

Social Media Sentiments of Real Estate Investment on Blockchain Technology in Post-COVID-19

Supharoek Siriphen¹, Tirapot Chandarasupsang², Annop Tananchana³, Siva Shankar Ramasamy² and Ahmad Yahya Dawod²

Submitted: 13/09/2023

Revised: 22/10/2023

Accepted: 14/11/2023

Abstract: The real estate sector is experiencing significant transformation in response to the impact of COVID-19, emphasizing the need for innovative approaches. This study examines the public's sentiment towards the adoption of blockchain technology, particularly digital tokens, for real estate investment in the post-pandemic era. Digital tokens offer numerous advantages, including fractional ownership, asset tokenization, real estate crowdfunding, streamlined property transactions, efficient rental management, enhanced property title records, and the creation of Real Estate Investment Trusts (REITs). These advantages could be realized by leveraging blockchain technology, resulting in enhanced liquidity, accessibility, transparency, and efficiency in the real estate sector. This article analyzed the sentiments expressed on social network platforms to understand the perceived benefits of utilizing blockchain-based digital tokens in real estate. Additionally, practical considerations related to the implementation of blockchain technology in the real estate sector were discussed, shedding light on the potentially transformative impact of this technology on the industry.

Keywords: Blockchain, Real Estate, Investment, Tokenization, Sentimental Analysis

1. Introduction

The COVID-19 pandemic had presented unprecedented challenges to the real estate sector, which was known for its complex and established systems. The global health crisis has significantly impacted the way real estate is bought, sold, and managed, highlighting the necessity for innovative solutions to adapt to the evolving landscape. In recent years, blockchain technology had gained substantial attention for its potential applications in various industries, including real estate. In the post-pandemic era, this study investigated the utilization of digital tokens on the blockchain within the real estate industry [1]. By enhancing liquidity, transparency, accessibility, and efficiency, digital tokens representing digital assets on the blockchain offer a unique opportunity to transform the sector. Leveraging the decentralized and immutable nature of blockchain technology, digital tokens could address several pain points in the real estate industry, bolstering its resilience and capacity to navigate the challenges posed by the pandemic. In the following sections, specific use cases of digital tokens in the real estate sector after COVID-19 pandemic were investigated [2]. These use cases included fractional ownership, asset tokenization, real estate crowdfunding, expedited

property transactions, rental management, improved property title records, and the establishment of Real Estate Investment Trusts (REITs). Through the analysis of these use cases, we aimed to shed light on the transformative potential of digital tokens on the blockchain and provide their implementation considerations. Furthermore, this study examined the benefits, drawbacks, and implications of employing digital tokens on the blockchain were unfolded in the post-COVID-19 real estate environment [3].

The implementation of blockchain technology in the real estate sector held immense potential for digitizing and streamlining property transactions, leading to the creation of a comprehensive digital audit trail. However, the disruptive nature of this technology posed challenges, particularly concerning the intricate socio-economic structure of established housing and mortgage markets. One notable aspect of this disruption is the tokenization of physical real estate assets. This digital transformation has the potential to reduce costs across the property transaction process, the absence of a centralized marketplace for token trading remains a significant obstacle. For considering sustainable development, tokenization can play a crucial role in financing the construction of smart buildings within intelligent urban landscapes. This approach offers a transparent and interoperable means for private investors to access revenue streams and participate in digital infrastructure projects. Moreover, blockchain technology presents opportunities for developing secure and transparent systems for property management and exchange. Nevertheless, these advancements also brought forth a

¹Department of Digital Innovation and Financial Technology, International College of Digital Innovation, Chiang Mai University, Chiang Mai, Thailand

²Academic Staff at the Department of Digital Innovation and Financial Technology, International College of Digital Innovation, Chiang Mai University, Chiang Mai, Thailand

