Antecedents of Blockchain Technology Acceptance: A Study in context of Supply Chain Management of SMEs of India

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Abstract

Purpose: This study sought to identify the primary drivers behind Indian SMEs' adoption of blockchain technology for supply chain management (SCM) and how they make decisions about it. Finding out which factor or factors are more strongly associated with the intention to adopt was another goal of the study.

Design/methodology/approach: To find out the factors influencing Blockchain Technology Acceptance in SMEs, authors used the TAM-TOE model of technology adoption. The authors used the Structural Equation Modeling Approach (SEM) through AMOS software to figure out how dependent and independent variables related to each other.

Findings: By using the TAM-TOE model, it looks at innovation, technological, organizational, environmental, and individual factors and comes up with nine different hypotheses. Out of them, six were confirmed. These six variables were: Relative benefit, Blockchain compatibility, Technology readiness, Management support, Perceived utility&Vendor support. However, variables like Security Risk,Regulatory Support&Ease of use not significantly associated with Blockchain Technology Acceptance by SMEs. Blockchain compatibility is further found to be a key factor in SMEs deciding to use blockchain in their supply chains.

Practical implications: The stakeholders, government officials, business leaders, and policy makers engaged in the deployment and provision of a blockchain service may all benefit from this study.

Originality/value: The study proposed that SME management authorities must provide the required infrastructure (both organizational&technical) to ensure a smooth blockchain experience in SCM. Moreover, it is suggested that Indian policymakers create a regulatory framework to govern the utilization of blockchain technology.

Keywords: Blockchain Technology, TEM-TOE model, SMEs, Supply chain Management, SEM

Introduction

Digitalization and tech adoption are essential for any country's economic success and environmental sustainability. Many nations are competing with one another and completing tasks more efficiently by utilizing modern technology. For economies to remain competitive and achieve their objectives, innovation and technology adoption are critical (Jiang, 2015; Chen, Lan, Gao, & Sun, 2018; Abdellah et al., 2024).Blockchain is being used all over the place because it's like a distributed database and has the potential to create audit trails. It's also playing a big part in modernizing the higher education system (Zheng et al.,2017; Gräther et al.,2018; Kumar et al., 2023).Lots of research has been done on how companies can figure out the potential benefits of 4.0 technology and how it affects the supply chain, but there's still a lack of research on how to implement it. Digital technologies are really important for managing and processing signals, since traditional supply chains are spread out and need to be maintained.Furthermore, suppliers and consumers no longer have to perform all of the job themselves.(Bär et al., 2018; Büyüközkan & Göçer, 2018; Govindan et al., 2018; Novais et al., 2019). SMEs' supply chains have become more complicated in recent years because of their size, different products, changing customer needs, unpredictable demand, having to work with multiple suppliers, lots of different locations to serve, and different middlemen (Kamble, Gunasekaran,& Arha, 2019). Blockchain technology is really important for supply chains in India especially for SMEs. They're the most vibrant and dynamic part of the country, and they're helping to tackle poverty, inequality, and other issues. Blockchain technology can help them optimize their operations and make them more efficient and productive. But it's not easy to get blockchain in India, since they don't have access to a lot of resources like skilled labor, capital, and technology (Kumar et al., 2017; Nayak &Dhaigude, 2019; Wong et al., 2020). That's why recent literature has focused on how digital technologies can be used to improve supply chain management and reduce production costs. It's also important for companies to invest in these technologies because they can help them stay competitive (Kumar Bhardwaj, Garg, &Gajpal, 2021).This paper provides an overview of the factors that influence the intention of Indian SMEs to integrate blockchain technology into their supply chains. It also provides an opportunity for stakeholders such as SMEs, Technology Developers, Vendors, and Regulators to consider the factors that influence their intention to embrace blockchain technology.To further investigate the factors influencing the adoption of blockchain technology in India's manufacturing and service sectors as well as other industries, the paper also introduces a new integrated technology adoption framework, the technological acceptance model, and the technological, organizational& environmental (TOE) model.

The following inquiries are the focus of this examination and study:

RQ.1: What motivates the managerial decision-making operations of Indian SMEs to embrace the use of blockchain technology for SCM?

RQ.2: Which factor(s) are more closely tied to the adoption intention?

