

Adaptation of block chain technology in SCM for steering managerial strategies: investigative study under Indian context

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Abstract

Purpose – Block chain technology (BCT) has apparent capability of handling information in digital format, which has dragged attention of the practitioners for its utility in industrial and manufacturing practices. Conversely, the managerial adoption of BCT is relatively limited, which motivated the authors to identify crucial dimensions that can persuade the acceptance of BCT from an executive perspective. Thus, the present study is aimed to conduct to understand crucial barriers under BCT for managerial implementation in supply chain management (SCM) of small and medium enterprises (SMEs).

Design/methodology/approach – The present study investigated evident barriers to understand implementation of BCT. A questionnaire based survey is performed to collect primary data from service and manufacturing based companies in India. Survey responses are received online and the data is analyzed in a scorecard. The scorecard embedded the scribed entries of Likert scale to determine the relative score.

Findings – In present study, sixteen barriers from three categories named as technological, organizational and environmental are evaluated, where, five sub-barriers from technological domain, seven sub-barriers from organizational domain and four sub-barriers from environmental domain are evaluated. The findings of the study determined that the three factors, i.e. “complexity in setup/use”, “Security and privacy concern” and “Technological awareness” mostly affect the adaptation of BCT in SCM. Conversely, “Market dynamics”, “Scalability” and “Cost” do not influence the intention to adopt the technology.

Originality/value – Only few studies have endeavored to ascertain the BCT adoption in SCM of SMEs in developing country like India. Thus, the study is filling a momentous gap of mapping BCT dimensions in the scholastic literature. The findings are expected to enable SMEs to understand important factors to be



considered for adopting BCT in their curriculum. Furthermore, the study may benefit the BCT developers and suppliers to endure customized solutions based on the findings.

Keywords Block chain technology (BCT), Adaptation, Barriers, SMEs, Questionnaire-based survey

Paper type Research paper

1. Introduction

Today, the digital transformations, integrated software's and technological platforms are utilizing by the businesses to manage their routine activities accurately and competitively (Soliman and Janz, 2004; Rane and Thakker, 2019). Today to harness maximum potential from available sources, it is required to seek and develop efficient tools and platforms (Sahu *et al.*, 2020; Jangde *et al.*, 2022). Today, numerous next-generation communication technologies like BCT, Internet of Things and cloud computing are available to avail unlimited competencies to diverse applications textures and contractual contexts (Werner *et al.*, 2020; Rahmazadeh *et al.*, 2020). To seek competitive benefits and improved operational presentation, the business globe is thinking to adopt these technologies in applied fields. Recently, BCT has come into sight as a broadly acknowledged transformative technology due to assumed assortment of benefits like easy in collaboration for companionship, transparency, ease understanding, process streamlining, cost optimization and verified record-keeping attributes etc (Saber *et al.*, 2019; Kamble *et al.*, 2021). BCT can retain various advantages in supply chains (SCs) such as cost optimization, effective transmission, verified record-keeping, transparency and route tracking.

The supply chains are nowadays posting enhanced complexity due to amplified sale of products, diversified product range, improve customer preferences, tentative demand conditions, need of collaboration with multiple partners, management of huge number of geographic locations, easy serving and introduction of variety of intermediaries (Bag *et al.*, 2021a; Sahu *et al.*, 2022). Hence, there is a need to incorporate technological push for globally transforming organizations from traditional to technology driven SC management systems. The same is also needed for enhanced and effective collaboration across customers, suppliers, partners and buyers under dynamic provisions (Choi *et al.*, 2019; Bag *et al.*, 2021a).

For increased efficiency, BCT is now needed to embrace in supply chain management (SCM) systems in recent times. BCT works with a distributed network, where each and every operation being validated and witness by many consensus in the form of nodes in the network chain. BCT holds immense caliber to enable verifiable and immutable records in conjunction with data transparency and route tracking (Saber *et al.*, 2018; Yoon *et al.*, 2020). In opposition, BCT adoption in SCs is inherent with many challenges like hardware and software rations, training requests, cost implication and security fear, etc. Thus, present study is conducted to demonstrate the BCT adaptation from the insights of manufacturing and service sectors in India. The attributed characteristics of BCT are considered to conduct present study with the intension to report the below mentioned research questions (RQ).

- RQ1. How to identify crucial dimensions towards persuading the recognition of BCT in organizational SC boundaries.
- RQ2. What are the crucial barriers and how to investigate these barriers, which are hindering the implementation of BCT in manufacturing and service sectors in India?
- RQ3. What are the necessary suggestions that can be presented to BCT developers and suppliers to induce customized solutions on BCT frameworks?

To report the above questions, the present study is conducted in six sections, where in first section, introduction to BCT is presented. The preceding literature belonging to BCT are

presented in section two to enlist crucial facts and research gaps. Section three is reporting the methodological structure of present study. Section four is reporting the case discussion and analytical part. Section five induces the discussions, which is followed by conclusions, managerial implication, limitations and future study in section six.

2. Literature review

A wide extent of literature survey is conducted to understand BCT contexts, where it is found that the block chain induces an open, shared and distributed ledger that permits the confession of information, responsibility and dependability acknowledgment (Zagurskiy and Titova, 2019; Wang *et al.*, 2019b). Block chain embraces an induced technology, which can be suitably applied for dealing with valuable information (Song *et al.*, 2020; Vaio and Varriale, 2020). BCT uses distributed ledger technology to entail peer-to-peer transaction network with the purpose to support in up-gradation of information from distributed networks (Lohmer *et al.*, 2020; Rawat *et al.*, 2021). Thus, its implementation in organizational SC may induce several benefits in terms of logistics management, adaptation of manufacturing technology, understanding demands, supplies and flexibilities in product, services and manufacturing process. Consequently, it is found significant to inquire influencers that possess the capability to haul organizations to embrace BCT (Sahu *et al.*, 2018; Ghode *et al.*, 2020; Aslam *et al.*, 2021).

In BCT, ledger blocks are considered to impose different business policies, which are verified and approved by all the associated user nodes under laid network. Thus, in industries, where financial transactions are needed, BCT can provide trust and certifications. BCT can preserve every part of product's data, including its subassemblies, parts and distribution networks (Zelbst *et al.*, 2019; Dwivedi *et al.*, 2020). It condenses the risk of service disruption in the stages of SCs. BCT can maintain digital integration between customers, partners, distributors in complex SC network. A block chain supply chain (BCSC) can assist in witnessing price, date, time, place, quality, documentation and supplementary information with the purpose to efficiently manage SC elements (Casino *et al.*, 2019; Dolgui *et al.*, 2019). The accessibility of relevant information with the utility of block chain can be helpful in increasing traceability of inventories over SC, management of human resources and assist in perceiving the dynamic condition of market (Van Hoek, 2019; Agrawal *et al.*, 2021). BCT can improve visibility and lead in conformity of contracts from outsourced parties in manufacturing. BCT can potentially boost organization arrangements and can provide support management tool for responsible manufacturing (Helo and Hao, 2019; Esmaeilian *et al.*, 2020). BCT has harvested substantial interest and has the aptitude to notably advance industries and SC environments.

