Blockchain-Based Recommendation System: A Review Focusing On Security Aspect

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Abstract

Recently, blockchain technology has caused considerable interest in academic research in the recommendation system domain. These records frequently contain encryption to achieve a comprehensive and reliable recommendation system. These records frequently contain encryption keys. Additionally, recommendation systems concerning suitable evaluation metrics are crucial to providing an accurate recommender system. Despite the attempts to address these issues through various strategies, very few researchers have considered a success in encrypting, especially in safeguarding the subscribers' data. Currently, blockchain technology has drawn a lot of interest amongst several researchers, including in the area of recommendation system. To define these gaps, the current study aims to review the adoption of blockchain as one significant upside plan to increase data protection in recommendation systems. The systematic literature review (SLR) method was used to analyze publications from different electronic databases and documents of studies from 2019 to 2022. This research contributed to an in-depth comprehension of blockchain-based security techniques for recommending systems in addition to offering an overview of currently available blockchain-based programs within industries. The report emphasizes and examines significant facts and information about the blockchain depends security techniques for recommendation networks. Researchers highlight interest in a higher rate of security data and highlight noteworthy elements determined by an independent evaluation technique.

Keywords: Recommendation system, Blockchain, Data records, Security, Data protection.

1. INTRODUCTION

Recommendation system has been utilized openly in various domains such as Amazon, Netflix, YouTube, and universities. A recommendation system can further gauge the clients' needs and reviews on the product quality to suggest personalized recommendations to each client [1, 2]. The recommendation system provides accessibility to vast amounts of information for customers' questions [3]. A kind of classification algorithm called a recommendations system sorts the data which is accessible and then provides recommendations for the viewers (users) to recommend items, interests, or, in the case of e-commerce, previous transactions [4]. The recorded data might be determined by the user's behaviors after visiting some websites. An intelligent recommender algorithm can forecast the things they would like to purchase. The capability of recommendation systems to accurately and broadly retrieve previous data feedback from customers is crucial to their success. Most recommendation algorithms are built on data centers that could have a point of failure and are extremely unstable [1]. Because of its decentralization and data integrity attributes, blockchain has established a huge security solution for understanding infrastructure cooperation and created the potential for magnifying weaknesses in multiple sectors. The blockchain solution greatly influences a company's online data technologies context [5–7]. Blockchain is essentially a database system that keeps an ever-growing collection of data entries that are verified by the access points, which are a core component of it. All transactions are stored in the database, which is kept in a blockchain platform. Blockchain is a distributed ledger system that eliminates the need for an intermediate organization [8].

Each access point in the blockchain technology has access to share the details within each previously performed transaction. While blockchain still seems to be a viable option for carrying out blockchain applications, certain security issues and restrictions still need to be and resolved [8]. The authors of [9] and [10] suggested blockchain security for distributing data records for huge data in recommendation systems. To guarantee security and anonymity, current technology can be combined with cryptocurrency in a decentralized manner [11].

There are few in-depth literature reviews that address both security and blockchain technology problems regarding recommendations systems in addition address the most significant concerns. In summary, this paper aims to determine a gap in integrating blockchain technology with a recommendation system through a systematic review evaluation. Academics can understand gaps in the literature and issues for empirical work with the created database of available literature on blockchain technology. On top of that, the main problems with recommendation systems can be resolved using this blockchain technology, ensuring comparative, security, privacy and confidentiality issues to be tackled. Whereas there have been a lot of research endeavors focusing on the use of blockchain computing for different purposes aspects, there has been no comprehensive examination to fill in the knowledge gap among data security with recommendation systems utilizing the blockchain.

- Integration of two domains, namely recommendation systems with blockchain, which are essential benefits in the academic research domain, to highlight challenges and opportunities in those areas.

- Heighten the challenges of integrated blockchain based on recommendation evaluation on system performance [5].

TABLE 1 shows the previous studies' application blockchain technology in various scope. Based on the last works' attention, studies have focused on investigating web recommendation, e-commerce, social media and tourism which is considered the main contributor to recommendation system.

Table 1: Summary Of Blockchain-Based Recommendation System [12].