Literature Review

There are many benefits associated with blockchain technology, such as increased visibility and transparency, reduced risks, increased privacy, traceability, and security. Blockchain was first brought into the Bitcoin network as a decentralized, open, and secure way to keep track of transactions, eliminating the need for a third party to validate transactions (Hughes et al., 2019; Wang, Singh, Wang,&Rit, 2019). Based on the Internet protocol, this application layer technology maintains a consistent and trusted record of transactions through the use of cryptographic algorithms and distributed consensus algorithms among a distributed community of users. Businesses that invest in cutting-edge technologies have found ways to reduce manufacturing costs and remain competitive (Ying, Jia,& Du, 2018; Wang et al., 2018). As a result, companies need to move away from uncoordinated silo-based silos and towards integrated operationalimprovements around internal end-to-end processes and outside customer interactions. In addition,

technology and operational capacities would need to be employed in conjunction and in a manner that maximizes the overall and cumulative effect(Mueller & Urbach, 2021).

Efficient supply chain is possible by using blockchain technology, which is done by creating a digital record of transactionsinvolved in the supply chain(Kamble, Gunasekaran,& Arha, 2019). It also helps to predict demand, manage supply chain disruptions, and reduce inventory costs. Because blockchain technology is immutable and has a timestamp feature, when used in supply chains, it does not allow for any kind of backdating or data manipulation, which makes it more reliable and transparent. In traditional supply chains, electronic data is collected, collected, and stored on the service provider's central servers (Verhoeven et al., 2018). These servers are vulnerable to attacks. However, thanks to distributed consensus and cryptography mechanisms, blockchain technology improves data security and provides an environment that is safe from cyberattacks (Ivanov et. al., 2019; Abd El-Latif et al., 2021; Hao et al., 2020).

Technology adoption means the intent of a user to choose a technology for the purpose of using it for their own benefit. Therefore, technology adoption will result in the dissemination of technology and, thus, the adoption and use of technology by the general public (Carr, 1999; Bhardwaj et al.,2021, Cho 2024; Min et al., 2024).The technology Acceptance Model (TAM) is a model that has been studied and written about by many researchers in the field of blockchain adoption in the supply chain (Kamble et al., 2019).Due to the fact that content adoption in an organization is contingent upon technological, environmental and organizational factors, TOE provides a more holistic view of technology adoption. The TOE framework may be adopted in a wide range of contexts, depending on the selection of the organizational, technical, and environmental factors, as different innovations have distinct adoption factors as well as different cultures and contexts (Baker, 2012; Mohtaramzadeh et al., 2018). Based on the existing literature and recommendations from many experts, this study has been designed to explore the impact of many variables on technology adoption attitudes, the relationship between technology adoption attitudes and

purpose of adopting blockchain technology in the supply chain management of SMEs in India.

Hypothesis Development-Various Dimensions of TAM and TOE:

Innovation Characteristics

According to Rogers et al. (2014), relative advantage and technological compatibility are two qualities that are thought to be innovation drivers for blockchain supply chain adoption. Blockchain technology is expected to bring a lot of relative advantages to supply chains, like transparency, traceability, and reliability. Studies have shown that organizations use blockchain when they see advantages that are better than what's already available (Awaysheh& Klassen, 2010; Guo & Liang, 2016; Francisco & Swanson, 2018; Park,2020). Having a high level of compatibility makes it easier for an organization to integrate blockchain technology into their supply chains (Picoto, Bélanger,& Palma, 2014).The degree of blockchain technology's interoperability affects how eagerly a company is to integrate it into its supply chains (Choi et al., 2020; Kouhizadeh, Saberi, & Sarkis, 2021).

H1: There is positive impact of block-chain relative benefit on the use blockchain in supply chains of SMEs

H2: There is positive impact of block-chain compatibility on the use blockchain in supply chains of SMEs

Technological Characteristics

The technology context assesses the readiness of organizations to utilize blockchain technology in their supply chains. This readiness is based on the availability of the necessary hardware and software, as well as specialized personnel, to facilitate the application of the advanced technology(Low, Chen,& Wu, 2011). Organizations should be adequately equipped with the necessary technical knowledge, education, experience, and skills to effectively implement the new technology, resulting in improved organizational performance (Klug & Bai, 2015; Lindman et al., 2017).

