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A Comparative Study: Blockchain Technology Utilization Benefits, Challenges and Functionalities

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ABSTRACT Blockchain technology enables users to verify, preserve, and synchronize the contents of a data sheet (a transaction ledger) replicated by multiple users. Blockchain technology has provided considerable advantages and incentives to industries in terms of enabling better services. This review aims to explore the benefits, challenges and functionalities that affect blockchain applications in different sectors. This article is constructed as a systematic literature review study. From 1976 articles, 168 final articles were selected and classified into three main dimensions, that is, benefits, challenges, and functionalities, in four different sectors: government, financial, manufacturing, and healthcare. The results were extracted and compared based on factors in three dimensions, which were categorized as benefits (informational, technological, economic, organizational, and strategic), challenges (technological, organizational, adoption, operational, and environmental and sustainability), and functionalities (point-to-point transmission, data ownership, data protection, and transaction processing). The results of this review study aim to support professionals, practitioners, and stakeholders who wish to implement and manage transformation projects related to blockchain in their sectors. Moreover, helping these possible blockchain users to understand the implied factors associated with blockchain would be beneficial for the decision-making processes of their organizations.

INDEX TERMS Blockchain technology, benefits, challenges, functionalities, government, finance, manufacturing, health care.

I. INTRODUCTION

With the increasing interest in blockchain and its implementation in various sectors and industries, many sectors represent significant areas for blockchain applications: financial, business, industrial, voting, and many other educational and medical applications [1], [2]. However, blockchain is a new technology, and while there is considerable excitement regarding its potential benefits, there is also considerable inaccurate information and uncertainty regarding the potential utility of blockchain in general.

Blockchain is one of the most recently developed technologies emphasizing the models and innovations of the Internet of Things (IoT) and artificial intelligence revolutions [3]. Blockchain is expected to have an impact on all industries and create an opportunity for enhancing business processes and building trust in data sharing and records management in every sector; for example, blockchain could play a vital role in different sectors with several applications, such as records management and data sharing. Blockchain is a technology that allows users to validate, keep and synchronize the content of a transaction ledger that is replicated across multiple users. In other words, blockchain is a decentralized transaction and data management technology [3] that does not require third-party control of data and for trust between participants. This property is achieved through an internal system where the transactions are time-stamped in a ledger; therefore, the data cannot be altered or modified without the approval and update of the ledger. This technology ensures security and trust while performing transactions [4], [5].

Despite the several benefits offered by blockchain, such as security, trust, and transaction transparency, which lead to faster transaction processing and data exchange, some sectors still might see blockchain as a distracting technology that

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cannot be trusted and needs to be managed; one example is the financial sector, which views blockchain as a disruptive technology [3], [6]. However, there are very few surveys, articles, and systematic reviews that address blockchain's applications, benefits, opportunities and challenges in different domains [1], [7]–[9]. Evidently, the literature lacks many concrete, systematic reviews of current blockchain-enabled state-of-the-art applications [1]; the existing work is limited and does not fully address different applications of blockchain in different domains [2], [4], [10], and it mainly focuses on explaining what blockchain is and briefly describes its applications. Some work offers an understanding of the current blockchain research and its real-world implementations [8] and reviews blockchain applications and discusses technical challenges, as well as recent advances in tackling the challenges, also pointing out future directions in blockchain technology [9]. A study conducted by [11], reviewed the blockchain benefits, challenges and functionalities in financial sector. Other study conducted by [1] aimed to investigate the current state of blockchain technology and presented a comprehensive classification of blockchain-enabled applications across diverse sectors, such as supply chain, business and healthcare, that did not cover other important sectors, such as government and manufacturing.

Researchers believe that more research still needs to be conducted to better understand, characterize and evaluate the utility of blockchain technology in different domains [1], [2], [4], [10], [11]. Further research is also needed to supplement ongoing efforts to address many challenges, such as scalability, interoperability, security and privacy, in relation to the use of blockchain technology [11]–[14].

To better understand the capability of blockchain, as well as its various impacts on different sectors, we conducted a systematic review of blockchain technology and its different implementations in different sectors, such as the government, financial, healthcare and manufacturing sectors, to pinpoint the gaps related to the benefits, challenges, functionalities and future directions of the usage of blockchain in each sector. This review categorizes blockchain benefits as benefits to informational, technological, economic, organizational and strategic aspects. Additionally, blockchain challenges are categorized as challenges to technological, organizational, operational, adoption and environmental and sustainability. Furthermore, this review categorizes blockchain functionality as the functional of point-to-point transmission, data ownership, data sharing, data protection and transaction processing.

The results of this study show that the adoption of blockchain technology is still very limited, and there is a lack of empirical evidence [15]. Evidently, the literature lacks a concrete and systematic review of the current blockchain-enabled state-of-the-art [1]. Despite the growing interest in the use of blockchain technology across different sectors, few studies have examined blockchain technology's benefits, challenges and functionalities of this technology [11], [16]–[18].

This review paper contributes to identifying the gaps in blockchain research, provides a comprehensive review of the adoption and use of blockchain in different sectors, indicates the potential practice of blockchain in those sectors and shows the benefits, challenges and potential future directions of blockchain research.

The remainder of this paper is organized as follows. In section 2, we present the blockchain technology background and its definition, characteristics, and different categories. The systematic review methodology and classifications related to each sector are discussed in section 3. The research results for each category are presented in section 4, and research discussions for each sector are given in section 5. Implications and future research are presented in section 6, and the research limitations are presented in section 7. The paper is summarized in section 8, where conclusions are drawn and future work is discussed.

II. BLOCKCHAIN TECHNOLOGY BACKGROUND

A. BLOCKCHAIN DEFINITION

Blockchain, a transactional database technology, is a decentralized way to manage validation and tamper-resistant transactions with consistency across a significant number of participants, also known as nodes [19], [20]. According to a study conducted by [20], blockchain can be classified as a type of distributed ledger technology that provides confidence to the user that information that is archived, such as certificates, is not tampered with. Various studies have shown that blockchain has the capability to decrease transactional obscurity, insecure states, and dubiousness by supplying complete disclosure of transactions and the supplementation of homogenous and verified facts across all participants in the network [21]. In addition, blockchain technology is anticipated to renovate economies and the social order profoundly through a reduction in the cost of transactions and in the requirement for well-recognized and trustworthy third parties [22], [23]. Moreover, a research by [24] stated that this technology can be deployed for recording transactional details, storing medical records, concluding binding agreements, keeping track of the movement of goods, storing individual records of credit, tracking the attribution of artworks, and verifying payments with the help of the supply chain along with many other processes and procedures.

B. BLOCKCHAIN CHARACTERISTICS

Trust and decentralization are the two major features that need identification when examining blockchain technology [8], [25]. Considering both of these significant characteristics, the next sections will provide details related to trust and decentralization in blockchain technology.

1) TRUST

The most significant characteristic of blockchain technology is veiled by blockchain's decentralized methodology [25]. Precisely, the network is secured by a proof-of-work protocol, and it abolishes the involvement of any third party to verify and record transactions. This protocol helps users of blockchain technology avoid dependence on third parties for the security of all transactions and assets [26]. According to [27], the complete technology code is open source for all participants, which eliminates the chances of building a backdoor into the system. This secure open access enables users to use blockchain conveniently in a manner similar to using their personal banking systems along with control over decisions for assuring the safety of their capital, which is contrary to the environment of banks, which control the capital and assets of their customers. There are few important terminologies that mirror the reliability and trustworthiness of blockchain technology, which includes shared and public interfaces [28], transactional peer verification [29], [30], minimum resistance in the dissemination of information [26], [28], and cryptography-based security [31], [32].