BCT is competent for communication, cooperation and possess the attribute of allowing users to interact with systems in real time (Azzi *et al.*, 2019; Esmaeilian *et al.*, 2020). BCT develops smart contracts for making business transactions reliable and to provide exchanges amongst parties within SC precisely (Hong *et al.*, 2013; Martinez *et al.*, 2019). The said technology makes the business transactions visible and induces the capability of safe financial transactions. From the operational point of view, the adoption of BCT can simplify SC practices by sinking disputes over invoices (Kouhizadeh *et al.*, 2021; Kang *et al.*, 2022). This technology can potentially improve diverse segments of manufacturing business and can add swiftness, reliability and cost-efficient statistics to the organizations (Pournader *et al.*, 2020; Kim, 2020). Purchase orders and agreements can be formalized between SC partners with their registration in digital formats by the utilization of BCT. With the BCT, confidential data can be stored and made available to the peers with a private key. Security, privacy and data transparency can be improved by the implementation of BCT into the operational domain of both small and large-scale businesses (Kурpjuweit *et al.*, 2019; La Cava and Naatus, 2020). BCT may endure prominent benefits to the SC in small and medium enterprises (SMEs).

Today, SMEs are giving their contribution to eradicate unemployment, poverty, income inequality and regional imbalances in many countries (Moore and Benbasat, 1991; Modgil and Sonwaney, 2019). Thus, BCT can facilitate SMEs to turn into more fruitful, vibrant, dynamic and competitive market (Lu, 2018; Shoaib *et al.*, 2020). The adoption of BCT in SMEs can optimize operational efficiency and can provide performance excellence. On the other hand, its adoption in SMEs are attributed in many challenges in the form of imperfect accessibility of different resources like skilled workforce, capital, technology penetration, etc (Hoxha and Sadiku, 2019; Jabbar and Dani, 2020). The implementation of BCT can be influenced by strategically searching and evaluating hidden barriers from the network. The same motivated the authors to carry out indeed research in this field. Research is conducted in BCT barriers context for realizing implementation of the BCT in SC from numerous aforesaid standpoint and benefits. The study examined potential barriers from diverse viewpoint to raise awareness about potential barriers for the purpose of strategically handling them in early phases of implementation.

2.1 Research gaps and motivations

An apparent scale of research has been found; where, the researchers worked to integrate technological elements to reinforce the technical capabilities of BCT (Kurpjuweit *et al.*, 2019; Lohmer *et al.*, 2020). Technical capabilities are amplifying by the practitioners to ease maintain distributed records of database. Evident practices and critical frameworks are proposed by the researchers to maintain agile transactions by BCT. Additionally, the capabilities of the BCT are continuously evolving from the insights to record digital events, which are taking place amongst shared network and participating parties (Dolgui *et al.*, 2019; Rawat *et al.*, 2021). But, deficient studies has been found by the authors, which highlighting the applied utility of BCT in numerous application fields. The same is identified as a historic research gap for present study and thus present study is conducted to understand the crucial barriers, which are impinging the BCT implementation.

Nowadays, BCT has been admired as a new technical insight by the practitioners for the digitalization. It has been understand that nowadays, digitalization can provide additional hands to the industries for the resolution of the problems and identification of the needs (Manupati *et al.*, 2020; He *et al.*, 2021). Digitalization can illuminate new insights, but its implication needs the support of through technology, which can capably synchronize assets and resources for serving to the customers (Shahnaz *et al.*, 2019; Queiroz and Wamba, 2019). BCT is quite efficient in aforesaid regard and verifies each transaction by according consents from the majority of the participants integrated into the decentralized system and maintains public ledger (Vaio and Varriale, 2020; Aslam *et al.*, 2021). The utility of BCT can create digital online world, which can capably unlock the gate of mounting an autonomous open and scalable system for arousing digital economy (Martinez *et al.*, 2019; Casino *et al.*, 2019). Today manufacturing industries are the spinal cord on any economy, where the implementation of BCT can harvest multiple benefits. Accordingly, crucial barriers are identified from the extent insights of decision makers, who belong to SMEs to reveal its implementation under said boundaries, which acts as a second research gap for present study. It has been found that the BCT has tremendous opportunities, but indeed revolution is required in the form of its applicability in different fields, which depends on the identification of barriers and challenges from the insights of manufacturing and service sectors. The same motivated the authors to embrace quality research in the direction of its implementation in numerous manufacturing and service sectors.

Many studies reviewed the technical structure of BCT, reported the fundamentals elements and working mechanism of BCT (La Cava and Naatus, 2020; Ghode *et al.*, 2020). Many studies reported the trends based on competent publications done on the boundaries of BCT. Many bibliometric analyses have been reported by the researchers, but still lack of

studies are found, which concentrated on the application utility of BCT and exploited crucial barriers and drivers (Dolgui *et al.*, 2019; Song *et al.*, 2019). BCT could make a digital asset, computerized data management system, but still the applied documents are deficient found, which established the practical implementation of block chain research related to the incorporation of BCT in modern applications to shape the future of BCT.

3. Methodology

The main intention of this study is to realize the most crucial barriers, which principally affect the BCT implementation in manufacturing and service-based companies. For the same, a questionnaires-based survey is performed by considering the decision makers from the field of SMEs. A questionnaire survey is utilized to collect the data for present study. Surveys are conducted, and online responses are received based on Google forms. The responses are received from decision makers using 10 point Likert scale, where 1 signifies the least critical and 10 signifies the most critical entity. The same are used to understand critical barrier, which can assist in making fruitful strategies and policies for the implementation of BCT in SMEs. The data is collected in a scorecard containing the scribed entries of Likert scale and the same are aggregated to compute the relative score (RSC). Equation (1) is utilized in this context to compute the RSC, where, *NDM* stands for number of decision maker and *TNDM* stands for total number of decision makers.

$$RSC = NDM \otimes 1 + NDM \otimes 2 + NDM \otimes 3 +NDM \otimes 10 / TNDM \quad (1)$$

A five step approach is utilized in present study as a methodological part to conduct the present study. The methodological flow chart can also be understood by Figure 1 to ease facilitate the practitioners in conducting similar studies in other application fields.

Step –1: Formulation of a list of questionnaires

In the preliminary phase, vital literature under BCT is identified. After, understanding the vital literature, it has been identified that a low extent of work is reported by the researchers in defining the application utility of BCT. Consequently, the considered literature is again studies to understand the critical barriers, which hampered the utility of BCT in diverse segments. Accordingly, three categories named as technological, organizational and environmental are realized by the authors having segmental relations with BCT structures, where sixteen barriers are identified. Five sub-barriers from technological domain, seven sub-barriers from organizational domain and four sub-barriers from environmental domain are realized. Accordingly, sixteen questionnaires are prepared to understand the crucial barriers and their ranking.

Step 2: Attainment of online responses from participants

After the preparation of the questionnaires, online survey is performed to collect the primary data for present study. Surveys are conducted and online responses are received for questionnaires based on Google forms. For the same, 10 point Likert scale is utilized; where 1 signify the least value of response and 10 signify the highest value of response.

Step 3: Evaluation of responses

Afterward, responses are evaluated based on the aggregation of responses. RSC is computed for the responses to understand the central tendency. RSC is computed to define a single value that can assist in describing the central position of collected data. The responses are aggregated to compute the RSC using Equation (1). The RSC is determined to understand the most crucial barrier.

