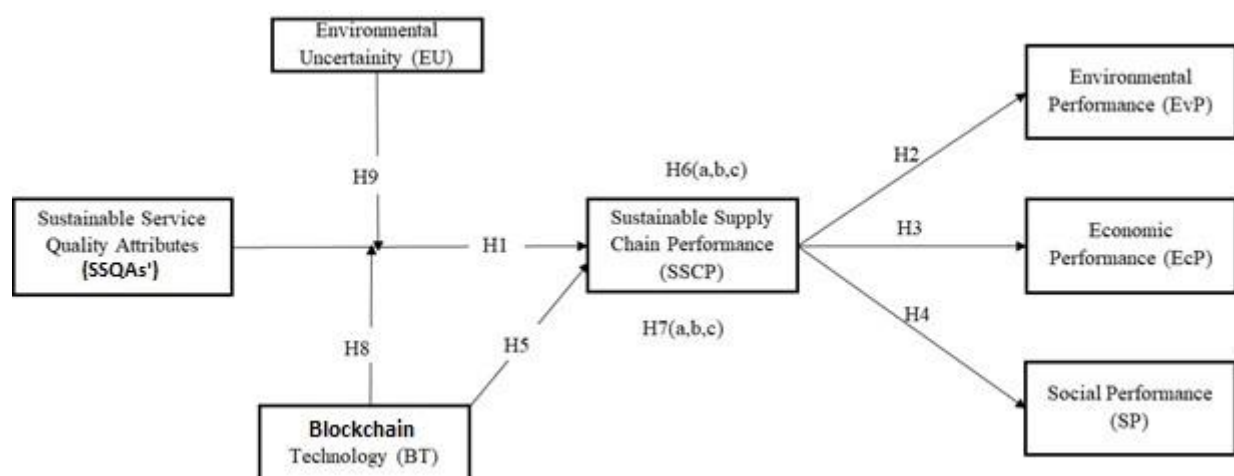


Figure 1. Theoretical framework.

3.1. Relationship between SSQAs and SSCP

Sustainable logistic service attributes develop customer satisfaction and build strong relationships [32]. The market-oriented approach to promoting sustainability encourages enterprises to design policies that facilitate reaching higher levels of sustainable performance [56]. Adopting green practices transforms the services sector and helps businesses achieve a higher performance [57]. Gupta and Singh (2020) [36] used sustainable service quality. They measured the operational excellence of the logistic service providers (LSPs) in India, and the findings indicated that logistic service providers following optimum resource utilization contribute towards supply chain performance objectives. Another study investigated the impact of the service quality provided by the LSPs, which contributes significantly to uplifting sustainable supply chain management and increasing the organization's performance [36]. In addition, Rajesh (2022) [58] mentioned that sustainable supply chain performance cannot be achieved without introducing sustainable attributes and indicators in the business model and that implementing sustainable practices enhances the sustainable performance of the business. The service quality of the LSPs in cross-border commerce cannot be achieved without following green practices that ultimately make the customer more satisfied and build a stronger and more reliable bond between the supply chain partners [59,60]. After considering the points mentioned earlier, it can be concluded that sustainable service quality attributes predict sustainable supply chain performance. With higher SSQAs, a firm can achieve higher SSCP. Thus, it is proposed that:

H1. *SSQAs have a significant relationship with SSCP.*

3.2. Relationship between SSCP and Triple Bottom Line

The TBL in the supply chain context is measured using social, economic, and environmental dimensions as performance indicators [48]. Firms opting for green supply chain operations develop the capabilities to become more responsive and resilient and help in the restoration process [61]. According to Shou et al. (2019) [62], sustainable supply chain management that evaluates environmental, social, and economic concerns shows a company's commitment to sustainability. This study examined green supply chain management practices through a thorough literature review. The analysis found that sustainable supply chain (SSC) practices help organizations establish triple bottom line performance indicators [63]. Manufacturing enterprises in Oman examined how a green supply chain affects the environment [64]. GSCM was found to reduce environmental costs and enhance enterprises' environmental impact significantly. In addition, sustainability-related initiatives taken by the firms help shape the supply chain to become more sustainability-oriented and reduce its harmful impact on the environment [49].

H2. *SSCP has a significant relationship with EnvP.*

Sustainability investments can help a corporation meet its micro- and macro-financial goals more effectively, benefiting all parties [65]. Even during the pandemic, the social and environmental approaches adopted by the firms improved the positions of their supply chain [66]. Awareness of the green revolution is critical to developing an efficient supply chain [67]. Kumar and Goswami (2019) [38] conducted a study in Indian manufacturing industries to examine the effects of SSC practices on TBL. The social factor was most significant for developing countries and helped remove sustainability barriers. The biggest sustainability drivers are decarbonization and environmental performance [68]. Another study found that lean manufacturing strategies assist firms in satisfying corporate social responsibility goals and improve social performance [69]. They shared that the supply chain, by focusing more on digital technologies, could positively affect the implementation of digital technologies and provide the organization with improved performance at the social and economic frontiers [70]. Similarly, lean manufacturing practices were found to be closely related to TBL performances [71]. The firm's size is not a barrier while implementing

SSCP practices to obtain TBL performance [72]. The preceding explanation shows that sustainable supply chain performance improves business TBL. Therefore, we suggest:

H3. *SSCP has a significant relationship with ECP.*

H4. *SSCP has a significant relationship with SP.*

3.3. Relationship between BT and SSCP

Implementing BT in SSCP has become necessary due to its trust, transparency, and security benefits to the supply chain partners [73]. Technological advancements in the supply chain domain are pushing researchers to rethink whether implementing these advanced technologies will have promising effects on sustainable practices [74]. BT support was implemented to the supply chain partners to design and produce environment-friendly offerings [75]. BT is an essential tool to reach cost efficiency and make the supply chain more transparent [76]. Narwane et al. (2021) [77] mentioned that BT enables firms to manage SC risks. Other scholars have endorsed the idea by stating that BT enables the business to be more efficient and aids the reduction of harmful materials [78]. BT-supported enterprises were reported to have improved transparency, making the supply chain more resilient and acting as an essential enabler of SSCP [79]. The literature highlighted that the firms make sustainable financing decisions to make their products/services greener and investments to tackle greenwashing, making the overall system more transparent to move towards SSCP [80]. The literature also indicates that BT's implementation influences the supply chain performance by meeting the expectations of the stakeholders by becoming more transparent, secure, and accountable [81]. Tan et al. (2020) [82] noted that incorporating the Internet of things and contemporary technologies in the logistics industry enables companies to utilize eco-friendly vehicles, recognize friendly practices, and undertake measures to decrease pollution to attain sustainability. Therefore, it is argued that implementing BT can strengthen the SSCP. Therefore, it is proposed that:

H5. *BT has a significant relationship with SSCP.*

3.4. The Mediating Role of SSCP in SSQAs and Triple Bottom Line

Studies have shown that firms always seek modern and efficient ways to become sustainable. Green supply chain management mediates the relationship between lean manufacturing and Pakistan's manufacturing industry's sustainability, allowing the business to boost efficiency [83]. The research conducted on Egyptian manufacturers revealed that GSCM mediated the connection between eco-innovation and export performance. Additionally, Hussein Ali, Gruchmann, and Melkonyan (2022) [32] revealed that LSPs evaluate their service quality in pursuit of sustainable performance. GSCM intervenes between sustainable logistics service quality and relationship performance. In a study, green innovations were the most significant element in achieving the SSCP that helped SMEs achieve closed-loop operational performances [84]. Borazon, Huang, and Liu (2022) [85] collected data from 270 electronic manufacturing SMEs to examine how GMO and SP are mediated by sustainable supply chain management. The firms implementing GMO established a unique ability to improve green supply chain management, which makes sustainable performance difficult without it. Integrating supply chain strategies improves performance and helps create a sustainable design with TBL benefits [86]. Therefore, it is inferred that SSQAs affect SSCP and SSCP helps achieve TBL and SSCP intervenes in the relationship between SSQAs and TBL. Thus, it is proposed that the following:

H6. *SSCP mediates the relation between SSQAs and (a) EnvP, (b) ECP, and (c) SP.*

3.5. The Mediating Role of SSCP in BT and Triple Bottom Line

Implementing cutting-edge technologies like the Internet of things, artificial intelligence, and blockchain technology is required to achieve SSCP. These modern technologies are facilitating organizations in reducing environmental pollution by becoming paperless and generating desirable outcomes for firms [87]. BT helps the organization create transparency to meet the customer's demands efficiently, which exerts more pressure on the organization to ask the other stakeholders to become more technology-oriented [74]. BT is a modern tool that facilitates organizations to implement their sustainable strategies and enhance their performance at all three levels: social, economic, and environmental [88]. BT enhances the supply chain performance by substantially reducing waste or carbon emissions while producing goods or services [89,90]. BT comes with the traceability of every transaction occurring in the supply chain; thus, the movement of raw materials or their origin can easily be traced to overcome environmental problems [91]. BT helps firms develop the capability to trace the products and processes and efficiently manage the resources to reduce energy waste [92]. BT enables firms to work more efficiently and reduce the cost of operations. According to [93], cost reduction and profit increase are the most common forms of economic performance; green technologies enable the enterprise to work according to environmental regulations [94]. BT brings the benefits of coordination, transparency, better control and access to data, and, most importantly, commitment from the management [95]. Moreover, digital and green capabilities bring lean and green SCP [96]. Using BT, firms reduce the lead time required to disseminate the information across the supply chain [97] and provide accurate records of the inventory stored [98].

BT also facilitates meeting the demands and expectations of the customers more efficiently. It enhances the satisfaction of the customers [99] and increases the confidence level due to trust built after the implementation of BT [100]. Additionally, businesses use BT to cultivate enduring relationships with their supply chain partners, resulting in enhanced relationship performance [101]. Based on the discussion above, it can be concluded that SSCP acts as a mediator between BT and TBL. Therefore, it is suggested that:

H7. *BT's relationship with (a) EnvP, (b) ECP, and (c) SP is mediated by SSCP.*

3.6. The Moderating Role of BT

Modern technologies like blockchain facilitate organizations to manage products, data, and services more efficiently. BT cannot provide solutions to every supply chain performance issue, but it influences transparency matters, makes the processes and products traceable, develops flexibility among the partners, and builds trust [102]. BT can influence supply chain practices and provide guidelines to improve business performance [103]. BT has great potential to transform the supply chain from an operational process to the role of the partners, and it can revamp the industrial sectors [104]. In a study of 291 employees of high-tech SMEs, BT was found to influence the internationalization of the SMEs, and it strengthened the integration among the supply chain partners by increasing their marketing and financial performance [105].

