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Blockchain Adoption in Real Time Applications: Characteristics, Challenges and Prospects

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Abstract: This paper investigates the different characteristics of blockchain which helps real time applications to overcome the challenges they are currently facing. A detailed study of adoption of blockchain in real time applications is performed. To achieve the aim of this study, the authors systematically reviewed the literature in order to provide answers to challenging queries regarding blockchain technology. We created a python function that looked through numerous databases to find blockchain adoption research work in different real time applications. We observed that healthcare, education, Internet of Things, finance, identity management, and government services are the major areas where blockchain is gaining a lot of attention. In addition to this, the impact of widely used blockchain features in these areas are also identified. In this study we provide an approach to identify potential barriers in adoption of blockchain in real time applications using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) tool. The objective of this approach is to prioritize these barriers based on their degree of influence while simultaneously examining and illuminating the causal relationships between them

Keywords: *blockchain, DEMATEL, barrier, cause and effect*

1. Introduction

Blockchain was initially developed to support the well-known cryptocurrency Bitcoin. Nakamoto originally put out the idea of blockchain for Bitcoin in 2008, and it was launched in 2009. Many essential technologies, such as distributed consensus techniques, cryptographic hashes, and digital signatures, enable blockchain to work in a decentralized context. Because all transactions take place decentralized, there is no need for any intermediaries to examine or confirm any of the transactions. Nowadays a secure network for performing transactions is gaining a lot of attention in different real time applications like education, healthcare and finance. The centralized systems are facing challenges like loss of information, leakage of sensitive information and lack of tamper proofness. The emergence of blockchain in global platforms has given an opportunity to overcome these challenges. Blockchain is adopted in finance to increase the efficiency and security of banking transactions [1]. Governance frameworks, utilizing blockchain to address security and privacy issues. Blockchain technology in energy applications, addressing the privacy concerns issue [2]. A transparent and effective military supply chain can be created using blockchain [3]. Identity management solutions with blockchain addresses privacy and security issues [4]. Blockchain solutions are adopted for keeping track of academic records and allowing each academician to produce their academic records with authenticity in a decentralized manner [5].

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Real time application major concerns are visibility and traceability. Blockchain base solutions keep track of all transactions to provide visibility and traceability [6]. Blockchain is also utilized to connect portable devices and consumer medical equipment to enhance transparency [7]. To keep track of incomplete contracts, food safety, privacy, and security governance are adopting blockchain [8]. Although there are works that have proposed the use of blockchain in real time applications, there is a distinct lack of focus on the feature's analysis of blockchain. This paper provides a detailed analysis on features of blockchain. The main contributions of this paper include

- ✓ Investigate different real time applications widely adopting blockchain
- ✓ Identifying features of blockchain used in real time applications
- ✓ Identifying potential barriers in adoption of blockchain in real time applications
- ✓ Conclusion and directions for future work

The rest of this paper is organized as follows: Section 2 discuss the methodology, Section 3 presents adoption of blockchain in different fields. Section 4 discusses features of blockchain utilized in various real time applications, Section 5 discusses barriers in adoption of blockchain in real time applications. Section 6 presents the DEMATEL approach to identify the barriers with their influence on real time applications. Section 7 concludes the paper and explores the possibility of future works.

2. Methodology

We employ an unbiased and thorough screening

methodology to discover scientific papers on blockchain-based applications.

2.1. Data Sources

We created a Python script that searches multiple online databases such as Google Scholar, IEEE Xplore, ACM, SCOPUS, and the Web of Science for relevant publications using a variety of blockchain-related keywords. The term "blockchain" was paired with phrases for each of the respective application areas to get the following search strings for the initial identification of articles.

• Finance: (‘‘blockchain’’ AND “Finance”)

• Healthcare: (‘‘blockchain’’ AND “Healthcare”)

• Education: (‘‘blockchain’’ AND “Education”)

• Identity Management: (“blockchain” AND “identity” AND “management”)

• Internet of Things (IoT): (“blockchain” AND “IoT”)

• Agriculture: (“blockchain” AND “Agriculture”)

• Energy: (“blockchain” AND “energy”)

• Military and Défense:(“blockchain” AND “military” AND “defense”)

• Transportation: (“blockchain” AND “transportation”)

• Government Services: (“blockchain” AND “government” AND “services”)

2.2. Selection Criteria

All found articles were not necessarily connected to the application areas, their relevance had to be investigated. As a result, the articles were screened, and duplicates were eliminated. Articles from unrelated research categories were excluded . The records were then evaluated for eligibility based on their titles and abstracts, and irrelevant publications were removed. Table 1 describes the criteria used to select the works for review and Figure 1 shows the selection process undertaken for this review.

