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Enhancing Supply Chain Management with Blockchain Technology

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Abstract:
In recent years, the market has changed significantly and become dynamic and demanding, which has brought the market into a highly competitive environment. The supply chain plays a crucial role in adapting the company to the dynamic environment as it relies heavily on collaboration, integration and flexibility. The applications related to the supply chain have attracted the attention of many business owners, and in order to improve the flow control of the supply chain, many special applications are being implemented. One of the most important new technological applications in the supply chain is blockchain technology, which has attracted the attention of many entrepreneurs due to its ability to quickly adapt to dynamic market conditions and business environment. Anyone reading this will learn about the impact of using blockchain technology in this field. The results of the research paper recommend companies to invest in blockchain technology to make the supply chain more transparent, flexible and secure. There is no doubt that blockchain technology plays an important role in building trust among supply chain stakeholders. Finally, the research also included some considerations about the positive effects and potential of blockchain in the area of collaboration and integration. Fast pace and changes related to BCT imposes a threat on many researchers investigating or performing a literature review on any of the Industry 4.0 technologies due to the accelerated speed of technology's revolution and evolution in addition to the increasing overlap across the various fields among which the technology may serve. Internet of Things (IoT) & smart contracts are the foremost technologies in using BCT for SCM.

Key Words: Block-chain, Industry 4.0, Internet of Things, Smart Contracts, Supply Chain Management, Traceability

I. INTRODUCTION

Most global companies have always faced supply chain management challenges. The company has always spent a lot of resources, which has led to various inefficiencies and the search for cost reductions. With the approach of blockchain technology, companies have thought about thinking forward. This technology could help advance the supply chain. According to analysts, blockchain technology can improve the modern supply chain structure by increasing supply chain efficiency, trust and transparency. Additionally, according to many supply chain leaders, the future of supply chain lies in blockchain solutions. The survey conducted by PwC in 2019 found that more than 24% of the industrial manufacturing industry wants to implement blockchain technology in supply chain management. Deloitte's 2020 Global Blockchain Survey shows that more than 55% of executives and practitioners consider blockchain to be their top priority. Blockchain technology plays a crucial role due to its distributed secure technology. The technology has attracted attention from both academia and industry. Blockchain is a distributed ledger technology that offers the participant secure settlement of transactions and transfers at a very low cost. Additionally, blockchain is not a new internet infrastructure, but it is extremely new to the supply chain networks that provide the future of business. (PwC - How can blockchain power industrial manufacturing?, 2022)

Many big names in consumer goods and food companies are testing blockchain technology for its outstanding advantage of traceability and transparency. Walmart has partnered with Nestle, Dole, Unilever and Tyson to test "farm-to-table" traceability through blockchain, and the traceability time of a bag of mango is reduced from a week to 2.2s through a blockchain-enabled system. Carrefour is testing blockchain in organic food and expects organic product sales to increase by $5 billion by 2022 through its revolutionized information system. The global food and agricultural blockchain market was $41.9 million in 2018 and is expected to reach $195.3 million by 2023 and $1.4 billion by 2028. (Nesreen El-Rayes J. J., 2022)

Some Important Terms:

1) Blockchain

It is known to be a sequence of encrypted data blocks, where the blocks contain the information that represents the data and the information is locked so that anyone who has the key can access the information. The chain contains many files

linked together and each of the files contains information such as a timestamp indicating when the data was created and historical information about the blocks in the blockchain. All blocks together are called a blockchain.

2) Block-chain infrastructure

The blockchain can only be accessed via a computer, laptop or server connected to the internet. All connected devices are called nodes of the blockchain. Blockchain is stored by the nodes and permission is granted to certain users, which will be discussed in the study of blockchain in the supply chain. A ledger is created when the blockchain is stored across the nodes, which are considered a system where the data is stored and shared across different locations, countries or institutions. Traditional databases are used in contrast to the distributed ledger, where the digital data is stored in a central location and in the blockchain the nodes store identical data.