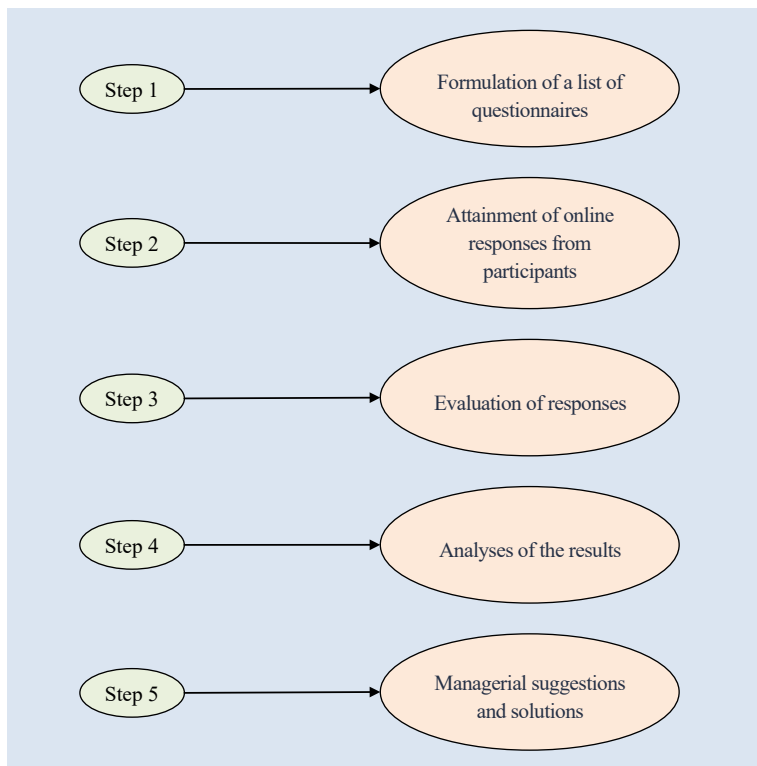


Figure 1.
Methodological flow
chart of present study

Step 4: Analyses of the results

Next, results are analysed based on attainment of *RSC* values. The analysis is performed for figuring out the critical barriers and to generate the ranking report of the barriers. Charts and graphs are also prepared in this regard to visualize the ease representation of data.

Step 5: Managerial suggestions and solutions:

Afterwards, suggestions and solutions are presented for ease implementation of BCT under the managerial domain by the organization. Identification of critical barriers will lead in achieving sustainable outcomes in terms of BCT development, fostering innovation, technical understandings, strategic planning, empowering technology, and practicing policies and linkages.

4. Case discussion

The present study is subjected to understand the possible hurdles in implementation of BCT in the SCs. The present study is conducted to persuade the acceptance of BCT from an executive perspective. There are several margins found, which replied the utility of BCT and motivated the authors to search crucial barriers towards the imposition of BCT in commercial SC domain. BCT in SCs can be used as a tool for the management of competitive pressure, clarity of the transactions, data reliability, accuracy, transparency and integrity amongst associates. It is found that alteration of organizational culture for process harmonization,

linkage amongst huge SC resources, support from the community, professional consultation and trading partner readiness to participate and so on are few evident characteristics found, which need to be prevailed for deemed implementation of the BCT. BCT can lead in reducing overhead expenses, data error rates and can save time in handling business tasks and to gain overall productivity.

The authors identified that potential drivers, knowledgeable studies and critical revisions related to BCT should be understood for sustainable development and further developing the utility of BCT (Saurabh and Dey, 2021). Critical research studies are needed to understand the applied practices of BCT for tracing product information (Yang *et al.*, 2021), for managing resiliency (Poonia *et al.*, 2021), to migrate from the centralized model to value chain (Leduc *et al.*, 2021) and to transform the traditional operational practices (Dong *et al.*, 2021). For arguing sustainability in SCs through BCT, theoretical frameworks based on drivers and compound barriers are needed to be evaluated (Bai *et al.*, 2022). Authors understood that BCT is a transformative technology and can give a variety of paybacks in SC in terms of ease collaboration with transparency between internal parties and external persons. Moreover; process streamlining, service management with cost optimization can be attained with BCT (Dolgui *et al.*, 2019; Yoon *et al.*, 2020), but its utility in application fields is still found deficient by the authors due to technical awareness, complexity in technology, cost concerns and many chains of inhibitors.

In responding towards the aforesaid concern, the study is conducted to argue about the utility of BCT in service and manufacturing industries. BCT is not so far effectively implementing by SMEs. Furthermore, scarce studies about security concerns and perceived ease of utility under the bench of BCT are found that can influence the intention to adopt BCT by the stakeholders (Casino *et al.*, 2019; Aslam *et al.*, 2021). Thus, present study is conducted to define the academic sphere and to determine the acceptance of BCT in SCs of SMEs in a developing country like India. The implementation of BCT in SCs can preserve numerous benefits in terms of sharing of information, traceability, monitoring, transparency, allocations etc. BCT can employ digitalization in SC, can import decentralized structure, can offer improved efficiencies and trust in making strategic decisions agilely and accurately (Lohmer *et al.*, 2020; Rawat *et al.*, 2021), but that too needed BCT utilization and resolution of implementation barriers. BCT implementation is bounded by clusters of barriers, drivers and factors from the side of economy, legislations, organization resources, priorities and intensions. Hence, present study is conducted by the authors to understand crucial barriers, which are hindering the adaptation of BCT in SMEs.

The study reviewed BCT barriers by considering the perceptions of decisions makers, where the perception of nineteen decision makers are received by the authors working in the field of printing and publishing, dairy products, catering services, beverages manufacturing and grocery store. The employees working at the level of executives and managers are contacted and the online questionnaires are shared with them. Nineteen respondents have filled the online questionnaires. The targeted population considered for this research is the professionals of the various service-based companies and manufacturing companies, so that the extent views of many divisions can be understood about the technological adaptability of BCT.

4.1 Barriers to implement BCT

It is observed that the examination of the process variables (barriers) is necessary for enhancing the utility of the system and for the development of the industrial and societal belongings. The same is also needed for implementation, to obtain integrated results from allied elements and to radically convince executives to adopt new technologies. The system variables and the implementer's needs are hidden hurdles towards an implementation of

novel technologies, which needs to be vigilantly identify prior to implementation. BCT integration requires the participation of all representatives and hence its adaptation is crucial in comparison to other in-house adoptable technologies. BCT integration with SCM requires the evaluation and identification of potential barriers for solution from practitioners, which may be external, internal or rooted from the system characteristics (Malik *et al.*, 2021). The present study evaluated barriers from three categories named as technological (Figure 2), organizational (Figure 3) and environmental (Figure 4), where, five sub-barriers from technological domain, seven sub-barriers from organizational domain and four sub-barriers from environmental domain are evaluated. It is affirmed that the exploitation of BCT in SCs is presently in the early stage and requires sustainable studies for the full acceptance, function and potential implication. Total of 16 barriers are presented in present study (Figure 5), whose technical description can be understand in section 4.1.1– 4.1.16.

4.1.1 Complexity in set up/use. Complexity is significant to define the excellence of the system. The same denotes the complicatedness of the system. Complexity in BCT can be feasible for the system security and may be responsible for decreasing the system reliability (Biswas and Gupta, 2019; Malik *et al.*, 2021). The efficient block chain system should not be too complex as it creates hurdles in operability and understanding. Thus, complexity can act as barrier for BCT adaptation by the concerns.