The literature considered in the search results was selected based on a four-year criterion, from 2016 to 2022. The studies considered for 2022 were those available at the time of conducting this research. The reason for choosing this criterion was to ensure that the most recent and relevant studies were provided to enable great future research in the field. Some of the literature appeared as duplicates in the different databases.

Table 1. Inclusion criteria for selected works

No	Criterion
1	Publication date between 2016 and 2022
2	Emphasis on real time application adopting blockchain technology
3	Emphasis on features of blockchain utilized in real time application

The works considered provide study of features of blockchain in real time applications. Those works that did not have enough implementation or design details were excluded from the review.

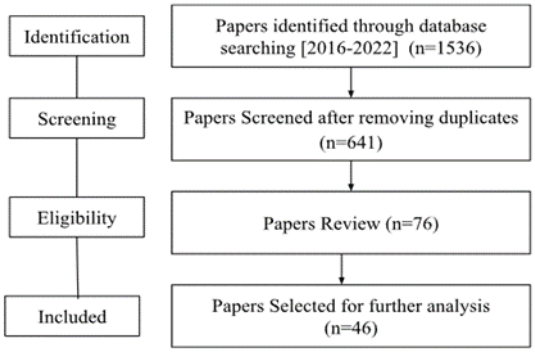

Fig.1. Selection Process

3. Adoption of blockchain in real time applications

Blockchain is gaining popularity due to its potential of improving security and confidentiality. The various features of blockchain are making blockchain technology one of the useful options for the digital world. It is important to understand the impact of these features on real time applications. In line with that a detailed study of blockchain technology in real time applications is done. The area of interest of blockchain in various sectors is shown in figure 2 . The graph shows the trends in several fields. It is found that blockchain-based education research increased significantly in 2021, with one of the key causes being the search for COVID-19 solutions. Researchers concentrating their efforts in the areas of healthcare, IoT, identity management, government services, and financial management have received a lot of attention. As a result, it is understood that blockchain-based applications have already been adopted by the academic community and that it is only a matter of time before they are implemented in our daily life.

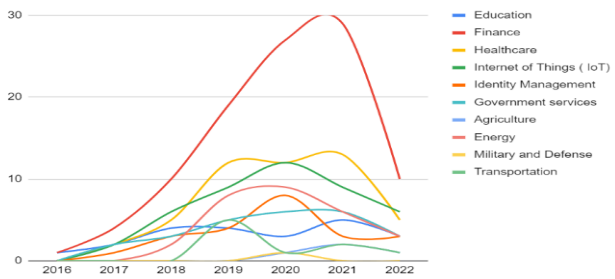

Fig.2. Adoption of blockchain in different real time applications

From the above statistics it is found that blockchain technology is widely used in the areas of healthcare, education, internet of things (IoT), finance, identity management and government services. To find the blockchain features that are being used, literature analysis is done in the identified domains (figure 3).

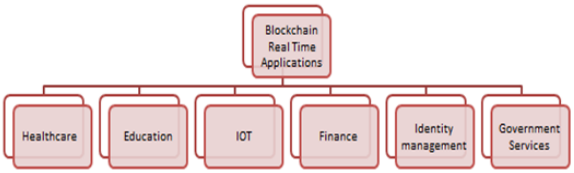

Fig.3. Real time application widely adopting blockchain technology

4. Features of blockchain utilized in various real time applications

From an extensive literature review on the identified domain, it is observed that while adopting blockchain in respective sector the major emphasis is given on following features of blockchain shown in Table 2