Domain	Classification RS	Blockchain	References	Outcome
E-commerce	Security in a recommender system Security in a recommender system Help user select items	Blockchain with e-commerce Distributed ledger Payments	[1, 3, 6, 8, 13]	Privacy issues Transaction Improved job searching
E-learning & education	Security in a recommendation system Malicious behavior in recommendation	Blockchain with smart contract Security and guarantee of credibility	[4, 14]	Heightened security issues Teachers' recommendation
E-purchases	Privacy a Recommendation system	Secure ledger of blockchain	[5, 15]	Security info in blockchain
Entry info	Privacy decentralized recommendation system	Secure ledger of blockchain	[5]	Smart Contract
Online Shopping	Collaborative filtering limited data	Security	[16]	MovieLens dataset
Smart Contract	Price recommendation	Online Auction Price Suggestion System to secure data	[9]	transparent online in blockchain technology to store records
	Managing data	The development of user information cryptocurrency recommender systems	[8, 10]	Reduce transaction cost
	Security standard vulnerability	Security smart contract	[1]	Vulnerabilities in the smart contracts

Currently, recommender system is being used more and more on online platforms, making a big impact. The review's report aid in identifying numerous well-known web recommenders. Personal Web Watcher maintains note of the users assessing the website link from the browsed websites to gather information about the visitors' self-interesting. Using enhanced encoding algorithms, suppose Internet technology represents user names as a weighting term - document matrix represents their likes and dislikes. To improve sales, an e-commerce website incorporates recommendation systems to provide clients with reviews and encourage them to purchase various goods that interest them. Item suggestions are based on the user's previous online shopping history or data collected. By turning visitors into purchasers, enhancing cross-sell by suggesting supplemental goods, and cultivating awareness of the brand, recommender system improves e-commerce profitability.

Massive amounts of data, including messages (Twitter posts, people commenting), photos, recordings, and files, have recently been shared through social media sites [14]. The challenges of overstimulation have indeed been addressed due to the wide-spread data distribution via social network-

ing sites. As a result, multiple social networking social media tools are using recommender systems to address this issue and recommend important data to specific end users [8]. In addition, the massive amount of data and subscriber data provided enhances security concerns and data encryption [16]. In [13], the study presents an RS for diabetic patients that stores electronic documents in cryptocurrency, seeking to make them a truthful business history. In [13], cryptocurrency is employed to secure both records (providers, producers, and distribution).

As travelers are planning to visit the uncharted territory, travel recommender systems generate tailored travel advice for them. They use these suggestions as equipment to help them make straightforward, simple, and reasonable decisions. Tourism recommender system applies two kinds of interfaces: the internet, which is particularly helpful before the visits, and the smartphone, which suggests opportunities when the visitor is there.

The integration of blockchain security in recommendations systems (RSs is relatively young, with its initial research in 2016 [17, 18] and a significant portion of additional research in both of the previous years. For the purpose of offering adequate domain awareness. For this study to provide an adequate overview of the topic and identify the difficulties and potential for future study, it is necessary to: (i) conduct an examination of similar studies and explain they have contributed, (ii) arrange the contribution according to a comprehensive classification that highlights the significant empirical studies particular fields.

A recommendations system must meet the minimum required in terms of security procedures, data security among individuals and the RS algorithm must follow all understood security standards. recommendations systems communicates with viewers by transmitting and capturing many types of data gathered. Regarding this hypothesis may be incorrect because malicious individuals can modify the private data of users who have been authorized or slant the recommendations made to benefit [19].

2. THE METHOD

The current part seeks to address issues and obstacles in blockchain and recommendation systems by evaluating research and published works in the data security domain which demonstrate, in addition improve comprehension of the significant performance. The research investigation will provide answers to the following research inquiries: How does a blockchain with a recommendation system improve security of data?

2.1 Data Source

This study was investigated by using keywords from two online databases: Google Scholar and Web of Science (WoS). The keywords are Blockchain technology, Recommendation system, Security, and E-commerce. An initial result in google scholar is 4,517 articles based on years from 2020 to 2022. Searching in WoS database, resulted in 381 articles from year 2019 to 2022. The search is conducted based on English language in the computer science & engineering domain. TABLE 2 depicts the number of articles in the initial search and after filtering.