Moreover, Huang et al. (2022) [106] concluded that BT is a strong influencer in developing technical capabilities and technological feasibility and a critical factor in boosting circular supply chain management. BT application in the supply chain facilitates the firms by providing a decentralized distributed ledger, maintaining the complete records of the transactions. It is a vital element of supply chain performance [107]. The arguments mentioned above highlight that blockchain technology has an influencing role on SSCP. Therefore, it is proposed that:

H8. *BT moderates the relationship between SSQAs and SSCP.*

3.7. The Moderating Role of the EU

The firm's incapability to precisely forecast the future course of events, which creates difficulties in decision-making resulting from incomplete information, is called environmental uncertainty [108]. Contingency theory states that firms must adjust based on environmental conditions to achieve sustainable performance goals. Accordingly, this theory elaborates that firms facing uncertainties shape their operations and business environment and base their strategies on the external environment [109]. Miller (1992) [110] mentioned that the increased environmental uncertainty forces the firms to bring higher levels of integration and coordination among the supply chain partners to form the best fit between the business and the external environment. Contingency theory, a known framework in the field of study, suggests that no universal management approach suits every situation. Successful leadership and organizational practices are contingent upon various factors [111]. Researchers have extended the application of contingency theory to domains such as management to investigate how organizations adjust to contextual challenges [112].

It is argued that SSQAs are essential for all the supply chain stakeholders, and on-time availability, accurately meeting the supply and demand, and sharing relevant information with the supply chain partners are significant to achieve higher performance. EU acts as a vital contingent element that can hamper the performance of SC partners if managed improperly [24]. Similarly, under higher EU, supply chain partners work together to mitigate the negative impact of the EU and overcome it working together. Based on the above-presented arguments, it is concluded that the EU influences SSCP. Therefore, it is proposed that:

H9. *EU moderates the relationship between SSQAs and SSCP.*

4. Research Design

The current study uses numerical measurement scales, and to address the research questions, statistical analysis was performed to find the empirical evidence. As per the suggestions by Papaioannou and Wilson (2010) [113], the current study adopted the deductive approach, proposed the hypotheses using existing theories, and estimated them using statistical techniques. This study used the Statistical Package for the Social Sciences (SPSS) v24 and Analysis of a Moment Structures (AMOS) v24 software packages for statistical analysis.

4.1. Sample and Data Collection

The present study employed a survey methodology to gather data, utilizing a self-questionnaire as the primary instrument for data collection. The survey instrument was partitioned into two distinct sections. Initially, the collected information about the respondents, like the name of the organization they are working with, designation, total experience, number of employees, sector that matches the firm's characteristics, services the logistics firm is providing, and the firm's annual turnover. Section 2 was devised to collect responses on a Likert scale of 1–5. Altogether, there were 45 questions in Section 2. This study's intended participants were logistics service providers offering logistics services. For data collection purposes, this study adopted the technique of purposive sampling and only collected the data from the providers of logistics services in the Punjab province of Pakistan from the SMEs in the logistics sector which offered the services of transportation, warehousing, skilled workforce, and information technology infrastructure, and had an annual turnover of over 50 million rupees. Prior to data collection, respondents were instructed on how to complete the survey questionnaire and apprised of the purpose of the study. They voluntarily participated and provided written consent to participate in this study. Researchers guaranteed the confidentiality and anonymity of the data provided by participants. We used a rule of thumb to determine the sample size and selected 5 respondents for each item. Given that the questionnaire consists of 45 items, the minimum sample size required for this study was determined to be 225. This determination was based on

the rule of thumb which suggests that the total number of items should be multiplied by a factor of 5 to 10 in order to calculate the appropriate sample size.

The survey was conducted from September to November 2022, and 375 questionnaires were physically and digitally distributed to respondents. Out of 375, only 310 questionnaires were received. Fifteen questionnaires were further eliminated due to more than 50% incomplete responses. Finally, 295 valid questionnaires were available for analysis. The sample population consisted only of male participants, with a mean age of 41.8 years. A total of 8% of the participants reported having 0–2 years of professional experience, while 25.7% indicated having 2–5 years of work experience.

Furthermore, 31.9% of the respondents reported having 5–10 years of experience, and the remaining 34.4% reported having more than 10 years of experience. Most participants indicated that their organization employs a workforce ranging from 101 to 500 individuals. A total of 46.8% of the participants were employed in the pharmaceutical industry, while 26.1% represented the paints and chemicals sector, and an additional 26.1% were affiliated with the fast-moving consumer goods (FMCGs) industry.

4.2. Measurements

This study utilized the measurement instruments of previous studies with a high significance level. All responses were quantified using a five-point Likert scale. Sustainable service quality attributes were estimated using a 17-item scale adopted from [5]. The scale items of sustainable supply chain performance were adopted from [114] and measured using an eight-item scale. Sustainability has three main dimensions: environmental, social, and economic performance. The scale to estimate environmental performance consisted of four items, and the scale items to estimate economic performance consisted of four items.

In contrast, the scale items used to estimate social performance consisted of four items. The scale items of the TBL were adopted from the previous literature [53]. The study adopted the four scale items of blockchain technology from [17]. The four item scale proposed by Kalyar, Shafique and Ahmad (2020) [115] was adopted and used to estimate the environmental uncertainty. The questionnaire is given in Appendix A.