Table 2. Features of Blockchain

Notation	Features of Blockchain	Description
DC	Distributed Ledger Technology (DLT) and Consensus Mechanism	This mechanism allows groups of users who don't trust each other to work together. It is a process of decision making where the network users agree and support a decision for betterment of the blockchain network [9].
TP	Transparency	It guarantees products are genuine rather than counterfeit and provide visibility [10].
IP	Interoperability	It is the capacity to share or view data across many blockchains [11].
IM	Immutability	Ensuring that transactions cannot be modified or destroyed [12].
SE	Security	It deals with end-to-end encryption to create a permanent record of transactions, reducing fraud and unauthorized activity [13].
C	Reduced Cost	It provides a secure environment in which encrypted transactions between consumer and seller can take place without the need for third parties to censor [14].
AY	Anonymity	A user can interact with a blockchain network without exposing their identity by using many randomly created addresses within the network [15].
TA	Traceability	Recording all the movements and states which the goods pass through, in real time [16].
DE	Decentralized	Blockchain technology is used to store data in a decentralized fashion so that everyone can validate the accuracy or correctness of the data in such a way that one group confirms the validity of data to another group without giving any information [17].
AT	Automation	Smart contracts can automate blockchain transactions. Smart contracts improve efficiency and accelerate the process. When the pre-specified conditions in smart contracts are met, the

next steps in the transaction or process are activated automatically [18].

Through detailed analysis of features of blockchain on identified domains (figure 4), it is observed that Distributed Ledger Technology (DLT) and consensus mechanism, automation, transparency, security, decentralization, immutability and interoperability are significant features while adopting blockchain in real time applications.

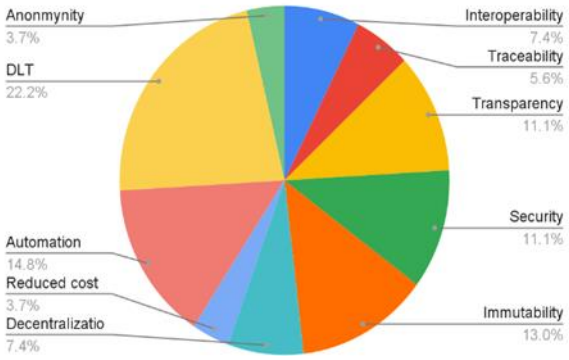

Fig.4. Features of blockchain used in different sectors

5. Barriers in adoption of blockchain in real time applications

The digital world is changing, and businesses are realizing that blockchain has the capacity to totally revolutionize industries. The technology advancement always comes with new difficulties. We used a mixed-methods research technique to thoroughly examine the adoption of blockchain technology in real time application and the obstacles that accompany it. Three main stages made up the research design (Figure 5): A thorough analysis of the literature, systematic interviews, and an analysis using DEMATEL [19]. We use a hybrid framework that combines the Technology-Organization-Environment (TOE) and Technology Acceptance Model (TAM) [20] to identify the obstacles to blockchain adoption. The TAM framework is used to study user views of the technology and how these perceptions may affect the adoption of blockchain in real-time applications, whereas the TOE framework is used to identify the factors that may influence blockchain adoption inside real-time applications The barriers identified are divided into 5 categories human ,government, technical, security and ethical (Figure 6).

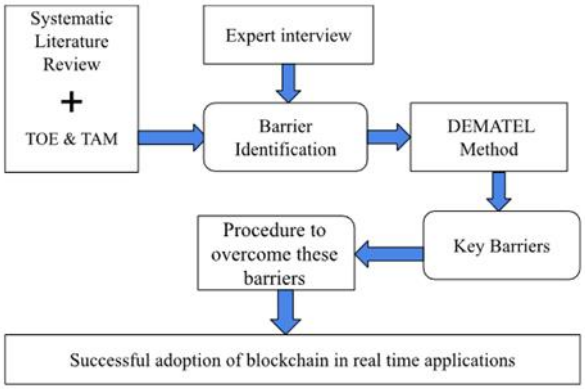

Fig.5. Research Design

5.1. Human Challenges (C1)

People are unaware of blockchain's potential applications outside of cryptocurrencies. Many organizations fail to recognize the value that blockchain could bring to their operations, as they are unaware of potential of blockchain features. Lack of knowledge and awareness regarding blockchain technology is main reason behind it. People who are unfamiliar with the concept of decentralization may find it difficult to understand, creating doubt on blockchain's reliability and security.

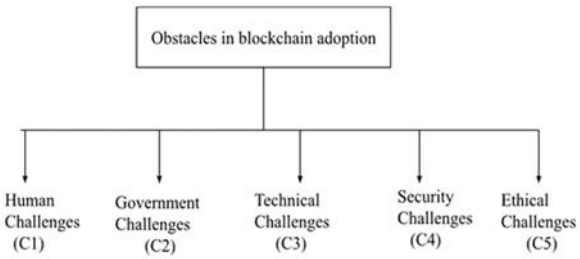

Fig.6. Barriers in adoption of blockchain in real time applications

5.2. Government Challenges (C2)

A lot of governments still lack clear legal frameworks for blockchain-related activity like smart contracts and cryptocurrency transactions. Businesses are reluctant to invest in the technology because of the legal implications. Countries have different blockchain regulations, which makes it challenging for businesses to operate internationally under a single strategy. The government is still defining rules for the use of blockchain in many nations,. Because the regulations are still being developed, many businesses and organizations are delaying the adoption of blockchain technology.

