Blockchain technology in supply chain management: an organizational theoretic overview and research agenda

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Accepted: 7 November 2022 © The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract
Blockchain technology is touted as a game-changer. Many experts consider blockchain technology as one of the disruptive innovations. Following significant success in the banking and finance sector, blockchain technology has found significant success in all fields, including health, manufacturing, transportation, disaster relief operations, and many others. Recently, the academician has contributed significantly towards understanding blockchain technology and its application in the management field. To understand how the literature on blockchain technology in the supply chain has progressed, we undertook an extensive review of the literature published in peer-reviewed journals using databases such as SCOPUS. We have further classified our literature into four stages (pre-adoption, adoption, implementation, and application). Finally, we synthesized the findings of the study and proposed a research framework to explain how an organization can build supply chain resilience and enhance supply chain performance with the help of blockchain technology. Finally, we have noted the limitations of the study and future research directions.

Keywords Blockchain technology · Supply chain management · Supply chain resilience · Systematic literature review · Sustainability · Traceability · Trust

1 Introduction
Blockchain Technology (BT) is a technology blessed with a decentralised storage system that is distributed, contracts that are digital and smart and asymmetric encryption whilst enabling visibility, transparency, traceability, and security to a network employing BT (Dutta et al., 2020; Katsaliaki et al., 2021). As a result of its decentralised, verifiable, and immutable
character, it has already disrupted or is on the path to disrupt a wide range of industries/areas/sectors such as banking, copyright, energy (renewable), healthcare, insurance, operations, real estate, and supply chains in general (Fosso Wamba et al., 2020a; Hald & Kinra, 2019; Pandey et al., 2022; Tandon et al., 2021). The enormous potential of blockchain to alter every step of SC, from the acquisition of raw materials to the delivery to customers, is well known (Babich & Hilary, 2020). The buzz around blockchain applications is still there, and we may be a few years away from their commercialization, but the future of this technology is bright (Pournader et al., 2020).

Previous studies by Hald and Kinra (2019) focused on BT’s effect on supply chain performance by conducting a systematic literature review (SLR) on 48 articles. Through this study, they were able to report different blockchain identities. Similarly, Pournader et al. (2020) conducted SLR along with bibliometric and co-citation analysis on 48 articles to study BT applications in SCs, transport and logistics. They discussed emerging themes along with the application of BT in SC, transportation, and logistics. Taking it further, Dutta et al. (2020) conducted SLR on 178 articles to study BT integration, application, and challenges in SC operations. They pertinently mentioned that all the major industries could be revamped with BT by targeting business process management and visibility.

However, this study stands different from past literature by exploring and conducting an in-depth investigation on BT adoption, implementation and future application through a self-developed guiding framework that specifically categorizes articles into four themes/perspectives and provides a fresh outlook on the literature by identifying and establishing the four distinct themes. Therefore, the present study provides the following contributions. First, as one of the first studies to attempt the categorization of BT literature in supply chain (SC) for understanding the perspectives of technology adoption and implementation, this study enlists key theories, and BT features utilised in each of the themes identified. Second, this study develops a relationship between blockchain and its impact on supply chain resilience (SCRES) by exploring the studies reviewed as per the review protocol. Past studies also indicate that BT plays a pivotal role in enhancing the SCRES (Dubey et al., 2020; Iftikhar et al., 2022) while SCRES itself presents as an area of interest for many scholars and industry experts since its strategies provide ways to thwart disruptive events (Tukamuhabwa et al., 2015). Third, the study proposes research agenda based on Whetten (1989) “5W and 1H approach” i.e., “what, who, why, when, where and how” and develops a comprehensive research framework for BT and its identified features from the literature. The framework lays the foundation for the future empirical testing.

There has been a dramatic increase in the amount of research being done in this field from 2017 onwards (Dutta et al., 2020), while research projects focused on BT’s impact on SC started to pick up by 2018 (Zhang et al., 2022). Thus, this study develops a comprehensive dataset of literature published from the year 2017–2022 based on a systematic literature search process. This study provides fresh insights on the current state of blockchain in SC and sets the stage for future research. Hence, the following objectives have been framed to execute this literature review study.

**RO1** To identify the themes, areas, and industries discussed in the BT in SC literature.

**RO2** To study if and how blockchain impacts SC Resilience (SCRES).

**RO3** To develop future research agenda and a comprehensive framework of BT and identified themes for future empirical testing.

We develop and follow a guiding framework that divides the study into four themes Refer Table 1.
Table 1 Guiding framework

| Pre-adoption                                      | Adoption                                                                 | Implementation implication                       | Application                                                                                                                                 |
|--------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| What are the pre-requisites for BT adoption?     | What are the factors that enable or create barriers to adoption?         | What have been the implications of adopting BT?  | What more could be achieved by implementing BT? |
| Do you require any pilot projects?               | Which areas have been the first to adopt the BT?                        | Are the expected implications in favour?         | Would BT be integrated with newer technologies for efficient use?                                                                            |
| Are SC Managers eager to undertake the change?   | How do managers take decisions of adoption?                              | Are the expectations being fulfilled when compared to the pre-adoption mindset? | Can BT be used for prolonged resilience and sustainability?                                                                          |

2 Methodology

The study conducted a systematic literature review (SLR) as per the Denyer and Tranfield (2009) and Tranfield et al. (2003) protocol and consequently adapted Dutta et al. (2020) search methodology. We established a rigorous procedure to include and exclude the articles starting with a set of search strings by evaluating the previous literature. The initial search keyword resulted in the generation of 2934 articles conducted in the Scopus database which is considered to be one of the world’s most reliable and comprehensive database for peer-reviewed journals (Tandon et al., 2021; Varriale et al., 2021). On further filtering, we set certain inclusion criteria. We only included articles that include discussion about BT in SC domain, and are published in top-peer reviewed journals, and the number was reduced to 1,382 and by selecting “English” as the only, the number went down to 1346. By limiting the subject areas to Business, Management and Accounting; Computer Science and Decision Sciences, the number went down to 1019. We then limited the journals to the top peer-reviewed journals. We arrived at a list of 390 articles upon this search category (as of 31 May 2022). Upon ensuring the availability and reading of full text articles, we arrived at the final count of 292 articles. Figure 1 represents the search methodology. Table 2 presents the inclusion and exclusion criteria.

3 Descriptive analyses

This section contains descriptive regarding year-wise classification, country-wise classification (country of focus and country of origin), methods utilised, most publishing journals, citation count, and industries in focus.

3.1 Year-wise classification

The study observed a boom in BT in SC research from the year 2017. It can be observed that there is a substantial increase in publications year to year with an almost twofold increase. This indicates that both academia and industry have started to put their eye on BT with seriousness. Figure 2 shows the trend of publications.
Fig. 1 Search methodology

Table 2 Inclusion and exclusion criteria

| Inclusion criteria                     | Exclusion criteria                     | Rationale                                                        |
|----------------------------------------|----------------------------------------|------------------------------------------------------------------|
| Papers that discuss BT in SC domain    | Papers that discuss BT in domains not related to SC | Aim of the study is to review papers focused on BT in SC         |
| Published in English language         | Not published in English               | Dominant language in the BT and SC field                        |
| Published in top-peer review journals (ABDC listed) | Conference papers, book chapters | Rigorous peer-review ensures quality work                        |
3.2 Year-wise Journal classification

We list the top 12 publishing journals year-wise in Table 3. We observe that IJPR (36) has published the most articles, followed by IJPE (17), CIE (16), IJIM (14), ANOR (12) and so on. This indicates that this research area has the attention of most of the top-rated journals in this domain.

Table 3 Year-wise journal classification

| Journal                                      | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
|----------------------------------------------|------|------|------|------|------|-------|
| International Journal of Production Research (IJPR) | 3    | 13   | 14   | 6    | 36   |
| International Journal of Production Economics (IJPE) | 1    | 3    | 7    | 6    | 17   |
| Computers and Industrial Engineering (CIE) | 4    | 2    | 7    | 3    | 16   |
| International Journal of Information Management (IJIM) | 1    | 11   | 1    | 1    | 14   |
| Annals of Operations Research (ANOR) | 1    | 7    | 4    |      | 12   |
| IEEE Transactions on Engineering Management (ITEM) | 6    | 5    | 1    |      | 12   |
| Journal of Cleaner Production (JCP) | 1    | 2    | 6    | 3    | 12   |
| Transportation Research Part E: Logistics and Transportation Review | 4    | 2    | 5    | 1    | 12   |
| Production Planning and Control (PPC) | 2    | 2    | 7    |      | 11   |
| Supply Chain Management (SCM) | 1    | 1    | 5    | 1    | 2    | 10   |
| Industrial Management and Data Systems (IMDS) | 1    | 3    | 4    |      | 8    |
| Journal of Enterprise Information Management (JEIM) | 3    | 5    |      |      | 8    |
| Total | 1    | 15   | 51   | 63   | 38   | 168   |
### Table 4 Industry-wise classification

| Industries                                                                 | Total |
|---------------------------------------------------------------------------|-------|
| Food (fish, wine, tea, dairy, milk, etc.)                                 | 52    |
| Multiple                                                                  | 26    |
| Manufacturing                                                             | 16    |
| Supply chain (3), logistics (11), transportation (1)                      | 15    |
| Agriculture                                                               | 12    |
| Fashion, textile (2), apparel (1)                                         | 12    |
| Healthcare (4), pharmaceuticals (4), drug (1), vaccine (1)                | 10    |
| Shipping (4), freight (2)                                                 | 6     |
| Banking/finance                                                           | 5     |
| Construction                                                              | 5     |

### 3.3 Industry-wise classification

Based on the data, we observed that food industry that includes fish, wine, tea, dairy, etc. had the most interest of authors followed by a combination of multiple industries; manufacturing; supply chain and logistics; agriculture; fashion and healthcare. Food SCs have been the focal application area of blockchain when it comes to traceability and transparency (Casino et al., 2021; Kittipanya-ngam & Tan, 2020; Treiblmaier & Garaus, 2022; Vu et al., 2021). Table 4 lists industry-wise classification.

### 3.4 Country-wise classification

We establish two tables for country-wise classification. Table 5 represents the Country of Origin which mentions the origin of research being published while Table 6 represents Country of Focus which mentions the country in which research has been conducted. China followed by UK, USA and India are four most publishing nations while India followed by China, USA and UK are the countries in which has been conducted.

### Table 5 Country of origin

| Country of origin | Articles |
|-------------------|----------|
| China             | 109      |
| UK                | 66       |
| USA               | 60       |
| India             | 53       |
| France            | 29       |
| Italy             | 14       |
| Turkey            | 14       |
| Germany           | 11       |
| Malaysia          | 10       |
| UAE               | 10       |
Table 6: Country of focus

| Country of focus | Articles |
|------------------|---------|
| India            | 38      |
| China            | 30      |
| USA              | 22      |
| UK               | 13      |
| Italy            | 10      |
| Malaysia         | 9       |
| Europe           | 8       |
| France           | 6       |
| Turkey           | 6       |
| Germany          | 5       |

3.5 Methodological classification

We adapt Saunders et al. (2019) onion model for methodological classification along with adaptation of Sharma et al. (2017). Figure 3 presents the methodology-based classification of the selected research papers. It can be observed that 19% are modelling-based studies (employing Stackelberg game-theoretical analysis, stochastic optimization, Nash bargaining, mixed-integer programming, etc.), 15% are case studies (employing interview, content analysis, etc.), 15% are conceptual or theoretical works, 15% are exploratory or interpretive in nature (employing MCDM tools such as ISM, DEMATEL, BWM, etc.), 12% are surveys followed by 11% of mixed methodology-based studies. Figure 3 shows the methodological classification.
4 Findings

In this section, we discuss the content analysis of the selected articles. This section henceforth leads to the findings from the content analysis and then the discussion as a subsequent section. In the findings, we construct tables for citations based on themes, the BT features explored in that theme and the theories utilised in the themes.

