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RESEARCH ARTICLE

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Blockchain technology enabled critical success factors for supply chain resilience and sustainability

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Abstract

Increasing complexity and the involvement of additional stakeholders make it impossible to predict the impact of each decision, which puts supply chain managers in uncertain situations. However, a supply chain that can adapt and react to the current scenario gives them some control over these ambiguous circumstances. These characteristics of sensing disturbances or threats and giving appropriate responses can be improved with the implementation of blockchain-enabled technologies and can prove critical to the success of supply chain resilience and sustainability. This study has identified 21 blockchain technology-enabled critical success factors for supply chain resilience and sustainability and grey theory is used to address the limitation of data availability. This study incorporates the combination of the Grey-DEMATEL (Decision Making Trial and Evaluation Laboratory) method to investigate the impact of critical success factors and to obtain the cause/effect relationship. Sensitivity analysis is performed to assess the robustness of obtained results. The findings indicate that internal integration is the most crucial causal factor, as it initiates the effects of many other critical success factors. Whereas Standardized Data Management, followed by Smart Ordering tops the effect group. As blockchain technology is still in its early stages of development, this study will encourage researchers and industry practitioners to strive for greater efficiency and effectiveness in their supply chain practices and to enhance the resilience and sustainability of their supply chains.

KEYWORDS
blockchain technology, standardized data management, supply chain resilience, sustainability

1 | INTRODUCTION

The processes of the supply chain have evolved with the technology to facilitate and minimize the distance between consumer and manufacturer. For instance, business transactions started from simple trust-based agreements, with days or even months of execution time, to banking systems that take only a few moments. However, despite these evolutions, in the last few years, supply chains have experienced major disruptions. These disruptions have challenged the supply chain stake holders as well as governments all around the world. For instance, COVID-19 has caused a slowdown in supply chain operations all around the globe, and after that, the Russia-Ukraine conflict adds more complications to the logistics (Ambrogio et al., 2022).

Abbreviations: AT, AssetsTracking (such as resources and products); BDO, BT-enabledDaily Operations; BT, BlockchainTechnology; CI, CustomerIntegration; CSF, CriticalSuccess Factor; CSFs, CriticalSuccess Factors; DEMATEL, Decision MakingTrial and Evaluation Laboratory; EFT, EfficientFinancial Transactions; EIC, Efficient Intra-Organizational Communication; EL, EfficientLogistics (Verification and Validation); IM, InventoryManagement; IN, InternalIntegration; INV, Invoicing (validation and approval); IRM, Initial RelationshipMatrix; ISP, Integrationof Strategic Partners; MPV, ManufacturingParameter Validation; OA, OrganizationalArchive for sensitive data/designs/plans; QDF, Quality datafor Forecasting and Analytics; RMS, Revenuemanagement system for the employee; SC, SmartContract; SCRS, SupplyChain Resilience and Sustainability; SD, StandardizedData Management; SDM, StandardizedDocument Management; SI, SupplierIntegration; SO, SmartOrdering; SOG, Structured Operating guidelines/parameters; SRV, Supplierand Raw material Verification; T_R, Total Relation Matrix; T_V, ThresholdValue.

These are a few examples of many global and local level disruptions that occurred in supply chains throughout the world. To address and mitigate the difficulties brought on by these disruptions, many researchers have examined the supply chains from the perspectives of resilience and sustainability (Negri et al., 2021). Although there has been a significant amount of study on sustainability and resilience separately in the literature, empirical data indicate that the two concepts are interconnected and by improving resilience sustainability will also get enhanced (Fahimnia et al., 2019; Negri et al., 2021).

Firms always desire a responsive and sustainable supply chain capable of recovery from disruptions; thus, they persistently search for technologies that help to convalesce Supply Chain Resilience and Sustainability (SCRS). SCRS refers to the characteristics such as adaptability to change and readiness to recover from disruptions and unexpected events in a way, which is sustainable. It makes supply chains able to continue operating even in the face of unforeseen disruptions by promptly recognizing and mitigating their effects, locating alternate sources of supply, enhancing the utilization of resources, and adapting to changes in demand. SCRS reduces the likelihood that supply chains will be disrupted by events like natural disasters, political unrest, and economic downturns, ensuring company continuity. In addition, governments are also implementing more regulations to make sure businesses function sustainability and firms can escape legal repercussions and guarantee adherence to environmental and social standards by implementing SCRS practices. With the increasing complexity and involvement of numerous parties in supply chains, it has become imperative for stakeholders to possess qualities such as transparency, traceability, security, resilience, and sustainability in order to tackle the challenges arising from the daily surge in demand. In addition, the supply chain processes need a simple, efficient, and secure environment to conduct various business transactions with efficient and correct information flow to maintain resilience and sustainability (Sawyerr & Harrison, 2020).

Supply chains throughout the globe are facing major disruptions due to the inefficiency of existing technologies in these challenging times. The need for the adoption of new technology is at its peak as the current political, economic, and social landscape is more challenging than ever. This non-stop disruption over the last few years has resulted in inefficiency, ineffectiveness, poor customer satisfaction, long delivery delays, and a decrease in revenues and sales (Zhu et al., 2020). For firms, it is critical to realize that these challenges related to end-to-end visibility and communication, if left unresolved would reduce the resilience and sustainability of the supply chain. Amid the calls for the mitigation of these challenges, Blockchain Technology (BT) is emerging as a possible solution. The BT is purposefully created as a distributed ledger technology to be extremely resistant to fraud and alteration. To digitally timestamp electronic documents and prevent manipulation, Stuart Haber and W Scott Stornetta first proposed the concept of a cryptographically secured chain of blocks in 1991. The creator(s) working under the alias Satoshi Nakamoto then released a white paper outlining the design for a blockchain. However, it became more well-known in recent years when it was incorporated with Blockchain technology to preserve transactions of the digital currency known as "Bitcoin." Every transaction in this ledger is authorized by the owner's digital signature, which also protects it from tampering and authenticates the transaction. As a result, the data in the digital ledger is quite safe. Bitcoin is not like traditional currency it is "mined" and not printed. This application of BT (Bitcoin) has gained popularity as it is cost-effective (works without intermediaries), more efficient, and more secure than other alternatives. The key advantages of using BT include its decentralized nature, anonymity, transparency, democratization, immutability, auditability, fault tolerance, and security (Alkhudary et al., 2022; Bhutta et al., 2021).

The strengths of BT can be used to ensure the stability and readiness of the supply chain and make it more adaptable to market needs/fluctuations. Features like decentralization, transparency, immutability, auditability, etc. are being used to support the functions of SCRS and can be proved critical to the success of a supply chain (Sawyerr & Harrison, 2020).

BT can be applied in a variety of processes to improve the sustainability and resilience of the supply chain (Figure 1). For instance, allowing end-to-end traceability of products, materials, and transactions enables all supply chain participants to confirm the products' origin, authenticity, and quality. In order to confirm that a product was made sustainably and ethically, its path from raw materials to final delivery can be traced. Utilizing smart contracts can decrease the need for intermediaries and improve supply chain effectiveness. In addition, the transparent and unchangeable record of all transactions facilitates the identification of supply chain inefficiencies and possible bottlenecks, as well as can help cut down on waste and better resource allocation. BT can also be used to monitor a product's carbon impact throughout the entire supply chain. This makes it possible for businesses to find ways to lower their carbon emissions and carbon footprint and to take part in initiatives that reduce carbon emissions.

Industries are in the process of thoroughly examining the various BT-enabled applications and implementing them in the places, and to enhance the resilience and sustainability of the supply chain. BT is now being used by organizations such as UbiMS to secure their data, intellectual property management, smooth and secure flow of information, enhance the efficiency of logistics, etc. (Tijan et al., 2019). Despite the potential that BT provides for the SCRS discipline, it has gotten a very small amount of attention in the SCRS literature and there have not been many studies published that exclusively address BT for SCRS (Cole et al., 2019). As the BT is still in its early stages of development, there is little information on the crucial success elements specific to the BT for the SCRS. By giving an overview of blockchain technology to the SCRS audience, examining the effects, and examining the connections between BT-enabled critical success factors for SCRS, this study intends to fill this research gap. The study discussed the following Research Questions (RQs):

RQ 1. What are the BT-enabled critical success factors for supply chain resilience and sustainability?

RQ 2. How different CSFs can be correlated and categorized for supply chain resilience and sustainability?

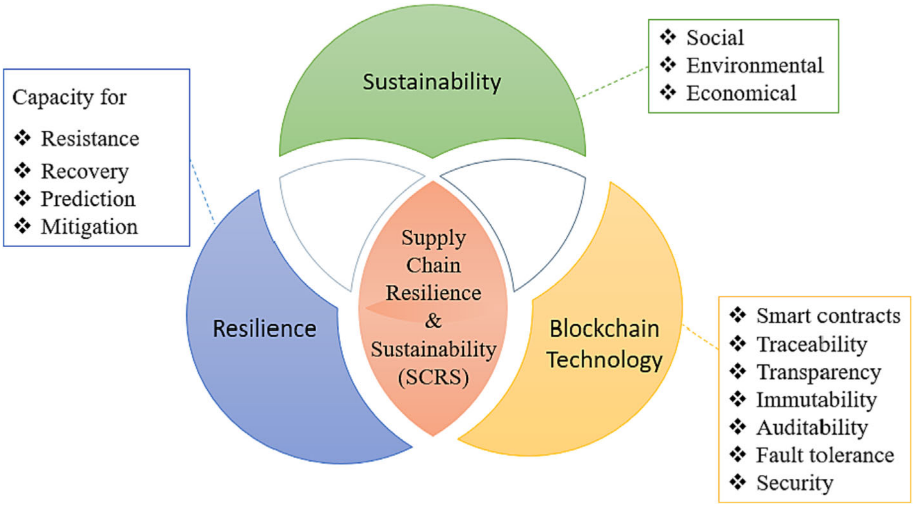

FIGURE 1 Resilience, sustainability, and blockchain technology.

RQ 3. In what priority, do these BT-enabled CSFs need to be implemented to enhance the resilience and sustainability of the supply chain?

The remaining portion of the study is provided as follows: The literature review is presented in section 2, and the methodology and the applications of the proposed model are covered in section 3. Results and discussion are presented in section 4 along with sensitivity analysis and managerial implications. The conclusion of the study and its limitations is presented in Section 5.