5.3. Technical Challenges (C3)

Different blockchain types, including public, private, and consortium, have evolved. The performance and confidentiality of the public blockchain, are key issues due to its permission-less characteristic. The fundamental issue with private and consortium/federated blockchains is

transparency because they do not permit every network user to read and edit transactions. Public blockchain transactions are longer because it takes about 10 minutes to validate a block, which slows down transaction speed. The blockchain network's scalability is becoming increasingly difficult as the number of members grows over time.

5.4. Security Challenges (C4)

A 51% attack is one of the challenges a blockchain network is facing when a malicious person controls over 50% of the mining capacity within a Proof-of-Work (PoW) blockchain. Endpoint security is another issue that occurs due to malware infections and bad password security are used to obtain unauthorized access to the blockchain network. Smart contracts which are used for automation facing vulnerabilities issues due to errors or gaps that could be used to steal funds or disrupt the business operations.

5.5. Ethical Challenges (C5)

The anonymity in real time applications poses moral dilemmas regarding how to strike a balance between accountability and privacy in blockchain transactions. As blockchain technology and cryptocurrency usage increase, the community must consider and manage concerns related to anonymous users. Blockchain requires a lot of processing power, There is a digital divide since access to it is restricted to those who can afford the required energy prices and equipment, leaving behind individuals and communities.

Once the barriers are identified we systematically interview experts to further improve our understanding of these challenges. The group of experts consisted of 9 members with extensive backgrounds in blockchain technology. Each expert had a deep understanding of blockchain applications in real-world situations. In order to find connections between the barriers that were identified, we applied DEMATEL technique to the interview data and created causal-effect maps [19]. This method gave a thorough grasp of the fundamental reasons behind the obstacles, offering crucial information for future research aimed at enhancing blockchain acceptance in real-time applications. We use Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to analyze barriers to blockchain adoption in real-time applications is probably due to its capacity to deal with uncertainty, capture intricate relationships between variables, handle subjective data, offer context-specific analysis, and provide qualitative insights into barrier interactions.

6. Dematel Method

We took a comprehensive approach to our study, including expert consultations, expert interviews, and literature research. Using these techniques, we were able to identify 5 major obstacles that affect blockchain adoption in real time applications

Step 1: An initial average matrix M is obtained (Table 3) by consulting with blockchain professionals to identify key barriers on a scale ranging from 0 to 4 (where 0 indicates no influence, 1 indicates low influence, 2 indicates medium influence, 3 indicates high influence, and 4 indicates very high influence and n represents the total number of experts.

Table 3. The initial average matrix M

	C1	C2	C3	C4	C5
C1	0	4	4	3	0
C2	4	0	4	4	4
C3	4	4	0	2	0
C4	4	4	3	0	3
C5	4	4	0	3	0

Step 2: Matrix normalization (M')

The normalization procedure of the DEMATEL approach is to divide the elements of the matrix of direct relations by the highest of its linear sums, equation I (Table 4)

$$M' = \text{lambda} * M \quad \text{(I)}$$

Where: lambada = 1/greatest of matrix M's linear sums

Table 4. Normalized matrix M'

	C1	C2	C3	C4	C5
C1	0	0.25	0.25	0.1875	0
C2	0.25	0	0.25	0.25	0.25
C3	0.25	0.25	0	0.125	0
C4	0.25	0.25	0.1875	0	0.1875
C5	0.25	0.25	0	0.1875	0

Step 3: Complete impact matrix (C)

The complete impact matrix is calculated using equation II (Table 5) Where: I = Unit matrix

$$C = M'(I - M')^{-1} \quad \text{(II)}$$

Table 5. Total effect matrix C

0	0.216	0.190	0.129	0	0.535
0.272	0	0.229	0.228	0.160	0.891
0.203	0.203	0	0.075	0	0.483
0.251	0.251	0.152	0	0.105	0.760
0.219	0.219	0	0.132	0	0.571

Step 4: Value computation for important linkages and indicators is done using equation III and IV (Table VI)

$$X_i = \Sigma_{i=1}^{n} c_{ij} + \Sigma_{i=1}^{n} c_{ji} \quad \text{(III)}$$

$$Y_i = \Sigma_{i=1}^{n} c_{ij} - \Sigma_{i=1}^{n} c_{ji} \quad \text{(IV)}$$

Where: X – the significative indicator, Y – the relationship indicator, c_{ij} – direct and indirect influence from indicator i to indicator j, n – the number of challenges.