4.1 Classification of articles based on identified themes

This section classifies the articles as per the perspectives regarding conceptualization, designing, adoption, implications, and future applications, and hence, generates four major themes or perspectives viz a viz pre-adoption, adoption, implication of implementing and applications of blockchain technology in SC. Table 21 summarises the four themes.

4.1.1 Pre-adoption theme/perspective

This theme/perspective relates to the pre-requisites/requirements for the adoption of BT, designing and execution of any pilot projects and to understand the intentions of SC managers whether they are eager to undertake the adoption of BT in SC. Under this theme, we have classified 62 articles as shown in Table 7. Table 8 represents theories utilised under pre-adoption theme. Table 9 represents BT features explored under pre-adoption theme.

Treiblmaier (2018) discussed about structurisation and management of SC that would incorporate BT. The study utilised principal agent theory (PAT), transaction cost analysis (TCA), resource-based view (RBV) and network theory (NT) for recommending BT integration in a SC. Chang et al. (2019) provided conceptual guidelines concerned with designing and implementation of practical business system design. The study proposed a novel BT based real-time process and tracking of logistics that would reduce costs related to cash backlogs. Thus, study presented an opportunity of mitigating inefficiencies by improving transparency, speedy payments, tracking, and improved convenience. Queiroz and Fosso Wamba (2019) utilised unified theory of acceptance and use of technology (UTAUT) to understand BT adoption behaviour and usage of individuals. The survey identified a distinct

Table 7: Studies under pre-adoption theme

| Pre-adoption | Kim and Laskowski (2018), Sander et al. (2018), Treiblmaier (2018), Azzi et al. (2019), Chang et al. (2019), O’Leary (2019), Hartley and Sawaya (2019), Kamble et al. (2019, 2021), Queiroz and Fosso Wamba (2019), Van Hoek (2019), Bai and Sarkis (2020), Dolgui et al. (2020), Epiphaniou et al. (2020), Garrard and Fielke (2020), Guggenberger et al. (2020), Ghode et al. (2020), Hastig and Sodhi (2020), Hew et al. (2020), Jabbar and Dani (2020), Jain et al. (2020), Karamchandani et al. (2020), Kumar et al. (2020), Rashideh (2020), Wong et al. (2020a, 2020b), Yong et al. (2020), Albizri and Appelbaum (2021), Büyüközkökan et al. (2021), Casino et al. (2021), Danese et al. (2021), Diniz et al. (2021), Erol et al. (2021), Kamran et al. (2021), Giri and Manohar (2021), Oropallo et al. (2021), Queiroz et al. (2021), Saurabh and Dey (2021), Tsalakis et al. (2021), Tezel et al. (2021), Vivaldini and de Sousa (2021), Vivaldini (2021a, 2021b), Wang et al. (2021a, 2021b, 2021c, 2021d, 2021e), Xue et al. (2021), David et al. (2022), Faasolo and Sumarliah (2022), Martins et al. (2022), Mangla et al. (2022), Nath et al. (2022), Oguntegbe et al. (2022), Chowdhury et al. (2022), Kayikci et al. (2022a, 2022b), Li et al. (2022), Oh et al. (2022), Sodhi et al. (2022), Hamdan et al. (2022), Hartley et al. (2022), Sumarliah et al. (2022), Wamba and Queiroz (2022) |
| Theory/model/paradigm | Citations |
|----------------------|-----------|
| Affordance theory    | Albizri and Appelbaum (2021) |
| Behavioural Reasoning Theory | Oguntegbe et al. (2022) |
| Design Science Research (DSR) | Kim and Laskowski (2018), O’Leary (2019), Guggenberger et al. (2020), Jabbar and Dani (2020), Albizri and Appelbaum (2021), Diniz et al. (2021), Tezel et al. (2021) |
| Dynamic Control theory (DCT) | Dolgui et al. (2020) |
| Dynamic Capability (DC) | Wamba and Queiroz (2022) |
| Fit For Purpose Theoretical Framework | Kamran et al. (2021) |
| Fuzzy Set Theory | Bai and Sarkis (2020), Büyüközkan et al. (2021) |
| Grey Theory | Ghode et al. (2020) |
| Innovation Diffusion Theory (IDT)/Diffusion of Innovation (DOI) | Hew et al. (2020), Hartley et al. (2022), Nath et al. (2022), Sumarliah et al. (2022), Wamba and Queiroz (2022) |
| Institutional Theory (IT) | Hew et al. (2020), Hartley et al. (2022), Sumarliah et al. (2022), Wamba and Queiroz (2022) |
| Network Theory (NT) | Treiblmaier (2018), Tsolakis et al. (2021) |
| Organizational Information Processing theory (OIPT) | Giri and Manohar (2021) |
| People, process, & technology model (PPT) | Kayikci et al. (2022a, 2022b) |
| Principal-Agent Theory (PAT) | Treiblmaier (2018), Tsolakis et al. (2021) |
| Resource Based View (RBV) | Treiblmaier (2018), Tsolakis et al. (2021), Wamba and Queiroz (2022) |
| Technology Acceptance Model (TAM) | Kamble et al. (2019), Karamchandani et al. (2020), Jain et al. (2020), Giri and Manohar (2021), Kamble et al. (2021), Hamdan et al. (2022), Wamba and Queiroz (2022) |
| Theory of Planned Behaviour (TPB) | Kamble et al. (2019) |
| Technology Organisation and Environment (TOE) | Wong et al. (2020a, 2020b), Kamble et al. (2021), Faasolo and Sumarliah (2022), Hamdan et al. (2022), Nath et al. (2022), Oguntegbe et al. (2022) |
| Transaction Cost Analysis (TCA) | Treiblmaier (2018), Tsolakis et al. (2021) |
| Sensemaking Theory | Wang et al. (2021d) |
| Stakeholder Theory | Sander et al. (2018) |
| Synergetic Theory | Xue et al. (2021) |
| System Dynamics Model | Xue et al. (2021) |
| UTAUT | Wong et al. (2020b), Queiroz and Fosso Wamba (2019), Queiroz et al. (2021) |
existence of differences in adoption behaviours of individuals from India and USA. Following this study, Queiroz et al. (2021) empirically validated UTAUT proposed model in Brazil and found effort expectancy, facilitating conditions, social influence, and trust are the most critical constructs that directly affect behavioural intention to adopt BT. Kamble et al. (2019) statistically validated a model based on technological acceptance model (TAM), theory of planned behaviour (TPB) and technology readiness index (TRI) to understand perception of users on BT adoption. The study found that constructs of TRI have no significant effect on TAM constructs of perceived ease of use and usefulness while behavioural intention was significantly affected by perceived usefulness, perceived behavioural control and attitude. Similarly, Karamchandani et al. (2020) analysed perception of enterprise BT among service industry professionals using technological acceptance model (TAM) theory. The results were promising as the professionals of Indian Service Industry believed in practicality of enterprise BT especially in quality of information, quality of service, reliability of delivery, mass customisation and customer relationship. The study by Jain et al. (2020) tested the effect TAM theory constructs on the behavioural intentions of online consumers towards BT. The study found a direct impact of three constructs of TAM on the behavioural intention which further had direct impact on actual behaviour towards using BT. Moving away from TAM, study by ) adopted technology, organisation and environment (TOE) framework to study behavioural intention of users in Malaysian Small-Medium Enterprises (SMEs). The study

| BT features            | Citations                                                                 |
|------------------------|----------------------------------------------------------------------------|
| Immutability           | Wong et al. (2020a, 2020b), Ghode et al. (2020)                            |
| Privacy                | Li et al. (2022)                                                           |
| Provenance             | Kim and Laskowski (2018), Garrard and Fielke (2020)                       |
| Traceability/tracking  | Kim and Laskowski (2018), Sander et al. (2018), Azzi et al. (2019), Chang et al. (2019), O’Leary (2019), Queiroz and Fosso Wamba (2019), Garrard and Fielke (2020), Hastig and Sodhi (2020), Hew et al. (2020), Casino et al. (2021), Diniz et al. (2021), Giri and Manohar (2021), Kamran et al. (2021), Oropallo et al. (2021), Saurabh and Dey (2021), Tsolakis et al. (2021), Vivaldini (2021a, 2021b), Wang et al. (2021e), Hartley et al. (2022), Sumarlah et al. (2022) |
| Transparency/visibility| Sander et al. (2018), Queiroz and Fosso Wamba (2019), Bai and Sarkis (2020), Ghode et al. (2020), Jain et al. (2020), Wong et al. (2020a, 2020b), Diniz et al. (2021), Giri and Manohar (2021), Kamran et al. (2021), Oropallo et al. (2021), Tezel et al. (2021), Tsolakis et al. (2021), Vivaldini (2021a, 2021b), Hartley et al. (2022), Nath et al. (2022), Wamba and Queiroz (2022) |
| Trust                  | Queiroz and Fosso Wamba (2019), Garrard and Fielke (2020), Ghode et al. (2020), Casino et al. (2021), Oropallo et al. (2021), Queiroz et al. (2021), Saurabh and Dey (2021), Tezel et al. (2021), Wang et al. (2021e), Nath et al. (2022), Wamba and Queiroz (2022) |
| Smart contract         | Kim and Laskowski (2018), Dolgui et al. (2020), Epiphaniou et al. (2020), Yong et al. (2020), Albizri and Appelbaum (2021), Kamran et al. (2021), Vivaldini (2021a, 2021b), Wang et al. (2021d), Martins et al. (2022), Kamble et al. (2021), Wang et al. (2021e), Li et al. (2022), Nath et al. (2022) |
| Security               | Epiphaniou et al. (2020), Wong et al. (2020a, 2020b), Kamran et al. (2021), Kamble et al. (2021), Wang et al. (2021e), Li et al. (2022), Nath et al. (2022) |
found out that complexity, cost, competitive pressure, and relative advantage had significant effects on behavioural intention. Innovation diffusion theory (IDT) and institutional theory (IT) too have been utilised to check the intention to use the BT in industries (Hartley et al., 2022; Hew et al., 2020). Wamba and Queiroz (2022) applied a set of five theories to empirically study intention to adopt BT. They empirically validated that there were differences in variables affecting adoption intention of users from India and USA. The study by Kamble et al. (2021) used machine learning to predict BT adoption in SC. Hastig and Sodhi (2020) identified six major business requirements and six critical success factors for successful implementation of SC Traceability systems in pharmaceutical and cobalt mining industries. Identification of such factors would help in conducting case based research and inspire many other empirical works. Van Hoek (2019) adopted Reyes et al. (2016) framework and reported that factors from the framework are indeed relevant when it came to BT consideration for SC. The study found leadership engagement, customer demand, leadership commitment, etc. to be the factors that favour pilot development projects in case of BT implementation in SC. Kayikci et al. (2022a, 2022b) in their review paper reported that under the umbrella of PPT (people, process, and technology), there were clear opportunities and impediments in case of people and technology. Massive benefits that arose out of implementing BT in SC especially in Food SC outweighed the risks. The study outrightly mentioned security and need of massive infrastructure as the boosters of usage and implementation of BT. Van Hoek (2020a, 2020b) adopted multiple case study method to explore the knowledge gained by the early adopters of BT in SC. Insights gained from case studies indicated possibility of developing pilot projects with a concern for swift launches by scoping existing pilots in a planned manner with engagement of all stakeholders. Erol et al. (2021) evaluated the feasibility of BT using fifteen indicators while comparing between seven industries using AHP and TOPSIS. The study found that industries of logistics and SC along with healthcare and finance were the most feasible options for BT projects while need for improved traceability, visibility and reduced fraud turned out to be the most important indicators. Wang et al. (2021a, 2021b, 2021c, 2021d, 2021e) reported a 2-year study of smart contract initiative by engaging in DSR (design science research). The study further utilised theory of business model along with sensemaking theory to give shape to future BT deployment in SC and addressed problems SC transparency and provenance. Oropallo et al. (2021) designed circular BT platform using integrated Triple Retry Framework. The study utilised in-depth case study and conducted face-to-face interviews along with direct observation and results highlighted role of BT as a technological capability which could improve the controlled waste movement and activities related to product return. Chowdhury et al. (2022) proposed a BT decision framework that would be used to assess the feasibility of BT adoption in contexts related to risk management. For such a framework, the study used TAM predictors, VUCA constructs and resilience to understand their effect on intention to adopt BT. The survey results showed that all the constructs positively affected the managers intention to adopt BT. Oh et al. (2022) proposed a framework based on seven dimensions that offer conceptual guidance on designing a BT enabled SC. The seven dimensions network, governance, data processing, database, data, value transfer and platform were stacked into 3 different design decision perspectives: configural, operational and strategic. Büyüközkan et al. (2021) proposed a customer-focused BT design by utilising group decision making (GDM) approach. The study was conducted in a qualitative way and generated critical factors to help in design of an effective BT enabled SC structure. However, a study by Sodhi et al. (2022) explained the adoption experience of emerging technologies (such as BT) by studying the perception of managers utilising affordance theory. The study reported there is no connection between the characteristics of the
technology and the users’ expectations at the early stages of adoption. Such an initial disconnect between characteristics of technology and the expectations of managers could explain inflated expectations that were followed by a low of disappointment concerning emerging technology as explained in the Gartner Hyper Cycle since most of the users of emerging technology focus on attainment of similar benefits for SC like the old ones.