4.1.2 Compatibility. This indicates the system effectiveness to work collectively without having any problems or conflict. Block chain system should be companionable enough to meet the expectations, integration with desirability and consumers beliefs against standards

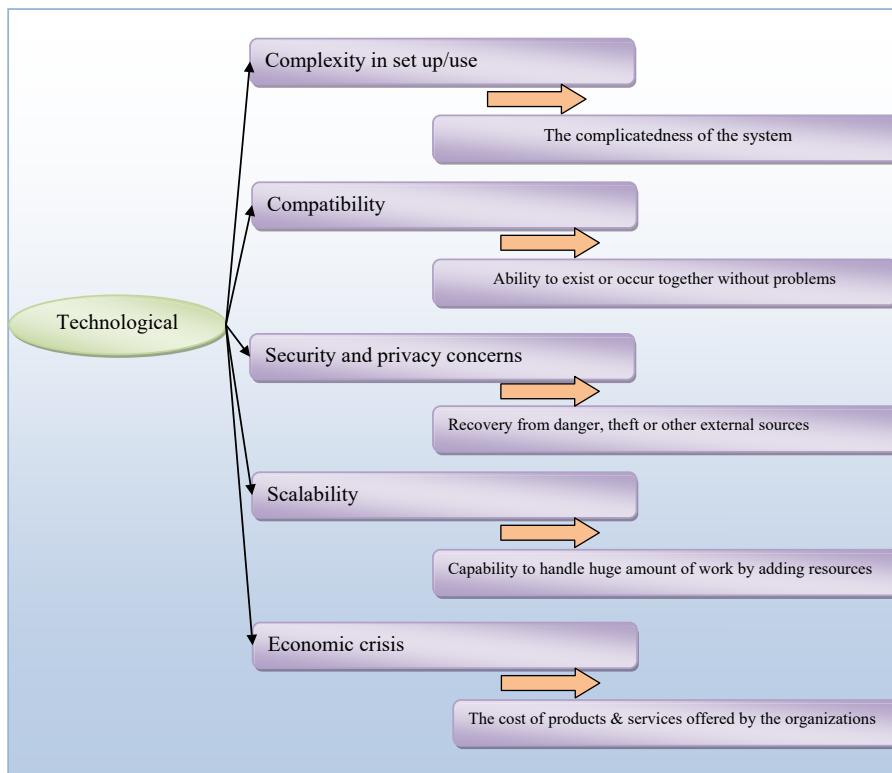


Figure 2.
Categorization of sub-
barriers under
technological domain

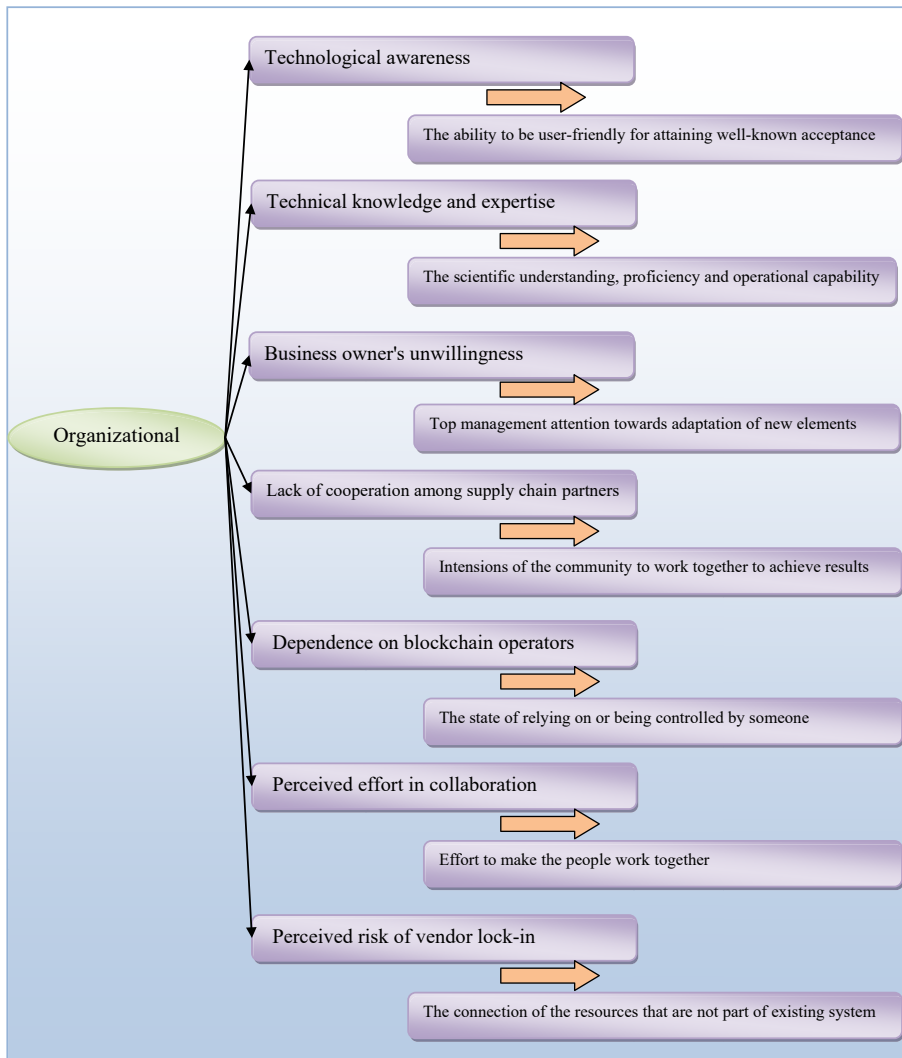


Figure 3.
Categorization of sub-barriers under organizational domain

or reference point (Ghode *et al.*, 2020; Aslam *et al.*, 2021). Thus, compatibility can act as barrier for BCT adaptation by the concerns. The present technology should assure the level of service that should be provided and acceptable by the customer against the benchmark over which the performance is to be judged.

4.1.3 Security and privacy concerns. This point towards the effectiveness of system to recover from danger, theft and other external sources. The security and privacy concerns should have to be high enough to prevent it from nondesirable external resources (Kouhizadeh and Sarkis, 2018; Bag *et al.*, 2021b). Security and privacy concerns are increasingly demanding in any business. As the BCT systems stored personal data in the block and their safety concerns are the top most priority (Lohmer *et al.*, 2020; Rawat *et al.*, 2021). The system should be safe enough that data risk management should be completely

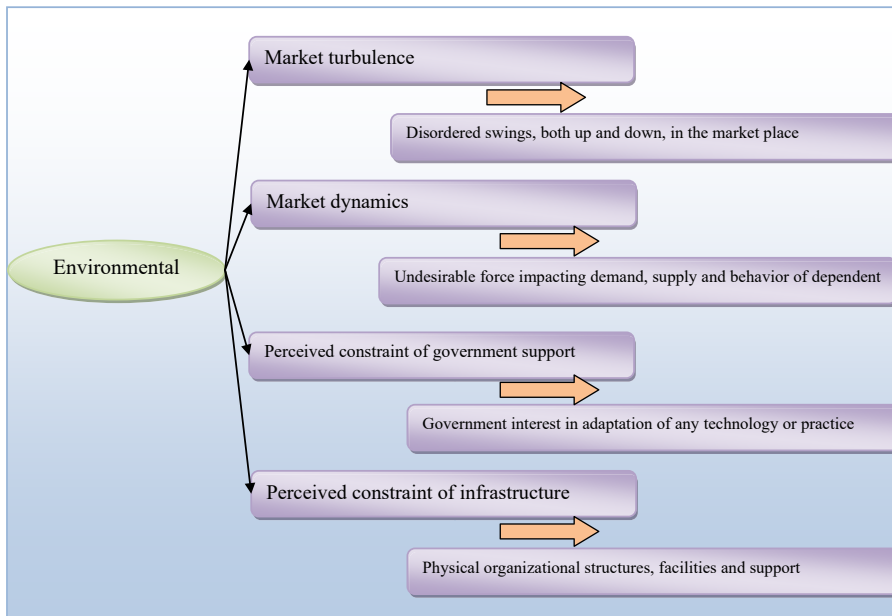


Figure 4.
Categorization of sub-
barriers under
environmental domain

secured. Thus, security and privacy concerns can act as barrier for BCT adaptation by the dependent.