3) Adding to the block-chain

To add data to the blockchain's block, a node must send a transition request with the data that will be added to other nodes of the blockchain's network to create the block. It is necessary to agree to the addition of the new block to the blockchain before the block is added to the chain. At the time of validating the new block, the node fog confirms that the block is correctly formatted and there are no duplicate transactions in the block. Once the block is validated, an encrypted block is added to the blockchain and blockchain network; it is stored by the other nodes. Due to the encryption nature of the blockchain and the distributed ledger format, the data on the blockchain is not hackable and therefore there is great trust in the data stored on the blockchain. Blockchain Process is shown below:

Table 1: Blockchain Process

Node (Member of blockchain network) submits request for transaction to blockchain network.	Encrypted Block created	Other Nodes Validate Transaction	Block added to blockchain	All Nodes receive the new block
				

[Source: (Dr. Chetanpal Singh, 2022)]

II. REVIEW OF LITERATURE

According to Ruli Liu, Wenxue Ran and Shiwen Liu in their research Article "**Blockchain Technology Applied to Supply Chain Management: a Systems' Analysis" in 2023,** in this blast technology, blockchain technology has greatly improved the transparency, traceability, and rapid response capability of supply chains. Moreover, it has played a large role in achieving sustainable supply chain development. They have chosen bibliometrics research method and visualization software as a research tool. This study uses a systematic literature review to elaborate on the application of blockchain technology in supply chain management. Based on 4 clear research questions, we set appropriate search criteria, and 591 studies are selected as research objects. (Ruli Liu, 2023)

BCT fundamentally changes the way traditional SCM works and concludes that technology is one of the key critical and dominant barriers to blockchain in SCM, which would pose a threat particularly to industries, the fear of technology adoption have. To illustrate the difficulties faced by brick-and-mortar retailers (e.g. Macy's, J.C. Penny, Toys R US, etc.), cable television services (e.g. Direct TV, Dish, etc.), and traditional news media etc. and many others are creating a consensus about FOMO – the fear of missing out – with the introduction of technology. Therefore, the emergence of blockchain immediately attracted public attention, and companies flocked to adopt the technology without hesitation. However, given the irrational impetus for technology adoption combined with the confusion over Bitcoin and blockchain,

many unsuccessful blockchain projects have emerged, and the failure rate is reportedly as high as 92%. (Bitcoinist, 2022), (Abeyratne & Monfared, 2016)(Tian, 2016)

IoT and smart contracts are the leading technologies in using BCT for SCM. The electric power industry is ahead in the integration of BCT because of the advanced usage of smart contracts. Furthermore, BCT has a strong potential for fostering sustainable SCM. Ref. developed a framework for designing circular blockchain platforms. Trust, social influence, and effort expectancy are three facilitating conditions for BCT adoption. There are 53 applications for BCT toward SCM. Ref. identifies five strengths of Blockchain application from the operations management perspective, including visibility, aggregation, validation, automation, and resilience. On the other hand, BCT has a dark side; their study indicates five corresponding weaknesses: lack of privacy, lack of standardization, garbage in, garbage out, black box effect, and inefficiency.(Kim & Laskowski, 2022) (Babich & Hilary, 2020) (Centobelli, Cerchione, Del Vecchio, Oropallo, & Secundo, 2021)

Typically, a traditional supply chain consists of suppliers, manufacturers, logistics companies, wholesalers and retailers working together to deliver products to end users. However, the larger supply chains become the more complex they become. As a result, traditional supply chains lack traceability and transparency, becoming an industry-wide challenge that leads to painful inefficiencies with delays, errors and increased costs. To solve this problem, supply chain participants need a unified view of the data while being able to independently and confidentially verify transactions, e.g. B. Production, shipping, delivery and sales. It shows how BCT is reshaping interoperability between these participants through transparent information sharing. For example, Amazon Managed Blockchain can provide the end-to-end visibility that today's supply chains need to track and track their entire production process with increased automation efficiency. (Aichih (Jasmine) Chang, 2022)

According to Cole, Enterprise Resource Planning, Radio Frequency Identification and blockchain are considered complementary technologies and it is extremely important to analyze their best combination so that we can maximize impact and impact. (Cole R, 2019)

According to Saberi S., there are four obstacles to blockchain development-ready SCs: organizational, organizational, technical and external variables. There is no doubt that despite these obstacles, blockchain technology is extremely useful as a driver of digitalization in the Southwest.(Saberi S, 2019)