³Director of International Research and Academic Service Center, International College of Digital Innovation, Chiang Mai University, Chiang Mai, Thailand

unique set of challenges that must be addressed. It was imperative to navigate issues related to regulatory frameworks, legal considerations, data privacy, scalability, and the standardization of blockchain protocols. Only by tackling these challenges could the full potential of blockchain technology in the real estate sector be realized. In this article, an examination was conducted on the viewpoints shared across social media platforms to gain insights into the perceived advantages of incorporating blockchain-based digital tokens within the real estate domain. Additionally, the article explored practical considerations associated with the integration of blockchain technology in the real estate sector, thereby shedding light on the potential transformative influence this technology could exert on the industry. The benefits of increased accessibility for investors, improved liquidity, reduced transactional friction, enhanced security, and the potential for democratizing real estate investment were examined. Furthermore, the challenges related to regulatory frameworks, scalability, interoperability, and user adoption that must be tackled for the widespread implementation of these solutions were addressed. The application of digital tokens on the blockchain presented a promising opportunity to reshape the real estate industry in the aftermath of the COVID-19 pandemic. By embracing these technological advancements, the industry could overcome traditional barriers, adapt to the new normal, and cultivate a more transparent, efficient, and inclusive ecosystem. Through this exploration, the aim was to provide valuable insights and inspire further research and innovation in this emerging field at the intersection of blockchain and real estate.

1.1. Literature review

Khalid et al.'s [4] systematic review examined blockchain technology's role in the real estate sector. It explored various use cases, including property transactions, land registration, and smart contracts, as well as the potential future paths of blockchain in real estate. Ciriello [5] explored the concept of tokenizing real estate assets using blockchain technology, highlighting potential benefits such as increased market liquidity, fractional ownership, and enhanced transparency. In a similar vein, Saari et al. [6] conducted a systematic review focused on the application of smart contracts in real estate transactions, an overview of the benefits and implementation issues associated with smart contracts in the context of property transfers, rental agreements, and escrow services. The potential of smart contracts to improve transaction efficiency and reduce fraud was discussed. Gupta et al. [7] provided a thorough review of the current landscape and future directions of blockchain technology in the real estate industry. Several benefits of this technology, including increased transparency, cost reductions, and

enhanced security were reviewed. Issues around scalability, regulatory frameworks, and data protection were also investigated. Moreover, an integrative review was conducted to examine the potential impact of blockchain technology on the real estate industry. Several benefits of blockchain were mentioned, including increased trust, faster transactions, and reduced intermediation. Importantly, research gaps were identified, and a future research agenda was proposed for exploring blockchain's real estate implications. Sharma et al. [8] examined various applications of smart contracts across platforms and sectors, including education, voting, real estate, entertainment, IoT, supply chain, and healthcare. The deployment of these applications and proposed potential solutions for the future were discussed. Timuçin and Biroğul [9] focused on the use of Consensus-oriented Smart Contracts (CoSC) in property transactions within the real estate industry. CoSC could enhance efficiency, transparency, and trust in multi-party transactions. Hammad et al. [10] acknowledged the potential of blockchain technology to democratize real estate investing through tokenization, which enables fractional ownership and provides accessibility to smaller investors. Shahaab et al. [11] discussed the "Registration of Overseas Entities and Beneficial Owners" (ROEBO) bill in the context of real estate, exploring how blockchain could facilitate information sharing among organizations. Serrano [12] introduced the concept of using Non-Fungible Tokens (NFTs) for real estate data, promoting transparency for investors. Similarly, Pande et al. [13] discussed blockchain applications in real estate, including fractional ownership sales, property registration databases, and commercial property purchase assistance. For instance, they proposed the Bitland project, which aimed to develop a blockchain-based network for managing investment properties. Tan and Nguyen [14] introduced the Real Estate Transaction Trace (RETT) system on the Ethereum Blockchain platform, designed to manage and track real estate transactions in Vietnam. The system's potential through a prototype was demonstrated. Laarabi et al. [15] conducted a study to evaluate the use of smart contracts in real estate, providing a classification of prevalent research topics and potential applications. Belov and Slastnikov's [16] studied a blockchain-based system for electricity consumption accounting in real estate, suggesting improvements in energy supply management. Varfolomeev et al. [17] emphasized the potential of blockchain in facilitating reliable and secure smart contracts for real estate rentals. Veuger [18] emphasized the potential of blockchain for secure and transparent property transactions and land registrations. Konashevych [19] presented a comprehensive analysis of blockchain's role in land registration and property rights protection. Pankratov et al. [20] concluded that blockchain adoption in real estate could enhance transaction integrity,