H3:There is positive impact of block-chain technology readiness on intention to use blockchain in supply chains of SMEs

Organizational Characteristics

Security concerns and Top Management Support (TMS) are two organizational features that are thought to be drivers of blockchain supply chain adoption (Hsu, Liu, Tsou & Chen, 2019; Lutfi et al., 2020). It has indicated that TMS involves the provision of sustenance, assurance, and vigorous involvement of administration in the preparation, development, and implementation of technology in the business, as well as its utilization by the workforce (Liu, Tsou,& Chen, 2019; Alsyouf et al., 2020). Hsu et al., 2019,Similarly, security concerns are also important determinants of blockchain technology adoption. Blockchain transactions are usually clear, reliable, and traceable, which helps stop fraud in supply chains. But if there's a lot of agreement between people, it can be hard to keep track of who's doing what, so security can be at risk. Plus, people might be worried about their privacy and security because of data vulnerabilities in distributed ledgers (Queiroz & Wamba, 2019; Clohessy et al., 2020).

H4: Providing top management support will have a positive impact on the desire of SMEs to use blockchain in supply chains.

H5: Block-chain technology security risks will have a negative impact on the ability of SMEs to integrate it into supply chains.

Individual Characteristics

According to (Grover et al., 2019), individual traits like perceived ease of use (EOU) and perceived usefulness (PU) are crucial for encouraging individuals to use technology. Based on the tech adoption model's recommendations, perceived utility is the degree to which we expect the use of technology to improve our performance (Grover et al., 2019).There's a ton of research in the literature that shows there's a big connection between how much we think tech is useful and how likely we are to adopt it. It's seen as a key factor in the technology adoption model. Perceived usefulness often thought of as the main driver that encourages people to use new technology(Venkatesh & Davis, 2000; Chen & Barnes, 2007). Similarly, Perceived ease of use is also an important determinant of blockchain technology adoption (Gounaris and Koritos,2008). Those who perceive less effort are more likely to use technology

with ease, while those who perceive more effort are more likely to use it with ease. The ease of using tech services can have a big impact on how people feel about them in the long run. It can also make people more likely to use innovative technology and use it with Internet banking (Gefen, Karahanna& Straub, 2003).

H6: The perceived utility will have a positive impact on the desire of SMEs to use blockchain in supply chains.

**H7:**There is positive impact of block-chain ease of use on intention to use blockchain in supply chains of SMEs.

Environmental Characteristics

In various studies,regulatory support and vendor support have been observed as two essential dimensions of environmental characteristics for the intention to adopt technology in the supply chain of SMEs. The term "regulatory support" is used to describe policies and legislation that have a significant impact on the adoption of a new technology (Guo & Liang, 2016; Kouhizadeh, Saberi,& Sarkis, 2021). Vendor support is also essential for getting the most out of new tech. They make sure security is up to scratch, data is accessible, and there's no chance of them locking you out. So, having vendor support can really help people get the most out of the new technology. (Gangwar, Date & Ramaswamy, 2015; Kumar, Samalia & Verma, 2017).

H8: There is positive impact of block-chain regulatory support on the use blockchain in supply chains of SMEs

H9: Vendor support will have a positive impact on the desire of SMEs to use blockchain.

Figure 1: Conceptual Model
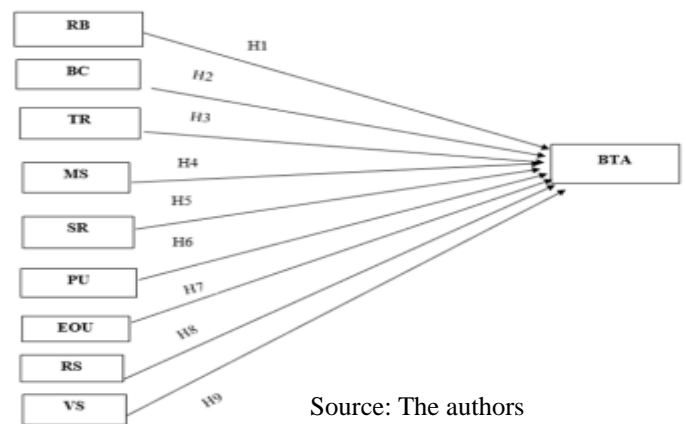
Source: The authors

Where,

RB: Relative Benefit; BC:Blockchain compatibility; TR:Technology Readiness; MS:Management Support; SR:Security Risk; PU:Perceived Utility; EOU:Ease of use; RS:Regulatory Support; VS: Vendor Support; BTA: Blockchain Technology Acceptance

Research Methodology

Research Design: This study used quantitative research to gather data through interviews with people and online surveys. They created a survey tool in the form of a pre-filled questionnaire and used both primary and secondary sources of data.