Blockchain technology can help achieve the seven goals of SCM: cost, quality, speed, dependency, risk reduction, sustainability and flexibility. Blockchain was discussed as a way to break down data silos and provide a data source in digitalization using real-time data control required for all trusted partners in the network. With the help of blockchain, trust and security can be easily improved. Additionally, there are also business assets that would use blockchain to help build trust by improving efficiency, reputation and responsiveness. It is easy to conclude that blockchain has a huge impact on supply chain performance. However, when it comes to operations management, blockchain offers many advantages over the existing systems. (N., 2018)

Table 2: Blockchain Technology and supply chain transparency:

[1] Blockchain based supply chain Management							
[2] Supplier	**[3] Producer**	**[4] Distributor**	**[5] 3PL**	**[6] Retailer**	**[7] Store**	**[8] Customer**	
[9] Uploads Data on Anti-bacterial Fodder	[10] Gets Information on Cow and designated beef products, cuts and prepares meat accordingly	[11] Automatically receives notification about receipt of beef products.	[12] Is Informed about origin and destination of beef products	[13] Runs machine learning based forecasting	[14] Has full transparency on delivery time	[15] Scans QR code via app	
[16] Cow is tagged	[17] Adds QR Code to	[18] Chooses suiting 3PL	[19] Reviews instructio	[20] Adds potential	[21] Adapts orders,	[22] Gets insights into	

with RFID chip, Proving free range	packaging	based on truly available data on customer, Delivery date etc.	ns how to store the products	receipts & wine suggestions to the data record.	promos etc.		beef origin, ageing duration etc and suited recipes and wines.
[23]	[24] Adds QR Code to packaging	[25] Chooses suiting 3PL based on fully available data on customer, delivery date etc.	[26] Flexibly optimizes network flows	[27] Provides app for end customer	[28]	[29]	Earns points in cross company loyalty program

[Source: (Dr. Chetanpal Singh, 2022)]

As shown in the table above, blockchain plays a crucial role in the supply chain field in solving two main problems based on transparency, traceability and irreversibility of transaction data. The two main problems of the supply chain are the difficulty and inadequacy in moving and taking responsibility due to insufficient information transparency and inferior product quality, which is not easy to eliminate due to the multi-zone and long-term characteristics of logistics.

III. OBJECTIVE OF THE STUDY

The purpose of the research is to discuss blockchain technology and how it can help logistics companies. Blockchain technology is a new technology and most people are not familiar with this innovation. However, the paper helped readers learn more about the adoption of blockchain technology and how it can help with supply chain management.

IV. RESEARCH METHODOLOGY

B. Research Question

How can technology help provide a solution to some of the supply chain challenges?

C. Research Motivation

In the supply chain area, there are many products that are delivered to the customer, which are independent companies. For these reasons, the company cannot compete as isolated companies, but is also part of the vast supply chain network. In addition, companies also face uncertainty challenges due to globalization and high customer expectations. Additionally, there is tremendous competition in the market and a complex supply chain that requires collaboration across supply chains. Supply chains are fragmented due to internal competition and limited information sharing. In addition, these limitations also have a great impact on business performance and lead to challenges and limitations such as high operational costs and storage capacity, which can be easily solved by blockchain technology.

D. Data Collection

There are a couple of keywords that are supply chain and blockchain in the searching process. The research paper has been chosen based on the past seven years and the aim is to go for related topics that resemble previous research publications. Journals such as Google Scholar, European Journal, Science Direct, Research Gate, Taylor, Elsevier, etc have been taken into account to research.