streamline settlements, and increase fund security, providing insights into blockchain's future role as a valuable tool in the industry. Wouda and Opendakker [21] suggested that a blockchain-based infrastructure could enhance real estate transactions by offering secure and transparent data storage and transfer by creating a digital audit trail for office building transactions. Proskurovska et al., [22] explored the transformative potential of blockchain in the residential real estate sector, including its impact on public and private cross-sector relationships. Chow and Tan [23] highlighted blockchain's facilitation of tokenization for physical real estate assets, aiming to reduce costs and digitize properties. Moreover, RealX [24], operated by InnovestX, was a post-COVID-19 platform that leveraged blockchain technology to revolutionize real estate investments. It served as a decentralized marketplace, empowering users to engage in various activities such as buying, selling, and fractional

ownership. RealX's primary goal was to democratize real estate investing by facilitating smaller capital investments and enhancing accessibility.

2. Method

The hypothesis of this study proposed that social media users predominantly expressed positive sentiments towards investing in digital tokens on the blockchain in the real estate business. It could be inferred that the benefits to investors outweigh the challenges in this context. Consequently, real estate investment projects involving blockchain-based assets might exhibit a higher potential for success. The methodology used to test this hypothesis is illustrated in Figure 1. The use of blockchain technology in real estate investing on social media should be seen favorably and help the sector flourish in the post-COVID-19 scenario.

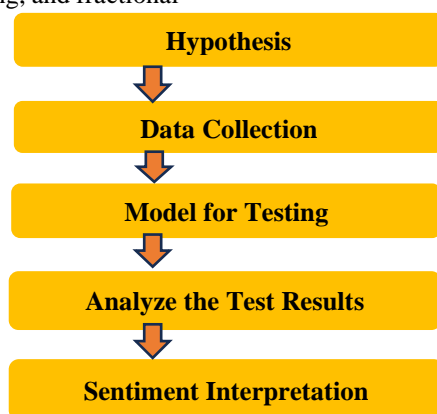


Fig 1. Research methodology of the study

2.1. Data collection

Data was collected from Reddit posts to explore users' perspectives on investing in digital real estate assets and blockchain technology in the post-COVID-19 era. Reddit offered a diverse user base and active communities, making it an ideal platform for collecting a range of opinions. Python-based web scraping tools were used to extract data from Reddit. The study focused on the intersection of digital real estate assets and blockchain in investment, with data collected from various sections on the Reddit platform. This analysis aimed to gain insights

into individuals' attitudes and opinions in this investment trend. The data spanned from 2020 to 2023, allowing us to capture discussions during the post-COVID-19 period. Combining sentiment analysis with other analytical approaches could reveal specific themes and patterns within the collected data.

2.2. Model

A hypothetical study model of sentiments towards investing in digital tokens on the blockchain in the real estate business was shown in Figure 2.



Fig 2. Modeling process for sentiment analysis

2.2.1. Reddit stream

This section presented information regarding the application of blockchain in real estate investment. The data collection process was conducted using the Reddit

streaming API (Application Programming Interface) in conjunction with the Python programming language. This approach facilitated the real-time collection of data, enabling the capture of up-to-date information and insights. The search results were organized based on their

relevance within the blockchain in real estate investment on the Reddit website, such as Enhanced Security and Efficiency, Global Investor Connectivity, Tokenization of Real Estate Assets, Lower Costs, and More Efficient Transactions. This organization allowed for effective data preprocessing in the subsequent steps of the research.

2.2.2. Preprocessing of data

In the preprocessing of Reddit data, a data cleaning process was applied using Regular Expression in Python. This process involved correcting, modifying, and

removing unwanted parts from the dataset. Several steps were taken to clean the data, including removing duplicates, eliminating Unicode and hyperlinks, and removing emojis. Text normalization techniques, such as lowercase conversion, URL removal, accent removal, stop word removal, and stemming/lemmatization, were also employed to standardize the text. These cleaning procedures ensured that the data was in a standardized and manageable format, enabling more accurate and reliable analysis in subsequent stages of the study.