2 | LITERATURE REVIEW

Resilience and sustainability are critical for supply networks; however, while there has been substantial research on sustainability and resilience separately in the literature, empirical evidence shows that the two concepts are interconnected (Fahimnia et al., 2019; Singh et al., 2023). The previous contribution and research gaps of the key literature are presented in Table 1. In addition, the available literature is discussed in the context of SCRS, the integration of BT for SCRS.

2.1 | Supply chain resilience and sustainability (SCRS)

Resilience refers to the capacity for resistance and recovery from unanticipated disturbances making a supply chain act in a way that is both resourceful and prompt, bringing things back to normal, or better (Bayramova et al., 2021). On the other hand, sustainability refers to a system's capacity to satisfy present needs without endangering the ability of future generations to do the same. Sustainability entails the long-term, equitable maintenance of ecological, social, and economic processes (Ivanov, 2018). The relation between resilience and sustainability is that resilience is a necessary condition for sustainability. A system that is not resilient cannot be sustainable, as it will not be able to withstand the various shocks and stressors that it will face over time. In contrast, a resilient system is more likely to be sustainable, as it can adapt to changing conditions and maintain its essential functions and structures (Al Azmi et al., 2022). Moreover, sustainability can enhance resilience by promoting the development of more robust and diversified systems that are better able to cope with uncertainties and disruptions.

Supply chain disruptions can result from a variety of factors, including internal problems and external ones, affecting the SCRS. Internal problems may include machine failure due to improper inspection and maintenance, improper or inadequate integration between various departments, etc., whereas external problems may rise due to situations like natural disasters or accidents. These incidents typically happen quickly and without warning. In many supply chains, external supplier operations result in logistical activities like the provision of raw materials, component assembly, production, and product flaws. A corporation must build the logistics, procedures, and capabilities that enable quick and effective reactions as supply chain disruptions occur. This also boosts the organization's ability to carry out routine commercial operations (Kaviani et al., 2020). The research shows that collaboration with partners in the supply chain is essential during disruptions because it promotes visibility, awareness, and decision-making in the face of challenges. It is possible to conclude that supply chains can benefit from resilience and sustainable practices.

2.2 | Integration of blockchain technology (BT) for SCRS

According to the research that has been done so far, the implementation of BT may show to be one of the most important factors in the achievement of resilience and sustainability goals. Researchers conducted a bibliometric analysis, a systematic literature review, and a text mining approach, focusing mostly on publications over the last 20 years, to investigate the possible impact that BT could have on the

TABLE 1 Key literature review.

S.N.	Aims	Methodology	Results	Research gaps	Reference
1	To discuss the ways to enhance supply chain resilience using BCT	Literature review-based study	Features like efficient transactions, asset tracking, etc can improve the resilience	Theory-based study	(Min, 2019)
2	To develop a blockchain adoption model for supply chains	Survey and structural equation modeling	Technology adoption model for blockchain	Based on certain assumptions	(S. Kamble et al., 2019)
3	Analysis of continuance intention in blockchain-enabled supply chain	Expectation-confirmation model (ECM)	Application of extended version of ECM	The study considered only stake holder trust	(Fosso Wamba, 2019)
4	Analyze the influence of BCT on supply chain resilience.	An agent-based simulation study	Smart contracts and collaborations with time-efficient processes can improve the resilience of a supply chain	Theory-based study	(Lohmer et al., 2020)
5	Blockchain's effects on supply chain efficiency	The survey-based technology adoption model	Performance can be improved with blockchain technology	More variables can be included	(Fosso Wamba et al., 2020)
6	To identify the impact of blockchain solutions on supply chain resilience	Literature review	Blockchain technology has a positive impact	Theory-based study	(Bayramova et al., 2021)
7	To investigate the effects of blockchain on sustainable supply chain practices	Partial least squares structural equation modeling (PLS-SEM)	Blockchain technology along with green information systems has a positive influence on sustainable practices	The impact of individual behavioral barriers needs to be investigated	(Khan et al., 2021)
8	Readiness assessment of block chain technology implementation	The fuzzy best–worst method	Readiness assessment and management approach for blockchain implementation is presented	The proposed study depends on the expert's knowledge	(Irannezhad et al., 2021)
9	Investigation of the relationship between BCT and sustainable supply chain performance	Survey-based statistical analysis	Discovering that the performance of the sustainable supply chain is positively impacted by blockchain technology.	Based on specific sectors can be more generalized	(S. S. Kamble et al., 2021)
10	To study the role of blockchain implementation challenges in supply chain sustainability	The bayesian best worst method	Interconnection of barriers and the priority of each element is given	Results are not experimentally tested	(Liu et al., 2021)
11	To develop a framework for blockchain adoption in the supply chain	Diffusion of innovation (DOI) theory and DEMATEL	The relative advantage of the technology and the external pressure are the most prominent enablers	Respondents are from a specific region	(Agi & Jha, 2022)
12	Investigation of performance improvement, because of blockchain implementation.	The fuzzy data envelopment analysis model	The performance of the mineral supply chain may be significantly impacted by blockchain technology.	Specific industry-based study	(Yousefi & Mohamadpour Tosarkani, 2022)

performance of supply chains. They made the point that BT has the potential to play an important part in ensuring the reliability of supply chains, fostering trust, and safeguarding intellectual property (Fosso Wamba et al., 2020; Ghadge et al., 2020; Rejeb et al., 2021; Xu et al., 2020). Implementation of BT-enabled technologies in supply chains is also broadly discussed by researchers and traceability, transparency, stakeholder involvement, and collaboration along with supply chain integration and digitalization termed as the major factors (Bär et al., 2018; Chang & Chen, 2020; Sobb et al., 2020). Researchers have also explored the different attributes and adoption factors of BT-enabled technology such as transparency, information immutability, smart contracts, technology readiness, traceability, flexibility, real-time information sharing, and security of the data capabilities. They have pointed out that BT-enabled technologies are emerging as important game changers for SCRS (Callinan, 2022; Kamble et al., 2019; Kim & Shin, 2019; Meidute-Kavaliauskiene et al., 2021).

The integration of BT is increasing to support the resilience and sustainability characteristics in the supply chain, according to several surveys on BT adoption; more than 60% of businesses have already deployed or are in the process of implementing blockchain technology (Min, 2019). Researchers have analyzed the effect of BT on SCRS considering different aspects and methodology. For instance, the effect of BT on supply chain resilience is analyzed by Lohmer et al. (2020), through a simulation-based study, and the importance of smart contracts to improve resilience and sustainability is explained by Yousefi and Mohamadpour Tosarkani (2022). The importance of transparency and disintermediation properties of BT and its strong effect on supply chain performance is discussed by Li et al. (2021). The use case of BT for healthcare, food, and logistics in the supply chain is discussed by Kouhizadeh et al. (2021), and they suggested that transparency, traceability, and improved efficiency can help organizations to increase their profits significantly. It further becomes imperative for firms that are aiming for the digital transformation of their supply chains to adopt this (Rana & Daultani, 2022). Figure 1 shows the relationship between supply chain resilience, sustainability, and BT.

3 | METHODOLOGY

The Grey System idea was conceptualized for the first time in 1982 and used for systems that are lacking information, such as structure messages, operation mechanisms, and behavior documents. In most cases, one can determine which Grey System they are dealing with based on the existing grey relations, grey elements, and grey numbers (which are denoted by $\otimes$). The term "grey" refers to things that are lacking, incomplete, uncertain, etc. (Julong, 1989). When used in conjunction with the DEMATEL approach, the grey systems theory facilitates a thorough study of the linguistic data gathered from respondents. It reduces information loss and captures the core of judgments (Prashar & Aggarwal, 2020). The method has been applied to a wide range of domains such as to understand the cause/effect relation of barriers in the agriculture supply chain by S. Yadav and Singh (2020), and Kouhizadeh et al. (2021) use it to do a detailed examination of the factors that influence and facilitate the adoption of blockchain technology. The combination of grey and DEMATEL methods is successfully applied by Agi and Jha (2022), who used it to create the BT adoption framework for supply chains, and Gupta and Barua (2018), to model the factors that encourage green innovation in manufacturing organizations. DEMATEL is one of the best approaches for analyzing cause/effect relationships in complicated models, which is one of the main benefits of utilizing this approach, however, it fails to comprehend the uncertain situations or lack of information (Gupta & Barua, 2018). Thus, the grey approach is combined with DEMATEL to address this issue. The Grey approach works well with limited data under vagueness. In addition, the successful application of the grey DEMATEL method in various fields of supply chain makes it a suitable approach for the proposed study.

Applications of BT can be included in the supply chain to improve its resilience and recovery capacities as well as make it sustainable and prepared for unforeseen obstacles. The considered supply chain includes suppliers, manufacturers, logistics (inbound and outbound), and customers, to have a better grasp of SCRS. The literature review is carried out with the aforementioned components of the supply chain in mind, and the identified BT-enabled Critical Success Factors (CSF) for SCRS are sorted into four categories. 1. Manufacturer, 2 suppliers, 3. Logistics, and 4. Customers. The specification of experts is given in Table 2.

A questionnaire is circulated and 230 responses are received out of that 205 are selected for screening criteria. To identify the interrelations among BT-enabled CSFs for SCRS a panel of 4 members is selected and the Delphi technique is employed. The responses are collected and analyzed after every round and a summary is presented to experts. The process continued until a consensus is reached among experts. The proposed research framework to examine the causal relationship among BT-enabled CSFs for SCRS is shown in Figure 2.

Twenty-one BT-enabled Critical Success Factors (CSF) for SCRS are identified and presented in Table 3. These factors have been discussed by many researchers in a wide range of applications. As smart contract concerning BT and BT-enabled integration of the supply chain to enhance visibility, trust, and resilience is widely considered and discussed by most researchers (Bayramova et al., 2021; S. S. Kamble et al., 2021; Khanfar et al., 2021; Kim & Shin, 2019; Li et al., 2021).

TABLE 2 Specification of experts.