4.1.4 Scalability. This indicates the system capability to handle a growing amount of work by adding resources. Thus, the issue of scalability can act as barrier for BCT adaptation by the concerns. The block chain system should be designed in such a manner that the system should be capable enough and robust that one can increase or decrease the system performance (Zelbst *et al.*, 2019; Dwivedi *et al.*, 2020) in accordance towards processing demands. The system should be designed in order to have lower maintenance costs, better user experience, higher agility, expandability, manageability, portability, extensibility, connectivity and functionality.

4.1.5 Economic crisis. Business organizations are focusing towards finding the right solution for their customer's demand in order to attain competitive advantage and to evade towards cost statistics (Wang *et al.*, 2019a; Vatankhah Barenji *et al.*, 2020). The development of the efficient block chain system initially demands huge cost, massive resource allocation and risk, before its commencement (Casino *et al.*, 2019; Dolgui *et al.*, 2019), which may refrain practitioners in implementing it. Thus, investment towards costs prior to BCT commencement can act as barrier for BCT adaptation by the concerns. Various research center and software development are needed towards finding the ways for the cost reduction in the block chain system development stage to enable various organizations to utilize block chain system for their products and services.

4.1.6 Technological awareness. Technological development is vastly emerging, requires individual's attentiveness and outlooks towards the improvement in existing system characteristics. The block chain system should be developed by keeping in mind the individual skills, their intellectual capability and have to be user-friendly for attaining well-known acceptance across concerned organizations/markets (Lu, 2018; Shoaib *et al.*, 2020). Thus, technological awareness can act as barrier for BCT adaptation by the concerns.

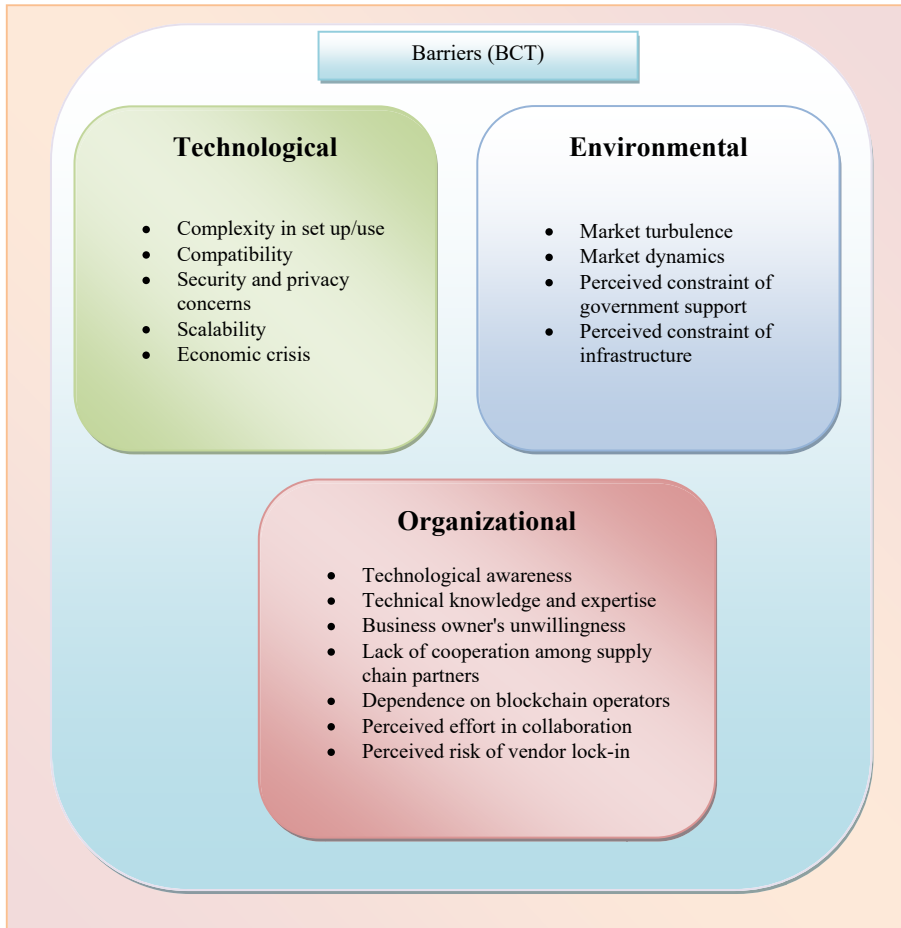


Figure 5.
Pictorial
representation of
barriers to
implement BCT

4.1.7 Technical knowledge and expertise. This refers to the dedicated understanding and proficiency that an individual should need to perform multifarious actions and procedures in computational working environment. The block chain system for a successful business should be diverse and simple towards its operational capability and should not require high technical knowledge and expertise (Hong *et al.*, 2013; Martinez *et al.*, 2019). Thus, Technical knowledge and expertise can act as barrier for BCT adaptation by the concerns.

4.1.8 Business owner's unwillingness. Implementation of new technology over conventional or obsolete technology is always a challenging task. The decision for its implementation is primarily depends upon the willingness of top management. Business owner's in primary stage avoids adaptation as it requires massive involvement of huge working capital, cost, personnel involvement, resources allocation, finance, management etc (Bag *et al.*, 2021a, b). Thus, business owner's unwillingness can act as barrier for BCT adaptation by the concerns. The benefits and the huge opportunities that may be achieved with the implementation of new technology should motivate the top management for its adaptation for moving towards futuristic growth of an organization.

4.1.9 Lack of cooperation among supply chain partners. This point towards the intensions of the community to work together to achieve results. The individuals helping each other are prominently required to achieve a common goal. Thus, issue of cooperation among supply chain partners can act as barrier for BCT adaptation by the concerns. The lack of cooperation or noncooperation amongst dependents will hinder the proper functioning and aggravate existing development challenges (Wang *et al.*, 2019a; Vatankhah Barenji *et al.*, 2020).

4.1.10 Dependence on block chain operators. This point towards the state of relying on or being controlled by someone or something else. It is evident that the individuals often like to work independently to acquire quality outputs. In BCT, verifiable records are maintained, thus the dependability of one entity towards other for approval may hamper the efficiency of the outputs due to the dependent cause (He *et al.*, 2021; Kang *et al.*, 2022). Thus, dependence on block chain operators can act as barrier for BCT adaptation by the concerns.

4.1.11 Perceived effort in collaboration. The same point towards describing an effort implicated by the system or technology to make the people work together. Collaborative is frequently used in a positive perspective to refer the force towards two or more parties productively working together for the attainment of common goal or shared project (Malik *et al.*, 2021; He *et al.*, 2021). Thus, the accumulation of people to work together under one BCT roof can be an evident barrier to avoid BCT implementation by the concerns in industrial SCM.

4.1.12 Perceived risk of vendor lock-in. Vendor lock-in may induce an issue towards involving a moving data to a totally different type of environment and may involve reformatting the data (Malik *et al.*, 2021; Kang *et al.*, 2022). This characterized the inability or limited ability to make the connection of the resources like vendors that are not the internal part of the existing system. Thus, perceived risk of vendor lock-in can act as barrier for BCT adaptation by the concerns.

4.1.13 Market turbulence. Market turbulence points towards the occurrence of time making disordered swings, both up and down, in the market place. Thus, market swings and up-down circumstances can act as barrier for BCT adaptation by the concerns. The implications of market turbulence adversely affect the implementation of the any new technology (Wang *et al.*, 2019a; Malik *et al.*, 2021). The market turbulence shifts the mind of the emerging business opportunities and creates hurdles in deploying capital.

4.1.14 Market dynamics. The same point towards any undesirable force that will impact demand, supply and the behaviors of producers and consumers. The supply and demand changes in the market normally describe market dynamics, which are due to the imposition of many external or internal factors that stimulus the Individuals, corporate or the government (Bag *et al.*, 2021a; Malik *et al.*, 2021). Thus, market dynamics can act as barrier for BCT adaptation by the concerns.