It is important to note that pre-adoption theme has predominantly mentioned TAM, DSR, TOE theories that are related to either intention to adopt or to the designing of BT based SC in case of DSR. Since, BT is still in its nascent stage, and studies on intention to adopt are very scant. Hence, it becomes pertinent to study the perception and intention of its users before adopting the technology to understand the expectations it has generated among the masses.

4.1.2 Adoption theme/perspective

This theme/perspective relates to the early adoption projects, enablers of adoption, barriers of adoption and the decisions related to adoption of BT. A total of 78 papers have been classified under this category as shown in Table 10. Table 12 presents theories utilised under adoption theme. Table 13 presents BT Features explored under adoption theme.

Saberi et al. (2019) identified and categorised four types of barriers to adoption of BT i.e., intra-organizational barriers, inter-organizational barriers, system-related barriers, and external barriers. The study focused on successful adoption of BT for tracing sustainable practices in a SC. Kamble et al. (2020) identified and established relationships between thirteen enablers of BT adoption in agriculture supply chains (ASCs). They employed interpretive logic on the BT enablers and used Interpretive Structural Modelling (ISM) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methodology (Samad et al., 2022; Yadav et al., 2021) to establish otherwise complicated causal relationships. They found traceability (Sharma et al., 2021a, 2021b) to be the most important enabler followed by immutability and provenance. Kouhizadeh et al. (2021) utilised TOE and force-field theories along with DEMATEL to identify, classify and establish barriers to BT adoption. The study found technological barriers to

Table 10 Studies under adoption theme

| Adoption | Saberi et al. (2019), Fosso Wamba et al. (2020b), Chod et al. (2020), Farooque et al. (2020), Papathanasiou et al. (2020), Shoaib et al. (2020), Kamble et al. (2020), Sahebi et al. (2020, 2022), Schuetz and Venkatesh (2020), van Hoek (2020b), Yadav and Singh (2020), Ali et al. (2021), Balci and Surucu-Balci (2021), Bag et al. (2021), Caldarelli et al. (2021), Baharmand et al. (2021), Dede et al. (2021), Dong et al. (2021), Ghode et al. (2021), Guo et al. (2021), Gupta et al. (2021), He et al. (2021), Karakas et al. (2021), Karuppiah et al. (2021), Kouhizadeh et al. (2021), Li et al. (2021b, 2021d), Mathivathanan et al. (2021), Liu et al. (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g), Nandi et al. (2021), Narwane et al. (2021), Niu et al. (2021a, 2021b), Pun et al. (2021), Patil et al. (2021), Rainero and Modarelli (2021), Razak et al. (2021), Sharma et al. (2021a, 2021b), Shen et al. (2021), Sundararanki et al. (2021), Suwanposri et al. (2021), Tan and Sundararanki (2021), Vafadarnikjoo et al. (2021), Vu et al. (2021), Yadav et al. (2021), Wu et al. (2021, 2022), Xiong et al. (2021), Yang et al. (2021), Agi and Jha (2022), Anastasiadis et al. (2022), Bai et al. (2022), Benstead and Moradiou (2022), Çolak and Kağnicioğlu (2022), Fan et al. (2022), Galati (2022), Govindan (2022), Huang et al. (2022), Ji et al. (2022), Han and Rani (2022), Kayikci et al. (2022), Khan et al. (2022a, 2022b, 2022c), Kumar et al. (2022a), Moretto and Macchioni (2022), Naef et al. (2022), Omar et al. (2022), Samad et al. (2022), Sislian and Jaeglter (2022), Song et al. (2022), Xu et al. (2022), Yi et al. (2022), Yousefi and Mohamadpour Tosarkani (2022), Zhou et al. (2022) |
have the most prominence specifically security, negative perception and immaturity to be the prominent barriers. Fosso Wamba et al. (2020b) through a survey established that BT adoption is significantly affected by trading partner pressure and the knowledge sharing while BT adoption significantly improves transparency and hence, SC performance. van Hoek (2020b) empirically studied the adoption rates, drivers, and barriers by conducting a series of workshops. This study went beyond the normal exploration of pilots and uncovered the adoption progress of BT in industry. Improving data and product security, visibility and SC processes were the top-rated drivers while lack of understanding about integration, potential benefits and costs including ROI were the top-rated barriers. Guo et al. (2021) explored early adoption determinants and found opportunistic behaviour of managers to be the reason for early adoption. Mathivathanan et al. (2021) identified and analysed BT adoption barriers using Total Interpretive Structural Modelling (TISM) and Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) analysis. The study identified lack of familiarity with BT and lack of business awareness as the top-most influential barriers to adoption. Vafadarnikjoo et al. (2021) analysed BT adoption barriers in manufacturing SC and found transaction-level uncertainties as the most prominent barrier. Ali et al. (2021) utilised multiple case studies in Malaysian Halal Food SC to build a framework related to BT adoption opportunities/drivers and challenges. The study found complexity and capability, cost, and competitive advantage, change management and external pressure, and regulatory capability as key challenges to BT adoption. In a survey by Nayal et al. (2021), the influence of factors such as SC risk, SC integration, cost, top management support, etc. was tested using SEM and all the factors positively influenced the adoption of BT. Baharmand et al. (2021) investigated enablers and barriers to BT adoption in humanitarian SC. The study also utilised a case study to reveal that BT added value by increased traceability, visibility which meant increased transparency. Bai et al. (2022) evaluated BT enablers in African Cocoa industry by utilising TOE framework and best–worst method (BWM) and found smart contracts, security and tracking as major enablers. Galati (2022) explored the role of social capital in adopting BT. The study utilised multiple case studies and identified BT adoption to be dependent on relational capital as a necessary but not a sufficient condition.

However, Wu et al. (2021) analysed strategies for BT adoption in case of fresh product SC. They found that BT adoption isn’t an optimal decision as it depends on traceability cost proportion allocation between SC members, product deterioration rate and consumers product acceptance degree without BT. He et al. (2021) in a similar setting found BT adoption non-beneficial to supplier and retailer. Li et al. (2021b) showed that the decision to adopt BT for authentication purposes in a luxury SC depended on the cost difference between a manual technology and BT. The results showed that decision to adopt BT was positive when the cost difference was small. Anastasiadis et al. (2022) proposed that a decision to adopt BT as a traceability system could stir the adoption of circular economy and sustainability practices (Tsolakis et al., 2022). Ji et al. (2022) found that decision to adopt BT in SC if and only if sensitivity of consumer exceeds the minimum requirement level along with the consideration of reaping big profits in the manufacturers case who will adopt the BT. Wu et al. (2022) further proposed that BT adoption depends on consumers awareness about traceability and cost-sharing of BT-based traceability between manufacturer and retailer. Fan et al. (2022) reiterated that BT adoption depends on consumers awareness about traceability and the cost of using BT along with production cost of supplier and manufacturer. Naef et al. (2022) argued that for successful adoption of BT in a bigger network of SC, centralised leadership was the key. Kumar et al. (2022a) proposed a BT 4.0 based framework for an agricultural SC. The study focused on enhancing transparency, traceability, and sustainability of SC by adopting BT. Song et al. (2022) utilised game theory to understand BT adoption behaviour...
A total of 23 studies have focused on barriers of adoption while 15 are focused on enablers. Table 11 lists the studies exploring enablers and barriers to Adoption Theme.

### Table 11 BT studies exploring enablers and barriers to adoption theme

| Context | Citations |
|---------|-----------|
| Barriers to adoption | Saberi et al. (2019), Farooque et al. (2020), Sahebi et al. (2020), Papathanasiou et al. (2020), Schuetz and Venkatesh (2020), van Hoek (2020b), Balci and Surucu-Balci (2021), Bag et al. (2021), Caldarelli et al. (2021), Baharmand et al. (2021), Narwane et al. (2021), Mathivathanan et al. (2021), Patil et al. (2021), Kouhizadeh et al. (2021), Karuppiah et al. (2021), Ghode et al. (2021), Vafadarnikjoo et al. (2021), Vu et al. (2021), Govindan (2022), Han and Rani (2022), Khan et al. (2022a, 2022b, 2022c), Moretto and Macchion (2022), Samad et al. (2022), Xu et al. (2022) |
| Enablers of adoption | Kamble et al. (2020), van Hoek (2020b), Yadav and Singh (2020), Papathanasiou et al. (2020), Shoaib et al. (2020), Baharmand et al. (2021), Gupta et al. (2021), Sharma et al. (2021a, 2021b), Suwanposri et al. (2021), Yadav et al. (2021), Vu et al. (2021), Agi and Jha (2022), Bai et al. (2022), Kayikci et al. (2022a, 2022b), Moretto and Macchion (2022), Sahebi et al. (2022), Samad et al. (2022), Yousefi and Mohamadpour Tosarkani (2022) |

of firms under risk. The found that firms will adopt BT when there is low trust in information or BT adoption cost is low.