Table 1. The dataset of the preprocessing

No.	Relevance	Total of Titles Before Preprocessing	Total of Titles After Preprocessing
1	Increased Transparency and Trust	230	126
2	Enhanced Security and Efficiency	235	222
3	Global Investor Connectivity	250	66
4	Tokenization of Real Estate Assets	233	196
5	Lower Costs and More Efficient Transactions	215	209
Total		1,163	819

The total number of posts and associated comments (Table 1.) related to blockchain for real estate investment before and after preprocessing. Rows 1 to 5 specified the names of interest investigated in this study, including 1) Increased Transparency and Trust, 2) Enhanced Security and Efficiency, 3) Global Investor Connectivity, 4) Tokenization of Real Estate Assets, and 5) Lower Costs and More Efficient Transactions. The "Total of Posts after Preprocessing" column indicated that out of the total of 1,163 posts, 819 were relevant to the names of interest for this research. The objective of this experiment was to explore whether opinion actors on the Reddit platform could influence sentiments toward real estate investment through the use of blockchain in a post-COVID-19 situation. The results of the preprocessed dataset were recorded in a CSV file, facilitating the organization of data with variables represented in columns and observations in rows.

2.2.3. Classification tools

In this experimental analysis, the study utilized the "Sentiwordnet" resource to compare the overall analysis scores obtained from the Naive Bayes Classifier (NBC) implemented by "TextBlob". These two sentiment classifiers were employed to assess the overall polarity scores for the purpose of comparison. Furthermore, TextBlob was used to conduct a detailed polarity analysis on the application of blockchain in real estate investment

and to determine the subjectivity of posts. Additionally, word frequency was employed for topic modeling in order to infer the various topics of discussion and identify the most commonly occurring words. TextBlob was an extensively powerful natural language processing (NLP) library for Python, explicitly designed to process textual data. It provided a consistent application programming interface (API) that enabled the exploration of various common NLP tasks, such as part-of-speech tagging, noun phrase extraction, sentiment analysis, and more. The Naive Bayes Classifier (NBC) was a classification technique that stems from Bayes' theorem, with the underlying assumption of independence among predictors. Essentially, NBC postulated that the presence of a particular feature in a class was unrelated to the presence of any other feature. This assumption was mathematically represented by the following equation, which was derived from Bayes' theorem:

Where (1):

$P(C|X)$ represents the probability of class C given the presence of feature X

$P(X|C)$ signifies the probability of feature X given class C

$P(C)$ denotes the prior probability of class C

$P(X)$ represents the prior probability of feature X

$$P(C|X) = \frac{P(X|C)*P(C)}{P(X)} \quad (1)$$

SentiWordNet **Error! Reference source not found.** represents the outcome of automatically annotating all synsets of WORDNET based on the concepts of "positivity", "negativity", and "neutrality". These scores indicate the level of positivity, negativity, and neutrality associated with the terms within the synset. It is important to note that different senses of the same term can exhibit distinct opinion-related properties. For instance, they can vary in their levels of positivity or negativity.

2.2.4. Sentiment analysis method

Polarity was a sentiment analysis technique used to determine the positivity, negativity, or neutrality of a post. It evaluated the sentiment of Reddit users' texts to assess their attitudes. Sentiment analysis involved analyzing the writer's attitude and categorizing it as positive, negative,

or neutral. Polarity indicated the strength of an opinion, which could be positive or negative. Strong positive emotions, such as admiration or trust, significantly influence the discussed object. Subjectivity, on the other hand, related to personal involvement with an object, varying among individuals. The article explores sentiment analysis, specifically polarity and subjectivity, to understand attitudes and emotions expressed in comments. Researchers analyzed the sentiment of Reddit users' texts to gain insights into overall sentiment and opinions. An overview of the polarity metrics used in the analysis, with scores ranging from -1 (indicating highly negative sentiment) to +1 (indicating highly positive sentiment), was shown in Figure 3. Subjectivity metrics evaluated the level of subjectiveness or opinion in a comment. A score of 0 represented an objective statement or fact, while +1 indicates a highly subjective or opinionated comment.