2) DECENTRALIZATION

Among other major features, decentralization is a predominant feature of blockchain technology. The most significant aspects of decentralization include resistance to censorship and immutableness [25]. Research conducted by [8] highlighted that one of its specialized features includes non-dependency on a third party for the security and safety of an individual's assets or capital. Moreover, the government or cyberterrorist would not be able to pass through the personalized ledger optimized for personal utilization, which is mainly due to the circularized and decentralized traits of blockchain technology. The integrated proof-of-work feature aids computing in the resolution of any sort of problematic mathematical issues. Moreover, proof-of-work is also a well-recognized system for consensus that is currently deployed to reconcile millions of decentralized nodes. As a result, prevention against discretional dilution of the supply of money is assured, which promotes the certainty of the safety of assets [25]. There are few important terminologies that exhibit the critical attributes of decentralization built into blockchain technology—for instance, pseudonymity of members [31], the potential usability of automation [32], [33], redundancies of data [27], and participation of peers in development 'versatility' [34].

C. BLOCKCHAIN CATEGORIES

Generally, blockchain is classified into three main categories: public, consortium and private [35].

As public blockchain is related, each participant bears a similar set of rights and prerogatives. These include equal delegation of authority to every participant rather than centralized authorization given to a third party [35], [36]. Meanwhile, every party has the liberty to enter or leave the network. This feature is cost-free for every participant, and the validation of transactions can be performed by any source, including Bitcoin [33]. Also, [35] emphasized that in the case of consortium blockchain, the validation of transactions cannot be performed by anyone. Additionally, [9] signified that only some of the essential members have the authority to validate transactions. Other members still have an option for validating their transactions before the implementation of validation; these key members should have access to the agreement. In addition, in the case of private blockchain, centralized configuration protocols are ensured [33]. In addition, [35] stated that only a solitary body is authorized to make decisions along with the authoritativeness of actions and control of the process of validation of transactions. A research by [9] stated that the centralized authoritative member will assure that the proposed consensus is the only one to be followed. This is similar to the constitution of any centralized structure—for instance, government organizations working for different states.

III. RESEARCH METHODOLOGY

Successively implementing methodology adopted by [37], [38], systematic review methodology is deployed for the purpose of investigating the topic of concern in this research. Moreover, the large numbers of articles in information systems (ISs) are consistently updated, which makes it difficult for IS specialists and those involved in the process of decision-making to constantly keep track of published material to integrate effective evidence-based practices [39]. In addition, [40] further emphasized that specialized people should not concentrate solely on the results of studies while concluding any decisions, as there is a possibility that studies may exhibit bias or portray inconclusiveness in results. A research conducted by [41] stated that strong evidence with informed practices should be considered by decision-makers and specialists to integrate evidence-based concrete and theoretic perceptions. The systematic review is among the well-recognized approaches to construct an evidence-based judgement and analysis of practices recommended for ISs. Also, [42] debated that implementation of prescribed protocols, particularity in the search process, incorporates the rigor in a systematic review that is comprehended as an efficient and effective approach for the conclusion of results. In addition, [37] signified that despite criticality of efficiency, effectiveness is crucially important. Furthermore, [37] debated that "synthesizing the literature and revealing the depth of knowledge on an area's critical key concepts and the relationships between these concepts" will ensure the effectiveness of work.

While considering formulating a review-based article, it is significant to concentrate on a set of guidelines and rules for the systematic review [43]. To formulate a competent systematic review, a protocol-based review process was initiated. This included a systematic approach for identifying, selecting and assessing the related literature [44]. It is argued that if this organized procedure is followed, it ensures unbiased, consistent, objective-based, apparent and thorough study [38], [42]. The strategies and rules presented by [11], [43], [45] are adopted for this systematic review. The study is confined to three stages: planning, execution and reporting. The process of each stage is demonstrated in Figure 1.

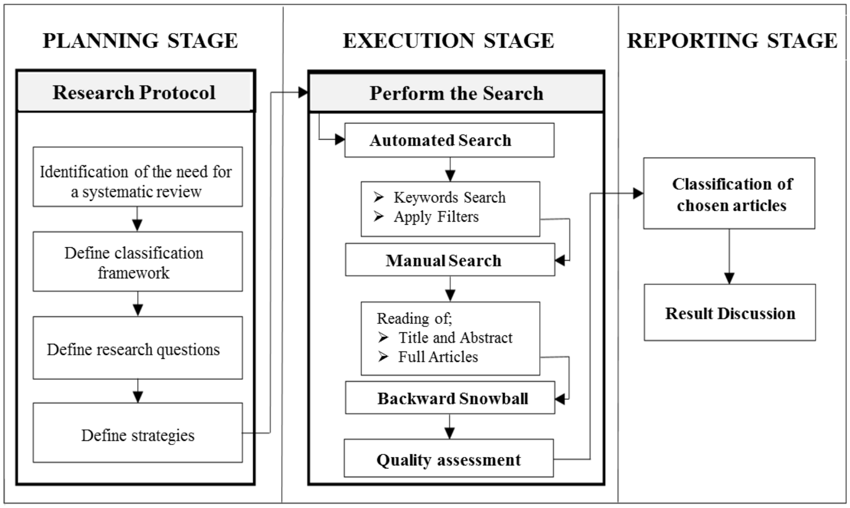

FIGURE 1. Systematic review stages [11], [43], [45].

A. PLANNING STAGE

The requisites for the systematic review should be identified. Therefore, identification should be considered the initializing step of the planning phase. As defined in the former part of the study, the review does not outline any comparative study among distinctive sectors, such as governing authorities, financial organizations, the manufacturing sector and healthcare systems. Comparative study will promote better comprehensive information and understanding that will help research and practice in the selected topic under examination. However, a number of versatile studies have been conducted to evaluate the benefits, challenges, and functionalities of blockchain technology in the abovementioned sectors.

The research protocol forms were developed as the second step of the planning stage. The protocols of the current systematic review facilitate the foundation of understanding the theoretical and practical aspects interlinked with the benefits, challenges, and functionalities of blockchain technology in the government, financial, and manufacturing sectors and in healthcare systems. This research focuses and concentrates on these sectors because of the current literature emphasize on certain blockchain application areas such as internet of things (IoT), smart cities, identity management, data management, business and industry, government, privacy and security and healthcare. Therefore, we found out that majority of these applications fall under the chosen sectors. A review protocol was formulated to demonstrate the framework of the classification of this review study. The selected framework was produced by [46] to facilitate the management of journal articles for users within the IS sector. A comparative classification framework for social science literature review was headed by [47]. This current systematic review also uses this framework. The framework of categorization has three directions in terms of the impact of blockchain technology on the abovementioned sectors. These directions include the benefits, challenges, and functionalities of blockchain technology. The first direction includes the benefits of informational, technological, organizational, economic and strategic approaches. The second direction covers challenges related to operational, practical, technological, adaptation, environmental and sustainability issues. The third direction addresses information and issues related to the functional or practical aspects of transmission from point to point, the entitlement of data, data sharing, security, and transaction processes. The investigators formulated the framework of categorization by including other categories, specific to each direction, in the framework (see Table 2).