Table 2: Source of database

	Database	Initial Results	After filtering
1	Google Scholar	4,517	20
2	Web of Science	381	70
3	Emerald	171	15
4	Science Direct	43	10
5	IEEE	648	20

2.2 Analysis Based on Domain

The major study question is to comprehensively understand the stream study focusing on blockchain. Within the analysis of the relevant research in online databases, we highlighted the overall comprehensive of blockchain technology with the recommendation system domain in the current study. This study's planning is based on blockchain technology and a recommendation system that will assist in academic research in this domain with a full understanding of how to implement blockchain and academic gaps. The highest domain where blockchain is being employed is IoT (see FIGURE 1). The second domain is business management which has focused on blockchain. Furthermore, the domains smart city, e-vehicles, transportation system, data security, and e-commerce focused on implementing blockchain, while studies in blockchain technology with recommendation system is fewer than in other domains. For this reason, the current study heightened the research limitation on blockchain technology in recommendation systems.
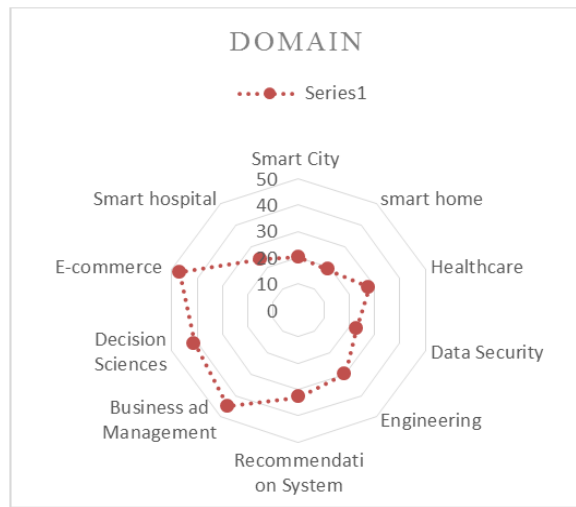

Figure 1: Selected Studies Based On Domains

2.3 Analysis Based on Years

The classification of the chosen source articles' published years is illustrated in the FIGURE 2. It's important to highlight that all the chosen articles got released after 2022. This demonstrates how

blockchain studies is a relatively new and rapidly developing field. A closer examination of the availability of journal articles years reveals that, of the total number of articles chosen, 30% are released in 2020, 20% in 2021, and 50% in 2022. The fact that there are more articles per year demonstrates that there is a need for distributed ledger technology. A reference for every chosen original document is illustrated in FIGURE 2. An article may draw information from the academic community, business, or both.
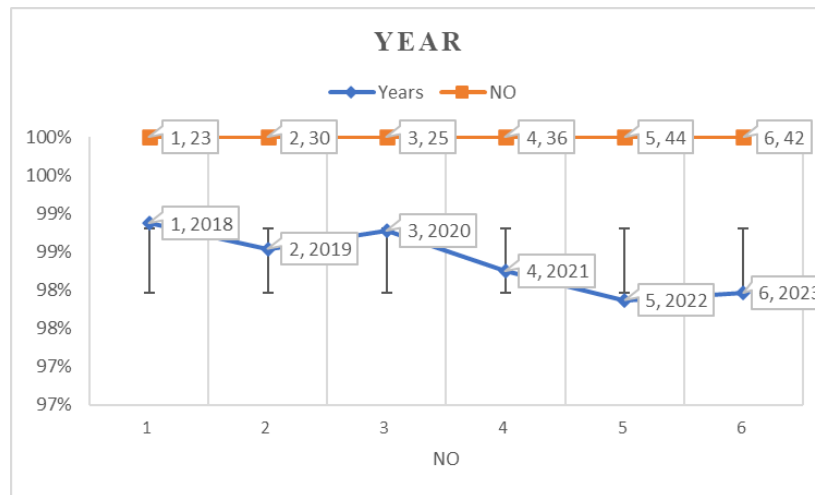

Figure 2: Selected paper based on industry and year

2.4 Blockchain-based Recommender System

Blockchain may be one of the most significant elements that can be implemented in several areas in the future, depending on the fast development of cryptocurrency-related technologies. This is so because blockchain technology includes details and has a wider range of applications than currency. According to [20], this advancement seems to be a respondent indication for reaching the world's goals regarding sustainable development. By improving corporate sales and business, for example, blockchain technology could help create a smart city [21, 22]. Being one of the key characteristics of blockchain-based technologies, factors such as privacy and security, accessibility, and reliability must be considered to establish trust-free sharing services. So, records are always available depending on outside organizations because a blockchain is a distributed database. Additionally, as this platform may be considered a cloud platform in which users maintain backups of the data and approve modifications by a majority, security is guaranteed. According to [23], the capability of blockchain technology to improve infrastructure is needed to establish "modern social contractual agreements for resource efficiency. They claim that blockchain offers a platform that allows data exchanges without the need for security solutions, promoting genuine inter-dependencies between individuals to address issues. As a result, this option provides an outdated, highly centralized business strategy. Hence, new technology displaces the recent business paradigm, which was previously run by established highly centralized, and powerful organizations like local authorities, and businesses. Blockchain technology would be used in "block-stack," an alternative DNS-like system that uses blockchain technology instead of a Domain name system (DNS data centers to decentralize control of DNS (domain name system) data. An IP (internet protocol) identity is returned