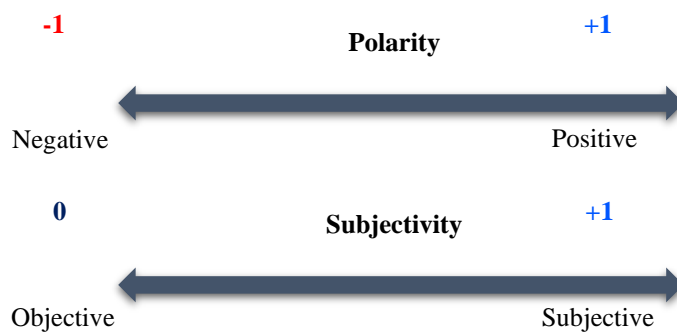


Fig 3. Polarity and Subjectivity metrics

2.2.5. Data visualization

The sentiment analysis was obtained from the sentiment classifier, which could be either TextBlob or SentiWordNet. The objective was to identify patterns, common themes, and significant shifts in sentiment within the analyzed data. To aid in this analysis, visualization techniques such as heat maps could be employed. A heat map presented a visual depiction of sentiment scores across various aspects or topics. By plotting sentiment scores using a color gradient, areas of high positivity, high negativity, or neutrality could be readily discerned. Moreover, during the evaluation, the outcomes were compared derived from the TextBlob and SentiWordNet sentiment classifiers. the positive and negative sentiments, scrutinizing the key aspects or features were separately analyzed that contributed to each sentiment. Through the comparison of outputs from different sentiment classifiers, insights could be gained regarding their strengths, weaknesses, and the level of agreement or divergence in sentiment classification. This evaluation process enabled us to comprehend the patterns of sentiment within the analyzed data, unveil any notable shifts or trends, and acquire deeper insights into the factors driving positive and negative sentiments. The

combination of heat maps and comparative analysis between sentiment classifiers provided a comprehensive evaluation of the sentiment analysis results, facilitating a more nuanced understanding of the sentiment expressed in the data.

3. Results and Discussion

This section presented the results of our experiments, which were aligned with the article questions stated in the introduction. The study conducted sentiment analysis to examine people's attitudes towards real estate investment through blockchain on the Reddit platform in a post-COVID-19 context and determined the subjectivity of these attitudes. Additionally, exploratory data analysis provided quantitative insights into the study dataset.

3.1. Exploratory Data Analysis

The Exploratory Data Analysis (EDA) approach was used to analyze the total number of comments in (Table 1) after preprocessing from (2.2.2). The primary objective was to summarize their main characteristics through visualizations. The EDA process was considered a crucial step conducted prior to sentiment analysis or model building, as it helped unveil valuable insights that held significance in later stages of the results. As shown in

Figure 4, a graph was plotted to illustrate the dominant discussions among Reddit users, which primarily revolved around the topic of "Enhanced Security and Efficiency." This topic received the highest level of

engagement and was the most discussed. On the other hand, 'Global Investor Connectivity' was the least discussed topic among Reddit users.

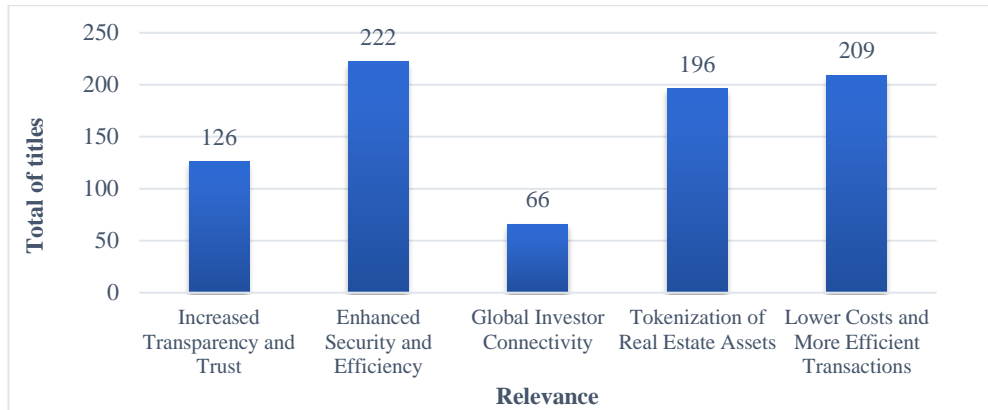


Fig 4. A plot illustrating the count of occurrences for the names of interest

The prevalent words associated with Reddit users were examined. The study enhanced our Pandas data frame by adding token columns and removing stopwords, punctuation, and emojis. Afterwards, a word cloud image

was created to visualize the frequent words. For instance, Figure 5 presented the words that demonstrated high co-occurrence with the term blockchain technology in real estate in the responses.