The classification framework for this study that is depicted in Table 2 is the result of a review of the literature in terms of the influence of blockchain in the four aforementioned sectors.

Definition of the research questions formulates the third step of the planning stage. Definition of the research questions is a critically significant step in each systematic review. Through the satisfaction of each research question, the review of the literature chiefly achieves its objectives. The research questions for this study are as follows:

- What are the achievable and anticipated benefits of the execution of blockchain technology for the government, financial, manufacturing and healthcare sectors?
- What are the crucial challenges confronted in the execution of blockchain technology for the government, financial, manufacturing and healthcare sectors?
- What are the recent and mutual areas of blockchain-enabled government, financial, manufacturing and healthcare sector functionality?
- What are the outcomes of previous studies and their execution in guiding the forthcoming investigation?

Definition of the strategies for article selection formulates the fourth step of the planning stage. An integrated strategy was adopted in the fourth step. The strategy comprises broad automated searches in various online databases and manual review of the selected articles.

The strategy of broad automated search integrates the determination of the most suited online references [48]–[50]. The selected online databases in the current review of the literature included Science Direct, IEEE, Scopus, Google Scholar, ACM Digital, and Emerald. In addition, substantial tools for filtering were used for each database to limit the research results [50], [51].

The extensive manual review approach was adopted, including a reading of titles and abstracts at the initial level [48], [52], [53]. Then, irrelevant studies were excluded through full article reading [45], [49].

The backward snowball technique was adopted to complement the broad automated search and manual review, and it is important to recover those articles that were not included in previous searches. It is applied to utilize the rundown of references to recognize the new articles suitable for inclusion [54]. The beginning stages inspect the list of references and remove unsatisfactory articles based on selected criteria such as year of publication, language and type of publication. Another step that follows is the removal of articles to avoid duplication. After the removal of these articles, the rest are suitable for integration into the literature review. Backward snowballing along with these steps ensures that the articles are in accordance with the standards selected and mentioned previously and that each article is inspected in-depth prior to continuing with another article if there are no data remaining for inspection in that article [45], [54], [55]. The combination of these strategies increases the chances that this review has covered numerous articles related to the area of research.

B. EXECUTION STAGE

The execution phase comprises the application of selection strategies to aid the filtration of all the search results to narrow down the selected number of relevant articles. The six techniques used are explained as follows:

- Different words are searched considering the articles that are already significant and published. Searching through keywords is a continuous task [51], [56]. The approach for choosing words for search terms is satisfied when the underlying known articles are found definitively to the relevancy of articles [57]. The previously named online databases provide a chance to use advanced search options to find relevant articles with combined-word searches. In this review, the keywords used to explore articles included blockchain technology; benefits; challenges; functionalities; impact; government; financial; manufacturing; and healthcare sector.
- To restrict the results of the research, various tools were employed to filter search results for relevant articles [58]. As numerous articles were delivered due to the underlying search of different databases using special catchphrases, the number of articles was limited through the use of filters including area of research (ISs), year of publication (2015-2020) and type of document (published article from a journal and conference paper).
- The researchers checked each item in the search manually to assure that the titles and abstracts of the searched articles were relevant while focusing on exclusion criteria for final indexed lists [48], [52].
- The full text of the articles was also evaluated to differentiate significant information related to the topic of concern [52], [59].
- To supplement the broad automated search, a backward snowball technique was also adopted to restore unidentified related articles from previous searches [60].
- The criteria for the assessment of quality of articles were to assure the value of the included studies [61]. A checklist was developed based on quality parameters to evaluate the inclusion or exclusion of an article. The checklist comprised questions taken from studies of [11], [61], [62]. The criteria included in the checklist were focused on adequate discussion related to the objective of research; clarity of statement of the research problem or question; the accessibility and explanation of research data; the selected methodology; and the demonstration of the findings of research along with relevancy of the findings to satisfy the question of the study.

Studies that met all the defined criteria were later integrated into the final review. The details of the elements of an indexed list of literature are shown in Figure 2.

The review-based research was conducted from October 15, 2019, to March 15, 2020. The protocol discussed in the planning stage was followed carefully. A total of 1976 articles were identified through an initial search for selected keywords. Later, the scrutiny process was conducted according to the abovementioned criteria. As a result, 168 articles were finalized based on the predefined selection criteria.

C. SUMMARIZING STAGE

The review protocols were improved, and all the pre-established steps were executed for the systematic review. Figure 2 demonstrates the number of selected articles finalized for this review study. Specifically, after the initial keyword search was conducted, 1976 articles had been selected. After applying filters, the number of studies selected was 841. This is the final number of selected studies found relevant with the help of a broad automated search.

Later, the investigator of the study manually reviewed the titles and abstracts of these studies for identification of relevancy and avoided duplication of information. After this screening, 378 articles were excluded from the systematic review; thus, the number of inclusive articles was 463. Furthermore, after going through the full text of the scrutinized articles, 304 irrelevant articles were excluded, resulting in the remaining 159 articles. Consequently, a backward snowball technique was applied considering the references, and

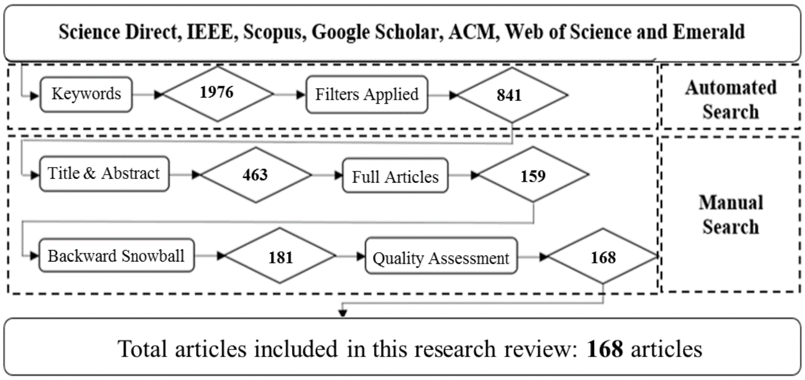

FIGURE 2. Execution stage results.

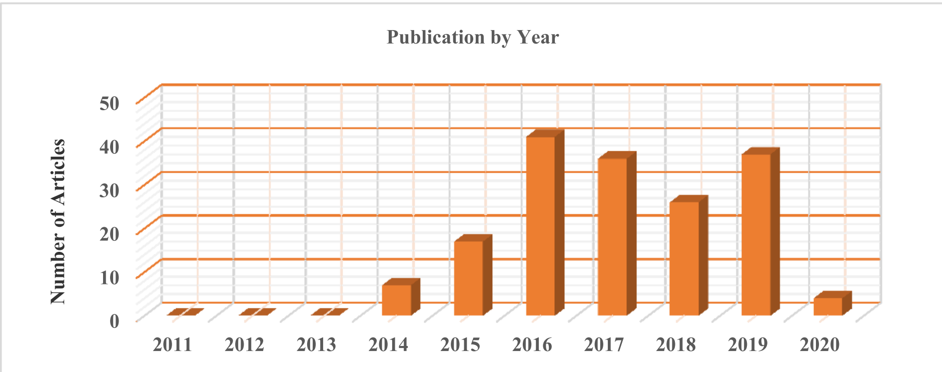

FIGURE 3. Publications by year.