5. Data Analyses and Results

Convergent validity was established using exploratory factor analysis to estimate factor loadings, and all constructs were found to have values for all items against each construct that were more than the established criterion of 0.60 [116]. After that, CR values were computed for each construct, which were all higher than 0.70. The estimated values and AVE values for each component were also larger than 0.50. One SSQA item and two SSCP items were eliminated from the estimation process to improve the quality of the estimated values. The outcomes demonstrated the data's validity and dependability. Table 2 displays the outcomes.

Using the variance inflation factor (VIF), we tested the data for multi-collinearity and found that VIF values were within the range (VIF values of 1.447–1.1153, with tolerance values of 0.867–0.993). Next, the discriminant validity was calculated, and the results are shown in Table 3.

Table 2. Convergent validity, internal consistency, and Reliability.

Variables	Items	Convergent Validity		Internal Consistency Reliability	
		Loadings >0.70	AVE >0.50	Cronbach's alpha >0.60	CR >0.60
Sustainable Service Quality Attributes			0.584	0.898	0.957
	SSQA1	0.803			
	SSQA2	0.784			

Table 2. Cont.

Variables	Items	Convergent Validity	Internal Consistency Reliability	
	SSQA3	0.783		
	SSQA4	0.806		
	SSQA5	0.795		
	SSQA6	0.795		
	SSQA7	0.813		
	SSQA8	0.797		
	SSQA9	0.812		
	SSQA10	0.801		
	SSQA11	0.782		
	SSQA12	0.761		
	SSQA13	0.746		
	SSQA14	0.741		
	SSQA15	0.717		
	SSQA17	0.719		
Sustainable Supply Chain Performance		0.514	0.871	0.862
	SSCP1	0.769		
	SSCP2	0.756		
	SSCP3	0.544		
	SSCP4	0.621		
	SSCP5	0.794		
	SSCP6	0.673		
	SSCP7	0.747		
	SSCP8	0.772		
Environmental Performance		0.583	0.847	0.848
	EnvP1	0.818		
	EnvP2	0.832		
	EnvP3	0.802		
	EnvP4	0.849		
Economic Performance		0.582	0.845	0.847
	EcoP1	0.775		
	EcoP2	0.795		
	EcoP3	0.739		
	EcoP4	0.709		
Social Performance		0.65	0.872	0.874
	SP1	0.768		
	SP2	0.880		
	SP3	0.660		
	SP4	0.866		
Blockchain Technology		0.696	0.921	0.899
	BT1	0.852		
	BT2	0.868		
	BT3	0.814		
	BT4	0.855		
Environmental Uncertainty		0.612	0.86	0.862
	EU1	0.813		
	EU2	0.778		
	EU3	0.857		
	EU4	0.886		

Table 3. Discriminant validity.

	MSV	SSQA	SSCP	BT	EU	SP	EnvP	EcoP
SSQA	0.042	0.765						
SSCP	0.115	0.052	0.717					
BT	0.248	0.074	0.272 ***	0.834				
EU	0.03	0.087	0.005	0.039	0.782			
SP	0.169	0.136 *	0.335 ***	0.339 ***	0.174 **	0.806		
EnvP	0.004	−0.061	−0.009	−0.002	0.046	−0.045	0.763	
EcoP	0.248	0.205 **	0.339 ***	0.498 ***	0.122 †	0.411 ***	−0.041	0.763

Note: Significance of correlations: † $p < 0.100$; * $p < 0.050$; ** $p < 0.010$; and *** $p < 0.001$.

5.1. Common Method Bias (CMB)

Our study necessitated the examination of any potential biases that may be associated with the subject matter. The VIFs for each variable were examined to solve this CMB problem. The analysis found that all the variance inflation factor (VIF) values were less than five, which rules out the possibility of multi-collinearity or a common method bias in the dataset. Additionally, we employed full collinearity VIFs, a recognized and reliable approach to evaluate both method bias and multi-collinearity [117]. The CMB problem was also identified using Harmon single-factor analysis, which found that the overall variance was just 32.6%, below the criterion of 50%. Hence, no CMB issues were found in the study.

5.2. Structural Equation Modeling (SEM)

The subsequent phase involves doing an empirical examination of the causal model and the hypothesized propositions. First, the structural equation model was run, and the model fitness values were estimated. Initial model fitness values were a poor fit, so the re-specified model was run following the steps of [118]. The results of the initial and re-specified model are shown in Table 4.

Table 4. Measurement of model fitness values.

CFA Indicator	Threshold Value	Initial Model	Modified Model
CMIN/DF	≤ 3	2.492	1.717
GFI	≥ 0.80	0.785	0.824
AGFI	≥ 0.80	0.759	0.800
CFI	≥ 0.90	0.854	0.93
RMSEA	≤ 0.08	0.071	0.049
NFI	≥ 0.90	0.779	0.91
TLI	≥ 0.90	0.843	0.924
IFI	≥ 0.90	0.855	0.93
PCLOSE	> 0.05	0.000	0.589
SRMR	< 0.08	0.053	0.052

After estimating the model fitness, the direct and indirect effects of the proposed hypotheses were calculated. The SEM results are shown in Figure 2.

The hypotheses about the direct, mediating, and moderating relationships were examined separately. Research uncovered a significant and positive relationship between SSQAs and SSCP, with a beta coefficient of 0.249 and a p -value of less than 0.001. EnvP ($=0.180$, $p < 0.01$), ECP ($=0.370$, $p < 0.01$), and SP ($=0.182$, $p < 0.01$) are significantly positively correlated with SSCP. The relationship between BT and SSCP is found to be statistically significant, with a positive association. The path coefficient value (β) is estimated to be 0.057, and the p -value is less than 0.01. The findings provide support for all the hypotheses regarding direct relationships, as evidenced by the data presented in Table 5.