Respondents types	For screening criteria	Average work experience (years)	To identify the interrelations	Average work experience (years)
Industry expert	30	5.5	3	8
Academicians	80	6.0	1	12
Research scholar	95	2.0	-	-

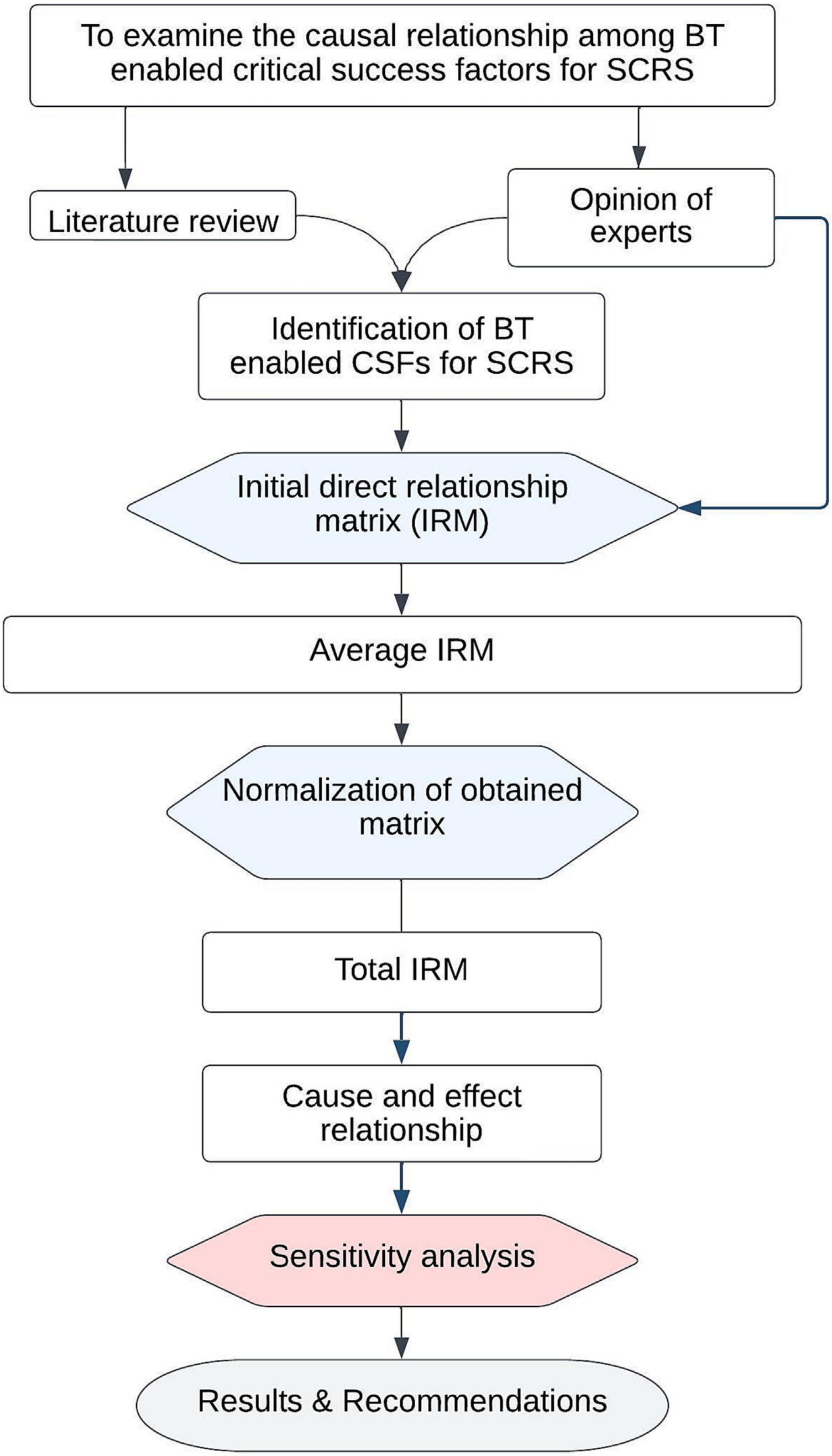

FIGURE 2 Proposed research framework.

3.1 | Steps of the Grey-DEMATEL approach

The procedure for the grey DEMATEL method is broken down into the following steps, which are detailed below:

Step 1- Development of Initial Relationship Matrix (IRM)

The initial relationship matrix is formulated based on impact ratings from the respondents. The responses are collected based on

TABLE 3 BT-enabled critical success factors (CSF) for SCRS.

Group	Sl no	Critical success factors (CSF)	Description	References
Supplier	1	Smart contract (SC)	Digital contract management, execution, or verification. There is no requirement for intermediaries to complete the transactions because smart contracts function on the blockchain network, which handles every transaction in a contract. They offer a more efficient, affordable, and secure approach to managing and carrying out agreements.	(Khanfar et al., 2021; Kim & Shin, 2019; Lohmer et al., 2020; Yousefi & Mohamadpour Tosarkani, 2022)
	2	Internal integration (IN)	By combining serial numbers, bar codes, sensors, and digital tags, BT creates a unified and transparent platform that uses a distributed database to make it easier to regulate internal processes.	(Bayramova et al., 2021; S. S. Kamble et al., 2021; Li et al., 2021; Lohmer et al., 2020)
	3	Structured operating guidelines/ parameters (SOG)	The operational standards and parameters are made more understandable and accessible due to BT's assistance in standardizing document management.	(S. S. Kamble et al., 2021)
	4	Supplier integration (SI)	BT provides a replica of the network at every node, making data transparent to stakeholders. In this instance, all transactions are consensually based to promote openness and confidence.	(S. S. Kamble et al., 2021; Li et al., 2021)
Manufacturer	5	Inventory management (IM)	By logging any purchase order and providing a copy of the data available to the stockholders utilizing its distributed nature, BT makes inventory management inside SCs easier.	(S. S. Kamble et al., 2021; Lohmer et al., 2020)
	6	Supplier and raw material verification (SRV)	To lessen the likelihood of data manipulation and forgeries, BT logs every transaction and flow of data following confirmation in SCs and does not permit editing, tampering, or change.	(S. S. Kamble et al., 2021)
	7	BT-enabled daily operations (BDO)	Using data properties inherent in transactions, BT reduces needless stages in the settlement process and the requirement for clearance by outside organizations along with that it helps in streamlining the daily routine operations of the firm.	(S. S. Kamble et al., 2021; Min, 2019)
	8	Manufacturing parameter validation (MPV)	The BT can be used for production parameter validation because of its immutability.	(S. S. Kamble et al., 2021)
	9	Revenue management system for the employee (RMS)	Due to the secure and transparent nature of BT, it can be used for efficient revenue-sharing methods.	(S. S. Kamble et al., 2021)
	10	Quality data for forecasting and analytics (QDF)	BT ensures the quality of the data it offers by keeping a record of transaction history, ensuring the integrity of the information, and making every transaction transparent to all stakeholders.	(Kumar Bhardwaj et al., 2021)

(Continues)

TABLE 3 (Continued)

Group	Sl no	Critical success factors (CSF)	Description	References
	11	Organizational archive for sensitive data/designs/plans (OA)	The level of security in BT is the best, which is why it is the perfect option for storing sensitive data/designs/plans.	(Alazab et al., 2021)
Logistics	12	Standardized data management (SD)	BT creates an immutable audit log to capture the data transaction after verification in supply chains. To reduce the possibility of data being manipulated or falsified, BT also forbids modification or tampering.	(Kumar Bhardwaj et al., 2021)
	13	Efficient logistics (verification and validation) (EL)	The BT gives its approval to and provides support for transactions and document exchanges depending on the terms that parties have agreed upon. This helps with compliance with other rules as well as improving logistics processes by removing bottlenecks.	(S. S. Kamble et al., 2021; Min, 2019)
	14	Efficient intra-organizational communication (EIC)	BT facilitates more streamlined and automated communication between entities while maintaining the highest possible level of trust.	(S. S. Kamble et al., 2021; Lohmer et al., 2020)
	15	Integration of strategic partners (ISP)	The distributed nature of BT allows it to share the information flow regarding ongoing processes from the beginning to the end, giving the required supply chain entities on blockchain access to data free from bias and error.	(Bayramova et al., 2021; S. S. Kamble et al., 2021; Li et al., 2021; Lohmer et al., 2020)
	16	Invoicing (validation and approval) (INV)	By implementing a distributed system, BT lessens the possibility of late payments and ineffective asset management while speeding up the conclusion of the transaction process.	(Agi & Jha, 2022; Jiang et al., 2022)
	17	Assets tracking (such as resources and products) (AT)	Traceability of assets can be made easier by high-performance data records, distributed databases, and regulated user accesses.	(Bayramova et al., 2021; S. S. Kamble et al., 2021; Min, 2019)
Customers	18	Smart ordering (SO)	BT can help participants manage the orders more effectively by helping them keep track of data like pricing, dates, location, quality, certifications, and other important factors.	(Bayramova et al., 2021; S. S. Kamble et al., 2021)
	19	Efficient financial transactions (EFT)	BT uses smart contract-driven trade transactions to exchange assets in SCs, eliminating intermediaries and lowering transaction costs in the process.	(Agi & Jha, 2022; Jiang et al., 2022; Min, 2019)
	20	Standardized document management (SDM)	To keep the standard documents in good working order, standard tools, processes, and performance measure indicators are used.	(Agi & Jha, 2022; Kumar Bhardwaj et al., 2021)
	21	Customer integration (CI)	By keeping track of each purchase order and making a copy of the information accessible to stockholders due to its distributed nature, BT facilitates customer integration among SCs.	(Agi & Jha, 2022; S. S. Kamble et al., 2021; Li et al., 2021)

TABLE 4 Linguistic assessment and associated grey values.

Linguistic assessment	Intensity of impact	Associated grey values
No impact	0	(0.0,0.1)
Very low impact	1	(0.1,0.3)
Low impact	2	(0.2,0.5)
Moderate impact	3	(0.4,0.7)
High impact	4	(0.6,0.9)
Very high impact	5	(0.9,1.0)

the linguistic scale given in Table 4 and each respondent 'k' assessed the direct impact of factor 'm' over factor 'n'. Let us say 'i' represents the number of BT-enabled CSFs and 'j' is the selected number of respondents for the study. Thus, a total of 'j' initial relation matrices are constructed based on the impact parameters. The linguistic scale and associated grey values are presented in Table 4.

Step 2- Computation of Grey Matrix corresponding to each IRM

By specifying a higher and lower range of values as indicated in linguistic scale Table 4, the matching grey matrices are produced from the values acquired in step 1 (Gupta & Barua, 2018b; Julong, 1989).

$$\otimes G^k_{mn} = \otimes \geq \_G^k_{mn}, \overline{\otimes} G^k_{mn} \tag{1}$$

Where 1 ≤ k ≤ j; 1 ≤ m ≤ i; 1 ≤ n ≤ i.