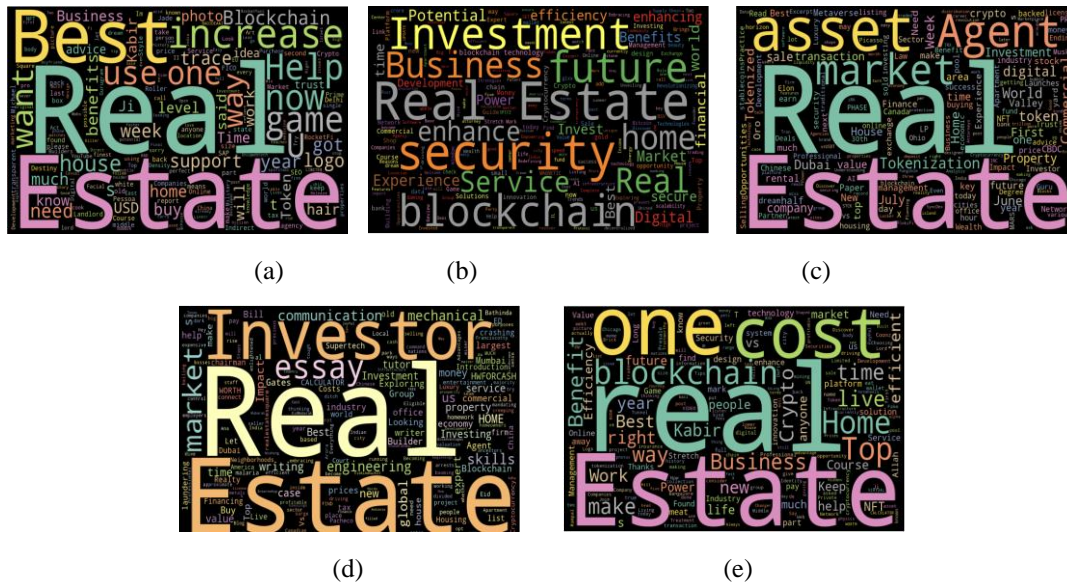


Fig 5. Words that exhibited the highest frequency of co-occurrence among Reddit users related to blockchain in real estate investment. (a)– Increased Transparency and Trust. (b)– Enhanced Security and Efficiency. (c)– Global Investor Connectivity. (d)– Tokenization of Real Estate Assets. (e)– Lower Costs and More Efficient Transactions.

3.2. Sentiment analysis

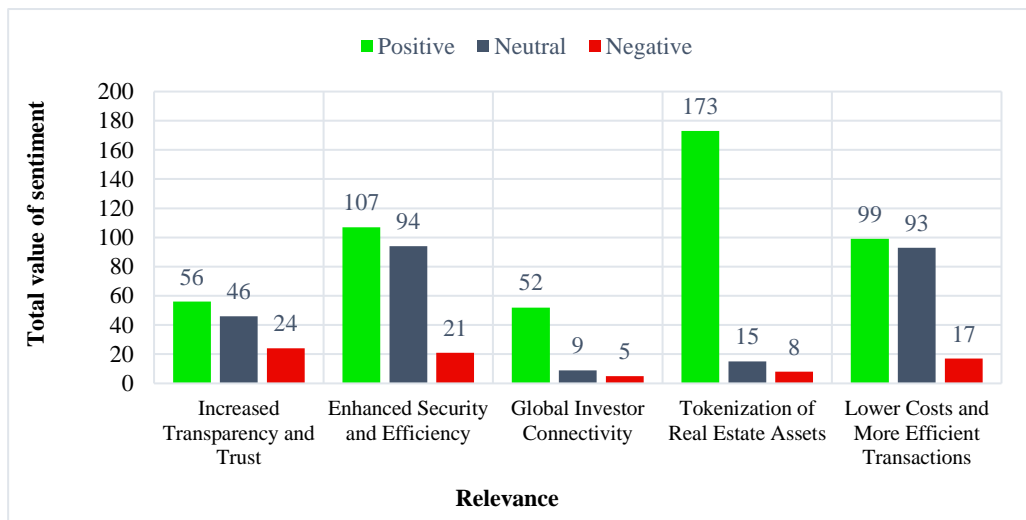
The results of sentiment analysis using the TextBlob and Sentiwordnet tools were showed in the following results:

3.2.1. Textblob classifier

The highest positive sentiment value in real estate investment through blockchain was observed in the category named "Tokenization of Real Estate Assets," reaching 88.26% of the overall user interest on Reddit, as shown in Table 2 and Figure 5. The data indicated a predominantly positive sentiment overall, rather than negative.