A total of 23 studies have focused on barriers of adoption while 15 are focused on enablers. Table 11 lists the studies exploring enablers and barriers to Adoption Theme.

### 4.1.3 Implication of implementing theme/perspective

This theme/perspective relates to the outcomes of implementing BT either through virtual platform, a simulation or in real word scenario. This sub-section also discusses whether the outcomes are positive and whether they meet or go beyond the expectations at pre-adopter and adoption stage. A total of 87 studies falls under this theme as listed in Table 14. Table 15 lists theories utilised in implication of implementing theme. Table 16 lists BT features explored under implication of implementing theme.

Choi (2019) utilised game theory while comparing the traditional retail jewellery operations with the BT backed ones and found that BT generated higher benefit to both manufacturer and consumer by utilising diamond authentication and certification. Martinez et al. (2019) investigated effect of BT through resource base view lens while being implemented on customer order management process and found that BT improved process efficiency, order traceability, and further reduced the number of operations while saving average order time. Ivanov et al. (2019) analysed the impact of BT as a track and trace technology on SC. The study found that an advanced track and trace system like BT increased SC visibility, enhanced real-time identification of events which lead to a decrease in disruption risk and hence, reduced chances of ripple effect. Choi (2020) proved that BT-enabled SC considerably faced lower operational risk (Chaudhuri et al., 2021) than the normal SC. Dubey et al. (2020) argued that BT could be successfully utilised to enhance transparency, swift trust, and further improve collaboration along with improved supply chain resilience (SCRES) in a humanitarian SC. In line with the effect of BT on SCRES and ripple effect, Lohmer et al. (2020) utilised agent-based simulation model to analyse the impact of BT on disruptions and SCRES. The simulation indicated that BT successfully promotes SCRES and its aligned strategies if smart contracts were employed for collaboration under risk. Manupati et al. (2020) while being focused on the sustainability developed a BT based distributed
Table 12 Theories utilised under adoption theme

| Theory/model/paradigm                        | Citations                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------|
| Force-field theory                          | Kouhizadeh et al. (2021)                                                 |
| Fuzzy set theory                            | Bag et al. (2021), Karuppih et al. (2021), V. S. Yadav et al. (2021)    |
| Game theory                                 | Liu et al. (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g), Liu et al. (2021d), Niu et al. (2021a, 2021b), Pun et al. (2021), Shen et al. (2021), Wu et al. (2021), Yang et al. (2021), Fan et al. (2022), Ji et al. (2022), Song et al. (2022), Wu et al. (2022), Zhou et al. (2022) |
| Grey theory                                 | Dong et al. (2021), Karuppih et al. (2021), Narwane et al. (2021)         |
| Grounded theory                             | Suwanposri et al. (2021)                                                 |
| Information processing theory (IPT)         | Sislian and Jaegler (2022)                                               |
| Innovation adoption theory                  | Vu et al. (2021)                                                         |
| Innovation diffusion theory (IDT)/diffusion of innovation (DOI) | Guo et al. (2021), Agi and Jha (2022), Çolak and Kağnicioğlu (2022), Yi et al. (2022) |
| Mean-risk theory                            | Choi (2021)                                                              |
| Network theory                              | Yousefi and Mohamadpour Tosarkani (2022)                                 |
| Resource based view (RBV)                   | Baharmand et al. (2021), Nandi et al. (2021), Sundarakani et al. (2021), Benstead and Moradlou (2022) |
| Resource dependence theory (RDT)            | Nandi et al. (2021)                                                      |
| Technology acceptance model (TAM)           | Liu et al. (2021d), Tan and Sundarakani (2021), Caldarelli et al. (2021), Kouhizadeh et al. (2021), Nayal et al. (2021), Patil et al. (2021), Suwanposri et al. (2021), Bai et al. (2022), Xu et al. (2022) |
| Technology organisation and environment (TOE) | Caldarelli et al. (2021), Kouhizadeh et al. (2021), Nayal et al. (2021), Patil et al. (2021), Suwanposri et al. (2021), Bai et al. (2022), Xu et al. (2022) |
| Social capital theory                       | Galati (2022)                                                            |
| Social network theory                       | Bai et al. (2022)                                                        |
| Stakeholder theory                          | Balci and Surucu-Balci (2021)                                            |
| UTAUT                                       | Nayal et al. (2021)                                                      |

ledger for monitoring SC performance and further aimed at optimising operational costs and emission levels. The study utilised Mixed Integer Non-Linear Programming (MINLP) model and found that BT ensured the minimisation of the objectives. Pan et al. (2020) reported that BT implementation had significant effect on enterprise organisational capabilities such as asset turnover rate and reduction of sales expense rate. The study further proposed that BT introduced a trust mechanism along with an improvement in decentralized operations and data integrity. Rogerson and Parry (2020) conducted multiple case studies-based interviews from food industry. They reported empirical evidence of BT leading to an increase in SC visibility, provenance, and a protection against counterfeits. Similarly, Köhler and Pizzol (2020) utilised multiple cases based study to check impact of BT implementation in food SC. The study found that food BT had enhanced transparency, visibility traceability in SC and hence, lead to an increase in trust. Khan et al. (2021) based on a survey concluded that BT positively impacted green SC practices which lead to a positive organisational performance. Qian
Table 13 BT Features explored under adoption theme

| BT features          | Citations                                                                 |
|----------------------|---------------------------------------------------------------------------|
| Immutability         | Saberi et al. (2019), Shoaib et al. (2020), Caldarelli et al. (2021), Ghode et al. (2021), Karuppiah et al. (2021), Niu et al. (2021a, 2021b), Sahebi et al. (2022), Samad et al. (2022) |
| Privacy              | Saberi et al. (2019), Kamble et al. (2020), Karuppiah et al. (2021), Yadav et al. (2021), Sharma et al. (2021a, 2021b), Sahebi et al. (2022) |
| Provenance           | Saberi et al. (2019), Kamble et al. (2020), Yadav et al. (2021), Sahebi et al. (2022), Samad et al. (2022) |
| Risk management      | Kamble et al. (2020), Shoaib et al. (2020), Choi (2021), Karuppiah et al. (2021), Sharma et al. (2021a, 2021b), Sahebi et al. (2022), Samad et al. (2022), Song et al. (2022) |
| Traceability/tracking| Saberi et al. (2019), Kamble et al. (2020), Shoaib et al. (2020), Baharmand et al. (2021), Gupta et al. (2021), Niu et al. (2021a, 2021b), Rainero and Modarelli (2021), Sharma et al. (2021a, 2021b), Tan and Sundarakani (2021), Yadav et al. (2021), Vu et al. (2021), Wu et al. (2021), Yang et al. (2021), Anastasiadis et al. (2022), Bai et al. (2022), Benstead and Moradiou (2022), Fan et al. (2022), Ji et al. (2022), Ji et al. (2022), Kumar et al. (2022a), Omar et al. (2022), Sahebi et al. (2022), Samad et al. (2022), Wu et al. (2022), Xu et al. (2022), Yi et al. (2022) |
| Transparency/visibility| Saberi et al. (2019), Kamble et al. (2020), Chod et al. (2020), van Hoek (2020b), Fosso Wamba et al. (2020b), Gupta et al. (2021), Sahebi et al. (2020), Shoaib et al. (2020), Ali et al. (2021), Baharmand et al. (2021), Caldarelli et al. (2021), Ghode et al. (2021), Liu et al. (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g), Niu et al. (2021a, 2021b), Sharma et al. (2021a, 2021b), Suwanposri et al. (2021), Vu et al. (2021), Bai et al. (2022), Benstead and Moradiou (2022), Kumar et al. (2022a), Moretto and Macchion (2022), Omar et al. (2022), Kayikci et al. (2022a, 2022b), Sahebi et al. (2022), Samad et al. (2022), Sislian and Jaegler (2022), Xu et al. (2022), Zhou et al. (2022) |
| Trust                | Saberi et al. (2019), Shoaib et al. (2020), Baharmand et al. (2021), Ghode et al. (2021), Karuppiah et al. (2021), Rainero and Modarelli (2021), Yadav et al. (2021), Sislian and Jaegler (2022), Bai et al. (2022), Ji et al. (2022), Kumar et al. (2022a), Omar et al. (2022), Xu et al. (2022), Yi et al. (2022) |
| Smart contract       | Saberi et al. (2019), Kamble et al. (2020), Shoaib et al. (2020), Sundarakani et al. (2021), Tan and Sundarakani (2021), Yadav et al. (2021), Bai et al. (2022), Omar et al. (2022), Samad et al. (2022), Sislian and Jaegler (2022) |
| Security             | Saberi et al. (2019), Kamble et al. (2020), Shoaib et al. (2020), Caldarelli et al. (2021), Rainero and Modarelli (2021), Sharma v (2021a, 2021b), Sundarakani et al. (2021), Suwanposri et al. (2021), Bai et al. (2022), Omar et al. (2022), Sahebi et al. (2022), Samad et al. (2022) |

and Papadonikolaki (2021) argued that BT implementation provides solutions for enhanced contracting, data tracking and resource transferring in SC which in turn enhance trust from various sources in a SC. Keeping a hold onto trust is crucial for any SC Finance firm and BT can help in that direction removing information asymmetry and inequality (Du et al., 2020). Brookbanks and Parry (2022) argued that BT implementation doesn’t introduce trustless disintermediation. Instead, the study argued that new trustworthy intermediaries had to be introduced who could be trusted. In sync with the information sharing issues, Nandi et al. (2020) reported that firms implementing BT are focused on improving operational-level capabilities such as coordination and information sharing capabilities) rather than on
Table 14 Studies under implication of implementing theme

| Implication of implementing/adopting | Choi (2019, 2020), Choi and Luo (2019), George et al. (2019), Ivanov et al. (2019), Longo et al. (2019), Martinez et al. (2019), Sheel and Nath (2019), De Giovanni (2020), Du et al. (2020), Dubey et al. (2020), Gourisetti et al. (2020), Hayrutdinov et al. (2020), Li et al. (2020, 2021a, 2021c, 2022a); Lohmer et al. (2020), Guo et al. (2020), Köhler and Pizzol (2020), Manupati et al. (2020), Nandi et al. (2020), Ozdemir et al. (2020), Pan et al. (2020), Roeck et al. (2020), Rogerson and Parry (2020), Shen et al. (2020, 2022), Tönnissen and Teuteberg (2020), Tozanli et al. (2020), Zelbst et al. (2020), Adel and Younis (2021), Bai et al. (2021), Benzidia et al. (2021), Chang et al. (2021), Chaudhuri et al. (2021), Choi et al. (2021), Hong and Hales (2021), Khan et al. (2021), Kshetri (2021, 2022), Kumar (2021a), Liu et al. (2021e), L. Liu et al. (2021b), Maity et al. (2021), Mangla et al. (2021a), Niu et al. (2021a, 2021b), Paul et al. (2021, 2022a, 2022b), Qian and Papadonikolaki (2021), Quayson et al. (2021), Treiblmaier and Sillaber (2021), Wang et al. (2021a, 2021b), Westerlund et al. (2021), Xia et al. (2021), Xu et al. (2021a, 2021b), Xu and Choi (2021), Xing et al. (2021), Yu et al. (2021, 2022), Babu et al. (2022), Brookbanks and Parry (2022), Dang et al. (2022), Ghode et al. (2022), Erol et al. (2022), Kusi-Sarpong et al. (2022), Liu (2022), Ning and Yuan (2021), Philosoophian et al. (2022), Tan et al. (2022a, 2022b), Tian et al. (2022), Tao et al. (2022), Raj et al. (2022), Treiblmaier and Garaus (2022), Wu and Yu (2022), Xu and Duan (2022), Xu and He (2022), Yang et al. (2022), Zeng et al. (2022) |