22 more studies were added, resulting in a total of 181 articles. As a result of the implementation of the entire selection process, 168 articles remained. They were assessed through the four quality assessment criteria defined earlier. The actual number of articles selected from the broad manual review was 168.

D. SOME COMMON ATTRIBUTES OF THE CHOSEN ARTICLES

This section presents the distribution of articles by publication year and chosen journal type. In addition, the distribution of articles according to sectors mentioned in the classification framework is shown. Each of these common attributes will be discussed next.

1) DISTRIBUTION OF ARTICLES BY PUBLICATION YEAR

In Figure 3, the general number of chosen articles over the years that the researchers examined in this review study is outlined. Researchers established that the highest number of articles were published in 2016 with 37 articles, and the lowest number of articles were published in 2011, 2012 and 2013, with zero articles. The majority of the articles were published between 2016 and 2019, thereby signifying the recent interest in this research area (see Figure 3).

2) DISTRIBUTION OF ARTICLES BY ARTICLE TYPE

Figure 4 demonstrates the type of articles that were chosen for this review study (Journal; conference; book; government report; and technical report). Researchers found that the highest number of chosen articles were journal articles with 104 articles, whereas there were only 3 government reports. For more details about the article type distribution, see Figure 4.

3) DISTRIBUTION OF ARTICLES ACCORDING TO SECTOR

The research topic is a comparative study about the impact of blockchain in different sectors. These sectors included government, financial, manufacturing, and healthcare. The quantity of articles that were published every year and related to each sector from the classification research framework is displayed in Figure 5. Thus, the aggregate number of articles published within the government sector is ($n = 63$); the financial sector is ($n = 49$); the manufacturing sector is ($n = 31$); and the healthcare sector is ($n = 25$). From Figure 5, we can note that the majority of the publications that investigated the impact of blockchain were within the government sector.

IV. RESEARCH RESULTS

The impact of utilization of blockchain technology in governing organizations and the financial, manufacturing and

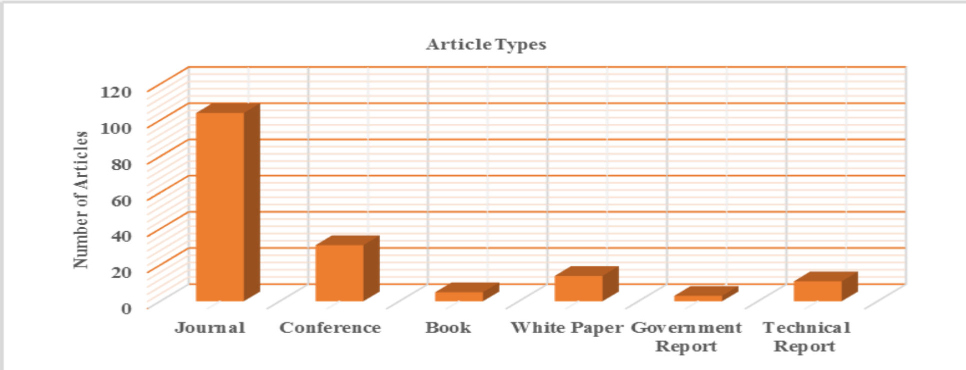

FIGURE 4. Distribution of articles by article type.

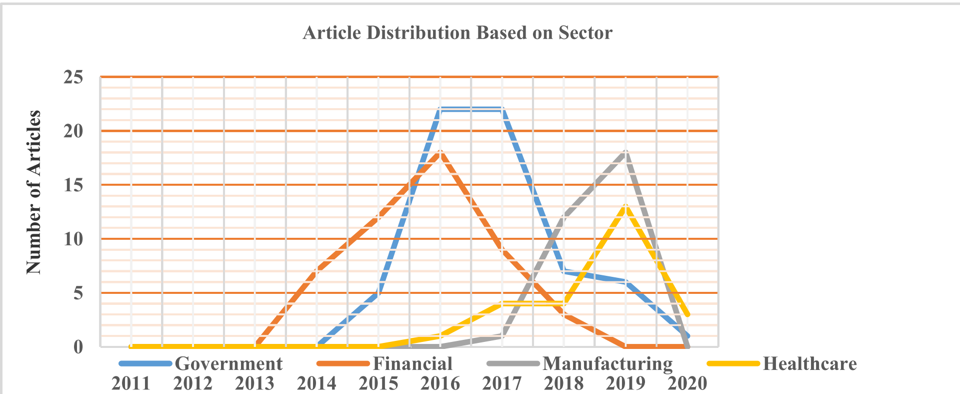

FIGURE 5. Research topics according to classification framework.

healthcare industries was reviewed in depth, and the results were inspected and promoted. The three directions were considered, including the benefits, challenges and functionalities of blockchain technology, and on the basis of these factors, a categorization research framework was applied. The selected articles for this review-based study are defined in Tables 1, 2 and 3 on the categorization research framework.

A. BLOCKCHAIN BENEFITS DIMENSION

Informational, technological, organizational, economic, and strategic are the five different categories of this dimension. The topics of data quality and integrity, minimizing human errors, information access, privacy, reliability, data sharing, and anonymous information are collected under the informational benefits category. In addition, the category of benefit to technology has topics on flexibility, smart contract applicability, security, increased resilience, complexity reduction, high speed, high degree of authenticity, proof of identity, and automatization process. The economic benefits category comprises literature on cost reduction, energy management, and quicker, cheaper acquisitions of shares. The category organizational advantages cover trust, transparency and auditability, prediction capability, control of transactions, clear ownership, voting accuracy, secure storage and transmission, new organizational model, and decentralization. Last of all, the literature on identity management, improve justice services, avoid fraud, reduce corruption, hold self-executing smart contracts, ensure trusted and immutable transactions and record keeping, and regulation measurements are included in the category of strategy related benefit. For more details about blockchain benefits, see Table1.

B. BLOCKCHAIN CHALLENGES DIMENSION

Technological, organizational, operational, adoption, and environmental and sustainability are the five aspects of this dimension. Security, privacy, computation efficiency, immaturity, and integration are all under technological challenges. The literature relating to organizational readiness and transformation, risk of error for complex business rules, trade-off between several blockchain aspects, and structural design are all under organizational challenges. Moreover, the literature on interoperability, compatibility, standardization, new governance models, and regularity issues comes under adoption challenges. Scalability, latency and performance, blockchain maintenance, process flow management, and data availability are all under operational challenges. Last, the literature about laws and regulations support, accessibility,

TABLE 1. Blockchain benefits.