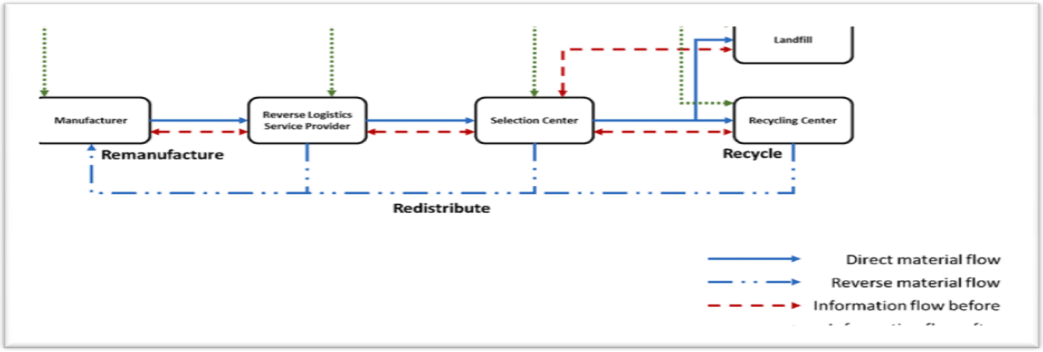
E. Research Gap

Blockchain technology offers many advantages, but is not a comprehensive solution in the area of supply chain management. There are many problems with blockchain-based technology and other related technologies. The project must consider challenges in the area of supply change and supply chain system, as a blockchain-based system requires various legislative decisions. In addition, the current blockchain platform does not meet the supply chain system's high transaction throughput requirements. The supply chain includes diverse participants. Therefore, it is necessary to create incentives such as efficiency improvements to improve liquidity and data security so that participants are well motivated. Other important issues related to blockchain include security and privacy. There are concerns about IoT data and the

current IoT system is based on the centralized model in which the IoT devices are discovered, connected and validated. Therefore, it is necessary to think about the transformation to recognize blockchain technology.

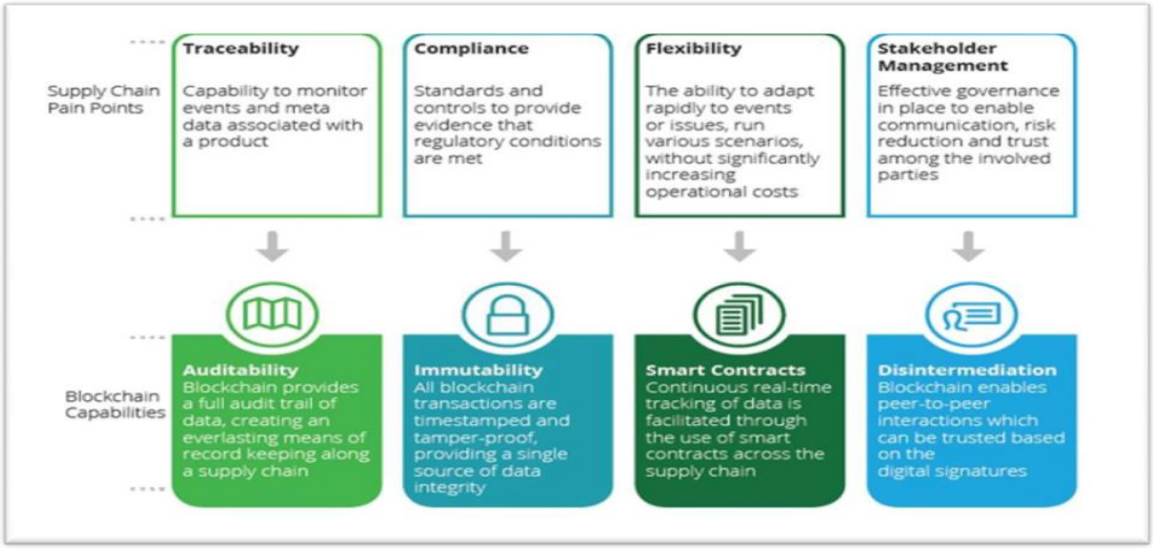
V. DATA ANALYSIS & INTERPRETATION

Graph 1: Blockchain technology for bridging trust, traceability and transparency in circular supply chain