Strategic ones such as collaboration and integration as such improvements lead to better SC performance parameters based on the type of industry such as reduced cost, quality improvement, increased flexibility and process improvement. Liu et al. (2021b) through their case study method argued that IoT and BT together (Gopal et al., 2022) were more effective in mitigating information asymmetry issues and hence, dilute SC finance risks leading to appraised value creation as well as value appropriation (Ning & Yuan, 2021). In a surprise turn of events, Shen et al. (2020) reported that on an online marketplace platform BT was preferred for selling second-hand products that are low in uniqueness and low in quality but not for high quality products. BT also reportedly improved horizontal integration which improved SC’s overall profit. However, Niu et al. (2021a, 2021b) utilised mathematical modelling to understand impact of BT and reported BT to be double-edged sword. On one hand, it increased firms wholesale profit but reduced its retailing profit and tax benefits on the other. Mangla et al. (2021) investigated societal impact of BT in context of sustainable milk SC using systems theory. The study argued that BT had positive impact on social parameters related to milk SC such as improved food security, decreasing food fraud, assisting healthy food access, etc. Xu et al. (2021b) argued that BT made products greener, and brought about SC coordination whilst bringing manufacturer and the platform more profits. Wang et al. (2021a) through their multimethod study comprising of an experiment and case study found that BT adoption specifically as tracing system improved product sales, SC transparency, process management and significantly decreased product returns. In a very unique study by Bai et al. (2021), results indicated a huge improvement in trust and transparency when trust values from sensors were recorded in BT in the green SC. Erol et al. (2022) argued that BT’s traceability, improved coordination and collaboration along with improved trust alleviate the
effect of barriers to circular economy (CE) adoption i.e., BT could act as an enabler of CE. Kshetri (2022) analysed multiple case studies of BT in mineral/metal industry and found that BT increased the flow of authentic information in the SC. Shen et al. (2022) modelled a situation aimed at combating copycats. It was found that the firm deploying BT tended to reduce the quality of products (Tao et al., 2022) as more quality didn’t bring more profits as the consumer already differentiated between an imitation and a genuine product as a consequence of BT. Paul et al. (2022a) via their event study reported that BT enabled SC firms during Covid-19 pandemic stayed safe from significant valuation loss and volatility of market. Paul et al. (2022a, 2022b) through their survey in tea industry found BT impacted transparency, traceability positively which further improved goal of having circular SC and high performance. Philsoophian et al. (2022) surveyed about the impact of BT on SC performance. The study found that two features of BT transparency and security highly impacted mediating role of BT between knowledge sharing and SC performance. Kusi-Sarpong et al. (2022) also reported BT successfully mediated between intellectual capital and sustainable production. Tan et al. (2022a) employed case-study method with underlying theoretical base of agency and institutional theories in case of Halal SC in Malaysia. They found out that the firms utilising BT were able to ensure transparency and traceability throughout SC as BT helped firms within the SC to access and manage transaction details without any delays. In addition to that, firms ensured that halal religious requirements were met using a smart contract and sensors or RFID tags. Tian et al. (2022) conducted field experiments and found that BT solved issues related to operational efficiency by utilising features of immutability and traceability. Treiblmaier and Garaus (2022) conducted two experiments in food SC and identified that BT’s traceability helped to establish product quality in consumers perception and lead to a purchase intention.

This theme has seen several works focused on game theoretical modelling, simulations, experiments, real word case studies from industry and results have been extremely promising. From improving trust, transparency, traceability to SC performance (Philsoophian et al., 2022) and increase in profits, BT provides a fresh look at how a technology can be significant by moving beyond its stereotypical features of tracking and tracing.

4.1.4 Application theme/perspective

This theme/perspective relates to the applications of BT in SC while also integrating with newer technologies. It also explores phenomena such as resilience, sustainability, green, circular SC as the future application areas. The potential SC application areas for BT discussed in the literature are Food SC (Behnke & Janssen, 2020; Bumblauskas et al., 2020; Kittipanyangam & Tan, 2020; Liu et al., 2020; Vivaldini, 2021a), Agricultural SC (Hu et al., 2021; Liu et al., 2020; Mishra & Maheshwari, 2021; Mukherjee et al., 2021), SC Risk Management (Choi et al., 2019; Manupati et al., 2022; Rauniyar et al., 2022; Shashie et al., 2020), Sustainable SC (Gong et al., 2022b; Khan et al., 2022b; Liu et al., 2021c; Wang et al., 2022; Xia et al., 2021), etc. 65 studies fall under this heading as listen in Table 17. Table 18 lists major areas to be explored under the application theme. Table 19 lists theories utilised under the application theme. Table 20 lists BT features mentioned under application theme.

Min (2019) proposed supply chain resilience (SCRES) as a potential application area. According to the study, BT has the potential to alleviate risks and uncertainty and enhance SCRES with the help of its features of immutability, traceability, risk management and smart contracts. Wang et al. (2019a) argued that future research on BT application in SC would focus on extending the provision of automated visibility/transparency, traceability (track and trace) (Kumar et al., 2022b) to all the relevant stakeholders in SC to build trust by
removing any disintermediation especially in SC’s related to crucial artifacts such as vaccine, diamonds, luxury items, etc. This is because as the implementation scale increases so does the need to be transparent and traceable. Behnke and Janssen (2020) propounded BT as a highly efficient information traceability system. The study proposed a set of boundary conditions so that the implementation of BT becomes practical. Schmidt and Wagner (2019) suggested to explore the effect of BT implementation on relationship structures, disintermediation through various theoretical lenses such as agency theory and network theory. Cole et al. (2019) listed out numerous application areas such as product safety and security, quality management, reduction of counterfeiting, automation of contracts, new product development, and reduction of intermediaries. Pournader et al. (2020) in line with Saberi et al. (2019) and Babich snd Hilary (2020) proposed few application areas such as procurement, contracting, trust in buyer–supplier relationship, SC governance, SC risk management, sustainable SC, etc. Bumblauskas et al. (2020) suggested that food distribution as the target area of application specifically the egg SC in case of Europe. The study proposed use of Hyperledger Sawtooth by utilising proof of elapsed time consensus mechanism and thus,

Table 15 Theories utilised in implication of implementing theme

| Theory/model/paradigm | Citations |
|-----------------------|-----------|
| Agency theory         | Chaudhuri et al. (2021), Tan et al. (2022a) |
| Dynamic capability view (DCV) | Sheel and Nath (2019), Benzidia et al. (2021), Kusi-Sarpong et al. (2022) |
| Fuzzy set theory      | Ozdemir et al. (2020), |
| Game theory           | Choi (2019), De Giovanni (2020), Guo et al. (2020), Hayrutdinov et al. (2020), Bai et al. (2021), Niu et al. (2021a, 2021b), Xu et al. (2021b), Xu and Choi (2021), Yu et al. (2021), Liu (2022), Tao et al. (2022), Wu and Yu (2022), Xu and Duan (2022), Li et al. (2022a), Yang et al. (2022) |
| Grounded theory       | Qian and Papadonikolaki (2021) |
| Information processing theory (IPT) | Martinez et al. (2019), |
| Institutional theory (IT) | Tan et al. (2022a) |
| Mean-risk theory      | Choi (2020), |
| Network theory (NT)   | Paul et al. (2021), Tan et al. (2022b) |
| Organizational information processing theory (OIPT) | Dubey et al. (2020) |
| Principal-agent theory (PAT) | Kshetri (2021) |
| Relational view (RV)  | Xing et al. (2021), L. Liu et al. (2021) |
| Resource based view (RBV) | Dubey et al. (2020), Qian and Papadonikolaki (2021), Tan et al. (2022b) |
| Transaction cost economics (TCE) | Martinez et al. (2019), Sheel and Nath (2019), Nandi et al. (2020), Paul et al. (2021), |
| Signaling theory      | Treiblmaier and Garaus (2022) |
| Social exchange theory | Wang et al. (2021b) |
| System dynamics       | Mangla et al. (2021), |
| Systems theory        | Zelbst et al. (2020) |
Table 16  BT features explored under implication of implementing theme

| BT features | Citations |
|-------------|-----------|
| Immutability | Ozdemir et al. (2020), Kshetri (2021), Maity et al. (2021), Tian et al. (2022) |
| Privacy | Maity et al. (2021), Shen et al. (2022) |
| Provenance | Roeck et al. (2020), Rogerson and Parry (2020), Babu et al. (2022) |
| Risk management | Ivanov et al. (2019), Choi (2020), De Giovanni (2020), Lohmer et al. (2020), Chaudhuri et al. (2021), Babu et al. (2022), Dang et al. (2022) |
| Traceability/tracking | George et al. (2019), Ivanov et al. (2019), Gourisetti et al. (2020), Kühler and Pizzol (2020), Ozdemir et al. (2020), Tönnessen and Teuteberg (2020), Kshetri (2021), Li et al. (2021c), Maity et al. (2021), Mangla et al. (2021), Paul et al. (2021), Tan et al. (2022a), Tönnessen and Teuteberg (2020), Tozanlı et al. (2020), Zelbst et al. (2020), Xu et al. (2021a), Wang et al. (2021a), Yu et al. (2021), Babu et al. (2022), Brookbanks and Parry (2022), Liu (2022), Kshetri (2022), Paul et al. (2022a, 2022b), Philsoophian et al. (2022), Raj et al. (2022), Tan et al. (2022b), Wu and Yu (2022), Xu and He (2022) |
| Transparency/visibility | George et al. (2019), Ivanov et al. (2019), De Giovanni (2020), Dubey et al. (2020), Gourisetti et al. (2020), Guo et al. (2020), Köhler and Pizzol (2020), Ozdemir et al. (2020), Roeck et al. (2020), Rogerson and Parry (2020), Kshetri (2021), Li et al. (2021c), Maity et al. (2021), Mangla et al. (2021), Paul et al. (2021), Tan et al. (2022a), Tönnessen and Teuteberg (2020), Tozanlı et al. (2020), Zelbst et al. (2020), Xu et al. (2021a), Wang et al. (2021a), Yu et al. (2021), Babu et al. (2022), Brookbanks and Parry (2022), Liu (2022), Kshetri (2022), Paul et al. (2022a, 2022b), Philsoophian et al. (2022), Raj et al. (2022), Tan et al. (2022b), Wu and Yu (2022), Xu and He (2022) |
| Trust | Longo et al. (2019), De Giovanni (2020), Du et al. (2020), Dubey et al. (2020), Gourisetti et al. (2020), Köhler and Pizzol (2020), Ozdemir et al. (2020), Roeck et al. (2020), Rogerson and Parry (2020), Tönnessen and Teuteberg (2020), Li et al. (2021c), Paul et al. (2021), Qian and Papadonikolaki (2021), Raj et al. (2022), Treiblmaier and Sillaber (2021), Erol et al. (2022) |
| Smart contract | De Giovanni (2020), Lohmer et al. (2020), Manupati et al. (2020), Roeck et al. (2020), Kshetri (2021), Raj et al. (2022), Tan et al. (2022a), Xu and He (2022) |
| Security | De Giovanni (2020), Nandi et al. (2020), Li et al. (2020), Ozdemir et al. (2020), Li et al. (2021a), Maity et al. (2021), Xu et al. (2021a), Babu et al. (2022), Philsoophian et al. (2022), Raj et al. (2022), Xu and He (2022) |