The IRMs are modified into grey relation matrices as per the obtained grey values, i.e. $\left[\otimes G^1_{mn}\right], \left[\otimes G^2_{mn}\right], \ldots \ldots \ldots, \left[\otimes G^j_{mn}\right]$ (Rajesh & Ravi, 2015).

Step 3- Average Grey Relation Matrices

The computation of the average grey relation matrix $\left[\otimes G^l_{mn}\right]; k = 1 - j$ is performed using 'j' grey relation matrices,

$$\otimes \tilde{G}_{mn} = \left(\frac{\sum_k \underline{\otimes} G^k_{mn}}{j}, \frac{\sum_l \overline{\otimes} G^k_{mn}}{j}\right) \tag{2}$$

Step 4- Computation of crisp matrices from average grey matrices

By using a three-step, modified converting fuzzy values into crisp scores approach, the grey values are transformed into crisp values as follows (Julong, 1989; Rajesh & Ravi, 2015; Xia et al., 2015).

i. Grey value normalization

$$\underline{\otimes} \tilde{G}_{mn} = \left(\underline{\otimes} \tilde{G}_{mn} - \min_n \underline{\otimes} \tilde{G}_{mn}\right) / \Delta^{max}_{min} \tag{3}$$

Where $\underline{\otimes} \tilde{G}_{mn}$ represents the value of the normalized lower limit for the grey number $\otimes \tilde{G}_{mn}$

$$\overline{\otimes} \dot{G}_{mn} = \left(\overline{\otimes} \tilde{G}_{mn} - \min_n \overline{\otimes} \tilde{G}_{mn}\right) / \Delta^{max}_{min} \tag{4}$$

Where $\overline{\otimes} \dot{G}_{mn}$ represents the value of the normalized upper limit for the grey number $\otimes \tilde{G}_{mn}$, and

$$\Delta^{max}_{min} = \max_n \overline{\otimes} \tilde{G}_{mn} - \min_n \underline{\otimes} \tilde{G}_{mn} \tag{5}$$

ii. Computation of total normalized crisp value

$$z_{mn} = \left(\frac{\left(\underline{\otimes} G_{mn}\left(1 - \underline{\otimes} \dot{G}_{mn}\right) + \left(\overline{\otimes} \dot{G}_{mn} \times \overline{\otimes} \dot{G}_{mn}\right)\right)}{\left(1 - \underline{\otimes} \dot{G}_{mn} + \overline{\otimes} \dot{G}_{mn}\right)}\right) \tag{6}$$

iii. Calculation of the final crisp values

$$z^*_{mn} = \left(\min \underline{\otimes} \tilde{G}_{mn} + z_{mn} \times \Delta^{max}_{min}\right) \tag{7}$$

and,

$$Z = \left[z^*_{mn}\right] \tag{8}$$

Step 5- Computation of the normalized direct crisp matrix

By calculating B and multiplying the average relation matrix Z by B, the normalized direct crisp relation matrix, A, is created i.e.

$$B = \frac{1}{\max_{1 \leq m \leq i} \sum_n^i z^*_{mn}} \tag{9}$$

And

$$A = Z \times B \tag{10}$$

Each element of matrix A ranges from 0 to 1.

Step 6- Computation of total relation matrix T_R

$$T_R = A \times (I - A)^{-1} \tag{11}$$

Where I represent the identity matrix.

TABLE 5 Average grey relation matrix for BT-enabled CSFs for SCRS.

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
SC	0	0.25	0.35	0.45	0.175	0.45	0.325	0.125	0.15	0.4	0.3	0.45	0.475	0.225	0.45	0.4	0.2	0.3	0.4	0.35	0.35
	0.1	0.5	0.6	0.75	0.45	0.75	0.55	0.35	0.3	0.7	0.6	0.75	0.725	0.45	0.75	0.7	0.5	0.6	0.7	0.65	0.65
IN	0.2	0	0.3	0.1	0.25	0.125	0.7	0.075	0.25	0.15	0.2	0.2	0.075	0.7	0.125	0.1	0.1	0.25	0.15	0.35	0.175
	0.5	0.1	0.55	0.3	0.5	0.35	0.9	0.25	0.5	0.4	0.5	0.5	0.25	0.9	0.35	0.3	0.3	0.5	0.4	0.65	0.45
SOG	0	0.6	0	0.125	0.225	0.075	0.275	0.075	0.1	0.125	0.6	0.45	0.15	0.4	0.375	0.175	0.1	0.15	0.25	0.575	0.4
	0.1	0.9	0.1	0.35	0.45	0.25	0.55	0.25	0.25	0.35	0.9	0.75	0.35	0.7	0.65	0.45	0.3	0.4	0.5	0.825	0.7
SI	0.6	0.15	0.275	0	0.45	0.5	0.225	0.125	0.05	0.55	0.2	0.2	0.5	0.15	0.675	0.25	0.2	0.4	0.2	0.4	0.3
	0.8	0.35	0.55	0.1	0.75	0.8	0.45	0.35	0.2	0.85	0.5	0.5	0.8	0.4	0.925	0.55	0.5	0.7	0.5	0.7	0.6
IM	0.5	0.45	0.45	0.825	0	0.3	0.65	0.375	0.025	0.675	0.3	0.525	0.9	0.3	0.55	0.25	0.6	0.75	0.3	0.5	0.7
	0.8	0.75	0.75	0.975	0.1	0.6	0.85	0.65	0.15	0.925	0.6	0.775	1	0.6	0.85	0.55	0.9	0.95	0.6	0.8	0.9
SRV	0.45	0.45	0.35	0.75	0.525	0	0.325	0.325	0.025	0.325	0.2	0.35	0.2	0.3	0.325	0.3	0.1	0.25	0.1	0.45	0.45
	0.7	0.55	0.65	0.95	0.7	0.1	0.55	0.6	0.15	0.6	0.5	0.65	0.5	0.6	0.6	0.6	0.3	0.55	0.3	0.75	0.75
BDO	0.175	0.9	0.675	0.225	0.375	0.225	0	0.25	0.225	0.375	0.55	0.5	0.3	0.775	0.25	0.25	0.35	0.475	0.5	0.55	0.6
	0.4	1	0.925	0.45	0.625	0.45	0.1	0.5	0.5	0.625	0.85	0.8	0.6	0.925	0.55	0.55	0.65	0.75	0.8	0.85	0.9
MPV	0.1	0.4	0.825	0.125	0.4	0.4	0.3	0	0.1	0.35	0.4	0.3	0.15	0.25	0.35	0.175	0.225	0.3	0.175	0.35	0.25
	0.3	0.7	0.975	0.35	0.7	0.7	0.6	0.1	0.3	0.6	0.7	0.6	0.4	0.55	0.65	0.4	0.45	0.6	0.4	0.65	0.55
RMS	0.15	0.25	0.25	0.025	0.2	0.3	0.35	0.2	0	0.325	0.5	0.375	0.15	0.25	0.1	0.6	0.025	0.15	0.55	0.45	0.15
	0.3	0.55	0.55	0.15	0.4	0.5	0.6	0.4	0.1	0.55	0.8	0.65	0.3	0.55	0.25	0.9	0.15	0.3	0.85	0.75	0.3
QDF	0.15	0.3	0.4	0.1	0.25	0.35	0.6	0.4	0.05	0	0.6	0.675	0.375	0.5	0.5	0.4	0.3	0.75	0.3	0.6	0.675
	0.4	0.6	0.7	0.3	0.55	0.65	0.9	0.7	0.2	0.1	0.9	0.775	0.65	0.8	0.8	0.7	0.6	0.95	0.6	0.9	0.925
OA	0.05	0.4	0.25	0.15	0.325	0.2	0.3	0.35	0	0.25	0	0.6	0.4	0.65	0.5	0.4	0.25	0.5	0.2	0.55	0.2
	0.2	0.7	0.5	0.4	0.6	0.5	0.6	0.6	0.1	0.5	0.1	0.9	0.7	0.85	0.8	0.7	0.5	0.8	0.5	0.85	0.5
SD	0.3	0.6	0.4	0.35	0.475	0.475	0.5	0.25	0.3	0.5	0.6	0	0.5	0.65	0.5	0.3	0.4	0.6	0.4	0.725	0.525
	0.6	0.9	0.7	0.6	0.75	0.75	0.8	0.5	0.5	0.65	0.9	0.1	0.8	0.85	0.8	0.6	0.7	0.9	0.7	0.875	0.775
EL	0.35	0.4	0.4	0.4	0.775	0.175	0.65	0.25	0.2	0.5	0.3	0.6	0	0.65	0.6	0.5	0.75	0.5	0.4	0.5	0.525
	0.6	0.7	0.7	0.7	0.925	0.45	0.85	0.5	0.4	0.65	0.6	0.9	0.1	0.85	0.9	0.8	0.95	0.8	0.7	0.8	0.775
EIC	0.5	0.9	0.2	0.15	0.25	0.25	0.6	0.125	0.05	0.125	0.35	0.4	0.15	0	0.275	0.2	0.125	0.2	0.1	0.55	0.2
	0.8	1	0.5	0.4	0.5	0.5	0.9	0.35	0.2	0.35	0.65	0.7	0.4	0.1	0.55	0.45	0.35	0.5	0.3	0.85	0.5
ISP	0.35	0.375	0.15	0.575	0.35	0.15	0.525	0.1	0.25	0.4	0.3	0.4	0.4	0.55	0	0.15	0.175	0.4	0.2	0.2	0.6
	0.65	0.575	0.4	0.825	0.6	0.4	0.775	0.3	0.5	0.7	0.6	0.7	0.7	0.75	0.1	0.4	0.45	0.7	0.5	0.5	0.9

TABLE 5 (Continued)