Dimension	Category	Type	Sector				Reference
			Government	Financial	Manufacturing	Healthcare	
BENEFITS	Informational	Data quality and integrity	✓	✓	✓	✓	[1][16][31][63][64][65][66][67][68][69][70][71][72][73][74][75][76][77]
		Minimizing human errors	✓				[66][75][78][79]
		Information access	✓	✓		✓	[7][18][64][65][77][80][81]
		Privacy	✓	✓	✓		[1][3][9][16][31][34][66][69][77][82][83][84][85][86][87]
		Reliability	✓		✓		[16][66][70][74][88][89]
		Data sharing	✓	✓	✓	✓	[1][2][3][5][8][13][14][16][31][34][74][77][81][83][87][90][91][92][93][94][95][96][97][98][99][100][101][102][103][104]
		Information anonymity	✓				[3][75]
	Technological	Flexibility	✓		✓		[1][66][89][97]
		Smart contract applicability	✓		✓		[16][68][85][105][106][107][108]
		Security	✓	✓	✓	✓	[1][3][9][16][32][69][70][77][87][91][96][97][103][108][109][110][111][112][113][114][115][116][117][118][119][120]
		Increased resilience	✓		✓		[69][75][79][87][114][115][121][122][123]
		Complexity reduction	✓				[80][85]
		High speed	✓	✓	✓	✓	[3][8][33][68][79][124][125][126]
		High degree of authenticity	✓	✓	✓	✓	[1][9][32][76][117][127]
		Proof of identity	✓				[1][69][117][128]
		Automatizing process	✓		✓		[1][79][120][129][130][131]
	Economic	Cost reduction	✓	✓	✓		[3][16][26][68][69][73][77][79][80][82][85][97][116][120][124][125][132][133][134][135][136][137][138]
		Energy management	✓	✓	✓		[3][66][74][82][119][133][134]
		Quicker, cheaper acquisitions of shares	✓	✓			[68][82][124][132]
	Organizational	Trust	✓	✓	✓		[1][15][31][34][69][74][78][80][85][91][108][120][134][139][140]
		Transparency and auditability	✓		✓		[3][15][16][66][68][74][75][77][79][115][120][122][141][142]
		Prediction capability	✓			✓	[1][10][66]
		Control of transactions	✓	✓	✓	✓	[5][17][31][33][69][79][91][124][143][144]
		Clear ownership	✓		✓		[1][68][79][86]
		Voting accuracy	✓				[1][68][79][145][146]
		Secure storage and transmission	✓	✓	✓	✓	[1][9][12][17][33][69][110][111][112][113][119][133][147][148][149]
		New organizational model			✓		[98][123]
		Decentralization		✓	✓		[17][25][26][99][124][133][150]
	Strategic	Identity management	✓	✓			[1][3][16][31][65][73][77][90][92][147][151][152][153]
		Improve justice services	✓				[3][85]
		Avoiding fraud	✓				[3][15][69][78]
		Reducing corruption	✓				[1][68][69][73][79]
		Holding self-executing smart contracts	✓				[68][69][77][85]
		Ensured trusted and immutable transactions and record keeping	✓	✓	✓		[9][69][77][80][85][89][119][141][142]
		Regulation measurements	✓		✓		[3][113][154] [155]

TABLE 2. Blockchain challenges.

Dimension	Category	Type	Sector: Government	Financial	Manufacturing	Healthcare	Reference
CHALLENGES	Technological	Security	✓	✓	✓	✓	[2][3][7][8][10][12][13][14][16][17][26][68][69][75][76][100][101][102][106][118][120][127][149][156][157][158][159][160]
		Privacy	✓		✓	✓	[1][3][5][10][12][13][14][16][68][75][76][77][95][102][103][106][149][161][162][163][164]
		Computation efficiency	✓		✓		[3][15][69][75][114][127][144][165]
		Immaturity	✓				[3][15][69][159]
		Integration				✓	[4][67][100][104]
	Organizational	Organizational readiness and transformation	✓	✓	✓		[15][16][17][68][75][85][97][114][136][156][157]
		Risk of error for complex business rules	✓		✓		[15][16][88][99][105][106][107][144][166]
		Trade-off between several blockchain aspects	✓				[1][85][87]
		Structural design	✓				[15][68][85]
	Adoption	Interoperability	✓	✓		✓	[2][3][4][12][13][14][15][70][75][95][118][167][168]
		Compatibility	✓			✓	[2][3][4][15][75][95][118]
		Standardization	✓	✓	✓	✓	[2][3][4][33][75][98][118][119][168][169][170]
		New governance model	✓		✓	✓	[15][17][75][76][85][155]
		Regularity issues	✓	✓	✓		[3][15][75][114][136][155][168][171][172][173][174]
	Operational	Scalability, latency and performance	✓	✓	✓	✓	[1][2][4][5][9][10][15][31][70][75][89][114][151][175]
		Blockchain maintenance	✓				[3][68][75][114]
		Process flow management:			✓		[74][97][119][136][176]
		Data availability				✓	[4][67][118]
	Environmental & Sustainability	Laws and regulations support	✓	✓	✓		[15][33][136][155][168][177]
		Accessibility	✓		✓	✓	[14][15][126][178][179]
		Sustainability concerns	✓	✓	✓		[15][18][75][85][88][114][119][136][164][175][180][181][182]
		Liabilities			✓		[119]

sustainability concern, and liabilities make up the environmental and sustainability related challenges. For more details about blockchain challenges, see Table 2.

C. BLOCKCHAIN FUNCTIONALITY DIMENSION

Point-to-point transmission, data ownership, data sharing, data protection, and transaction processing are among the categories of this dimension. The literature on payment processes is covered in the point-to-point transmission. The literature on support data storage, privacy protocols, and digital identity credit resources is included in the data ownership. The literature on data automatic recording and decentralized management comes under data sharing. The literature on privacy protection, key cryptography, and support data security all come as a part of data protection, and as a final category, transaction processing entails information about smart contracts. For more details about blockchain functionalities, see Table 3.

V. RESEARCH DISCUSSION

This section discusses the benefits, challenges and functionality of blockchain technology-based systems that need further consideration, analysis and research—particularly in the government, financial, manufacturing, and healthcare sectors. As blockchain technology development and applications cover a wide range of areas, future research can be diverse. To give clear idea about the use of blockchain technology for decision making in different sectors, the research discussion is offered based on the following areas of blockchain technology: benefits, challenges, and functionality.

TABLE 3. **Blockchain functionalities.**

Dimension	Category	Type	Sector: Government	Sector: Financial	Sector: Manufacturing	Sector: Healthcare	Reference
FUNCTIONS	**Point-to-Point Transmission**	Payment process	✓	✓	✓		[3][9][17][33][35][69][73][75][119][123][133][183][184][185][186]
	Data Ownership	Support of data storage	✓	✓	✓	✓	[35][68][85][100][149][166][175][187]
		Privacy protocol	✓	✓			[17][69][188]
		Digital identity	✓	✓			[1][17][147][189]
		Credit resources		✓	✓	✓	[17][31][35][183][189][190]
	Data Sharing	Automatic data record	✓	✓	✓	✓	[1][3][7][8][12][13][16][34][66][67][69][75][76][81][91][101][103][104][160][161][162][191][192]
		Decentralized management		✓	✓	✓	[2][4][10][17][25][26][81][99][100][101][102][103][124][126][127][133][150][160][166]
	Data Protection	Privacy protection		✓			[9][25][31][34][193]
		Key cryptography	✓	✓			[3][9][16][25][69][75][194]
		Support of data security		✓	✓	✓	[2][7][81][160][179]
	Transaction Processing	Smart contracts	✓	✓	✓		[3][15][17][68][85][126][131][142][144][189][195][196][197]

A. GOVERNMENT SECTOR

Governments around the world are starting to recognize the urgent needs to integrate blockchain-enabled applications into their operation processes and outcomes with the aim of improving their public services and eliminating some of the current governance problems, such as fraud, corruption and inefficiency [1], [15], [87]. In fact, Table 1 shows a diversity of benefits attributed to blockchain technology that can contribute to the services offered by the governments of many countries to the benefit of their citizens [3], [79], [85]. These benefits can have significant effects on the way governments at public or private levels operate by improving the transparency of transactions between government agencies and citizens, reducing fraud and human errors that might occur during the transaction process, preventing corruption and e-voting manipulation, enhancing trust of citizens towards their governments, and creating a secure and private record storage and transaction mechanism [16], [79], [85]. In particular, blockchain could serve as a secure and private communication platform for such government transactions and public services as marriage registrations, tangible and intangible assets registry, ownership and digital identifications, passport, information exchange, and criminal records [1], [85]. The World Citizen project is an example of a secure decentralized passport service that identifies citizens all over the world [1]. In addition, the Estonia government is offering public notary services to its residents through signed electronic IDs by the government [16]. These IDs will be used to notarize official documents from any location in the world. Accordingly, blockchain can create a true digital identity to become an instrument to reinforce equality and opportunities to worldwide citizens. Blockchain may also improve government measuring instrument regulations using decentralized computations and measurement processes [3].