4.1.15 Perceived constraint of government support. Government constraints can be key focus towards the adaptation of any technology or practice. The same may be significant to demonstrate the economy analysis to redeem the contribution of any policy or provision (Malik *et al.*, 2021; Bag *et al.*, 2021b). The government supports may be significant to induce innovative startups and helps for the entrepreneurs to grow. Thus, perceived constraint of government support can act as barrier for BCT adaptation by the concerns.

4.1.16 Perceived constraint of infrastructure. The same refers the basic physical and organizational structures and facilities, which are needed for the operation of an organization or enterprise. Infrastructure defines the set of fundamental facilities that support the sustainable functionality of companies. The companies should setup up improved infrastructures nomenclatures to maintain the simplicity and effectiveness of new technology (Bag *et al.*, 2021a; Malik *et al.*, 2021). Thus, perceived constraint of infrastructure can act as barrier for BCT adaptation by the concerns.

4.2 Analysis

BCT has the potential to improve different aspects of the manufacturing industry and can make it more swift, reliable and cost-efficient. However, sustainable businesses ventures are not adopting it. Thus, in present study, BCT is evaluated in the direction of hurdles, which are unstimulating business owners to pull BCT into their manufacturing enterprises. The present study has used qualitative research that involved data collection through online surveys. For this purpose, a survey instrument in the form of Google form is structured with developed questionnaires. Primary data sources are used in the study. A questionnaire survey is employed as the data collection method for this research. The authors have done this survey by sending Google form to various manufacturing and service sectors under Indian context. A Google form with a questionnaire link had been sent to the e-mail of the respondents. The questionnaire link had been hosted online. The details of the research objectives had been shared with the respondents to seek their consent to participate in the study. The participation had kept voluntary with follow-up emails at frequent intervals by the authors with a request to participate in the survey. The questionnaires demography can be understand from Table 1. The targeted population of present study is the professionals of the various service-based companies and manufacturing companies. The pictorial representation of the survey form can be seen from Figure 6.

Question	Description	Analysis
Q1	How would you see (scale from 1 to 10) “the Complexity in set up/use” act as a barrier to implement block chain in your company?	Scorecard
Q2	How would you see (scale from 1 to 10) “the Compatibility” act as a barrier to implement block chain in your company?	Scorecard
Q3	How would you see (scale from 1 to 10) “the Security and privacy concerns” act as a barrier to implement block chain in your company?	Scorecard
Q4	How would you see (scale from 1 to 10) “Scalability” act as a barrier to implement block chain in your company?	Scorecard
Q5	How would you see (scale from 1 to 10) “Cost” act as a barrier to implement blockchain in your company?	Scorecard
Q6	How would you see (scale from 1 to 10) “Technologic awareness” act as a barrier to implement block chain in your company?	Scorecard
Q7	How would you see (scale from 1 to 10) “Technical knowledge and expertise” act as a barrier to implement block chain in your company?	Scorecard
Q8	How would you see (scale from 1 to 10) “Business owner’s unwillingness” act as a barrier to implement block chain in your company?	Scorecard
Q9	How would you see (scale from 1 to 10) “Lack of cooperation among supply chain partners” act as a barrier to implement block chain in your company?	Scorecard
Q10	How would you see (scale from 1 to 10) “Dependence on blockchain operators” act as a barrier to implement block chain in your company?	Scorecard
Q11	How would you see (scale from 1 to 10) “Perceived effort in collaboration” act as a barrier to implement block chain in your company?	Scorecard
Q12	How would you see (scale from 1 to 10) “Market turbulence” act as a barrier to implement block chain in your company?	Scorecard
Q13	How would you see (scale from 1 to 10) “Market dynamics” act as a barrier to implement block chain in your company?	Scorecard
Q14	How would you see (scale from 1 to 10) “Perceived constraint of government support” act as a barrier to implement block chain in your company?	Scorecard
Q15	How would you see (scale from 1 to 10) “Perceived constraint of infrastructure” act as a barrier to implement block chain in your company?	Scorecard
Q16	How would you see (scale from 1 to 10) “Perceived risk of vendor lock- in” act as a barrier to implement block chain in your company?	Scorecard

Table 1.
The demographic format of questionnaires

(a)

(b)

(c)

(d)

Figure 6.
Pictorial
representation of sent
survey form

The survey data are used for the establishment of face validity of the survey questionnaires. The data obtained from the questionnaire survey is analyzed. A survey questionnaire with a ten-point ranking scale is utilized to indicate the relative importance of the identified barriers. The received responses can be identified from [Table 2](#) and representation of received responses can be identified from [Figure 7](#).

5. Discussions

There are several insights that are received from the responses. The responses received are plotted in the form of histogram. The same are represented in [Figure 7](#), where the x-axis of

Table 2.
The received response
in scorecard

Barriers	1	2	3	4	5	6	7	8	9	10
Complexity in setup/use	0	0	0	0	0	0	3	4	4	8
Compatibility	0	0	1	3	3	8	3	0	0	1
Security and privacy concern	0	0	0	0	0	0	2	5	11	1
Scalability	1	0	1	4	4	6	1	2	0	0
Cost	0	0	1	3	5	3	4	3	0	0
Technological awareness	0	0	0	1	2	2	3	4	6	1
Technical knowledge and expertise	0	0	1	0	2	4	3	2	6	1
Business owner's unwillingness	0	0	0	1	1	2	6	3	5	1
Lack of cooperation among supply chain partners	0	0	1	0	1	4	8	2	2	1
Dependence on block chain operators	0	0	0	1	2	4	3	4	3	2
Perceived efforts in collaboration	0	0	0	1	4	5	7	2	0	0
Market turbulence	0	0	0	5	6	4	2	2	0	0
Market dynamics	0	0	1	6	5	5	1	1	0	0
Perceived constraint of infrastructure	1	0	1	4	3	3	5	1	1	0
Perceived constraint of government support	0	1	2	1	7	2	4	1	1	0
Perceived risk of vendor lock-in	0	1	0	1	6	6	3	2	0	0

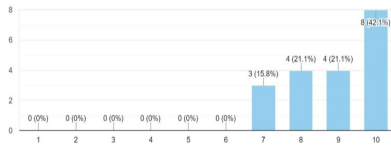
the histogram represents the allotted value of the likert scale and y-axis of the histogram represents the number of decision makers. Here, one can identify the attributed scale value corresponding to the barriers by the decision makers. From Figure 7, one can understand that a scale value of 10 has given by eight decision maker for the asked first questionnaire (Q1). The same are aggregated by employing Equation (1) to determine a mean response score (Table 3). The pictorial representation of the aggregated mean response score can be understood from Figure 8, where one can observe that “Complexity in setup/use” has attained a mean response score of 8.89 to rank as first significant barrier. “Security and privacy concern” with a mean response score of 8.57 and “Technological awareness” with a mean response score of 7.52 is observed to rank as second and third level barrier respectively. “Market dynamics” with a mean response score of 5.10 and “Scalability” with a mean response score of 5.21 is found as the least crucial barrier opposing the BCT implementation.

The study argued that BCT can be used to decline negative impacts served to the environment by the firms with the synchronized movement of their supplies for satisfying demands. BCT can assist in maintaining efficient reverse logistics activities by the companies to earn more profits by handling reverse logistics mechanism and the same in turn will help in the conservation of resources. BCT can be used to curtail environment loads and can prevent pollution marks from the unwarranted emission of energy. The reduction in pollution, energy consumption, resource consumption etc. can be attained by the implementation of BCT in SCs. The same can be achieved by fixing momentous information pertaining to replacing poor and outdated resources, exposing non standardized data, introducing new and advance mechanism, effectual store management for mass production, enhancing green manufacturing capacity, boosting processing ability with less steps etc.