Table 6. Significance indicator (U) and relation indicator

Obstacle Indicator	Description	Value of Significance Indicator (X)	Value of Relation Indicator (Y)	Cause- Effect Chain
C1	Human Challenges	1.263	-0.192	Effect
C2	Government Challenges	1.562	0.219	Cause
C3	Technical Challenges	1.055	-0.088	Effect
C4	Security Challenges	1.193	0.327	Cause
C5	Ethical Challenges	0.837	0.305	Cause

(V) values

Step 5: Cause-effect diagram

The cause and effect relationship between the challenges occurs in adoption of blockchain in real time applications is map

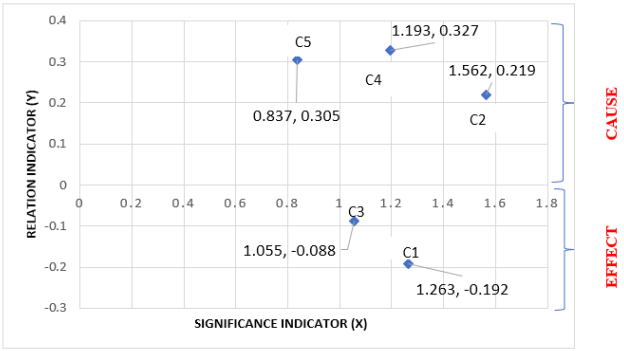

Fig.7. Cause-Effect Map

Upon analyzing Fig. 7 and Fig. 8 we can conclude that, among the identified barriers within the dataset under consideration, the most dominant barrier that has the greatest influence on the others is barrier C2 (Government Challenges). This barrier has the highest relation index value and, as a result, is the cause in the causal effect map that has been created. Two additional barriers are also in the position of causes, in addition to this: (C4) security and (C5) ethical challenges. The barriers affected by these causes are barrier(C1) human and (C3) technical. When we observed Table 6 , Fig. 7 and Fig.8 few inferences are made

- ✓ Diverse countries have extremely diverse blockchain rules, which makes it difficult for firms to operate globally using a single approach that influences human participation.
- ✓ The lack adequate internet connectivity, issuers regarding scalability and interoperability affects blockchain's acceptance.
- ✓ High energy and equipment requirements are necessary to set up blockchain for any real-time application, which has a big impact on how widely people and communities accept it.

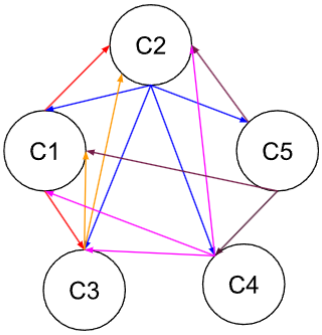

Fig.8. Realtionship map

7. Conclusion

Blockchain technology is attracting a lot of attention from around the globe. In this study, We have identified the real-time applications where blockchain technology is widely used. We have found that blockchain offers a number of features that could be quite useful for modern applications. But a lot of challenges need to be overcome before blockchain's benefits can completely manifest. The DEMATEL approach is proposed for assessing and analyzing possible obstacles to blockchain adoption in real-time applications. Although the presented approach was applied for analyzing the barriers in adoption of blockchain in real time applications it has certain limitation. Barriers were identified through a survey of the literature and expert opinions, so there is always a possibility that some important barriers will be overlooked throughout the article's selection and review process. It would be fascinating to look into how DEMATEL can be used in the future to make better decisions in the face of uncertainty in conjunction with more advanced uncertain theories like cloud model theory and fuzzy linguistic word sets.

Author contributions

Suhas Lawand: Conceptualization, Methodology, Field study, Writing-Original draft preparation.

Dr. Prashant Nitnaware: Data validation, Visualization and representation validation, Writing-Reviewing and Editing

Conflicts of interest

The authors declare no conflicts of interest.

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