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
INV	0.25	0.2	0.225	0.25	0.2	0.175	0.6	0.1	0.1	0.2	0.6	0.75	0.35	0.5	0.75	0	0.175	0.6	0.725	0.45	0.6
	0.55	0.45	0.5	0.55	0.45	0.4	0.9	0.25	0.3	0.4	0.9	0.95	0.6	0.8	0.95	0.1	0.4	0.9	0.875	0.75	0.9
AT	0.1	0.175	0.25	0.175	0.275	0.425	0.3	0.1	0	0.45	0.4	0.55	0.75	0.5	0.4	0.25	0	0.45	0.25	0.45	0.45
	0.3	0.45	0.5	0.45	0.55	0.7	0.6	0.3	0.1	0.55	0.7	0.75	0.95	0.8	0.7	0.5	0.1	0.75	0.55	0.75	0.75
SO	0.525	0.325	0.45	0.65	0.625	0.4	0.3	0.55	0.05	0.5	0.4	0.6	0.6	0.4	0.45	0.35	0.65	0	0.5	0.5	0.6
	0.775	0.6	0.75	0.85	0.875	0.7	0.6	0.75	0.2	0.8	0.7	0.9	0.9	0.7	0.75	0.65	0.85	0.1	0.8	0.8	0.9
EFT	0.3	0.3	0.25	0.4	0.5	0.35	0.3	0.4	0.3	0.3	0.4	0.75	0.4	0.425	0.7	0.675	0.25	0.6	0	0.6	0.4
	0.6	0.6	0.55	0.7	0.65	0.6	0.6	0.65	0.5	0.5	0.7	0.95	0.7	0.7	0.9	0.925	0.55	0.9	0.1	0.9	0.7
SDM	0.25	0.6	0.525	0.3	0.5	0.475	0.35	0.275	0	0.25	0.9	0.3	0.4	0.55	0.475	0.4	0.3	0.4	0.65	0	0.5
	0.55	0.9	0.775	0.6	0.8	0.6	0.65	0.55	0.1	0.5	1	0.6	0.7	0.85	0.725	0.7	0.6	0.7	0.85	0.1	0.8
CI	0.125	0.4	0.35	0.3	0.6	0.45	0.4	0.5	0.3	0.35	0.55	0.375	0.9	0.3	0.45	0.55	0.75	0.75	0.5	0.4	0
	0.35	0.7	0.65	0.6	0.9	0.75	0.7	0.8	0.5	0.6	0.85	0.625	1	0.6	0.75	0.75	0.95	0.95	0.65	0.7	0.1

Step 7- Cause and effect parameters

Let R_m be the sum of rows, C_n is the sum of columns, and t_{mn} represents the elements in the total relation matrix. Thus, using equations (12) and (13), it can be calculated as:

$$R_m = \sum_{n=1}^{l} t_{mn} \forall m \quad (12)$$

$$C_n = \sum_{m=1}^{l} t_{mn} \forall n \quad (13)$$

Step 8- Threshold setup and graph plotting

With the help of values obtained from equations (12) and (13), a causal diagram can be plotted.

3.2 | Application of the proposed method

The stepwise application of the proposed model is presented below:

Step 1- In this step, the 21 BT-enabled critical success factors are identified through a literature review, and a detailed questionnaire is circulated among industry experts, researchers, and academicians to obtain the responses. A group of four experts (Table 3) has been used to identify the interrelations and direct impact among 21 BT-enabled CSFs. The experts used a linguistic scale to evaluate the impact of one BT-enabled CSFs over another. The used linguistic scale is presented in Table 4. Based on the opinion of experts four 21 × 21 direct relation matrices are developed.

Step 2- The obtained expert matrices are converted to initial grey relation matrices as per the scale given in Table 4.

Step 3- By using four grey relation matrices the average grey relation matrix Z is computed. This matrix is shown in Table 5.

Step 4- The crisp relation matrix is computed using a three-step-modified converting fuzzy values into crisp scores approach. By using equations 3, 4, and 5 the grey value normalization is performed then total normalized crisp values are obtained using equation 6, and in the final step, the grey values are transformed into crisp values using equations 7 and 8 as shown in Table 6.

Step 5- Normalization of the crisp relation matrix is performed using equations 9 and 10. The normalized direct crisp relation matrix A is presented in Table 7.

Step 6- The total relation matrix of BT-enabled CSFs for SCRS T_R is calculated using equation 11 and shown in Table 8.

Step 7- Let R and C be vectors with dimensions of 21 by 1 and 1 by 21, respectively, reflecting the sum of row elements and column elements in the total relation matrix T_R, as described by Equations 12 and 13.

TABLE 6 Crisp relation matrix of BT-enabled CSFs for SCRS.

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF
SC	0.0000	0.3167	0.4333	0.5868	0.2412	0.5868	0.3893	0.1607	0.1625	0.5263
IN	0.2727	0.0000	0.3643	0.1200	0.3071	0.1555	0.7800	0.0865	0.3071	0.1929
SOG	0.0000	0.7455	0.0000	0.1555	0.2677	0.0865	0.3483	0.0865	0.1079	0.1555
SI	0.6683	0.1744	0.3466	0.0000	0.5656	0.6244	0.2667	0.1548	0.0551	0.6833
IM	0.6167	0.5583	0.5583	0.8667	0.0000	0.3833	0.7182	0.4569	0.0262	0.7826
SRV	0.5318	0.4500	0.4457	0.8310	0.5689	0.0000	0.3773	0.4028	0.0263	0.4028
BDO	0.2083	0.9000	0.7826	0.2639	0.4435	0.2639	0.0000	0.3022	0.2846	0.4435
MPV	0.1186	0.5021	0.8677	0.1534	0.5021	0.5021	0.3851	0.0000	0.1186	0.4167
RMS	0.1605	0.3318	0.3318	0.0264	0.2300	0.3400	0.4214	0.2300	0.0000	0.3799
QDF	0.1909	0.3870	0.5043	0.1190	0.3283	0.4457	0.7391	0.5043	0.0550	0.0000
OA	0.0553	0.5091	0.3071	0.1929	0.4064	0.2727	0.3909	0.4214	0.0000	0.3071
SD	0.3909	0.7455	0.5091	0.4214	0.5808	0.5808	0.6273	0.3071	0.3400	0.5289
EL	0.4182	0.5043	0.5043	0.5043	0.8163	0.2294	0.7214	0.3045	0.2286	0.5275
EIC	0.6167	0.9000	0.2667	0.1891	0.3022	0.3022	0.7333	0.1528	0.0548	0.1528
ISP	0.4289	0.4005	0.1815	0.6533	0.4003	0.1815	0.5965	0.1118	0.2901	0.4863
INV	0.3198	0.2405	0.2793	0.3198	0.2405	0.2033	0.7259	0.1032	0.1149	0.2211
AT	0.1149	0.2230	0.2959	0.2230	0.3358	0.5065	0.3773	0.1149	0.0000	0.4379
SO	0.5965	0.3862	0.5441	0.7012	0.7105	0.4863	0.3718	0.5905	0.0508	0.6022
EFT	0.3773	0.3773	0.3198	0.4928	0.5152	0.4074	0.3773	0.4635	0.3282	0.3282
SDM	0.3250	0.7333	0.6130	0.3833	0.6167	0.4872	0.4417	0.3420	0.0000	0.3022
CI	0.1528	0.5000	0.4417	0.3833	0.7333	0.5583	0.5000	0.6167	0.3364	0.4152

TABLE 6 (Continued)

CSFs	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
SC	0.4053	0.5868	0.5792	0.2750	0.5868	0.5263	0.2842	0.4053	0.5263	0.4658	0.4658
IN	0.2727	0.2727	0.0865	0.7800	0.1555	0.1200	0.1200	0.3071	0.1929	0.4500	0.2320
SOG	0.7455	0.5682	0.1750	0.5091	0.4645	0.2320	0.1200	0.1929	0.3071	0.6786	0.5091
SI	0.2711	0.2711	0.6244	0.1919	0.7901	0.3300	0.2711	0.5067	0.2711	0.5067	0.3889
IM	0.3833	0.6130	0.9000	0.3833	0.6750	0.3250	0.7333	0.8273	0.3833	0.6167	0.7727
SRV	0.2696	0.4457	0.2696	0.3870	0.4028	0.3870	0.1190	0.3283	0.1190	0.5630	0.5630
BDO	0.6750	0.6167	0.3833	0.8143	0.3250	0.3250	0.4417	0.5718	0.6167	0.6750	0.7333
MPV	0.5021	0.3851	0.1900	0.3266	0.4436	0.2091	0.2648	0.3851	0.2091	0.4436	0.3266
RMS	0.6273	0.4645	0.1605	0.3318	0.1079	0.7455	0.0264	0.1605	0.6864	0.5682	0.1605
QDF	0.7391	0.6750	0.4606	0.6217	0.6217	0.5043	0.3870	0.8310	0.3870	0.7391	0.7875

TABLE 6 (Continued)

CSFs	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
OA	0.0000	0.7455	0.5091	0.7250	0.6273	0.5091	0.3071	0.6273	0.2727	0.6864	0.2727
SD	0.7455	0.0000	0.6273	0.7250	0.6273	0.3909	0.5091	0.7455	0.5091	0.7658	0.6214
EL	0.3870	0.7391	0.0000	0.7214	0.7391	0.6217	0.8310	0.6217	0.5043	0.6217	0.6170
EIC	0.4417	0.5000	0.1891	0.0000	0.3420	0.2457	0.1528	0.2667	0.1182	0.6750	0.2667
ISP	0.3718	0.4863	0.4863	0.5905	0.0000	0.1815	0.2192	0.4863	0.2586	0.2586	0.7193
INV	0.7259	0.8200	0.4074	0.6090	0.8200	0.0000	0.2033	0.7259	0.7533	0.5508	0.7259
AT	0.4928	0.5994	0.8200	0.6090	0.4928	0.2959	0.0000	0.5508	0.3198	0.5508	0.5508
SO	0.4863	0.7193	0.7193	0.4863	0.5441	0.4289	0.7012	0.0000	0.6022	0.6022	0.7193
EFT	0.4928	0.8200	0.4928	0.5065	0.7645	0.7750	0.3198	0.7259	0.0000	0.7259	0.4928
SDM	0.9000	0.3833	0.5000	0.6750	0.5565	0.5000	0.3833	0.5000	0.7182	0.0000	0.6167
CI	0.6750	0.4435	0.9000	0.3833	0.5583	0.6091	0.8273	0.8273	0.5262	0.5000	0.0000

Step 8- A threshold value is established by adding 1 time the standard deviation to the mean of the items in the total relation matrix T_R to eliminate minor causes/effects among enablers before plotting a causal relation between them. The direct and indirect impacts that BT-enabled CSFs m have on other BT-enabled CSFs are summarised in R_m, and the direct and indirect effects that BT-enabled CSFs n has on other BT-enabled CSFs are summarised in C_n. $(R_m + C_n)$ and $(R_m\text{-}C_n)$ is calculated from the total relation matrix T_R and presented in Table 8. Figure 3 presents the obtained digraph. It displays the causal relation among BT-enabled CSFs for SCRS from the values of $(R_m + C_n)$ and $(R_m\text{-}C_n)$. The direction from cause BT-enabled CSFs to affect BT-enabled CSFs is represented through lines and represents the two-way relationships among CSFs.