Beyond the above benefits, blockchain can also add economic value to government organizations in terms of operational cost reduction, energy management, and faster transaction processes [16], [69], [73], [77], [79]. Cost reduction can be obtained by lowering administrative costs, providing cost-efficient security solutions and by enabling tax authorities to have more control over the tax system to prevent tax revenue losses. For instance, [79] stated that blockchain can reduce the cost of the preparation of financial, auditing and taxation reports and transactions [79].

One of the core technological benefits of blockchain is the smart contract applicability to regulate diverse government transactions that require authentication, authorization and accounting capabilities. Simple examples that illustrate the usage of smart contracts in e-government services are property ownership transfer and e-voting [85]. In the case of property ownership transfer, all the agreed conditions can be stored in the smart contract, and once fulfilled, the transaction will be executed to register the new owner [85].

Several authors view blockchain as a technology push that competes with the role of government in society, as transactions can be handled by distributed ledger technology running on P2P platforms [85], [122]. Due to the decentralized functionality of blockchain, establishing trust between the participating parties or the need to have a centralized authority is no longer required [3], [75]. This is accomplished through a peer-maintained self-sovereign system where transactions are time-stamped in a ledger chronologically [3], [75].

Despite the abundant benefits of blockchain technology in the government sector, the literature presents significant challenges to be faced in adopting blockchain technology for e-government services and systems. Challenges may include security, scalability, immaturity, interoperability, compatibility, lows and regulation support, and new governance models [3], [15], [16], [33], [69], [75], [159].

Although blockchain technology provides a secure platform of information storage and exchange, certain security challenges related to cybersecurity issues and threats, the trade-off between security and performance, and key management and cryptography should be addressed [1], [8], [16], [75], [87], [120], [127], [149], [159]. For instance, well-established security mechanisms that provide proper protection against governance attacks, such as 51% attacks, denial of service (DoS) attacks, saboteurs misleading attacks, and prisoner's dilemma type strategies, within an open source blockchain have not been developed, or they have not been used and adopted widely enough for a serious test. Another challenge is due to the development of weak encryption keys that make the keys vulnerable to brute force attacks. The challenge of key management can be observed due to its complex nature, which makes private keys vulnerable to unauthorized access. This complexity can be attributed to the fact that effective key management should include user security awareness, organizational and departmental coordination and interactions, and defining system policies.

The size limitation and frequency of the blocks along with the number of transactions the network may process is recognized as a scalability challenge. Therefore, addressing such issues as the number of replicas in the network, performance concerns in terms of the number of transactions processed per second, and latency concerns is required [1], [15], [70], [75], [114].

Laws and regulations could impact how far and how fast blockchain technology could be adapted [15]. However, blockchain technology may not reach its peak adoption due to governments' regulations uncertainties and international differences [15], [75], [85]. This means that blockchain has not been adequately tested, and hence, immaturity of the technology itself caused the adoption challenge. Moreover, due to the lack of a standard protocol for adopting blockchain-based solutions among government agencies, interoperability and compatibility issues might appear [3], [70], [75], [85]. Accordingly, standardization, new government models, user acceptability, and organization transformation are major challenges that need to be overcome to facilitate the integration of blockchain-based solutions into government application development.

B. FINANCIAL SECTOR

Blockchain technology is expected to bring significant benefits to consumers, today's banking systems, and society as a whole. Aside from the implications for security and increased transparency of transactions for all parties, institutions, or customers, this can have a positive impact on market prices and costs [11]. These benefits can be identified, simulated and analyzed as technology evolves and matures. Blockchain also offers the ability to hold secure payment transactions from customers of different banks in different regions, thus reducing the risk of fraud [17], [124], [198].

The underlying reasons for interest in blockchain for economic cost-benefit analysis are opportunities for speculation [11] and lower transaction costs at first glance [11], [82], [124]. In theory, the fee is optional and paid to successful miners. However, in reality, blockchain transactions require payment. This can usually be explained by the default values provided to the client software [132], [133]. By implementing blockchain, it provides a new business model. Point-to-point (P2P) transactions can support the development of the "sharing economy" because they can take advantage of asset transfer without the involvement of a third party [66]. You can participate in rejected economic activities [11], [66], [112].

The core of blockchain technology is that the business world can be decentralized [17], [133]. Also, transactions may be fast [11], [17]. The Bitcoin system is an example of a decentralized organization, where there is no central agency responsible for solving problems [26], [124], [150].

Before blockchain technology becomes mainstream in the financial sector, there are several important challenges to overcome. These issues include scalability [11], [151], [175], security [11], and response to regulatory challenges [11]. Blockchain technology is at a stage where regulators fully understand it [173]. Blockchain technology aims to improve the stability of the financial sector's infrastructure, so it is very attractive to regulations. However, I have some questions about jurisdiction and legal issues [11]. Similarly, the scalability issue is another challenge for successful blockchain operations [151], [175]. According to research, the increase in transactions and data permanently stored on all nodes is the cause of scalability issues [9].

Blockchain technology is an important area of concern for various enterprises, and reliable standards must be adopted to test security issues [33]. Recently, the International Organization for Standardization (IOS) was required to develop a global standard for blockchain technology in Australian standards. Since the design of the current blockchain network has not been standardized, serious problems may arise in its implementation. Various international and domestic organizations are trying to create recognized technical standards [11], [168].

The automatic recording of big data can be achieved through the blockchain [66]. It also allows institutions to store and share customer credit status in encrypted form [34], [91]. The financial resource chain includes manual inspections and paper transactions [11], [33]. The existence of many mediators, high cost, high transaction volume and non-illegal risks are the characteristics of this process. Using smart contracts to modernize existing paper processes can fundamentally reduce the manual intervention of blockchain technology.

C. MANUFACTURING SECTOR

Recent studies have shown that blockchain technologies support organizational goals and strategies to execute effective supply chain operations. This growth of interest could be formulated in informational, economic, organizational impact areas with a proven blockchain framework structure. Informational benefits are decentralization, sharing data and information, increasing the validity of information, and certification of supply chain network participation [74], [99], [126]. Moreover, sharing a high level of knowledge and services in open manufacturing ecosystems with the help of Edge computing [97].

While still in the early stage of technology development, the value of blockchain technology is extended visibility and traceability [141], digitalization and disintermediation, improved data security, and smart contracts [108], [126], [127], [131], [142], [179]. Additionally, the integration of the methodology, along with the business process modelling (BPM) approach, defines the value proposition in the supply chain network [98]. In addition, there is a technological side of supply chain functions found in the literature, such as the product ownership management system (POMS), owner privacy, customer participation [86], high degrees of authenticity [127], combining blockchain and deep learning models and credit evaluation systems [86]. Furthermore, manufacturing systems enabled by the IoT have many advantages in terms of flexibility, efficiency, availability, security and automatization of work processes [89], [120], [131].