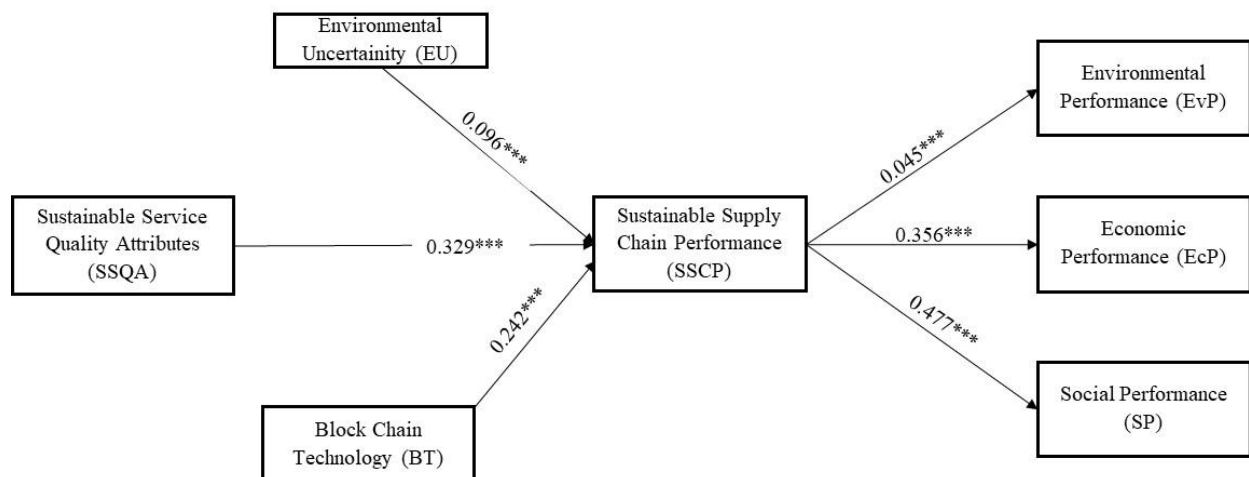


Figure 2. Structural equation modeling. Note: *** $p < 0.001$.

Table 5. Direct path effect coefficients.

Hypothesis	Structural Relationships	Coefficient (β)	Standard Error	t Statistics	p-Value
H1	SSQAs $\rightarrow$ SSCP	0.329 ***	0.054	2.849	0.000
H2	SSCP $\rightarrow$ EnvP	0.045 ***	0.078	2.366	0.000
H3	SSCP $\rightarrow$ EcoP	0.356 ***	0.064	5.568	0.000
H4	SSCP $\rightarrow$ SP	0.477 ***	0.079	6.002	0.000
H5	BT $\rightarrow$ SSCP	0.242 ***	0.045	5.399	0.000

Note: *** $p < 0.001$.

After evaluating direct hypotheses, indirect links were investigated. The study found that SSCP mediates the connection between SSQAs and EnvP ($\beta = 0.049$, $t = 2.85$). SSCP mediates ($\beta = 0.38$, $t = 3.085$) the link between SSQAs and ECP. Additionally, SSCP mediates the association between SSQAs and SP ($\beta = 0.128$, $t = 2.35$). The findings confirm hypothesis 6 (a,b,c) that SSCP mediates TBL. SSCP mediates relationships between BT and TBL, with $\beta = 0.135$ and $t = 2.391$ for BT-EnvP; $\beta = 0.271$ and $t = 3.318$ for BT-ECP; and $\beta = 0.095$ and $t = 2.717$ for BT-SP. The results are in Table 6.

Table 6. Direct and indirect path effect coefficients.

Hypothesis	Direct Effect	Indirect Effect	Results
SSQAs $\rightarrow$ SSCP $\rightarrow$ EnvP	0.069 ***	0.074 ***	Supported
SSQAs $\rightarrow$ SSCP $\rightarrow$ EcoP	0.189 ***	0.142 ***	Supported
SSQAs $\rightarrow$ SSCP $\rightarrow$ SP	0.199 ***	0.202 ***	Supported
BT $\rightarrow$ SSCP $\rightarrow$ EnvP	0.008 ***	0.009 ***	Supported
BT $\rightarrow$ SSCP $\rightarrow$ EcoP	0.427 ***	0.446 ***	Supported
BT $\rightarrow$ SSCP $\rightarrow$ SP	0.318 ***	0.403 ***	Supported

Note: *** $p < 0.001$.

5.3. Moderation Results

H8 stated the moderation effect of BT on SSQAs and SSCP, and the results revealed that when the SSQAs are low with higher levels of BT, there is no significant change in SSCP. However, with high SSQAs, BT strengthens the relationship and enhances the SSCP, indicating that BT strengthens the relationship. H9 stated the moderating role of EU in relationships between SSQAs and SSCP, and the results revealed that when the SSQAs are low with higher levels of EU, there is no significant change in SSCP. However, with high SSQAs, EU strengthens the relationship and enhances the SSCP, indicating that EU strengthens the relationship. The higher levels of EU make the firm design strong

relationships with the supply chain to enhance performance. The moderation results are shown in Figures 3 and 4.