Table 2. Sentiment analysis using TextBlob

Relevance	Positive	Neutral	Negative
Increased Transparency and Trust	56 (44.44%)	46 (36.5%)	24 (19.06%)
Enhanced Security and Efficiency	107 (48.2%)	94 (42.34%)	21 (9.46%)
Global Investor Connectivity	52 (78.79%)	9 (13.64%)	5 (7.57%)
Tokenization of Real Estate Assets	173 (88.26%)	15 (7.65%)	8 (4.09%)
Lower Costs and More Efficient Transactions	99 (47.37%)	93 (44.5%)	17 (8.13%)
Total	487 (59.46%)	257 (31.38%)	75 (9.16%)

**Fig 5.** Value plot of sentiment analysis using TextBlob

3.2.2. Sentiwordnet classifier

The highest positive sentiment value in real estate investment through blockchain was observed in the category named "Enhanced Security and Efficiency,"

reaching 57.21% of the overall user interest on Reddit, as shown in Table 3 and Figure 6. The data indicated a predominantly positive sentiment overall, rather than negative

Table 3. Sentiment analysis using SentiWordNet

Relevance	Positive	Neutral	Negative
Increased Transparency and Trust	54 (42.86%)	41 (32.54%)	31 (24.60%)
Enhanced Security and Efficiency	127 (57.21%)	60 (27.03%)	35 (15.77%)
Global Investor Connectivity	33 (50.0%)	21 (31.82%)	12 (18.18%)
Tokenization of Real Estate Assets	101 (51.53%)	61 (31.12%)	34 (17.35%)
Lower Costs and More Efficient Transactions	98 (46.89%)	61 (29.19%)	50 (23.92%)
Total	413 (50.43%)	244 (29.79%)	162 (19.78%)

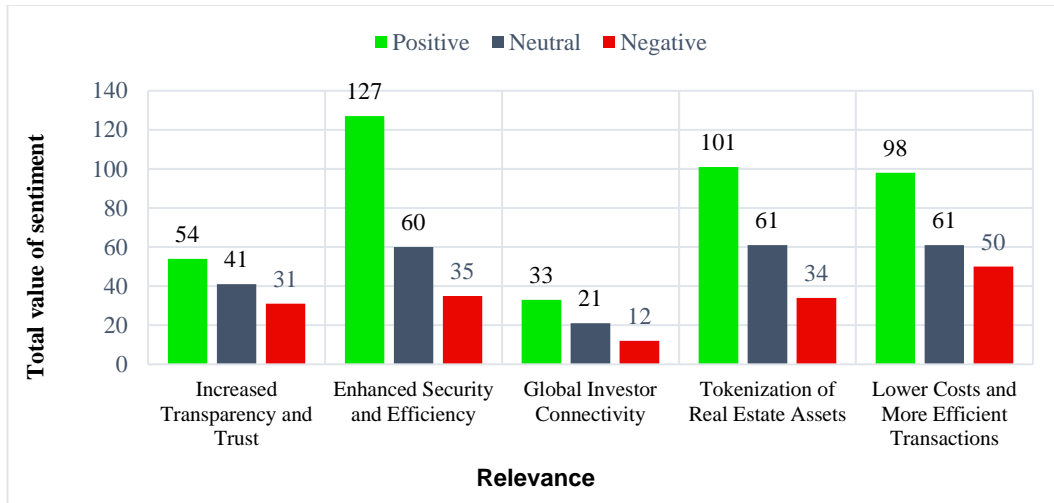


Fig 6. Value plot of sentiment analysis using SentiWordNet

TextBlob and SentiWordNet and found that the most positive comments in these two classifiers were different in which 88.26% of overall were positively interested in “Tokenization of Real Estate Assets” and 57.21% of overall were positively interested in “Enhanced Security and Efficiency”, respectively. A total of 1,163 data points were collected from public accounts. However, after the pre-processing stage, only 819 data points remained for further analysis. When comparing the performance of the two sentiment analyzers used in this study, TextBlob exhibited the highest number of data points classified as positive sentiment, with a count of 487. This accounted

for approximately 59.46% of the total data. Conversely, SentiWordNet had a higher number of data points classified as negative sentiment, representing approximately 19.78%, compared to TextBlob's 9.16%.