4 | RESULTS & DISCUSSIONS

The relationships and direct effects of 21 BT-enabled CSFs are explored in this work utilizing a combination of grey theory and DEMATEL methodologies. The importance and net cause/effect values of BT-enabled CSFs for SCRS are shown in Table 9. A threshold value (T_V) of 0.16102 is chosen to filter out relatively insignificant effects. The threshold value is obtained by adding one standard deviation to the mean and calculating the mean and standard deviation of the values from the total relation matrix (Xia et al., 2015). In the total relation matrix T_R, all relationships that reach or exceed the threshold value are highlighted (Table 8).

Figure 3 shows the digraph showing causal relations among BT-enabled CSFs for SCRS. When multiple related factors interact, the decision-making environment can quickly become complicated. Therefore, it is essential to discover the dependent relationship in order to identify the elements in causal groups that can be enhanced in order to enhance the components in the effect group and, by extension, the entire system (Gupta & Barua, 2018). The results are further reviewed in this section from the perspectives of the cause group, the effect group, and the correlation among BT-enabled CSFs, followed by a sensitivity analysis.

4.1 | Cause group

The causal or driver BT-enabled CSFs are ranked based on their $(R_m\text{-}C_n)$ $\forall m{-}n$ values as IN > EIC > ISP > SOG > OA > SDM > BDO (Table 9). Internal integration (IN) is found to be the crucial driving BT-enabled CSFs, as it initiates the effects of many other BT-enabled CSFs. BT-enabled internal integration uses combined serial numbers, bar codes, sensors, digital tags, etc., and creates a unified and

TABLE 7 Normalized direct crisp relation matrix of BT-enabled CSFs for SCRS.

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF
SC	0.0000	0.0272	0.0372	0.0504	0.0207	0.0504	0.0334	0.0138	0.0140	0.0452
IN	0.0234	0.0000	0.0313	0.0103	0.0264	0.0134	0.0670	0.0074	0.0264	0.0166
SOG	0.0000	0.0640	0.0000	0.0134	0.0230	0.0074	0.0299	0.0074	0.0093	0.0134
SI	0.0574	0.0150	0.0298	0.0000	0.0486	0.0536	0.0229	0.0133	0.0047	0.0587
IM	0.0530	0.0480	0.0480	0.0744	0.0000	0.0329	0.0617	0.0392	0.0023	0.0672
SRV	0.0457	0.0386	0.0383	0.0714	0.0489	0.0000	0.0324	0.0346	0.0023	0.0346
BDO	0.0179	0.0773	0.0672	0.0227	0.0381	0.0227	0.0000	0.0260	0.0244	0.0381
MPV	0.0102	0.0431	0.0745	0.0132	0.0431	0.0431	0.0331	0.0000	0.0102	0.0358
RMS	0.0138	0.0285	0.0285	0.0023	0.0198	0.0292	0.0362	0.0198	0.0000	0.0326
QDF	0.0164	0.0332	0.0433	0.0102	0.0282	0.0383	0.0635	0.0433	0.0047	0.0000
OA	0.0047	0.0437	0.0264	0.0166	0.0349	0.0234	0.0336	0.0362	0.0000	0.0264
SD	0.0336	0.0640	0.0437	0.0362	0.0499	0.0499	0.0539	0.0264	0.0292	0.0454
EL	0.0359	0.0433	0.0433	0.0433	0.0701	0.0197	0.0620	0.0262	0.0196	0.0453
EIC	0.0530	0.0773	0.0229	0.0162	0.0260	0.0260	0.0630	0.0131	0.0047	0.0131
ISP	0.0368	0.0344	0.0156	0.0561	0.0344	0.0156	0.0512	0.0096	0.0249	0.0418
INV	0.0275	0.0207	0.0240	0.0275	0.0207	0.0175	0.0623	0.0089	0.0099	0.0190
AT	0.0099	0.0191	0.0254	0.0191	0.0288	0.0435	0.0324	0.0099	0.0000	0.0376
SO	0.0512	0.0332	0.0467	0.0602	0.0610	0.0418	0.0319	0.0507	0.0044	0.0517
EFT	0.0324	0.0324	0.0275	0.0423	0.0442	0.0350	0.0324	0.0398	0.0282	0.0282
SDM	0.0279	0.0630	0.0526	0.0329	0.0530	0.0418	0.0379	0.0294	0.0000	0.0260
CI	0.0131	0.0429	0.0379	0.0329	0.0630	0.0480	0.0429	0.0530	0.0289	0.0357

TABLE 7 (Continued)

CSFs	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
SC	0.0348	0.0504	0.0497	0.0236	0.0504	0.0452	0.0244	0.0348	0.0452	0.0400	0.0400
IN	0.0234	0.0234	0.0074	0.0670	0.0134	0.0103	0.0103	0.0264	0.0166	0.0386	0.0199
SOG	0.0640	0.0488	0.0150	0.0437	0.0399	0.0199	0.0103	0.0166	0.0264	0.0583	0.0437
SI	0.0233	0.0233	0.0536	0.0165	0.0679	0.0283	0.0233	0.0435	0.0233	0.0435	0.0334
IM	0.0329	0.0526	0.0773	0.0329	0.0580	0.0279	0.0630	0.0710	0.0329	0.0530	0.0664
SRV	0.0232	0.0383	0.0232	0.0332	0.0346	0.0332	0.0102	0.0282	0.0102	0.0484	0.0484
BDO	0.0580	0.0530	0.0329	0.0699	0.0279	0.0279	0.0379	0.0491	0.0530	0.0580	0.0630
MPV	0.0431	0.0331	0.0163	0.0280	0.0381	0.0180	0.0227	0.0331	0.0180	0.0381	0.0280
RMS	0.0539	0.0399	0.0138	0.0285	0.0093	0.0640	0.0023	0.0138	0.0589	0.0488	0.0138
QDF	0.0635	0.0580	0.0396	0.0534	0.0534	0.0433	0.0332	0.0714	0.0332	0.0635	0.0676

TABLE 7 (Continued)

CSFs	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
OA	0.0000	0.0640	0.0437	0.0623	0.0539	0.0437	0.0264	0.0539	0.0234	0.0589	0.0234
SD	0.0640	0.0000	0.0539	0.0623	0.0539	0.0336	0.0437	0.0640	0.0437	0.0658	0.0534
EL	0.0332	0.0635	0.0000	0.0620	0.0635	0.0534	0.0714	0.0534	0.0433	0.0534	0.0530
EIC	0.0379	0.0429	0.0162	0.0000	0.0294	0.0211	0.0131	0.0229	0.0101	0.0580	0.0229
ISP	0.0319	0.0418	0.0418	0.0507	0.0000	0.0156	0.0188	0.0418	0.0222	0.0222	0.0618
INV	0.0623	0.0704	0.0350	0.0523	0.0704	0.0000	0.0175	0.0623	0.0647	0.0473	0.0623
AT	0.0423	0.0515	0.0704	0.0523	0.0423	0.0254	0.0000	0.0473	0.0275	0.0473	0.0473
SO	0.0418	0.0618	0.0618	0.0418	0.0467	0.0368	0.0602	0.0000	0.0517	0.0517	0.0618
EFT	0.0423	0.0704	0.0423	0.0435	0.0657	0.0666	0.0275	0.0623	0.0000	0.0623	0.0423
SDM	0.0773	0.0329	0.0429	0.0580	0.0478	0.0429	0.0329	0.0429	0.0617	0.0000	0.0530
CI	0.0580	0.0381	0.0773	0.0329	0.0480	0.0523	0.0710	0.0710	0.0452	0.0429	0.0000

TABLE 8 Total relation matrix of BT-enabled CSFs for SCRS.

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF
SC	0.0929	0.1645	0.1556	0.1559	0.1484	0.1508	0.1734	0.0969	0.0554	0.1558
IN	0.0823	0.0937	0.1089	0.0772	0.1063	0.0785	0.1553	0.0607	0.0523	0.0872
SOG	0.0684	0.1676	0.0891	0.0906	0.1172	0.0827	0.1358	0.0694	0.0409	0.0948
SI	0.1441	0.1454	0.1433	0.1051	0.1680	0.1490	0.1570	0.0929	0.0436	0.1646
IM	0.1757	0.2329	0.2101	0.2154	0.1741	0.1718	0.2493	0.1506	0.0586	0.2176
SRV	0.1300	0.1648	0.1485	0.1668	0.1639	0.0953	0.1610	0.1094	0.0401	0.1377
BDO	0.1219	0.2352	0.2016	0.1414	0.1820	0.1384	0.1629	0.1206	0.0715	0.1626
MPV	0.0852	0.1588	0.1714	0.1008	0.1460	0.1246	0.1491	0.0687	0.0438	0.1262
RMS	0.0823	0.1347	0.1192	0.0820	0.1148	0.1048	0.1429	0.0828	0.0315	0.1141
QDF	0.1236	0.1984	0.1845	0.1355	0.1784	0.1567	0.2265	0.1408	0.0537	0.1307
OA	0.0948	0.1773	0.1414	0.1185	0.1560	0.1200	0.1695	0.1140	0.0400	0.1322
SD	0.1521	0.2419	0.1980	0.1727	0.2126	0.1796	0.2348	0.1337	0.0814	0.1882
EL	0.1550	0.2228	0.1979	0.1801	0.2311	0.1528	0.2434	0.1328	0.0729	0.1898
EIC	0.1230	0.1855	0.1186	0.0994	0.1246	0.1053	0.1722	0.0773	0.0383	0.1006
ISP	0.1217	0.1616	0.1268	0.1515	0.1512	0.1110	0.1797	0.0871	0.0629	0.1448

TABLE 8 (Continued)

CSFs	SC	IN	SOG	SI	IM	SRV	BDO	MPV	RMS	QDF
INV	0.1275	0.1732	0.1537	0.1435	0.1601	0.1286	0.2125	0.1007	0.0564	0.1406
AT	0.0989	0.1527	0.1393	0.1216	0.1512	0.1388	0.1668	0.0902	0.0396	0.1429
SO	0.1683	0.2106	0.2007	0.1960	0.2232	0.1738	0.2130	0.1561	0.0577	0.1956
EFT	0.1416	0.1953	0.1690	0.1678	0.1933	0.1551	0.1987	0.1364	0.0762	0.1605
SDM	0.1326	0.2198	0.1872	0.1540	0.1959	0.1559	0.1988	0.1237	0.0478	0.1525
CI	0.1299	0.2160	0.1897	0.1675	0.2220	0.1749	0.2202	0.1564	0.0794	0.1774