BCT can deliver agility and assist in maintaining the resources to be made available for the next generation. Many firms ignored the agility practices due to lack to technological adaptation, which can be fulfill by BCT. BCT can strive towards attaining defect reduction by shipping right product in right quantity at right time. Resistance to adopt new procedures and undistributed roles and responsibilities can be best maintained by BCT. Momentarily gains by varying production levels can be handle by BCT by stimulating the ability of an enterprise to produce a variety of products and services; quick and easy by raw materials etc.

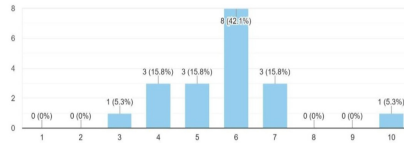
The same will lead in retaining environmentally friendly operations and can lead in the attainment of information technology for communication amongst dependents. BCT can be used to create eco-business structure by the management and can maintain green utilization and implementation. The same can be used to trace number of products failed before and after shipment to the customers, which in turn will help in counting quality index to the

How would you see (scale from 1 to 10) "the Complexity in set up" act as a barrier to implement block chain in your company?
19 responses



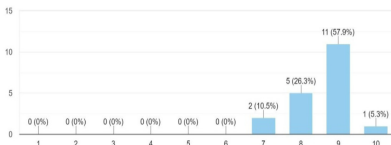
Responses for Q1
(a)

How would you see (scale from 1 to 10) "the Compatibility" act as a barrier to implement block chain in your company?
19 responses



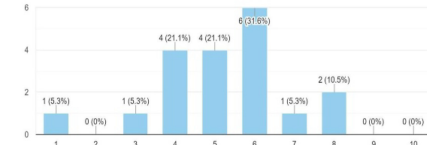
Responses for Q2
(b)

How would you see (scale from 1 to 10) "the Security and privacy concerns" act as a barrier to implement block chain in your company?
19 responses



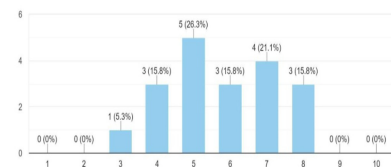
Responses for Q3
(c)

How would you see (scale from 1 to 10) "Scalability" act as a barrier to implement block chain in your company?
19 responses



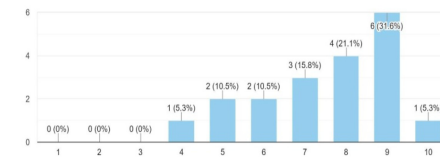
Responses for Q4
(d)

How would you see (scale from 1 to 10) "Cost" act as a barrier to implement blockchain in your company?
19 responses



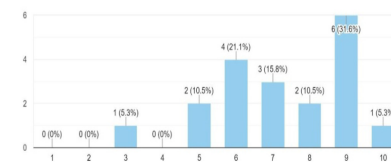
Responses for Q5
(e)

How would you see (scale from 1 to 10) "Technological awareness" act as a barrier to implement block chain in your company?
19 responses



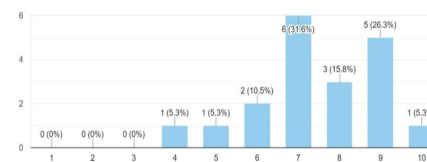
Responses for Q6
(f)

How would you see (scale from 1 to 10) "Technical knowledge and expertise" act as a barrier to implement block chain in your company?
19 responses



Responses for Q7
(g)

How would you see (scale from 1 to 10) "Business owner's unwillingness" act as a barrier to implement block chain in your company?
19 responses



Responses for Q8
(h)

Figure 7.
Representation of the
responses received
from questionnaires

(continued)

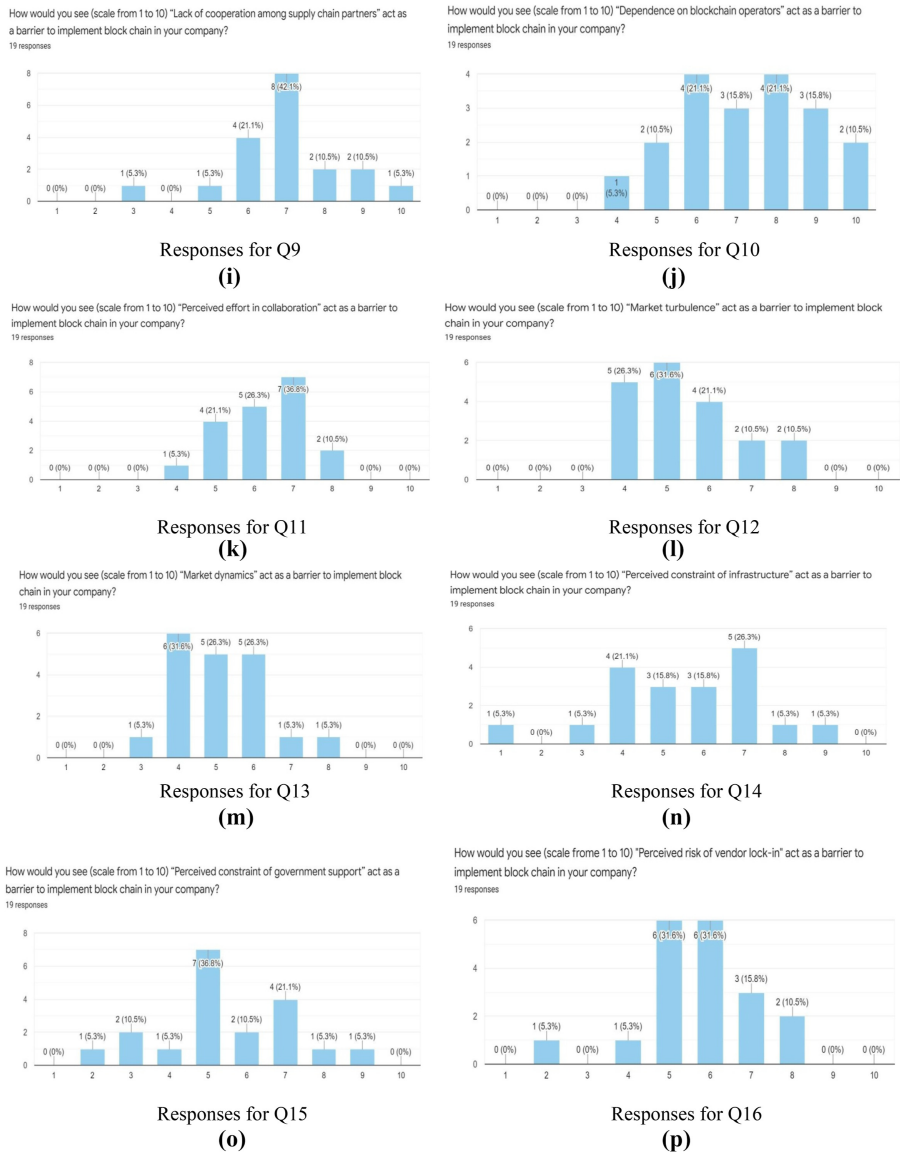


Figure 7

manufacturers. The same will assist in avoiding wastage of environmental resource. BCT can be used to develop innovate products and system that assist in long-term success for maintaining a sustainable environment. Degree of green innovativeness can be increase by chasing R&D efforts, which can be handled by BCT. BCT aids in furnishing commercial information to anyone at any corner anytime and saves time and wealth via advancing interactivity between customers, partners and public. BCT can be used to best handle effective communication link to enclose a direct association amongst sender and receiver.