Table 17  Studies explored under application theme

| Applications | O’Leary (2017), Tan et al. (2018), Cole et al. (2019), Choi et al. (2019), Hald and Kinra (2019), Hasan et al. (2019), Helo and Hao (2019), Min (2019), Montecchi et al. (2019), Schmidt and Wagner (2019), Wang et al. (2019b, 2021c, 2022), Yang (2019), Batwa and Norman (2020), Bumblauskas et al. (2020), Behnke and Janssen (2020), Chang et al. (2020), Di Vaio and Varriale (2020), Dutta et al. (2020), Filimonau and Naumova (2020), Kittipanya-ngam and Tan (2020), Kopyto et al. (2020), Li et al. (2021c; 2021f); ; ; 2020, 2020, J. Liu et al. (2021b), Liu and Li (2020), Pournader et al. (2020), Rodríguez-Espíndola et al. (2020), Fosso Wamba et al. (2020a), Sunny et al. (2020, 2022), Agrawal et al. (2021), Asante et al. (2021), Bechtis et al. (2021), de Boissieu et al. (2021), Hu et al. (2021), Karamchandani et al. (2021), Kumar et al. (2021), McGrath et al. (2021), Menon and Jain (2021), Mishra and Maheshwari (2021), Mukherjee et al. (2021), Raj Kumar Reddy et al. (2021), Rejeb et al. (2021), Sharma et al. (2021a), Sivula et al. (2021), Tandon et al. (2021), Varriale et al. (2021), Vivaldini (2021b), Ahmad et al. (2022), Friedman and Ormiston (2022), Gong et al. (2022a, 2022b), Grida and Mostafa (2022), Hrouga et al. (2022), Jiang et al. (2022), Khan et al. (2022a, 2022b), Manupati et al. (2022), Zhu et al. (2022) |
hopes to contribute to food traceability domain. Montecchi et al. (2019) argued enhancing provenance could be a potential application area as it focuses on reducing the uncertainty about authenticity, custody, integrity and origin. Dutta et al. (2020) through their literature review identified various industries that could be revamped by implementing BT such as agriculture, energy, finance, food, shipping, etc. They argued that improvements in transparency, traceability, business processes, etc. would revamp the listed industries. Counterfeits, clones are a huge problem in cross border e-commerce trade and as such present an application area for BT to solve the problem (de Boissieu et al., 2021; Liu & Li, 2020). Hald and Kinra (2019) posit that BT can solve the problems related to contract management, SC governance, structural complexity, SC coordination, and data inconsistencies. Rodríguez-Espíndola et al. (2020) explored the possibility of applying BT along with other technologies such as artificial intelligence in humanitarian logistics. The study suggested that BT due to its features of immutability, decentralised character, smart contracts present a very attractive application area along with other leading technologies while having a strong case of improving data accuracy needs, accountability, tracking ability and real-time transparency. Kopyto et al. (2020) predicted that by the year 2035 BT will be applied to SC. The study discussed how BT will be applied to SC by developing and discussing the projections that were rated by Delphi experts depending on factors such as probability of desirability, impact, and occurrence. Asante et al. (2021) argued that BT demonstrates huge potential to improve cyber-resilience, traceability, transparency, trust while integrating with other technologies in data-driven operations. Bechtsis et al. (2021) argued that data-driven technology such as BT provide an impetus to improve SC operations, security, resilience, and sustainability. Kayikci et al. (2021) proposed that BT application of immutability, traceability, transparency, and smart contracts could lead to operational excellence, effective collaboration, reduction of risks (Rauniyar et al., 2022), increased responsiveness and flexibility. Rejeb et al. (2021) argued facilitating accountability, auditability, data consistency, transparency and traceability are the main focal application areas of BT in future SC’s. The study pointed out a need for enhanced collaboration while overcoming vulnerabilities related to legacy technologies. Continuing with vulnerabilities and disruptions, Raj Kumar Reddy et al. (2021) pointed out that BT could address issues related to uncertainties in automotive SC by enabling and enhancing traceability, transparency, visibility for an efficient automotive SC. Karamchandani et al. (2021) conducted a survey in manufacturing SC and found that blockchain would play a greater role in reliable delivery and mass customisation of products. Friedman and Ormiston (2022) posit that BT favours sustainability and fairer SC with better food traceability. However, Khan et al. (2022b) reported that BT doesn’t directly impact SC sustainability but could be indirectly achieved through SC Integration (Wang et al., 2022) and SC Mapping. Hrouga et al. (2022) assert that BT’s features of immutability, transparency and smart contract would impact strategic SC partnership efficiency and growth which would further impact the SC performance and, hence, report SC partnerships as an area of application of BT. Khan et al. (2022a) reported that BT application in agricultural SC could enable integrity and trust, fraud and counterfeit prevention, traceability and transparency along with reliable data retrieval. Gong et al. (2022a) argued that BT presents a potential application in recycling SC for debris management and sustainability as its features of high traceability and transparency with the application of smart contract would be effective in establishing a global recycling network.
Table 18 Major areas to be explored under application theme

| Major application/substantive area | Citations |
|------------------------------------|-----------|
| Food SC                            | Behnke and Janssen (2020), Bumblauskas et al. (2020), Kittipanya-ngam and Tan (2020), Liu et al. (2020), Bechtsis et al. (2021), Vivaldini (2021a, 2021b), Kayikci et al. (2021), Menon and Jain (2021), Mishra and Maheshwari (2021), Friedman and Ormiston (2022), Pandey et al. (2022) |
| Agriculture SC                     | Liu et al. (2020), Agrawal et al. (2021), Hu et al. (2021), Menon and Jain (2021), Mishra and Maheshwari (2021), Mukherjee et al. (2021), Khan et al. (2022a) |
| SC risk management                 | Choi et al. (2019), Min (2019), Montecchi et al. (2019), Helo and Hao (2019), Kopyto et al. (2020), Bechtsis et al. (2021), Varriale et al. (2021), Manupati et al. (2022), Pandey et al. (2022), Rauniyar et al. (2022) |
| Sustainable SC                     | Di Vaiio and Varriale (2020), Bechtsis et al. (2021), McGrath et al. (2021), Xia et al. (2021), Gong et al. (2022a, 2022b), Khan et al. (2022b), Wang et al. (2022) |
| SC finance                         | O’Leary (2017), Fosso Wamba et al. (2020a), Liu et al. (2021c), Jiang et al. (2022), |
| Logistics                          | Tan et al. (2018), Pourmader et al. (2020), Tönnissen and Teuteberg (2020), Ajay Kumar et al. (2021), Hrouga et al. (2022), |

Table 19 Theories utilised under application theme

| Theory/model/paradigm                | Citations |
|-------------------------------------|-----------|
| Fuzzy set theory                    | Sharma et al. (2021a) |
| Game theory                         | Liu et al. (2020; 2021c); Grida and Mostafa (2022), |
| Grounded theory                     | de Boissieu et al. (2021) |
| Mean–variance theory                | Choi et al. (2019), |
| Network theory (NT)                 | Gong et al. (2022a, 2022b), |
| Resource based view (RBV)           | Bechtsis et al. (2021), Karamchandani et al. (2021) |
| Technology acceptance model (TAM)   | Yang (2019) |
| Transaction cost analysis (TCA)      | Schmidt and Wagner (2019), Bechtsis et al. (2021) |
| Relational view                     | Zhu et al. (2022) |
| Sensemaking theory                  | Wang et al. (2019a) |

4.2 Blockchain technology and SC resilience (SCRES)

PONOMAROV and Holcomb (2009) define supply chain resilience (SCRES) as the “adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”. Tukamuhabwa et al. (2015) summarised a set proactive and reactive strategies of SCRES. Among the most prominent SCRES strategies
| BT features               | Citations                                                                                                                                 |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Immutability             | Cole et al. (2019), Hald and Kinra (2019), Min (2019), Chang et al. (2020), Fosso Wamba et al. (2020a), Asante et al. (2021), Hu et al. (2021), Karamchandani et al. (2021), Kayikci et al. (2021), J. Liu et al. (2021), Mishra and Maheshwari (2021), Mukherjee et al. (2021), Sharma et al. (2021a), Varriale et al. (2021), Wang et al. (2021c), Ahmad et al. (2022), Hrouga et al. (2022) |
| Privacy                  | Fosso Wamba et al. (2020a), Menon and Jain (2021), Mukherjee et al. (2021), Varriale et al. (2021), Ahmad et al. (2022)                                                                 |
| Provenance               | Helo and Hao (2019), Montecchi et al. (2019), Batwa and Norrman (2020), Menon and Jain (2021), Vivaldini (2021a, 2021b), Ahmad et al. (2022) |
| Risk management          | Choi et al. (2019), Min (2019), Montecchi et al. (2019), Helo and Hao (2019), Kopyto et al. (2020), Bechtsis et al. (2021), Varriale et al. (2021), Manupati et al. (2022), Pandey et al. (2022), Rauniyar et al. (2022) |
| Traceability/tracking    | Tan et al. (2018), Cole et al. (2019), Hald and Kinra (2019), Helo and Hao (2019), Min (2019), Montecchi et al. (2019), Batwa and Norrman (2020), Behnke and Janssen (2020), Bunblauskas et al. (2020), Chang et al. (2020), Kittipanya-ngam and Tan (2020), Liu et al. (2020), Liu and Li (2020), Pourmader et al. (2020), Rodriguez-Espinola et al. (2020), Sunny et al. (2020), Agrawal et al. (2021), Asante et al. (2021), Bechtsis et al. (2021), de Boissieu et al. (2021), Hu et al. (2021), Karamchandani et al. (2021), Yasanur Kayikci et al. (2021), Ajay Kumar et al. (2021), Liu et al. (2021f), Menon and Jain (2021), Mishra and Maheshwari (2021), Raj Kumar Reddy et al. (2021), Rejeb et al. (2021), Sharma et al. (2021a), Vivaldini (2021b), Varriale et al. (2021), Ahmad et al. (2022), Friedman and Ormiston (2022), Gong et al. (2022a, 2022b), Hrouga et al. (2022), Khan et al. (2022a), Pandey et al. (2022), Zhu et al. (2022) |
| BT features         | Citations                                                                                                                                 |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Transparency/visibility | Tan et al. (2018), Cole et al. (2019), Hald and Kinra (2019), Min (2019), Montecchi et al. (2019), Yang (2019), Batwa and Norrman (2020), Bumblauskas et al. (2020), Dutta et al. (2020), Chang et al. (2020), Kittipanya-ngam and Tan (2020), Kopyto et al. (2020), Rodríguez-Espíndola et al. (2020), Fosso Wamba et al. (2020a), Pournader et al. (2020), Sunny et al. (2020), Asante et al. (2021), Bechtsis et al. (2021), de Boissieu et al. (2021), Hu et al. (2021), J. Liu et al. (2021), Karamchandani et al. (2021), McGrath et al. (2021), Menon and Jain (2021), Yasanur Kayikci et al. (2021), Mishra and Maheshwari (2021), Mukherjee et al. (2021), Raj Kumar Reddy et al. (2021), Rejeb et al. (2021), Sharma et al. (2021a), Vivaldini (2021a, 2021b), Wang et al. (2021c), Ahmad et al. (2022), Friedman and Ormiston (2022), Gong et al. (2022a, 2022b), Hrouga et al. (2022), Khan et al. (2022a), Pandey et al. (2022), Wang et al. (2022), Zhu et al. (2022) |
| Trust               | Helo and Hao (2019), Batwa and Norrman (2020), Chang et al. (2020), Liu et al. (2020), Pournader et al. (2020), Fosso Wamba et al. (2020a), Agrawal et al. (2021), Asante et al. (2021), Hu et al. (2021), Karamchandani et al. (2021), Menon and Jain (2021), Rejeb et al. (2021), Sharma et al. (2021a), Vivaldini et al. (2021), Wang et al. (2021c), Ahmad et al. (2022), Gong et al. (2022a, 2022b), Hrouga et al. (2022), Jiang et al. (2022), Khan et al. (2022a), Pandey et al. (2022), Zhu et al. (2022) |
| Smart contract      | Cole et al. (2019), Hald and Kinra (2019), Hasan et al. (2019), Helo and Hao (2019), Min (2019), Bumblauskas et al. (2020), Chang et al. (2020), Agrawal et al. (2021), Karamchandani et al. (2021), Menon and Jain (2021), Yasanur Kayikci et al. (2021), Ajay Kumar et al. (2021), J. Liu et al. (2021), Menon and Jain (2021), Mukherjee et al. (2021), Sharma et al. (2021a), Varriale et al. (2021), Vivaldini (2021b), Wang et al. (2021c), Grida and Mostafa (2022), Hrouga et al. (2022), Manupati et al. (2022), Zhu et al. (2022) |
| Security            | Cole et al. (2019), Min (2019), Batwa and Norrman (2020), Chang et al. (2020), Dutta et al. (2020), Liu et al. (2020), Fosso Wamba et al. (2020a), Bechtsis et al. (2021), Ajay Kumar et al. (2021), Yasanur Kayikci et al. (2021), J. Liu et al. (2021b), Sharma et al. (2021a), Varriale et al. (2021), Vivaldini (2021b), Wang et al. (2021c), Ahmad et al. (2022), Friedman and Ormiston (2022) |
use of information technology to enhance connectivity, visibility, collaboration, flexibility, agility, creating risk management culture, building security, and creating appropriate contractual agreements were discussed. Table 22 lists 12 studies that have explored BT in context of SCRES.