TABLE 8 (Continued)

CSFs	OA	SD	EL	EIC	ISP	INV	AT	SO	EFT	SDM	CI
SC	0.1774	0.1987	0.1797	0.1718	0.1951	0.1537	0.1281	0.1810	0.1556	0.1952	0.1851
IN	0.1169	0.1194	0.0908	0.1605	0.1045	0.0805	0.0764	0.1182	0.0890	0.1392	0.1125
SOG	0.1691	0.1576	0.1122	0.1556	0.1453	0.1004	0.0876	0.1257	0.1087	0.1725	0.1487
SI	0.1585	0.1662	0.1784	0.1566	0.2042	0.1320	0.1234	0.1820	0.1292	0.1895	0.1735
IM	0.2260	0.2531	0.2541	0.2330	0.2531	0.1749	0.2042	0.2666	0.1834	0.2620	0.2616
SRV	0.1544	0.1729	0.1447	0.1669	0.1679	0.1314	0.1066	0.1622	0.1129	0.1894	0.1802
BDO	0.2211	0.2222	0.1814	0.2382	0.1921	0.1523	0.1554	0.2138	0.1781	0.2358	0.2245
MPV	0.1612	0.1559	0.1238	0.1513	0.1556	0.1066	0.1074	0.1520	0.1089	0.1669	0.1479
RMS	0.1632	0.1543	0.1115	0.1425	0.1206	0.1460	0.0798	0.1259	0.1431	0.1673	0.1241
QDF	0.2311	0.2323	0.1934	0.2275	0.2213	0.1697	0.1564	0.2404	0.1643	0.2447	0.2360
OA	0.1381	0.2042	0.1673	0.2033	0.1901	0.1447	0.1260	0.1914	0.1297	0.2059	0.1630
SD	0.2466	0.1945	0.2216	0.2525	0.2384	0.1742	0.1771	0.2497	0.1865	0.2653	0.2389
EL	0.2197	0.2557	0.1736	0.2526	0.2494	0.1922	0.2045	0.2425	0.1876	0.2546	0.2412
EIC	0.1500	0.1581	0.1184	0.1194	0.1409	0.1054	0.0941	0.1366	0.0990	0.1783	0.1365
ISP	0.1629	0.1780	0.1631	0.1848	0.1338	0.1172	0.1166	0.1759	0.1253	0.1666	0.1925
INV	0.2163	0.2311	0.1788	0.2128	0.2255	0.1200	0.1324	0.2200	0.1844	0.2158	0.2180
AT	0.1774	0.1927	0.1934	0.1926	0.1797	0.1292	0.1019	0.1857	0.1329	0.1948	0.1849
SO	0.2251	0.2523	0.2313	0.2307	0.2344	0.1768	0.1939	0.1907	0.1930	0.2514	0.2473
EFT	0.2111	0.2442	0.1971	0.2172	0.2350	0.1926	0.1503	0.2328	0.1336	0.2437	0.2134
SDM	0.2363	0.2045	0.1917	0.2260	0.2124	0.1658	0.1510	0.2090	0.1848	0.1796	0.2161
CI	0.2363	0.2283	0.2410	0.2207	0.2305	0.1885	0.2014	0.2533	0.1850	0.2397	0.1852

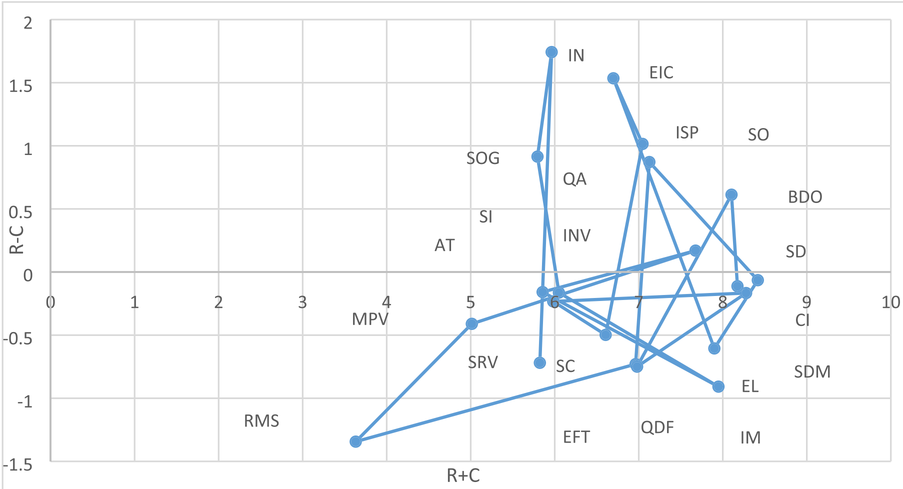

FIGURE 3 Digraph showing causal relations among BT-enabled CSFs for SCRS.

TABLE 9 Cause and effect parameters for BT-enabled CSFs SCRS.

BT enabled CSFs	R_m	C_n	R_m-C_n	$R_m + C_n$	Cause/effect
SC	2.551965	3.270991	−0.71903	5.822957	Effect
IN	3.852768	2.110321	1.742448	5.963089	Cause
SOG	3.354615	2.440209	0.914406	5.794824	Cause
SI	2.943178	3.106378	−0.1632	6.049556	Effect
IM	3.520301	4.428158	−0.90786	7.948458	Effect
SRV	2.848451	3.007125	−0.15867	5.855576	Effect
BDO	3.922768	3.752972	0.169795	7.67574	Cause
MPV	2.301375	2.711791	−0.41042	5.013166	Effect
RMS	1.143968	2.487533	−1.34357	3.631501	Effect
QDF	3.116329	3.845944	−0.72961	6.962274	Effect
OA	3.998673	3.1273	0.871374	7.125973	Cause
SD	4.176166	4.240575	−0.06441	8.416741	Effect
EL	3.647166	4.252252	−0.60509	7.899419	Effect
EIC	4.116416	2.581579	1.534838	6.697995	Cause
ISP	4.029777	3.014887	1.01489	7.044664	Cause
INV	3.054002	3.551849	−0.49785	6.605851	Effect
AT	2.874564	3.107235	−0.23267	5.981799	Effect
SO	4.055433	4.221876	−0.16644	8.277309	Effect
EFT	3.115188	3.864746	−0.74956	6.979935	Effect
SDM	4.35818	3.74556	0.61262	8.10374	Cause
CI	4.031287	4.14329	−0.112	8.174577	Effect

transparent platform that uses a distributed database to make other processes more resilient and sustainable. Being on top of the causal list of internal integrations affects the SD the most followed by IM, EL, CI, SO, QDF, EFT, INV, SRV, AND, and SC, respectively. It has a significant effect on most of the CSFs and thus, proved critical to the success of SCRS.

Internal integration is followed by efficient inter-organization communication (EIC) and Integration of Strategic Partners (ISP). Efficient inter-organization communication (EIC) facilitates more streamlined and automated communication between the entities while maintaining the highest possible level of trust thus, increasing the resilience among other stakeholders. EIC has prominent effects on EL, SD, IM, SO, QDF, CI, EFT, INV, AT, and SC, respectively in decreasing order. Whereas Integration of Strategic Partners (ISP) helps smoothen the information flow regarding ongoing processes from the beginning to the end, giving the required supply chain entities on blockchain access to data free from bias and error. It has prominent effects on IM followed by EL, SD, EFT, SO, CI, INV, QDF, SI, SC, and AT, respectively. When we presented the findings to industrial managers, they acknowledged these CSFs as a significant factor of SCRS.

4.2 | Effect group

The effect CSFs can be sorted as SD, CI, SRV, SI, SO, AT, MPV, INV, EL, SC, QDF, EFT, IM, and RMS in decreasing order of their prominence. Standardized Data Management (SD) is closer to the cause group and thus less influenced by them. SD has followed customer integration (CI), which facilitates the integration of customers among SCs by keeping track of each purchase order and providing a copy of the information available to stockholders due to its distributed nature. It increases transparency and traceability along with other features of SCRS. Supplier and Raw material Verification (SRV) hold the third position in the effect group. BT-enabled SRV process reduces the possibility of data manipulation and forgeries by logging each transaction and flow of data after supply chain confirmation and forbidding any kind of modification. Thus, increasing the trust among stakeholders and enhancing product quality.

4.3 | Correlation among BT-enabled CSFs

To understand the correlation among BT-enabled CSFs the BT can be prioritized based on ($R_m + C_n$) $\forall m{-}n$ values. The correlation order of this investigation is SD > SO > CI > SDM > IM > EL > BDO > OA > ISP > EFT > QDF > EIC > INV > SI > AT > IN > SRV > SC > SOG > MPV > RMS. As per this ranking, Standardized Data Management (SD) has the highest correlation with the other CSFs and is the most important BT-enabled CSF for SCRS. BT-enabled standardized data management creates an immutable audit log to capture the data transaction after verification in supply chains and eliminate the possibility of data being manipulated or falsified. It also forbids modification or tampering with the data thus, increase the assurance and trust among all the stakeholders and eventually making the processes efficient and resilient. Thus, proved critical to the success of SCRS. Smart ordering (SO) is the second most correlated BT-enabled CSF as it can help participants to manage the orders more effectively by providing them with the track of data like pricing, dates, location, quality, certifications, and other important factors. Customer integration (CI) is the third most correlated CSF as it keeps track of each purchase order and makes a copy of the information accessible to stockholders for efficient processing it also proved critical during uncertain circumstances thus, increasing the resilience and sustainability of the supply chain. Standardized Document Management (SDM) holds the fourth rank in correlation among CSFs, the usage of standard tools, methods, and performance measure indicators helps to keep the standard documents in good functioning order, which reduces error and facilitates creating a resilient and sustainable process.

Further analysis is performed by categorizing all the BT-enabled CSFs into different zones, Due to their dependence on causal CSFs, CSFs below the x-axis are referred to as effect CSFs and are also known as dysfunctional group CSFs. CSFs above the x-axis have the greatest prominence and are known as causal CSFs. According to Figure 4, the entire collection of CSFs can be split into four distinct groups, with zone 1 consisting of CSFs with the fewest connections, or CSFs with the least significance. The revenue management system for employees (RMS) belongs to this group of lowest significance whereas, Manufacturing Parameter Validation (MPV) lies on the boundary.