Research Instrument

The authors of this study surveyed managers and senior managers of small and medium-sized enterprises (SMEs) in India who work in supply chain management and management. They used a random sample approach to select employees of these SMEs. The managers who were actively involved in the use of blockchain technology services and AI services were included in the study. A well-designed questionnaire was prepared and sent to managers of small to medium-sized enterprises in Rajasthan, Maharashtra, Gujarat,and Haryanavia online mode. This questionnaire included questions on the demographic characteristics of respondents and features of Blockchain technology adoption by SMEs using a five-point Likert scale.

Sample Size and Demographic Profile of Respondents: The sample size was 380 participants for the survey "SMEs' Blockchain Technology Adoption". The total number of survey questionnaires distributed to managers was around 415. However, only 380 responses in full sense were received for analysis. All absent or invalid responses as well as random filling were removed, and 380 valid answers were sent to SPSS version 20 for analysis.Further analysis was doneusing AMOS software.The demographic profile of respondents includes all personal information of the 380 participants of this research. Education level included only graduates and postgraduates in which 60% of were postgraduates. Out of 380 respondents, 55% were senior managers, and remaining were managers. Among these managers, only 30% of the employees were female, whereas 70% were male employees. Around 65% of managers had been using blockchain technology for more than 4 years.

Scale Measurement Instrument

The integrated TAM-TOE model was represented in the structured questionnaire used as a research tool. The answers were scored on a scale of 1 (very disagreeing) to 5 (very agreeing). The scale items were all taken from previous studies that looked at blockchain adoption (Bhardwaj, Garg, & Gajpal,2021; Marakarkandy et al., 2017). The authors ran a pilot survey and sent out a questionnaire to ten supply chain professionals from different industries, like auto, logistics, food, and logistics. Based on the data analysis, the article ended up with 29 scale items, which are presented in Table 1. The authors used the Structural Equation Modeling Approach (SEM) to figure out how dependent and independent variables related to each other (Rai & Gupta, 2021). The authors did this using AMOS version 20, which is great for doing confirmatory factor analysis (CFA), multiple regression analysis, and path analysis.

Table 1: Questionnaire Statement

Construct	Items	Statement
Relative Benefit	RBS1	With the help of blockchain technology everyone associated with supply chain of the organization can access such information
	RBS2	blockchain technology is helpful to trace the origin and delivery point of material
	RBS3	With the help of blockchain technology we can access data and information at any point of time when required
Blockchain compatibility	BCS1	Our organization has developed IT infrastructure to support blockchain technology
	BCS 2	The blockchain support is associated with our organization's culture and values
	BCS3	our organization is already incorporating all the changes suggested by blockchain technology

Construct	Items	Statement
Technology Readiness	TRS1	My company is well aware about practical usages of blockchain to enhance supply-chain
	TRS2	Our supply -chain staff is well committed to connect blockchain technology with supply -chain works
	TRS3	our staff is technology savvy specially for application of blockchain technology
Management Support	MSS1	My senior management supports the use of blockchain
	MSS2	My senior management team is well aware about practical implementation and usages blockchain technology
	MSS3	My top -level management team is ready to take risks with-regards to blockchain technology application
Security Risk	SRS1	A little level of risk is always associated with utilizing blockchain technology for which our company has proper security measures
	SRS2	While using online transactions with the help of blockchain technology, our organization use security software
Perceived Utility	PUS1	Blockchain is useful to increase efficiency of supply chain
	PUS2	It is helpful to increase productivity of organization's supply-chain operations
	PUS3	Our organization's Blockchain application make supply-chain more effective
Ease of use	EOUS1	The technologies like blockchain are very simple and easy to use
	EOUS2	blockchain technology may be characterized as truthful and explicit
	EOUS3	It is easier to use as compare with traditional supply-chain methods
Regulatory Support	RSS1	Indian government has digital aim to promote the application of blockchain technology in organizations
	RSS2	Government has made appropriate policies to support industries for blockchain technology adoption
	RSS3	Government has made appropriate legal system to resolve any conflict arising due to use of blockchain technology
Vendor Support	VSS1	The vendor providing b lockchain technology to my company offers attractive incentive on use of their services
	VSS2	The vendor providing blockchain technology to my company also provide full technical support for technology adoption
	VSS3	The vendor also provides proper training facilities to our supply -chain staff for application of block-chain technology
Blockchain Technology Acceptance	BTAS1	my company is planning to set up blockchain management system (BMS) for supply chain management
	BTAS2	My company is planning for appropriate digital transformation of supply chain management in next few years
	BTAS3	My company aimed at continuous application of blockchain technology in supply-chain operations in next few years