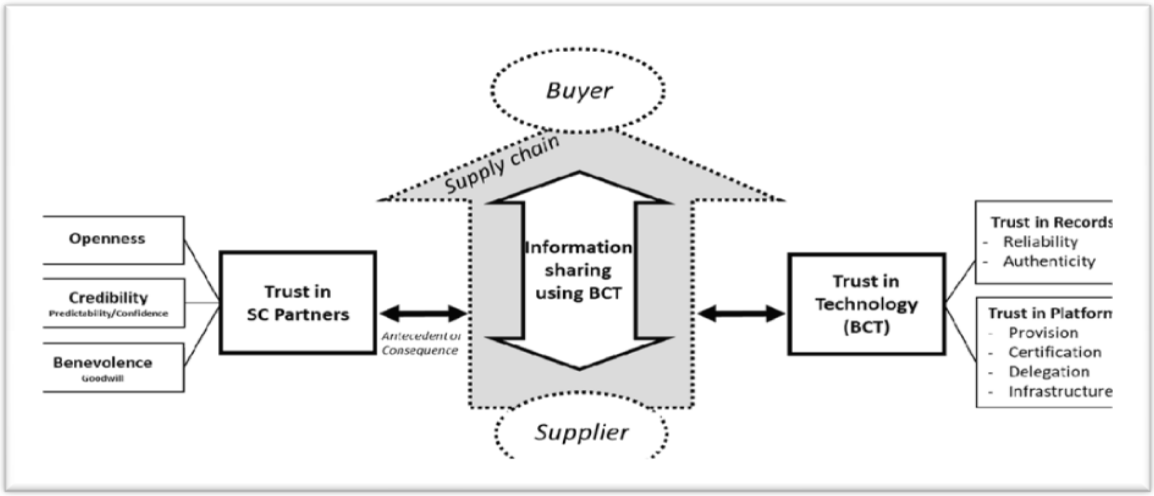
[Source: European Journal of Engineering and Technology Research, ISSN: 2736-576X]

Table 3: Blockchain and Supply Chain Flexibility



[Source: European Journal of Engineering and Technology Research, ISSN: 2736-576X]

Graph 2: Blockchain and Trust in Suppliers



[Source: European Journal of Engineering and Technology Research, ISSN: 2736-576X]

As the above figure shows, blockchain technology plays a crucial role in the 4.0 era industry due to its distributed secure technology. The technology has attracted attention from both academia and industry. Blockchain is a distributed ledger technology that offers the participant secure settlement of transactions and transfers at a very low cost. Additionally, blockchain is not a new internet infrastructure, but it is extremely new to the supply chain networks that provide the future of business

VI. HYPOTHESIS TESTING (IF ANY)

SCM and BCT publications still account for less than half of healthcare industry and BCT publications between 2010 and 2022. Therefore, considering greater adoption of BCT in the SCM context reflects the need for more scientific research in this direction. Based on the data collected, the US ranks first in frequency of disclosures among BCT and cybersecurity, second among banks, and the healthcare industry ranks third among SCM and government-related applications. India ranks first in all selected areas surveyed except cybersecurity. China ranks second in SCM and government applications, third in healthcare, and fourth in banking and cybersecurity. We manually reviewed more than 100 publications including BCT and SCM and conducted in-depth studies in addition to text mining analysis. The summaries of these publications include four main clusters of terms that appear 130 times or more. The two main clusters have a theme related to finance-related applications and healthcare, followed by a cluster related to the use of blockchain for supply chains related to agribusiness, the circular economy and a sustainable supply chain.

In numerical terms, based on 2265 summaries, traceability is the key feature closely linked to the blockchain and supply chain. In contrast, two features are completely missing: confidentiality and immutability. We acknowledge that there are several limitations to this review study. First, one of the main challenges of working on this study was the rapid pace and change associated with BCT. For many researchers studying or conducting a literature review of any of the Industry 4.0 technologies, this poses a threat as the revolution and development of the technology is accelerating and the different areas in which the technology can be used are expanding overlap. In addition, the analyzes and results are based only on one database. The decision to exclude and include abstracts by area was based on a consensus decision by the authors to exclude the research that may have no links/connections to the business areas and the applicability of the results in some areas such as engineering, physical sciences and life sciences.(Lee, et al., 2021) (Lee, et al., 2021) (Hastig & Sodhi, 2020)

Next Generation Blockchain

There is no doubt that the future will be more decentralized and data-driven, and BCT is one of the breakthrough technologies that makes this possible in a remarkable way. In addition, when used effectively, BCT can guarantee the accuracy of information retrieved by users without manipulation. This significantly solves the problem of information asymmetry and increases user trust. Although BCT has solid connections and deep roots in the FinTech regime, the term "blockchain" was not among the top 20 keywords between 2011 and 2021, but was used by 25 scientists involved in the study in providing their opinion put future research directions first.(IBM Blockchain Solutions: Where Blockchain for Business Comes to Life, 2022)

Blockchain has expanded its potential applications in more and more areas. The evolutionary transformation of BCT can be described from Blockchain 1.0 to Blockchain 4.0. This table summarizes development over time based on two BCT-related references. (Norman, 2017)

Below we discuss several possible research topics. BCT together with IoT offers a promising combination. For example, a pallet pooling system based on BCT and IoT has been proposed. They found that the proposed system has a positive impact on the overall quality of pooling, increases end-user trust and satisfaction, facilitates traceability, and minimizes errors. Additionally, this integration increases cybersecurity by minimizing system vulnerabilities.