when an HTML document is typed into a domain controller, making DNS akin to the website's book. Authorities and huge companies dominate domain names, and this concentrated influence will indeed encourage authority crimes such as censorship, unauthorized access, surveillance, and hacking assaults.

The quantity of data communicated between endpoints, the quantity or configuration of records collected from every connection point, and the data processing weight of every connection point all impacted the overall effectiveness and data protection of the method and its flexibility. Although this comes to protecting records, blockchain technology provides numerous benefits over typical database platforms. A defining feature of private collaboration and public cryptographic functions could differ [3, 24, 25], and they can still be fundamental to recommendation systems.

2.4.1 Decentralized

Compared to traditional centralized systems, distributed ledgers are distinguished by a decentralized form of deliberation between blocks of limited receivable and account information [16]. The cryptocurrency data is stored with a secure connection, related to a data source, and utilizes data in a peer-to-peer node. On the other hand, the blockchain is a collection of nodes linked together rather than a central database. The conception of blockchain technology within decentralized distribution systems elevated a novel method of storing and analyzing data which does not require public confidence between the various associated parties within the reduction. Cryptocurrency eliminates the requirement for nodes to accept one another because they are responsible for the administration of a functional process that users believe is significant, has an immediate impact, or is knowable. Decentralization works well for recommendation systems once security [26] or configurable [27] are the top issues. Compared to centralized data encryption techniques, data preprocessing, measurement confidentiality issues, encrypted communications, decentralized memory, and transformation of data used by recommendation systems eliminate the demand for subscribers to communicate current information and collaborate or a centralized access point.

2.4.2 Data encryption

The data encryption of records is considered an essential feature of blockchain technology because it needs to protect the recommender systems method's processed data from embarrassing challenges [28]. A record is linked to a business process and integrated into a "block" of data which includes the hash of the most recent block inside the sequence, which a clustering procedure encryption keys enhance that as well. As a block is tampered with, the cryptocurrency times, and the main factor including the interruption, is immediately apparent. A malicious user can still tamper with the subscriber or usernames by introducing or removing information, thereby influencing the recommendations [29]. The utilization of blockchain technology needed to store user details could benefit from its distributed ledgers and secure this access from unauthorized changes [30].

2.4.3 Reliability

Reliability is the investigation or confirmation of transaction data by third researchers, whether organizationally or external to an organization. The skill of blockchain to function like a decentralized system, in which transfers are continuously recorded or confirmed by users, has also progressed the centralized reporting concept more toward the current self-foundation [31]. A primary issue in electronic auditors is obtaining all authors' consent and verifying the record of processes. Cryptocurrency nodes have become an issue for auditors' independence, in which two users determine to recognize solely their nodes as acceptable. A significant challenge for independent auditors is the capability to conduct transaction records of any point on the system utilizing only the required usernames and passwords.

2.5 Types of Blockchain Technology Based on Recommendation System

Security Recommendation System: A reliable recommendation system is typically constructed to use cryptocurrency security rule that supports decentralized applications or contribute to solving various data organizational challenges, such as privacy, reliability, and validity, by employing encryption technology and data encryption [27]. A recommendation system's primary functions include identifying new subscribers (Registration), adding new objects (Starting creating an account), rankings current, and data processing the rates of current components (Compute score). The recommendation system needs to allow for decentralized evaluations or priority of multiple objects, in addition to being built on a channel that runs decentralized applications on a blockchain ledger, with no centralized database. An application of a decentralized recommender system was installed and configured on the Blockchain Public to illustrate the method's adequacy.

Trust Recommendation System: Trust is important in developing an effective recommender system to inform effective decision-making. It is now essential to confirm rapport with participants by utilizing cryptocurrency in the recommender system [8, 26]. Secure is implemented in this classification of a recommender system through the use of cryptocurrency to ensure data processing and the inclusion of blockchain networks in the primary proof-of-work. As a result, this certainly contributes to creating a dependable recommender system for collaborative environments providing security records and networking real-time updates concepts via a cryptographic protocol.