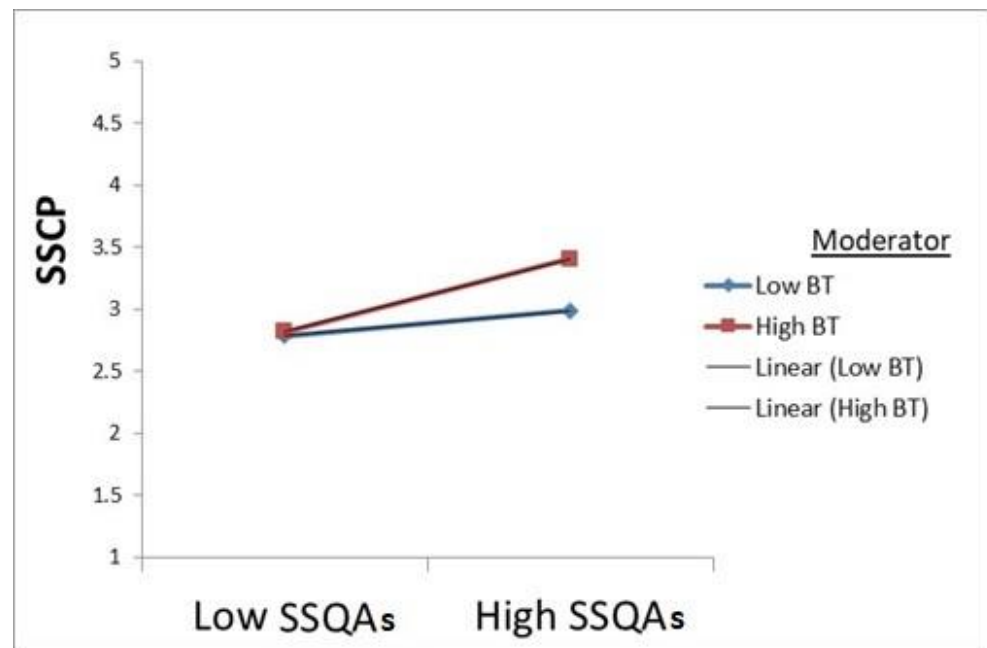


Figure 3. Moderation effects of BT.

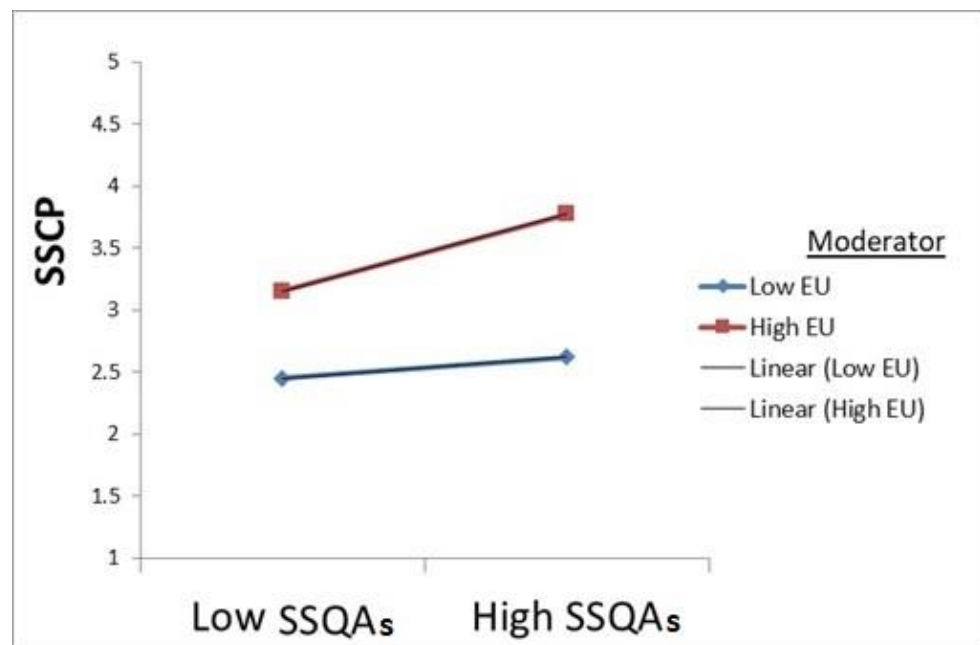


Figure 4. Moderation effects of EU.

6. Discussion and Implications of the Study

The world faces challenges from high carbon emissions and energy waste; achieving sustainability from TBL perspectives has become inevitable for businesses. The first hypothesis stated that SSQAs significantly impact the SSCP, and the results supported this hypothesis. The results indicated that firms were developing the ability to keep promises and, without failure, deliver green services. Further, they respond rapidly to the customer using green practices and maintain an adequate eco-friendly fleet of vehicles. They bring changes into the processes, keeping sustainability as the prime objective and following

the system of coordination and integration with all supply chain partners. They also develop an understanding to build strong trust among the supply chain partners, utilize the resources, and have an orientation to use renewable resources. This is why logistics service firms successfully achieve sustainable supply chain performance. As a result, these firms become more vigilant in responding to the risk emerging from the supply chain networks, substantially reduce the volume of waste, and become more efficient in fulfilling the customers' demands [119]. These findings are aligned with Rajesh (2022) [58], who mentioned that sustainable supply chain performance could not be achieved without introducing sustainable attributes and indicators in the business model, and implementing sustainable practices enhances the sustainable performance of the business. Moreover, the service quality of the LSPs in cross-border commerce activities cannot be achieved without following green practices that ultimately make the customer more satisfied and build a stronger and more reliable bond between the supply chain partners [59].