Source: Questionnaire developed by (Bhardwaj, Garg, & Gajpal,2021; Marakarkandy et al., 2017), modified by Authors

Analysis and Interpretation:

Validity & Reliability of Instrument/ Scale:

CFA is a great tool for analyzing things like internal consistency between statements, whether or not a factor is reliable and valid, and whether or not it's discriminatory. The convergent validity of the measurement model was estimated based on the available recommendations using average variance extracted (AVE) and composite reliability (CRs). The values of AVE and CRs for all constructs exceed the threshold values (0.5, 0.7) as shown in Table 2. This is a measure of how reliable the questionnaire items are and how consistent the measurement results are.

Table 2: Summary of Convergent Validity in confirmatory factor analysis (CFA)

Construct	CR	AVE
Relative Benefit (RB)	.792	.709
Blockchain compatibility (BC)	.880	.790
Technology Readiness (TR)	.716	.590
Management Support (MS)	.800	.630
Security Risk (SR)	.788	.599
Perceived Utility (PU)	.800	.610
Ease of use (EOU)	.836	.701
Regulatory Support (RS)	.729	.719
Vendor Support (VS)	.889	.680
Blockchain Technology Acceptance (BTA)	.890	.799

Source: The authors

AVE= average variance extracted (It is more than the recommended value i.e., 0.5, Ruvio et. al., 2008).

CR = Composite Reliability (It is more than the recommended value i.e., 0.7,Chin,1998; Pervan et. al., 2017)

Discriminant validity is how different variables can be separated from each other. In this model, each variable is good at being different from each other, as seen in Table 3.The criterion for determining the discriminatory validity of a measurement model is to determine whether the square root of an AVE for each construct exceeds the correlation coefficient for each pair of constructs. As indicated in Table 3, the diagonal values of the AVE for each of the constructs correspond to the required criterion. Therefore, the discriminatory validity of the measure model is confirmed.

Constructs	RB	BC	TR	MS	SR	PU	EOU	RS	VS	BTA
RB	.80	-	-	-	-	-	-	-	-	-
BC	.35	.85	-	-	-	-	-	-	-	-
TR	.30	.38	.75	-	-	-	-	-	-	-
MS	.38	.46	.46	.80	-	-	-	-	-	-
SR	-.20	.27	.10	.40	.80	-	-	-	-	-
PU	.30	.30	.34	.35	-.19	.80	-	-	-	-
EOU	.39	.49	.30	.27	.20	.46	.81	-	-	-
RS	.19	.40	.40	.30	.17	.29	.49	.82	-	-
VS	.37	.39	.36	.24	.29	.49	.39	.24	.79	-
BTA	.45	.55	.39	.54	.19	.54	.50	.25	.55	.90

Source: The authors

Model Fit Indices:

In this article, researchers have tried to find the relationship between all the variables of the TAM+TOE model and their association with blockchain technology acceptance intention by usingSEM, as presented in figure 2. The values of model fit indices were found appropriate as per the recommended values (Hooper, Coughlan, & Mullen, 2008; Rai, Dua,& Yadav, 2019). The values of Chi-square (χ^2)/degree of freedom (1.515, p =0.001), root mean square error approximation (RMSEA) is 0.028, Comparative fit index (CFI) is 0.980, Goodness-of-fit index (GFI) is 0.930, and Incremental fit index (IFI) is 0.980 which makes the model fit as suggested.