Companies can use several cryptographic protocols to provide them with a competitive edge. They can simplify their fundamental operations, lower operating costs, and increase the transparency and automation of industrial private property rights and transactions [32]. The use of blockchain in commerce has been the subject of numerous academic studies. Following our analysis of this research, researchers consider that companies should think about implementing blockchain technology in the following areas.

2.5.1 Data storing and sharing

Gathering and processing data is the most limited resource and is essential to any business. Blockchain technology offers dependable data security and effective data usage [33]. Blockchains are currently attracting a lot of attention because they allow independently alternatives to value production

and management. Many banks, Internet firms, automobile manufacturers, and even governments throughout the world have implemented or considering implementing blockchains to increase the reliability, scalability, and effectiveness of their offerings. Many different types of businesses may use blockchain to integrate crypto certificates because it is a highly distributed and secure public blockchain [34]. Because nobody can interfere with the records on the cryptocurrency, decentralized data storage means you provide the records to individuals throughout the public rather than a set objective. Organizations can use the blockchain to record transactions, enhance their security and reliability, and prevent records from becoming altered. Blockchain technology thus permits data transfer at the same time.

2.5.2 Transaction

Organizations may benefit from using electronic cash backed by blockchain technology to address funding-related issues. Cryptocurrency assists businesses that want to integrate non-cash transactions. Cryptocurrency helps businesses that want to integrate non-cash transactions. Additionally, cryptocurrency technology is a new type of venture capital [14]. Investment companies or business leaders can get additional innovative financing through token sales or initial coin offerings. By retaining, securing, and releasing crypto currents that are focused on blockchain systems, businesses can address cash flow difficulties with much flexibility.

2.5.3 The blockchain technology

The blockchain technology is built on the premise that only trustworthy ports oversee the system [5]. The so-called 62% Attacks can affect a system if malicious nodes co - operatively possess further processing capability. Despite Cryptocurrency being intended to be a tribute blockchain platform, [8, 20] contended that the vulnerability of a 51%. As a result, threat increased by business concentrations of cryptocurrency by a select few sizable blockchain systems.

2.6 Measurement Metrics

To analyze and measure the algorithms that are used in the recommendation system. Several methods, such as quality matrix, user's satisfaction matrix, and ranking matrix, are used to analyze recommendation systems.

Qualitative metrics are often used in the subject of recommender system and are particularly helpful when trying to create a strategy that will produce fewer failures. These metrics are utilized in a variety of recommendation systems functionalities. Accurateness and accessibility are some of the essential examples. Only a limited of these algorithms are well suited to transponder identification and recommender systems datasets. Content is categorized as important for a user through performance evaluation. The performance of the proposed recommender system is determined using some parameters.

The objective behind measurements, frequently employed in recommender system, is determining how well the recommendation system evaluates the accuracy, recollect, transfer function discount-

ing combined benefit mean classification performance and success rates. A current performance measures category examines the performance of ranking top things as opposed to the adequate performance of the scores generated by the classification algorithm, as in the prior category.

The viewers are the subjects of experimental trials to gauge the level of satisfaction with the recommendation system. A measurement, which gathers individual comments from the users, is commonly employed in many recommendation systems. This rating must have problems with limitations, the lack of an objective way to evaluate the recommender system performance, and comparisons between different networks.

3. RESULTS AND DISCUSSION

3.1 Limitations of blockchain application

Except for study such as [35], which uses blockchain, and [4, 36], which uses an important evaluation method based on blockchain to consider decentralized simulation besides different users, only a limited contribution which fully exploits blockchain performance [26]. Firstly, it is critical to identify cryptocurrency's significance for a challenge because of its comprehensive knowledge. recommendation system is divided to tow main reasons knowledge and data security to provide communication and enhance communication data security. Due to transmission delay, recent blockchain configurations cannot be adjusted to a huge number of data per second [13]. This is indeed a critical gap for e-commerce recommender systems, like those used by social networking sites [37–40]. That needs to be prepared to accommodate huge following, billions of products, and individual needs that arrive in streaming sites, and provide recommendations in microseconds Furthermore, decentralized recommendation systems have indeed been formulated to overcome issues faced in classical recommendation systems with a centralized power (which operates as a secure connection with ultimate control over the recommender system) by distributing independence and control to subscribers. Furthermore, whenever it keeps coming to disagreements or misbehavior, might cause major issues. As a result, addressing social unconscionable communications that may occur throughout behavior among multiple users is critical, as is examining adequate solutions that can transform reasonable processes, including the use of hyperfine switches accumulated from Crypto currency.