Next, it was stated that SSCP has a substantial relationship with TBL. The results revealed that logistics firms are developing visibility of their supply chain, having a proper mechanism of controlling their supply chain cost, significantly reducing the amount of waste, and developing an ability to cater to customers' orders promptly. Supply chains that are environmentally responsible and employ lean inventory management strategies tend to excel in the triple bottom line [120]. Such firms improve controls over pollution, prioritize cleaner production, increase their market share and revenue, improve the social image of the firm, and ensure the development of mechanisms related to the health and safety of the employees and other stakeholders. These findings match past studies that concluded that an SSC is a valuable resource for firms and helps develop triple bottom line performance indicators [63]. Moreover, investments made for sustainability help the business achieve its micro- and macro-level financial objectives more efficiently and create a win-win-win situation for all the stakeholders for their concerns about the economic, social, and environmental benefits resulting from the supply chain activities [65]. The above-mentioned findings answer our first and second research questions and prove that SSQAs are associated with SSCP and TBL performance practices.

The next direct hypothesis stated that blockchain technology has a significant relationship with SSCP. The results highlighted that the logistics firms implementing blockchain technology provide visibility and the traceability of the business processes in an extended format, create a smart contract with the supply chain partners, use it to improve customer services and make them sustainable, and improve the processes and the structure of the organization, and improve the overall performance of the supply chain. BT helps firms to reduce their supply chain costs properly, adhere to environment-related requirements more efficiently, and meet the expectations of the internal and external stakeholders of the supply chain. More importantly, it helps firms in tracking and reducing carbon emissions and reducing energy waste in the supply chain. Past studies also concluded similar findings and stated that implementing BT supports the supply chain partners in designing and producing environment-friendly offerings [75]. Similarly, Chod et al. (2020) [76] indicated that BT is an essential tool to reach cost efficiency and make the supply chain more transparent.

The findings of the first indirect hypothesis stated that SSCP mediates the relationship between SSQAs and TBL. The results revealed that logistics firms could deliver goods using sustainable approaches, equipped with a trained workforce to follow green warehouse practices and implement green practices. IT support for promoting green practices includes the capability to modify and update the processes and align them with green objectives, develop dynamic supply chain networks, and have a visibility of all these capabilities in the supply chain to develop the mutual understanding of using these abilities to achieve sustainable performance. This sustainable performance is displayed as a reduction in costs, sustainable value delivery to the customers, disclosure of information and making it public, designing environmentally friendly services, and developing green practices and competencies. The results stress that achieving TBL, SSQAs, and SSCP are necessary and complement each other. The next indirect hypothesis stated that SSCP mediates between

BT and TBL, and the results indicate that BT positively enhances the SSCP. Then, SSCP positively affects the logistics firms' economic, social, and environmental performance. These findings match the past studies of Hussein Ali, Gruchmann, and Melkonyan (2022) [32]. The researchers concluded that LSPs evaluate the quality of their services as they strive for sustainable performance, and they also noted that GSCM mediates the connection between logistical service quality and relationship performance. Similarly, BT also facilitates meeting the demands and expectations of the customers more efficiently. It enhances the satisfaction of the customers [99] and increases the confidence level due to trust built after the implementation of BT [100].

The results of the influencing role of BT in the relationship between SSQAs and SSCP concluded that when BT is not implemented, the SSQAs do not bring significant changes in the SSCP of the logistics firms. However, when the BT is implemented, it strengthens the relationship and increases SSQAs, leading to enhanced SSCP. The results indicate that visibility and traceability, improved customer services, updated process structures, and efficiency achieved through BT implementation significantly enhance the effects of SSQAs and thus increase the SSCP. Huang et al. (2022) [106] additionally determined that BT has a significant role in the enhancement of technical capabilities and technological feasibility, as well as serving as a crucial catalyst for the advancement of circular supply chain management. The findings of this study indicate that environmental uncertainty plays a moderating effect in the relationship between SSQAs and SSCP, particularly in situations of low environmental uncertainty.

Nevertheless, under high levels of EU, SSQAs significantly improve the SSCP. The findings highlighted that when customer orders change abruptly, the suppliers' performance and the competitors' actions are unpredictable. Rapid technological changes have caused firms to concentrate more on developing SSQAs, which has a multiplied effect on supply chain performance. The findings match the previous study, which concluded that the EU is a vital contingent element that can strengthen SC partners' performance if managed properly [24]. These findings answer our third research question and provide evidence that environmental uncertainty and implementing blockchain technology stimulate SSCP in service organizations.

6.1. Theoretical Implications

The current study makes theoretical contributions of several types. The major contribution is the theoretical framework this study has proposed to achieve the performance indicators of TBL in the SME sector related to logistics firms. The study has empirically proven that SSQAs are significant predictors of SSCP, and this helps the firms achieve the TBL performance objectives. This study also makes significant contributions by extending the literature on the dynamic capability view by taking SSQAs as a dynamic capability in the logistics SMEs in Pakistan. By addressing the environmental and energy-minimizing concerns, the current study also contributes towards the sustainable development goals (SDGs) related to climate action, responsible production, and consumption presented by the United Nations. Therefore, the framework proposed by the study is a strategic model that facilitates logistics firms to develop and deliver sustainable services to achieve sustainable performance. Similarly, by incorporating and integrating the contingency theory, this study further enhances the literature on sustainable supply chain performance and provides evidence. Moreover, this study is the first of its kind in the field of logistics SMEs in Pakistan. The proposed framework is instrumental for businesses to become sustainable, achieve higher economic growth, meet societal expectations, and reduce negative environmental impacts.