Table 4: Evolutionary Transformation of Blockchain Technology

	BCT 1.0 Bitcoin- "The Mother of all blockchain"	**BCT 2.0 Ethereum**	**BCT 3.0 Hyperledger**	**BCT 4.0 Industry 4.0**
Based on	**Distributed ledger technology**	**Smart Contracts, Proof of work**	**Smart contract + decentralized**	**BCT + A.I. Proof of Integrity**

		consensus mechanism	**Apps, Proof of stack, Proof of authority**	
Speed	**7 Transactions/ sec**	**30 Transactions/ sec**	**Thousands of Transactions/ sec**	**1 Million Transaction / sec**
Cost Level	**$$$$$$**	**$$$$**	**$$**	**$**
Well-known application	**Financial Application**	**Electronic voting, trading and real estate**	**Business Platform**	**Business-usable platform. Industry 4.0**

[Source: (Nesreen El-Rayes J. J., 2023)]

The supply chain is typically complex as multiple supply chains are interconnected and intertwined. Blockchain serving various supply chains may refer to this. Therefore, interoperability and chain-chain communication can be a potential research focus as they have been raised as a potential challenge in practice. Blockchain as a Service (BaaS) has been identified as a potential trend that will drive the development and revolution of the technology in the coming years. For example, IBM makes its Hyperledger Fabric blockchain service available to several large and medium-sized companies. Additionally, there have been several successful business use cases such as Food Trust, World Wire, etc. As a type of SaaS, BaaS is increasingly seen in the new business era. In this case, BaaS-related research is another focus.

Hashgraph is another decentralized distributed ledger-based technology to address the data storage challenge. Due to its high speed, fairness and security, Hashgraph is expected to be the next generation BCT. For example, Hashgraph can process up to half a million transactions per second, while BCT can process hundreds of thousands of transactions per second. However, there are only 34 publications on the SCOPUS database and blockchain. Researchers in China and India developed half of the publications for Hashgraph and Blockchain. Only seven of these papers were published by researchers in the United States. (Chang, Katehakis, Melamed, & Shi, 2021)

Finally, the holistic review aims to inspire research communities around the world to investigate and explore the open opportunities and areas discussed in this paper. To expand the implementation of BCT across SCM, it is important to examine the impact of next-generation technologies such as Web 3.0, Industry 4.0 and Society 5.0. For example, would Hashgraph replace or accompany BCT? Will BCT become more efficient than Hashgraph in certain industries? Are companies ready to move to the next generation distributed ledger if BCT is not fully utilized? As BCT is incorporated into additional SCM applications, many new research questions will emerge in the coming years.

As per the present research, Researcher draw two key points for research: blockchain technology should be used to enhance the cooperative relationship between supply chain members and the overall competitiveness of the supply chain and blockchain encryption technology should be innovated to reduce the risk of information and privacy leakage in the supply chain.

VII. CONCLUSIONS

This study conducted a holistic and in-depth literature review on BCT for SCM. In particular, we examined the wide range of potential applications and deployments where BCT represents a breakthrough, superior solution in providing truthful and authentic information compared to its competitor technologies. Due to its outstanding features, BCT is widely considered as a groundbreaking, decentralized and internet-based technology to ensure (1) accountability, (2) efficiency, (3) traceability, (4) transparency, (5) reliability and (6) security. In fact, the benefits of transparency, traceability, security and efficiency are enticing companies to explore and experiment with the potential of BCT. As a result, its adoption in SCM has been observed in many successful business applications. In contrast, confidentiality, immutability and scalability are the main challenges discussed in various studies. In addition to the financial application of BCT, researchers are also exploring the potential of blockchain in other areas such as supply chains, government systems, etc., and immense efforts have been made so far. This puts SCM third in terms of publication frequency after the healthcare industry and the government sector. Publications covering both SCM and BCT first appeared together in the Scopus database in 2016, and 88% of these publications fall into eight subject areas. Finally, 12% of publications related to SCM and BCT fall into the field of BIot.

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