A further significant issue in using blockchain in recommendation systems is its environmental level and its significant upside detrimental consequences on the environment. As a result, the research process used in blockchain technology for secure authentication has used concrete evidence regarding effectiveness [41, 42], because it requires massive flexibility, and therefore utilities, to access modeling or simulation estimations. Throughout this perspective, widespread adoption of blockchain technology could indeed counterweight emissions reduction contributions, as the current is indeed majority synthesized utilizing energy sources around the globe [1, 29, 32].

1. Blockchain-based recommendation system Issues with unanswered questions in blockchain adoption in recommendation systems are largely attributed to the blockchain [12, 32, 42, 43].

2. A distributed ledger blockchain's effectiveness is threatened by the higher energy consumption of the Proof of Work (PoW) decentralized network, necessitating the development of different classifiers [13].

3. While blockchain application is increasing, some companies and individuals remain skeptical, because of a need for regulatory oversight.

4. The existing blockchain users had already developed a large variety of non-interoperable configurations [44].

5. A further unresolved issue is the efficient utilization of the data employed by different recommendation systems and a recommendation system's capacity to concentrate on relevant data whilst still failing to understand old information [21]. Once this is resolved, it will become useful for you dealing with several nodes in a crypto currency-based recommendation system.

3.2 Challenges of Blockchain Technology in Various Domains

The conclusion of the current research addresses the main topics in various research that are not focused on addressing limitations and challenges integrated blockchain with the recommendation system domain. Current research paid attention to a blockchain with recommendation topics from security terms. The current systematic review sensitivity involved theaters and data records security issues. Despite different. recommendations in previous research to identify challenges. There is a need to address academic research [8, 34]. Current research addresses a different security scope of blockchain within the recommendation system. After analysis studies, although several researches have been done in the blockchain usability domain, there are still limited articles in security blockchain issues. FIGURE 3 shows several major trending topics needed for the blockchain and recommendation system domain research [45, 46].
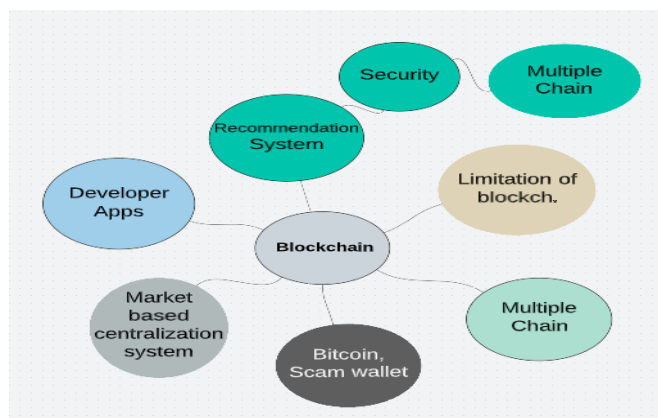

Figure 3: Several Topics In Blockchain

4. CONCLUSION

In this paper, we define current blockchain-depend Recommendation System with various elements such as security issues, blockchain significant influence, and distinct categories of blockchain-depend recommendation system and implementations. Furthermore, analyses the challenges and future academic study and in affecting the capacity of blockchain-based recommender systems. The purpose of current review is identification was to assess the capabilities and limitations of blockchain systems and future researchers. As a result, blockchain technology could indeed considerably aid in the improvement of recommendations systems by providing information security, privacy, data protection that is availability. Furthermore, it is important to note that the development of decentralized blockchain-depend recommender systems can present security implications. Additionally, relevant alternatives for creating fair workflows must be examined.

Blockchain has usually been offered as an alternate approach that may be integrated into RSS to deliver answers to unanswered problems, particularly those relating to private communication protection. As a result, blockchain can greatly aid in the improvement of recommending platforms that ensures the protection of information, accuracy, privacy, and availability. Further research is needed to integrate off-chain data retention in peer-to-peer distribution collaborative networks which allow the edge equipment to be connected or disconnected independently of time, and a distributed system called blockchain that records passwords of data addresses or developed theories, which can be a feasible option for edge-based centralized education.

5. FUNDING

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