Zone 2 represents the causal group with weaker driving power; however, no CSFs fall under this category. Zone 3 constitutes the most number of causal CSFs and represents strong driving power. The CSFs under zone 3 are most critical for the success of SCRS. The

TABLE 10 Assigned weights for sensitivity analysis.

	Expert 1	Expert 2	Expert 3	Expert 4
Case 1	0.4	0.2	0.2	0.2
Case 2	0.2	0.4	0.2	0.2
Case 3	0.2	0.2	0.4	0.2
Case 4	0.2	0.2	0.2	0.4
Case 5	0.3	0.2	0.3	0.2

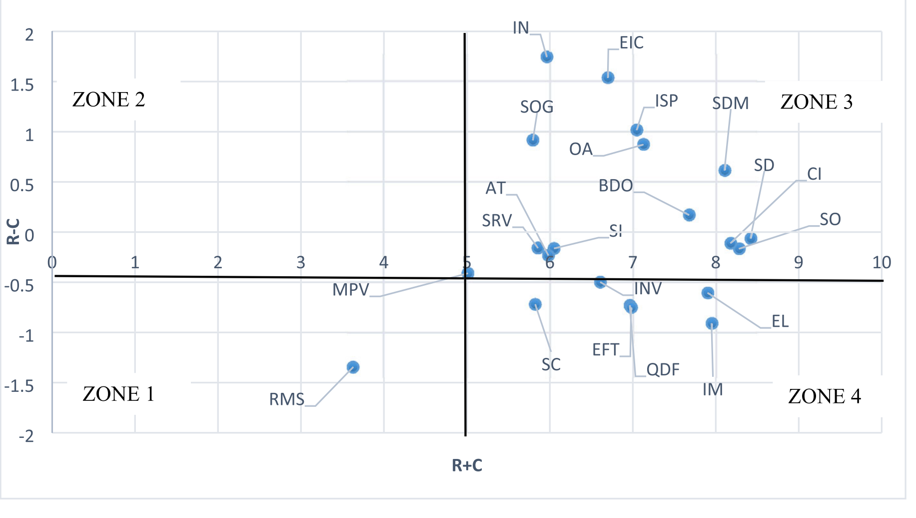

FIGURE 4 Zonal representation of BT-enabled CSFs for SCRS.

top highlights of this group are Internal Integration (IN), Efficient inter-organization communication (EIC), and Integration of Strategic Partners (ISP). Zone 4 represents the CSFs of high importance among the effect group and constitutes Invoicing (validation and approval) (INV), Efficient Logistics (Verification and Validation) (EL), Efficient Financial Transactions (EFT), Quality data for Forecasting and Analytics (QDF), Inventory Management (IM), and Smart Contract (SC). The CSFs of zone 4 need to be observed and implemented by management as soon as possible for the SCRS.

4.4 | Sensitivity analysis

Sensitivity analysis is essentially a procedure to evaluate the reliability and reliability of the methodology. Sensitivity analysis can be performed in a number of ways; one of these ways is to alter the weight assigned to a specific expert to observe how it affects the system as a whole (Gupta & Barua, 2018; Xia et al., 2015). The analysis is performed based on weights assigned as per Table 10.

A separate total relationship matrix is calculated for each case and the ranking of the CSFs based on their (R_m-C_n) values are given in Table 11. The sensitivity study demonstrates that the outcomes from the four alternative scenarios were not biased. Table 11 demonstrates unequivocally that in each of the four circumstances IN and EIC occupy the first two ranks, and RMS occupies the last rank in all five cases. The analysis clearly shows that there are no biases involved and there is a similarity in cause and effect groups thus, increasing the robustness of the result obtained. There is some difference present, which can be found in the table however, the final sensitivity results are consistent with the overall digraph shown in Figure 3.

4.5 | Managerial implications

The study's findings also have important managerial implications and observations that could help supply chains manage more effectively and plan for the successful implementation of BT to improve SCRS. First, the study contributes to the identification of BT-enabled CSFs to enhance the resilience of the supply chain. Second, it provides the prioritization of BT-enabled CSFs that will help in the systematic adoption of BT in supply chains. In addition to that, the causal relation and impact of these CSFs for SCRS will offer more insights to managers and help in decision-making. The CSFs of the cause group will aid in building a plan and providing a foundation for newly emerging enterprises to implement a resilient and sustainable supply chain equipped with the best features of BT. The causal relation will also help the managers to plan which CSFs will be given more priority and which ones receive the least. BT-enabled Standardized Data

TABLE 11 Cause/effect CSFs ranking.

	Case 1		Case 2		Case 3		Case 4		Case 5	
Rank	CSFs	R_m-C_n	CSFs	R_m-C_n	CSFs	R_m-C_n	CSFs	R_m-C_n	CSFs	R_m-C_n
1	IN	1.4943	IN	2.0652	IN	1.6542	IN	1.6442	IN	1.932
2	EIC	1.3200	EIC	1.8735	EIC	1.5559	EIC	1.2822	EIC	1.653
3	ISP	0.9635	ISP	1.1024	ISP	1.1046	SOG	0.8160	ISP	1.013
4	OA	0.8395	SOG	1.0840	SOG	0.8939	ISP	0.7991	SOG	0.884
5	SOG	0.7885	OA	0.9621	OA	0.8594	SDM	0.7747	OA	0.8345
6	SDM	0.6501	SDM	0.3549	SDM	0.5398	OA	0.7392	SDM	0.3342
7	BDO	0.1157	BDO	0.2056	BDO	0.1076	BDO	0.2349	BDO	0.3012
8	SD	0.0371	SD	0.0124	SD	0.0274	SD	0.0387	SD	0.0212
9	AT	−0.056	CI	−0.022	CI	−0.0701	AT	−0.117	CI	−0.027
10	CI	−0.170	SI	−0.024	SI	−0.1173	SO	−0.163	AT	−0.023
11	SO	−0.174	SRV	−0.059	SRV	−0.1944	CI	−0.170	SO	−0.069
12	SI	−0.242	SO	−0.077	SO	−0.2120	SI	−0.220	SI	−0.077
13	SRV	−0.279	MPV	−0.463	MPV	−0.3130	SRV	−0.260	SRV	−0.432
14	INV	−0.332	AT	−0.481	QDF	−0.4007	INV	−0.366	INV	−0.472
15	MPV	−0.419	QDF	−0.617	AT	−0.4027	MPV	−0.398	MPV	−0.661
16	EL	−0.468	EL	−0.636	INV	−0.6186	EFT	−0.491	EL	−0.589
17	EFT	−0.468	INV	−0.671	SC	−0.6971	SC	−0.561	QDF	−0.633
18	SC	−0.608	IM	−0.918	EL	−0.701	EL	−0.567	IM	−0.932
19	QDF	−0.838	SC	−0.930	IM	−0.8878	IM	−0.759	EFT	−0.938
20	IM	−0.963	EFT	−1.174	EFT	−0.8958	QDF	−0.927	SC	−1.153
21	RMS	−1.186	RMS	−1.611	RMS	−1.2320	RMS	−1.242	RMS	−1.625

Management (SD) has the highest correlation among all CSFs and Internal integration (IN) has the highest driving power thus; the study suggests that these two CSFs shall be given top priority while laying down the plan for BT implementation. Managers can use sensitivity analysis to ensure that there is no expert bias, the results are stable, and they can be applied to further refine the company's strategy. This enables managers to accurately focus on the significant CSFs identified through the study and to develop frameworks and policies for adoption. Thus, enabling the organization to achieve a successful SCRS.

4.6 | Research implications

Currently, the attention of academics, researchers, and practitioners is concentrated on how to boost the effectiveness of SCRS by employing BT-enabled services. Enhancing transparency, traceability, privacy, and security among all parties in SCRS is the function of BT. In this study, the authors have found that BT enabled CSFs for SCRS along with their mutual impact and causal relation among each other. Implementing blockchain-enabled technology is essential to building an SCRS, as it can enhance the system's ability to detect disruptions and respond appropriately. The research presented here identifies 21 critical success factors (CSFs) for SCRS that can be supported by BT. To prioritize these CSFs and obtain the cause/effect relation among them grey-DEMATEL method is employed. Among these factors, Internal Integration (IN), Efficient inter-organization communication (EIC), and Integration of Strategic Partners (ISP) are the most critical CSFs for the success of SCRS. Invoicing (INV), Efficient Logistics (EL), Efficient Financial Transactions (EFT), Quality data for Forecasting and Analytics (QDF), Inventory Management (IM), and Smart Contract (SC) are the CSFs of high importance among effect group. The findings and the approach of this work have major implications for academics and researchers looking for a deeper knowledge of BT deployment in the supply chain.

5 | CONCLUSION OF THE STUDY & LIMITATIONS

This paper discusses how achieving supply chain resilience and sustainability can be accomplished using BT-enabled technologies. Our study model showed the relationship between 21 BT-enabled CSFs using a Grey-DEMATEL approach and laying the groundwork for future research in the area. Sensitivity analysis is performed to assess the robustness of obtained results. This study showed that BT with supply chain operations can create a transparent and verifiable system for tracking assets, inventory, and other vital resources. This unified platform provides real-time supply chain and internal process visibility and accountability. Stakeholders can track and verify assets or items, eliminating fraud and counterfeiting, making data corruption harder for hostile attackers. The results show BT-enabled internal integration (IN) as the most important CSF for SCRS because it sets in motion the effects of many other BT-enabled CSFs. BT enabled internal integration to improve sustainability by streamlining operations. The transparency in integration improves resource tracking, reduces waste, and optimizes use. By tracking inventory levels and demand trends, organizations can decrease overstocking and stockouts, improving resource allocation and reducing environmental impact. When it comes to impact, however, Standardized Data Management (SD) and Smart Ordering (SO) are at the top of the list.

This study, conducted while BT is still in its infancy, will inspire researchers and industry practitioners to improve supply chain efficiency and effectiveness and enhance supply chain resilience and sustainability. However, there are a few limitations. The first limitation of this research is that it's possible not all CSFs were taken into account. Furthermore, the adoption priority of CSFs may vary for a different set of decision-makers, and this study is wholly dependent on their inputs. It is also possible to add new use cases and compare the outcomes by employing various MCDM approaches.

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