According to findings in the organizational impact of blockchain technology in the supply chain, it concentrates ''trust'' as a critical element in the blockchain environment with different levels of layers, and in other words, significant entities for blockchain-based supply chain (SC) roles are registrars, a standards organization, certifiers and actors [74], [120]. Trust among them is vital for overall performance achievements. The benefits of blockchain could be found as reducing interactions and communications among chains [136]; control of transactions that ensure peer-to-peer safe records [166]; decentralized databases, data ownership and secure storage [119], [149], [166], [199]; and peer-to-peer networks [123]. Moreover, high speed in the manufacturing processes [126]; data reliability and transparency for material flows; distributed trust while sharing among participants [74], [142]; data transparency (copy of the ledger); quality, reliability [88], [89] and security in terms of fraud cases (also called traceability), data and information immutability (modification needs network member consensus), and resistance to the modification of data [119], [123], [141], [148].

Although blockchain technology and business applications provide many advantages to supply chain organizations, there is still room for development and challenges that affect business performance [89] in the financial, technological, operational, adaptation of new systems, and finally in sustainability purposes. The most significant proportion of challenges that have been found for blockchain implementation is on the operational side in the literature. Companies should consider various operational processes, customs, and shipment routes when they plan supply chain operations. Therefore, not all countries are ready for blockchain-based technologies and business applications at this stage [136]. The most crucial challenge on the technological side requires a high Internet bandwidth connection and computing power to validate every transaction [127]. In addition, manufacturing systems would change from integrated and centralized systems to a shared and distributed system [120], which shifts from centralized based to decentralized blockchain system management so that transition may cause many problems in the adaptation period [176], [199]. It involves accessibility issues in various production systems in terms of data usage and dissemination through the network [99], [126], [179]. Moreover, there are many risk factors considered in supply chain and manufacturing operations, such as information delivery, production and procurement, demand volatility, policy and legal, accidental, disaster, currency fluctuations, unstable market conditions, shortages on the vendor side, transportation difficulties, and health and safety issues [166].

Sustainability is one of the essential elements in operations, specifically in supply chain management. Verifying sustainability indicators is not precisely clear in the blockchain approach [136]. Sustainable SCM consists of expanding the focus of environmental and social dimensions, recycling improvements, reducing energy usage, and providing more green products [74]. In addition, waste management (liabilities related to disposal) energy usage for green SCM [119] is related to a widespread phenomenon in the operation management field. Global SCM is in a complex environment with regulations and government decisions [136], [155], and the adoption of blockchain is very important for SC; it enhances the benefit for all stakeholders (namely, actors) who participated in the process [98]. Moreover, production and internal operations, for example, blockchain implications related to acquiring and maintaining certification, such as ISO 14001 and 14000, should be aligned with operation programmers and strategies [119].

D. HEALTHCARE SECTOR

Blockchain technology has a multitude of functions and features that can be utilized in the healthcare sector. These functions can be applied to a broad range of medical and healthcare systems. Some of the functions identified by this study are as follows: support data storage [100], data sharing function [1], [3], [12], [13], [75], [76], [81],

[101], [103], decentralized management function [2], [4], [10], [100]–[103], [160], and support data security [2], [7], [81], [156], [160].

Blockchain technology is expected to bring significant benefits to the healthcare sector in general. Beyond the security implications and increased transparency and control of transactions for all parties, either medical bodies or patients [13], [81], it can have a beneficial impact on data sharing and data quality and integrity [1], [13], [14], [100]–[104]. Decentralized management of medical records and data storage support will be great benefits of blockchain technology. Such benefits can be identified, simulated, and analysed as the technology evolves and matures. Blockchain also provides the opportunity to secure transactions and thus reduce the risk of fraud as well [103].

Despite the several benefits offered by blockchain, such as security, trust, and transaction transparency, which lead to faster transaction processing and data exchange [3], there are several challenges to be undertaken before the adoption and implementation of blockchain technology in the healthcare sector. The healthcare sector still views blockchain as a technology that cannot be fully trusted due to the nature and privacy of medical records and medical data [1], [12]–[14], [76], [102], [103]. The privacy and security of existing records are the main challenges in the healthcare sector [13], and the confidentiality of protected health information needs to be managed and protected from hacking attacks [12]–[14], [76], [100]–[102]. The interoperability of healthcare-related data is another challenge for medical practitioners in which different information technology (IT) systems can communicate, share, and use information [12]–[14]; accessibility is also a challenge regarding the operational success of blockchain [12]–[14]. Similar to any other disruptive technology, blockchain has a diversity problem that further limits accessibility.

As per the research, the increasing number of transactions and data stored permanently on every block are the cause of the scalability issue [13]. Finally, interoperability and data integrity are other challenges that blockchain is facing. The challenges are caused by variation and may be related to the absence of data standards, which reduces interoperability as a consequence of non-compatibility between systems that are meant to be improved by blockchain technology in the healthcare sector [100], [104].

Despite the massive potential of blockchain technology and the large amount of interest in it, we found that its impact on healthcare is still in the early stages. However, the healthcare sector is growing rapidly; we expect a substantial positive effect of blockchain in the healthcare sector soon. More research and studies need to be conducted to address and tackle the many challenges and issues blockchain technology is facing, such as interoperability, integration with the existing systems, uncertainty in cost, technological adoption limitations, and scaling.

VI. IMPLICATIONS AND FUTURE RESEARCH

The potential advantages and effective functions are seen in blockchain technology have attracted governments and other organizations in the health and business fields, and introduced this technology into operational processes and application development. However, because blockchain technology has not yet matured to be decentralized, some questions have been raised, and further attention needs to be paid to the widespread adoption of blockchain technology by various private and public organizations in the future.

The following section draws some important implications for future research and practical examples from the results of the systematic review. The benefits, challenges, and functions of blockchain technology have a continuous impact in the four areas.

A. IMPLICATIONS TO RESEARCH

The review study presented by this paper demonstrates important theoretical contributions to IT in general and to blockchain research specifically. It contributes to the IT literature by enriching studies on blockchain; most of the recent IS studies have examined big data, social media and cloud computing, whereas little is known about blockchain technology. Moreover, the review study adds a significant classification framework related to blockchain benefits, challenges, and functionalities. This framework also arises from the use of blockchain technology in four major application sectors (i.e., government, finance, manufacturing, and healthcare). Accordingly, the framework reveals five dimensions of benefits, including informational, technological, organizational, economic, and strategic, where each dimension can encamp varied foundations of benefits that correspond to certain sectors, as illustrated in Table 1. The framework also presents the functionality dimension by including point-to-point transmission, data ownership, data sharing, data protection, and transaction processing, such that each dimension can encamp varied functionality types, as illustrated in Table 3. Due to blockchain's benefits and functionalities, public and private organizations are actively investigating blockchains' suitability for data ownership of a wide range of tangible and intangible assets, from stocks and bonds to real estate and works of art [68], [85]. Furthermore, the integration of blockchain with the IoT leads to several applications' use cases [16]. Blockchain enables the peer-to-peer market throughout peer-to-peer communication between IoT devices, and it enables the tracking of assets throughout the supply chain using IoT.