Figure 2: Path Analysis Results and Hypothesis Testing:
SEM (Structural Equation Modeling)
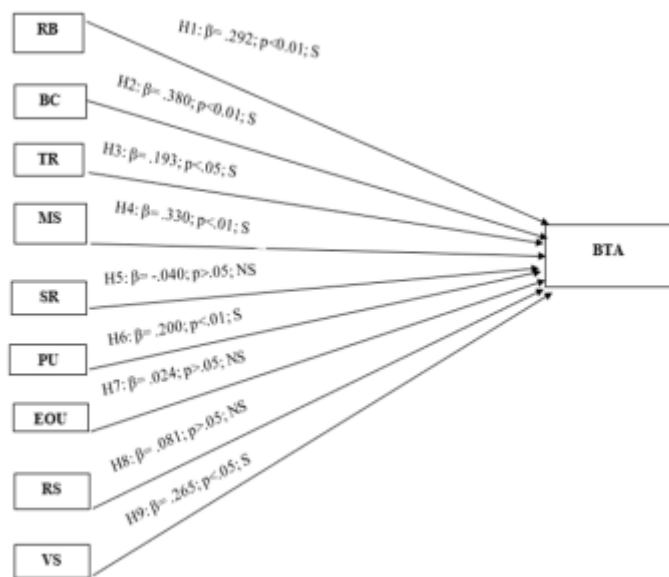
Source: The authors

Where,

β = Standardized path coefficients; **p value**= significance level; **S**= Hypothesis Supported; **NS**= Hypothesis Not Supported

The results of figure 2 aboveshows the values of RB (β = 0.292, CR = 3.300), BC (β = 0.380, CR = 4.750), TR (β = 0.193, CR = 2.200), MS (β = 0.330, CR = 4.070), PU (β = 0.200, CR = 2.409) and VS (β = 0.265, CR = 2.890) all these

factors have positive impact on BTA. Thus, the results indicated that hypotheses H1, H2, H3, H4, H6 and H9 were supported as their p values are less than 0.05. Whereas SR (β = -0.040, CR = -0.770), EOU (β = 0.024, CR = 0.780), and RS (β = 0.081, CR = .920), have less/negative impact on BTA. Hence results indicated that hypothesis H5, H7 and H8 not supported as their p values were more than the recommended value i.e., 0.05.

Conclusions

This study examines the many motivations that Indian small and medium-sized enterprises may have for integrating blockchain technology into their supply chains.It examines innovation, technical, organizational, environmental, and individual aspects using the TAM-TOE paradigm and generates nine distinct hypotheses. Six of the factors were confirmed. They were as follows: Relative advantage, compatibility with blockchain technology, technological preparedness, support from management, perceived utility, and vendor support. However, variables like Security risk, ease of use and Regulatory support not significantly associated withBlockchain technology acceptance by SMEs (Bhardwaj et al., 2021). Blockchain compatibility is further found to be a key factor in SMEs deciding to use blockchain in their supply chains. This study addresses a major gap in the research field since very few studies have looked at the manner in which small and medium-sized businesses in developing countries like India use technology. (Wong and colleagues, 2020; Nayak &Dhaigude, 2019). The research findings may be utilized by vendors, suppliers, tech developers, and regulatory bodies to determine the motivations for their adoption of blockchain technology. If suppliers can demonstrate the advantages of blockchain technology, such as accessibility of data, transparency, record validation, route monitoring, etc., small and medium-sized firms in India are more inclined to embrace the technology. Blockchain developers should provide customized tech solutions and have an understanding of the compatibility requirements of SMEs.

Limitations of the Study

It is thought that the sample size of 380 respondents in this study is too small to allow for the generalization of findings

to the full nation. Furthermore, data was collected from the employees of small and medium-sized enterprises (SMEs) in only a few states. Furthermore, only the employees of managers or senior managers were included in the study. This research work mainly validated the associated factors affecting adoption of block-chain technology by SMEs. This result cannot be generalized in all situations. Therefore, this study is not applicable to the entire supply chain operations or management of all small and medium enterprises (SME) in India. This study is purely an exploratory one.

Practical Implications

The potential for further exploration in this field is immense.The stakeholders, government officials, business leaders, and policy makers engaged in the deployment and provision of a blockchain service may all benefit from this study.According to the report, SME management authorities need to set up the required technological and organizational framework to guarantee a seamless blockchain experience for supply chain management.In addition, it is suggested that Indian policy makers create a regulatory framework to govern the utilization of blockchain technology.

Acknowledgement

Declaration of Conflicts of Interests

Authors declare that they have no conflict of interest.

Data Availability Statement

The database generated and /or analysed during the current study are not publicly available due to privacy, but are available from the corresponding author on reasonable request.

Declarations

Author(s) declare that all works are original and this manuscript has not been published in any other journal.

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