Min (2019) proposed SCRES as a potential application area of blockchain technology (BT). According to the study, BT has the potential to alleviate risks and uncertainty and enhance SCRES with the help of its features of immutability, traceability, risk management

| Citation                     | Journal                                      | Theme        |
|------------------------------|----------------------------------------------|--------------|
| Min (2019)                   | Business Horizons                            | Application  |
| Dubey et al. (2020)          | International Journal of Production Research | Implication  |
| Lohmer et al. (2020)         | International Journal of Production Economics| Implication  |
| Casino et al. (2021)         | International Journal of Production Research | Pre-Adoption |
| Nandi et al. (2021)          | Industrial Management and Data Systems       | Adoption     |
| Mukherjee et al. (2021)      | Operations Management Research               | Application  |
| Vivaldini and de Sousa (2021)| Benchmarking                                 | Pre-Adoption |
| Sharma et al. (2021a)        | Operations Management Research               | Application  |
| Razak et al. (2021)          | Production Planning and Control              | Adoption     |
| Bechtsis et al. (2021)       | International Journal of Production Research | Application  |
| Narwane et al. (2021)        | Annals of Operations Research                | Adoption     |
| Chowdhury et al. (2022)      | Annals of Operations Research                | Pre-Adoption |
and smart contracts (Iftikhar et al., 2022). Dubey et al. (2020) argued that BT could be successfully utilised to enhance transparency, swift trust (Shayganmehr et al., 2021), and further improve collaboration along with improved supply chain resilience (SCRES) in a humanitarian SC. Lohmer et al. (2020) utilised agent-based simulation model to analyse the impact of BT on disruptions and SCRES. The simulation indicated that BT successfully promotes SCRES and its aligned strategies if smart contracts were employed for collaboration under risk. Casino et al. (2021) proposed a BT-enabled traceability framework. The study implied that utilising BT had several benefits that include efficiency (minimisation of cost, more automation, and less paperwork); trust (accountability, auditability, and immutability); quality (process, product, and verifiability) and resilience (business continuity, decentralisation, and security). The study further accounts for SCRES by offering more benefits such as removing systemic and geographic boundaries while also enabling integration of different traceability data in SC. Nandi et al. (2021) call for creating BT capabilities and resources to improve SCRES. The study aims at developing L–A–D capabilities (localization, agility, and digitalization) by integrating BT-enabled circular economy system. The L–A–D capabilities then help in establishing SCRES as it provides a mechanism to respond to disruptions. Mukherjee et al. (2021) listed building SCRES as one of the benefits of BT-enabled SC. For SC to be resilient, accurate forecasting capabilities, visibility and real-time information sharing (Wong et al., 2021) are necessary and it in this respect, BT is instrumental in establishing enhanced anticipation, visibility and adaptable capabilities among stakeholders in SC (Pan et al., 2020). Vivaldini and de Sousa (2021) enlisted BT connectivity inhibitors that affect SCRES and SC interaction. In this aspect, the study lists 3 major inhibitors: coordination, technology understanding, and resources involved, and called for improving SCRES via BT enabled SC Interaction. Sharma et al. (2021a) derived twelve BT-enabled resilient strategies from the literature to enhance efficiency, survivability, and performance of food SC. The study found that BT based strategies such as flexibility, visibility and the change in network structure are the most effective strategies to fight disruption and enhance SCRES. Razak et al. (2021) propounded traceability system such as BT as an enabler of SCRES. The study mentioned the direct and indirect impacts of traceability on SCRES. In the direct impact case, BT-enabled traceability could be used as risk-identification tool while as BT-enabled traceability exhibits indirect role by enhancing formative elements of SCRES such as collaboration, flexibility, velocity and visibility. Bechtsis et al. (2021) argued that data-driven technology such as BT provide an impetus to improve SC operations, security, sustainability, and ultimately SCRES (Kazancoglu et al., 2022). Narwane et al. (2021) identified improving SCRES as one of the enablers of BT adoption. This is due to the fact that BT is a risk minimising disruptive technology (Ivanov & Dolgui, 2021). This was further supported by Chowdhury et al. (2022) who mentioned SCRES as one of the constructs that creates managers behavioural intention to adopt BT for managing risks.

Through this discussion, the study argues that there is a huge opportunity to empirically explore effect of BT on SCRES, and explore how SCRES can act as one of the motivations to implement BT in SC. This can be achieved by conducting empirical investigations to fill void in the literature.

5 Discussion

This study aimed at providing a comprehensive overview of the literature by conducting systematic literature review (SLR) on the lens of blockchain (BT) application in supply
chain. While conducting the review, it was found that blockchain in SC research has recently evolved as a highly researched area from 2017 (Dutta et al., 2020). The study shortlisted all the relevant studies based on the set review protocol and hence, developed a profile of top peer-reviewed journals along with the articles published in such journals. The study conducted descriptive analyses along with a rigorous content analysis of the articles to showcase the knowledge in a comprehensive yet in-depth manner. Hence, this led to a synthesis of knowledge that encapsulates journey of BT in SC from ideation to the implementation and the future application. Furthermore, the study explored the probable effects of BT on SC integration, collaboration, resilience, sustainability, and performance that provide directions for significant research opportunities to the researchers while also shedding light on significant managerial implications.

5.1 Theoretical contributions

This study contributes by proposing a guiding framework to identify studies that involve latest technologies such as blockchain (BT) and fitting them to a set of four specific themes or perspectives of the evolution of research in the domain. Such classification could be critical to understand the state of technology in academia and industry i.e., whether the technology is still in its nascent stage or if it has matured into an industry-wide accepted and implemented technology. In case of BT, the technology is still in its initial acceptance and implementation phase and promises to be an industry disruptive technology (Pournader et al., 2020). The study also identified top peer-reviewed publishing journals which also ensures the relevance of the research domain as most of the top journals are publishing the content on BT in SC. The study further contributes by identifying the leading industries of the world employing BT in their SC. It was identified that food industry has found its application in traceability, provenance, food security and establishing trust and transparency. The study established that very less empirical based survey studies have been conducted. This identification of gap has led to propositions and a conceptual framework for the future empirical testing and hence, provides a future research direction as well at the conclusion of the article. While many articles have talked about BT enablers/drivers and barriers, and explored them using interpretive logic, it becomes pertinent to understand the actual impact of these factors on BT enabled SC. So, the study proposes an industry wide organizational point of view to study the impact of such factors and go beyond just identification. Furthermore, the study identified theories utilised in the literature as well as the features of blockchain that are most talked about in articles. While going through the theories, it was found game theory, TAM, TOE, etc. as the most utilised theories and they have been utilised in context of adoption and possible implications of implementing BT in SC. This indicates that BT in SC research is attracting researchers apply a diverse set of theories and stimulates further research by applying theories to understand the impact of BT on SC Integration, SC Collaboration, SC Resilience (Cui et al., 2022) and ultimately SC Performance. In case of features, traceability, transparency, and trust are the most talked about ones. While traceability and transparency are usual suspects in case of food SC, trust happens to be the epitome of the BT enabled SC (Yavaprabhas et al., 2022).

5.2 Managerial implications

Our study has the following managerial implications: first, it provides an insight and direction to practitioners to understand the state of their industry in case of BT adoption and hence,
utilise four perspectives ranging from pre-adoption perspective (focused on intention of managers and the requirements of adoption) to the future research applications (focused on future research empirical studies, industries, features, sustainability, resilience and performance). Second, it provides impetus to exploring industry wide BT enabled trust mechanisms for managers while exploring applications in traceability, risk management, and transparency. Third, it enables managers to take the decision of adoption based on their requirements and critical success factors (the drivers or the barriers) along with the focus on reducing their adoption costs and increasing profits from utilising the BT while increasing the SC Performance, and SC Resilience to act as an anti-disruption technology. Fourth, the study contributes by enabling managers to understand whether the BT features identified in the four themes match their industry requirements and hence, provide a direction towards the adoption and implementation of BT in their firms.