Barrier	Mean value
Complexity in setup/use	8.89
Compatibility	5.73
Security and privacy concern	8.57
Scalability	5.21
Cost	5.42
Technological awareness	7.52
Technical knowledge and expertise	7.26
Business owner's unwillingness	7.47
Lack of cooperation among supply chain partners	6.94
Dependence on block chain operators	7.21
Perceived efforts in collaboration	6.26
Market turbulence	5.47
Market dynamics	5.10
Perceived constraint of infrastructure	5.47
Perceived constraint of government support	5.52
Perceived risk of vendor lock-in	5.73

Table 3.
Tabulation of attained
mean response score
values

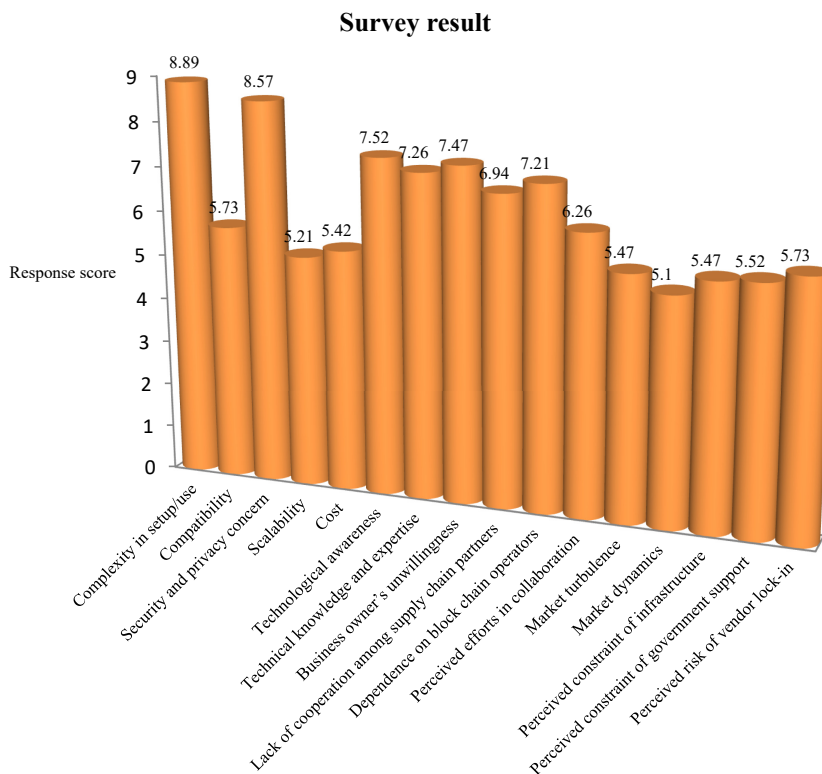


Figure 8.
Representation of
mean response score
(survey)

6. Conclusions

The study presented sixteen barriers from three categories for evaluation, i.e. technological, organizational and environmental. The five sub-barriers from technological category, seven sub-barriers from organizational category and four sub-barriers from environmental category

are evaluated to understand the critical findings related to the BCT adaptation in SMEs. The findings of the study determined that the three factors, i.e. “complexity in setup/use”, “Security and privacy concern” and “Technological awareness” mostly affect the adaptation of block chain. Conversely, “Market dynamics”, “Scalability” and “Cost” do not influence the intention to adopt the technology. The study found that the BCT implementation can be enhanced by instituting awareness program in mass domain to represent its utility and to evade towards complexity in use. It is demonstrated that the arrangement of the technological awareness program in turn will resolve scalability issues for the dissemination and utilization of BCT. The findings of the study can be utilized to redesign business models by the managers for attaining long term sustainability in the market place. The findings could be beneficial for marketing companies to evade towards BCT concerns for potential adaptations, so that the BCT can be utilize for providing services for saving time and effort. The findings are significant for the government and private regulatory bodies to devise appropriate standards to eradicate the uncertainties hindering BCT implementation. The study also highlights management barriers towards BCT acceptance. It is found that the organization’s top management should be first principally determined, ready and persistent towards agreement of new technology. The value can be created in working environment by top management’s commitment and determination, which is prerequisite for any development and implementation and that too is required to achieve successful implementation of BCT in any organization.

BCT can significantly improve SCs by facilitating faster moves and providing cost competent delivery of goods, enhancing goods traceability, maintaining harmonization among associates, and aid in maintaining financial constraints. Bundles of SCM activities pertaining to logistics supplies, logistics maintenance, direction towards managing hazardous themes, adaptation of manufacturing technology, realization of demands and supplies can be maintained by BCT. Additionally, reinforcement of SC capabilities towards reutilization, recycling, reprocessing by providing flexibilities in product, service, process, manufacturing ranges can be best managed by BCT. Moreover, recognition of brand, eco-creation aspects, design of sustainable products, failures, rectifications (internal and external) can be handled by BCT. Additionally, green purchasing, sustainable packaging, production flexibility, green innovation, volume flexibility, responsiveness ration, delivery speed, customers grievances, technical reliability, submission of information for distribution, decentralized decision making, reconfiguration ability towards new production model, core competencies, delivery flexibility, distribution flexibility, inventory flexibility, networking amongst partnering firms and virtual connection for sharing enterprise assets can be best manage by the implementation of BCT in SCs.

BCT can be used to purchase products and services that are less harmful to the environment. The same can broadly influence material mismanagement, ineffective performance framework, difference in organizational policy, geographical and cultural difference, vendor’s development etc. The easy communication for transactions with the concerns, who might be in the next room, floor or miles away can be handle by BCT. Thus, virtual communication amongst customers, top management, managers, engineers, supervisors, etc. in a network can be responded by BCT. The potential competitive tool to the enterprise to compete in quality, design, production, distribution of a product or service can be managed by the BCT. This adds worth to a prospective customer and can assist in acquiring unique capability to provide a particular product or service under low cost as compared to relative partners. A network constructs virtual enterprise and retort agility based on strength and core competencies of the partners can be attained by BCT.

6.1 Managerial implications

BCT can be used by the managers to employ widely and confidentially with the permission of the dependent under an allocated network. BCT can be utilized by the managers to trace the

origin, to assess the consequences, to define the duties, to dispatch information and to avoid an undesirable incidence under network. The present study can be used by the managers towards understanding BCT insights and making strategies for ease BCT implementation in their system for advancement. The present study benefits managers by suggesting barriers for adapting BCT for organization gains and statistics. The study contributed towards making understanding about BCT adoption to managers for maximum value creation. The study notionally revealed the integrated elements to be used by the managers for establishing the BCT foundation for future research and value creation under Indian context. The present study can be utilized by the practitioners for conducting scientific innovation in BCT context. Future studies are required to seek more related factors to expand the list of evident barriers. The findings of the study would provide strategic dimensions to the policy makers and practitioners working under the authorization of the government to devise national guidelines to support encouragement of BCT adoption among service and manufacturing organizations.

6.2 Limitations and future study

The major limitation of the studies is that the responses have been received from the decision makers based on the consideration of barriers at the first level of group. Consideration of questionnaires from the subgroup of barriers at the second level is required for attaining precise outcomes. Additionally, fuzzy logic techniques are also required to be incorporated in the second level of barriers subgroups for easy communication and for receiving judgment in the form of natural language of the decision makers. Furthermore, more barriers related to technical pillars, social pillar and economic pillars are also needed to be accounted in future studies.

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