6.2. Managerial Implications

This study's significant practical and managerial implications are drawn from the empirical results. The findings show that to achieve the TBL, managers must ensure that they transform their services and develop them by embedding sustainable service

quality attributes. The managers must ensure that their workforce is trained and equipped with environmental knowledge, they have alternative and renewable energy resources, make their warehouses green for the customers, transform their services and work to become paperless, and develop coordination among the supply chain partners for achieving sustainable practice goals. All these abilities facilitate the achievement of TBL objectives. In addition, the managers should also focus on implementing blockchain technology in their organizations, as it can help them bring transparency and traceability to the supply chain to achieve SSCP. The managers should also be vigilant about the external environments and be ready to deal with them by introducing more sustainable attributes in their services to mitigate the effects of environmental uncertainties.

7. Conclusions

In resource-scarce economies, sustainable service quality attributes have become necessary [101]. Past studies have used order quality, timeliness delivery, IT capabilities, etc., as the service quality attributes. This research has studied the impact of sustainable service quality attributes developed by the logistics SMEs in Pakistan on triple bottom line (TBL) sustainability performance indicators through the intervention of sustainable supply chain performance. The study also examined the moderating role of BT and environmental uncertainty. The findings confirmed the benefits of sustainable service quality attributes on the logistics firms' economic, social, and environmental performance. The findings also mentioned that implementing blockchain technology significantly influences SSCP. Similarly, environmental uncertainty also has an influencing role in strengthening the relationship between SSQAs and SSCP. The findings benefit managers and help them design sustainable service quality attributes that increase SSCP. The findings conclude that sustainable service quality attributes substantially contribute to achieving SSCP and lead the businesses to meet their triple bottom line performance objective.

8. Future Research Directions and Limitations

The research conducted in this study is subject to some limitations. The present study employed a unidimensional scale to measure the qualities of sustainable service quality. Five elements of it have been identified by scholars, which include commitment, competence, creativity and customization, communication, coordination, and teamwork. Future studies can use the multidimensional scale of SSQAs for better understanding. Second, this study collected data from the logistics company managers to estimate the study's variables. Future studies should collect customer data to know their points of view about SSQAs and other variables. Scholars aiming to replicate the current study could conduct the multi-group analysis to understand which logistics firms' homogeneous industry SSQAs facilitate a higher TBL. Subsequent research endeavors may incorporate additional factors such as big data analytics, artificial intelligence, circular economy, and smart technologies to augment the efficiency of sustainable service quality attributes concerning sustainable supply chains and the environment.

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Appendix A

Variable	Items	Source
Sustainable Service Quality Attributes	Ability to perform the promised green services without failure Ability to respond faster to customers by making use of green practices Ability to deliver goods through sustainable means Adequate number of CNG or eco-friendly fleet and green warehouses available to the logistics provider Equipped with an adequate number of trained personnel for adoption and implementation of green practices Ability to optimize distribution network for sustainability Ability to handle volume business of customers effectively Optimize the cost to be paid to LSPs for their green services Equipped with the adequate IT support for promoting use of green initiatives Frequency, quality, and accuracy of the content provided to the customer Ability to response to customer order/queries/complaints efficiently Ability to make sustainable changes in processes as per customer requirements Serving customers with creative and customized services in sustainable manner Adoption of technological options for encouraging digital processes (paperless) Coordinating and integrating sustainable practices among all supply chain partners Understanding and mutual trust among supply chain partners for successful operations Ability to optimize the available scarce resources and more utilization of renewable resources	[5]
Sustainable Supply Chain Performance	Our organization has visibility of supply chain dynamics in the network Risks in the supply network are managed proactively by our organization Our organization has proper control on supply chain costs Wastages in our supply chain network have been reduced significantly Our organization's primary supply chain has the ability to supply final customers with timely complete orders Our organization has the ability to adhere to environmental standards as per customer requirement Our organization has minimized buffer stocks at all levels throughout the supply chain Our organization's supply chain has the ability to respond faster than competitors in a volatile business environment	[121]
Environmental Performance	The firm's environmental sustainability measures improve pollution control The firm prioritizes cleaner production The firm strives for eco-efficiency to aid environmental performance The firm develops green competencies to manage its environmental impact	[53]
Economic Performance	The firm is experiencing increased market share The firm's net revenue has increased The firm has experienced sustainable product cost reduction The firm provides sustainable value to the consumer	[53]
Social Performance	The social image of the firm has been enhanced The firm has increased employee training in eco-innovation and sustainability The firm is more forthcoming with information disclosure to the public The firm ensures health and safety at work	[53]
Block Chain Technology	Blockchain technology provides extended visibility and traceability Blockchain technology improves customer service Blockchain technoogy improves organizational structure and processes Blockchain technology is efficient and helps to create smart contracts	[17]
Environmental Uncertainty	Our customers often change their order over the month Our suppliers' performance is unpredictable Competitors' actions regarding marketing promotions are unpredictable Our plant uses core production technologies that often change	[115]

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