6 Conclusion and limitations

This study provides a thorough review of 292 articles over a period of 5 years (2017–2022) by utilising SLR. The main objective of this was to identify the state of articles published in leading journals in context of BT in SC with year wise, journal wise, industry wise classifications, etc. while offering the future research direction as well. The study proposed four theme/perspective framework. This framework helps to understand the state of BT in SC both academically and industry wise. The study identified that very few pilot projects have been undertaken in industry while food industry has been the leading industry to employ BT in their SC for traceability and transparency purposes. Furthermore, the nature of findings highlights a need to have studies focused on trust, risk management, and development and implementation of smart contracts in SC. Each of the four themes summarises the BT features explored, theories discussed and utilised and the findings of the articles under each theme. Application theme itself caters to the future research possibilities and lends a good direction to scholars in identifying future key BT features as well as their application in critical SC areas. This study also adds value by summarising the possible application areas such as SC risk management, SC Integration, SC Collaboration, Circular Economy, Sustainability, SC Resilience and SC Performance. However, our study has a few limitations. The study didn’t consider grey literature, conference papers and books which at times could also contain advanced knowledge regarding the blockchain. The self-developed guiding framework is not absolute. However, it provides a pathway to understand the evolution and application of any new technology in industry and research.

7 Future research agenda

Based on the critical analysis of literature of BT in SC, this study proposes future research agenda to continue the advancement of the discipline and to address the unanswered questions for both management scholars as well as the practitioners. Our extensive review emphasizes that BT has a huge potential in changing the way actors manage a SC especially in tracking and tracing of products, ensuring transparency, building trust, managing risks, and developing a secure SC environment. The critical review further expands the horizon of application of BT and going beyond the tracking and tracing in different industries such as construction, retail, pharmaceutical, waste management, etc.
To organize our research agenda, we utilise Whetten (1989) “5W and 1H approach” i.e., “what, who, why, when, where and how”. Table 23 summarises the agenda.

- **What.** This section proposes to explore the enablers/drivers and barriers related to BT adoption and implementation specifically with regard to areas of sustainability, circular economy, resilience and SC integration (Chowdhury et al., 2022; Khan et al., 2022a; Oropallo et al., 2021; Tsolakis et al., 2021). This would address the question, “What critical factors would drive or inhibit an organization to adopt and implement BT to address the issues of sustainability, circular economy and resilience?”. It also addresses the question, “What are the motivations and intentions of the SC managers to adopt BT?”. Furthermore,

| Dimension | Future research direction | Questions |
|-----------|--------------------------|-----------|
| What      | To explore the factors driving or inhibiting adoption of BT in SC | 1. What critical factors would drive or inhibit an organization to adopt and implement BT to address the issues of sustainability, circular economy, and resilience? |
|           | To explore the motivations and intention of SC managers to BT adoption in SC | 2. What are the motivations and intentions of the SC managers to adopt BT? |
| Why       | To understand the motivational factors and their relationships behind the adoption and implementation of BT as well as the implications on socio-economic fabric and theories that address them | 1. Why BT-enabled transparency and trust would lead to better SC relationships? |
|           |  | 2. Why BT-enabled transparency and trust would lead to better SC integration? |
|           |  | 3. Why BT-enabled transparency and trust would lead to better SC performance? |
| How       | To explore the methods and methodologies that address the questions addressing issue of trust and risk management in BT-enabled SC | 1. How do managers tackle the issue of privacy vs transparency issue arising in BT-enabled SC? |
|           |  | 2. Does implementation of smart contracts establish trust, if yes then how? |
|           |  | 3. How does BT enhance risk management in a SC? |
| Who       | To address the questions related to actors such as intermediaries, BT & SC partners, stakeholders, etc | 1. Who will experience a higher impact of BT adoption and implementation, intermediaries, or the rest of the stakeholders? |
|           |  | 2. Will BT adoption and implementation adversely affect the existing relationships between the stakeholders in a SC? |
| When      | To addresses the questions related to timing of adoption and looking beyond the stereotypical uses | 1. When is it right for the firms/organisations/entities to adopt and implement BT? |
|           |  | 2. When should BT be integrated with I4.0 technologies? |
|           |  | 3. When will organisations look beyond tracking and tracing properties of BT? |
| Where     | To explore context and the application areas of BT | 1. Will the PESTLE dimensions influence and dictate the application of BT in SC? |
|           |  | 2. Which new application areas are to be identified where in legacy technologies can either be replaced or supplemented with BT? |
a dearth of empirical investigations on impact of BT on SC leads us to believe that there are numerous opportunities to develop constructs along with the empirical measures to characterize impact of BT constructs on SC constructs and moving beyond the exploration of drivers and barriers.

- **Why:** Through this section, the study draws up questions related to the motivational factors behind the adoption and implementation of BT as well as the implications on socio-economic fabric. One of the prime reasons to adopt and implement BT is to ensure trustworthiness to improve SC relationships and integration, no matter how debatable the topic itself is. It is further accompanied by the need of information transparency that is rather decentralized. Individuals today tend to shy away from traditional centralized scheme of authority especially in situations of crisis and are keen to get access to sensitive or well-kept information by the powerful entities (Lumineau et al., 2021). Such access to decentralized, transparent schema exudes a sense of trust that BT brings in. Another motivation to adopt and implement BT is minimization of risk and frauds. Hence, scholars can explore questions such as “Why would BT generated transparency and trust lead to better SC relationships, SC integration and SC performance?” To answer the questions, scholars can explore various theories to address the issues of “causality, explanation, prediction and generalization” from various disciplines such as information sciences and utilise theories such as social exchange theory (Wang et al., 2021b), institutional theory (Hartley et al., 2022), resource based view (Wamba & Queiroz, 2022), transaction cost economics (Roeck et al., 2020), etc. (Dubey et al., 2022).

- **How:** This section directs our attention to questions related to conduct of investigations related to underlying processes explaining impact of BT on SC i.e., methods and methodologies. There is a debate on the privacy, security, confidentiality vs transparency issue of BT (Xu et al., 2021a). Pandey et al. (2022) reported that BT helps in managing risks but didn’t come up with the explanation for it. Furthermore, there is a deficit on understanding of mechanism of smart contract established trust (Oropallo et al., 2021). Thus, we propose following questions arising from this section.

1. “How are managers going to tackle the issue of privacy vs transparency issue arising in BT-enabled SC?”
2. “Does implementation of smart contracts establish trust, if yes then how?”
3. “How does BT enhance risk management in a SC?”

Clearly, we lack empirical studies that address such questions. We also see scope of utilising multiple or mixed methods to generate both qualitative as well as quantitative data to address these questions.

- **Who:** An important aspect of blockchain is that it brings those people into collaborative, trustworthy environment that are essentially strangers to build an interorganizational trust (Yavaprabhas et al., 2022). This has a huge potential for certain actors who seek enhanced cooperation, coordination and collaboration to solve crisis situations especially in case of humanitarian concerns that require swift-trust among the stakeholders (Dubey et al., 2020). Going away with the intermediaries is a benefit of BT and smart-contracts (Christidis & Devetsikiotis, 2016). Thus, first question for scholars is, “Who will feel a higher impact of BT adoption and implementation, intermediaries or the rest of the stakeholders?” Second, “Will BT adoption and implementation adversely affect the existing relationships between the stakeholders in a SC?”. Such questions need to be addressed as BT could also adversely affect the existing business models.
• **When:** It is an important decision for any firm to decide on the timing of adoption and implementation and as such more critical to decide when not to. It should also be noted that BT is not necessarily a standalone technology and as such, would do better if integrated with other industry 4.0 technologies (Kamble et al., 2019). For the scholars, questions to address are 1) "When is it right for the firms/organisations/entities to adopt and implement BT?" 2) "When should BT be integrated with I4.0 technologies?". Furthermore, studies focus too much on traceability and transparency features of BT especially in food SC (Kittipanya-ngam & Tan, 2020; Razak et al., 2021). However, BT has the potential to go beyond this tracking and tracing. Hence, following question needs to be addressed as well, “When will organisations look beyond tracking and tracing properties of BT?”. This question sounds more critical because BT has been touted as the “potentially disruptive technology” (Sengupta et al., 2021) which is however, yet to be established.

• **Where:** This section reflects the context and the application areas of BT while considering geographical, technological infrastructure, political, socio-economical, cultural, and legal structure influence. Montecchi et al. (2019) argued enhancing provenance could be a potential application area as it focuses on reducing the uncertainty about authenticity, custody, integrity and origin. In a similar way, Cole et al. (2019) listed out numerous application areas such as product safety and security, quality management, reduction of counterfeiting, automation of contracts, new product development, and reduction of intermediaries. Keeping in mind the factors that could dictate application of BT, following question needs to be addressed, “Will the PESTLE dimensions influence and dictate the application of BT in SC?". Another question that needs to be answered is, “Which new application areas are to be identified where in legacy technologies can either be replaced or supplemented with BT?".

This study also calls for and develops propositions represented as a consolidated conceptual framework/theoretical model for future empirical testing because of two reasons: (1) the infancy of BT research in this domain (Queiroz et al., 2020; Wang et al., 2019a) and (2) a lack of empirical evidence in BT in SC domain (Caldarelli et al., 2021; Chowdhury et al., 2022; Cole et al., 2019; Roeck et al., 2020).

Although, many studies have argued and proposed the benefits of implementing BT in SC, few have been able to empirically validate them. Studies have proposed that BT leads to improved traceability (Erol et al., 2022; Hald & Kinra, 2019); security (Min, 2019; Philsoophian et al., 2022); transparency/visibility (Dubey et al., 2020; Pournader et al., 2020); risk management (Lohmer et al., 2020; Pandey et al., 2022), provenance (Montecchi et al., 2019; Roeck et al., 2020); and privacy (Fosso Wamba et al., 2020a; Shen et al., 2022). Montecchi et al. (2019) argued that BT enhanced provenance reduced uncertainty about authenticity, custody, integrity and origin which meant an establishment of trust is achievable. It was also observed that better risk management (Laeequddin et al., 2009), improved privacy and security instill trust among the partners of a SC (Oropallo et al., 2021). Köhler and Pizzol (2020) posited that enhanced transparency and traceability lead to trust which in turn lead to increased SC Collaboration (Erol et al., 2022), SC Integration (Zhang & Huo, 2013) and SC Resilience (Dubey et al., 2020). Chunsheng et al. (2020) argued that SC integration had high effect on SC Resilience while also impacting the SC performance. M. Chowdhury et al. (2019) proposed that SC resilience is likely going to enhance SC performance. Cao and Zhang (2011) indicated that SC collaboration had a bottom-line on a firm’s performance. Khan et al. (2022b) mentioned that BT doesn’t directly impact SC sustainability. However, it could be indirectly achieved through SC Integration (Wang et al., 2022).
Since there is a lack of empirical evidence in case of effect of BT on the features discussed and the effect of BT-enabled trust on SC integration, collaboration, sustainability, resilience, and performance, we propose the following set of propositions based on the above discussion and develop a theoretical model based on the propositions. Figure 4 presents the theoretical model.

P1: Blockchain technology (BT) implementation in SC enhances security, transparency/visibility, traceability, risk management, provenance, and privacy.

P2: BT features of immutability, security, transparency/visibility, traceability, risk management, provenance, smart contract, and privacy have a positive impact on trust.

P3: BT-enabled trust and application of smart contracts positively impact SC Collaboration.

P4: BT-enabled trust positively impacts SC Integration.

P5: SC Collaboration and SC Integration as a consequence of BT enabled trust positively impact SCRES and SC Performance.

P6: BT-enabled SCRES positively influences SC Performance.

P7: BT-enabled SC Integration can induce motivations for sustainability.

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