Specific challenge categories and types were introduced by the framework—i.e., technological, organizational, operational, adoption, and environmental and sustainability—to reveal various issues and concerns that require further attention in future blockchain-based application development and research. This classification framework will hopefully motivate and assist varied research efforts from different research fields, such as data security, IOT, big data, healthcare applications, e-education, smart cities, and e-government, to widely engage in this technology's implementation and development. We hope also that the proposed framework could serve as a guide for blockchain researchers in their future efforts. IT researchers could use this framework to explore how evolving innovations should be applied to understand their strategic impacts. Moreover, the categorization's generalization and flexibility offered in this framework can facilitate the consideration and adoption of new types of benefits, functions, and challenges that might appear by future research.

B. IMPLICATIONS TO PRACTICE

This paper not only has the theoretical significance of contributing to the IT field, but also made practical contributions to various organizational fields such as government, healthcare, finance, and supply chain industries. The proposed classification framework can inspire multiple organizations in different fields and support them to participate in the implementation, recruitment and development of the technology. The integration of true blockchain-based applications is affecting all these areas, providing them with excellent opportunities to build trust with customers and strengthen services and business processes [1], [75]. When it comes to peering, exchanging and tracking asset ownership, we have seized the opportunity through the new resources that blockchain can provide.

One of the most famous implementations of blockchain technology in finance took place in Australia [68]. The Dubai government has established the Global Blockchain Council, in which the Dubai Multi Commodities Centre is involved in a test case for the verification and transfer of Kimberley certificates [16]. In cooperation with the world's first functionally decentralized voluntary country, the Estonian government has launched a project to provide public notary services for Estonian e-residents [72]. The Honduras government is involved in a project using blockchain technology to correct and prevent decades-long land law violations [71]. The World Citizen project is another example of the integration of blockchain technology into the collaborative services of these governments to provide digital identity, as this project provides decentralized passport services to identify citizens around the world [1]. Also, blockchain technology can be used in healthcare to secure patient data and gain control of the health information shared with the data owner. For example, Telecommunication Corporation (Du) is testing a case of using health information to exchange information between service providers [94]. In general, and given the current impact of the COVID 19 pandemic on businesses and services of general interest, many industry and service sectors, such as government and financial agencies, see blockchain technology as an emerging and dominant solution that cannot be avoided and should be introduced, managed and rebuilt accordingly.

C. FUTURE RESEARCH DIRECTIONS

Since this technology is still in its infancy age, the findings of this research identify the urgent need for further studies to examine blockchain technology. Accordingly, several future research directions can be identified as following:

Further studies are required to examine blockchain technology's security features and its implications in such application environments that require a high level of identity and privacy as government and healthcare agencies [16], [85]. Additionally, designing new regulation models for government and healthcare agencies is required to create a proper transformation and acceptability of their operational processes, services, and applications towards blockchain technology [1], [75]. Furthermore, wasted resources and scalability are two of blockchain's operational challenges that have been discussed frequently not only in the financial sector but also in all other sectors [168]. To be more efficient in blockchain, the issue with waste resources needs to be resolved. Computational power is one of the most critical criteria of blockchain processing, and its effective and efficient use requires more study and consideration. The issue of scalability is another operational challenge that can have an impact on blockchain adoption success.

The application of blockchain technology is still in its infancy, especially in the financial sector. Researchers are researching and developing more prototypes and need to have an understanding of technologies related to financial applications. There are many conceptual framework models, including the model proposed by [11], it needs to be tested and implemented to evaluate its advantages and disadvantages.

The result of this investigation review is whether the impact on the blockchain environment has increased due to a large amount of energy required to deploy and maintain the network system and whether the blockchain investigation business model solution contains environmental factors. Blockchain is decentralized and has been far away from the trend of progress, but it is drawing the concerns of regulators and society to the sustainability of blockchain, which is an important area of future research. These concerns raise two key questions: (1) how can energy consumption be reduced? (2) Whether to apply computing power to use data processing.

It is also assumed that large data analytics can be well integrated into the blockchain, especially data management and data analysis. For data management, the blockchain system can be used to store data in a secure and decentralized manner. Besides, the blockchain defence component can verify the authenticity of the data. For example, patient data stored on shared mushrooms would be difficult to confuse, and no one can steal the data without the owner's permission. Blockchain marketing can be used to analyze data. This process makes it possible to identify potential partners for blockchain network business models and operations. A sensible blockchain can be applied to many uses, such as Internet-based devices and banking. Intelligent contract research can be divided into two types: development and evaluation. A good contract system can be improved. Evaluation involves performing and analyzing principles. It has been shown that even small mistakes can have serious consequences in making sensible agreements. Therefore, it is important to analyze intelligent contract attacks. On the other hand, good contract performance can be an important research topic. As blockchain technology receives more attention in the public and private sectors, it will be used in intelligent contract applications.

VII. RESEARCH LIMITATIONS

Despite the implications for and contributions to the research field of blockchain review, several limitations exist in this study. The review was limited to journal articles, conference proceedings indexed in Science Direct, IEEE, Google Scholar, ACM, Emerald, and Scopus sources. In general, conducting a systematic literature review heavily depends on the quality of primary studies and the appropriate methodology used. The nature of blockchain is a relatively new subject for the research area and is not widely studied; most of the papers were published in the last five years. In addition, there is a lack of empirical evidence and a systematic review of the current blockchain-enabled state-of-the-art [1]. First, the search for information was restricted to articles that included in their titles or abstracts the terms of the search strategy: Articles that use different terminology had not been identified. In addition, we only included articles with blockchain as the primary domain related to the sectoral subdomain search for the study. The small number of papers in the research field causes difficulties in comparing and generalizing findings. Second, the study concentrates on four major sectors, it would be extended to investigate further specific applications in relation to the selected sectors. Third, papers in languages other than English are not included; therefore, cross-cultural differences cannot be taken into consideration. Fourth, the research structure is conceptual; future research should test the developed propositions empirically to provide a more in-depth analysis. Finally, the systematic reviews considerably do not present significant statistical relevance and some constraints, which has a vital impact in any quantitative research.

VIII. CONCLUSION

Blockchain is a decentralized, transactional database technology that enhances business processes and constructs trustworthy data sharing among the chain. Therefore, this new technology enables users to verify, preserve, and synchronize the contents of a data sheet (a transaction ledger) replicated by multiple users. The research aims to pinpoint the gaps related to subject domains and provide future research directions for the use of blockchain in different sectors. The results of this review study also aim to support professionals, practitioners, and stakeholders who wish to implement and manage transformation projects related to blockchain in their sectors. Moreover, increasing their understanding of the implied factors would be beneficial for the decision-making processes of their organizations.

Blockchain is a new technology, and interest in academic studies has increased in recent years. The process of acceptance and implementation of new technology is complex within organizations. In addition, a scarcity of knowledge causes inappropriate decisions in managing projects and work routines. Subsequently, those decisive factors should be taken into consideration in the development and implementation process for the sectors. As this technology is still in the early stages, there are possibilities for future research areas to present usability and the perceptions of users for the implementation of blockchain technology. The regulations and new business models should be updated based on technology requirements along with environmental, sustainability, economic, technological, and information management perspectives. High-quality academic studies should concentrate on additional empirically tested studies in different sectors.

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