In terms of positive sentiment, SentiWordNet had the second-highest positive sentiment rate, with 413 data points, accounting for approximately 50.43% of the total data. This value was similar to the positive sentiment rate of TextBlob. For more detailed information, please refer to Table 4 and Figure 7.

Table 4. Percentage or number of polarity calculations from various sentiment classifiers

Sentiment Classifier	Positive	Neutral	Negative
TextBlob	487 (59.46%)	257 (31.38%)	75 (9.16%)
SentiWordNet	413 (50.43%)	244 (29.79%)	162 (19.78%)

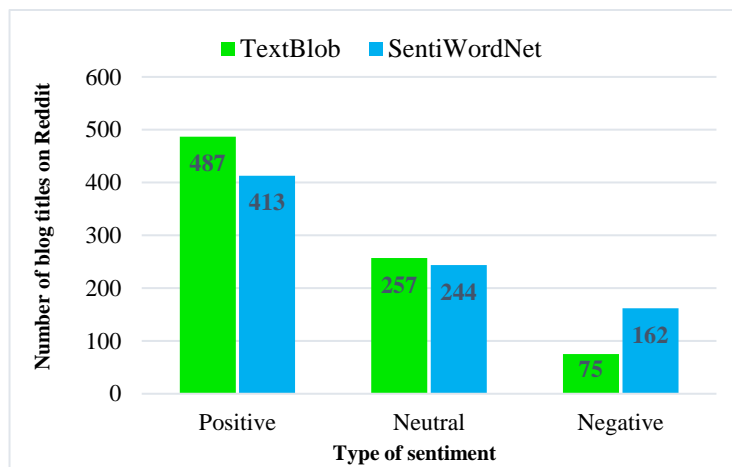


Fig 7. Calculation of polarity using each sentiment classifier

3.3. Discussion

The results of 3.2.1. and 3.2.2. showed that the positive and neutral sentiment results were similar because TextBlob utilized a Naive Bayes Classifier, a machine learning algorithm that classified text based on pre-labeled training data using probabilistic calculations. By incorporating this classifier, TextBlob was able to improve the accuracy and performance of its sentiment analysis. On the other hand, SentiWordNet utilized WordNet, a lexical database that contained synonym sets (synsets) for words. It assigned sentiment scores to these synsets, indicating the positivity, negativity, and neutrality of the words within them. By aggregating these scores, SentiWordNet determined the overall sentiment of a given text. While TextBlob and SentiWordNet employed different approaches and resources, which could yield different results when applied to the same dataset, the results of the study consistently demonstrated a positive sentiment, aligning in the same direction.

In the post-COVID-19 era, sentiment analysis of social media data reveals diverse opinions regarding the use of blockchain technology in real estate. The majority of opinions were positive, emphasizing the potential

advantages of blockchain, such as increased transparency, reduced fraud, and improved transaction efficiency. Users showed enthusiasm for the accessibility and fractional ownership opportunities offered by blockchain. However, concerns arise regarding the viability and scalability of blockchain in the real estate sector. Regulatory frameworks, data privacy, and interoperability were critical factors to consider for widespread adoption. The positive reaction from social media users reflects their interest in the transformative potential of blockchain in real estate. Blockchain enhances security, transparency, and efficiency by streamlining transactions and reducing costs. Despite the excitement, challenges related to legislation, standards, and interoperability need to be addressed to effectively utilize blockchain technology. Collaboration among industry players, legislators, and technology developers was essential in establishing robust frameworks that ensure data privacy, security, and legal compliance. Post-COVID-19 sentiment analysis of social media data revealed a range of opinions on blockchain in real estate, with the majority expressing enthusiasm and contributing to positive sentiment. Further discussion and detailed findings were presented in Table 5.

Table 5. Interpretation of the obtained data quantitatively

Relevance	Interpretation
Increased Transparency and Trust	Blockchain technology provides a decentralized and immutable ledger, ensuring transparency and instilling investor confidence. In the post-COVID-19 era, where trust in traditional investment avenues may have diminished, the transparency offered by blockchain can attract investors to real estate through social media platforms.
Enhanced Security and Efficiency	By utilizing cryptographic algorithms, blockchain technology enhances transaction and record security, reducing the risk of fraud and unauthorized activities. Utilizing blockchain for real estate investment on social media platforms can instill greater trust in the security of transactions, fostering a positive attitude and encouraging increased participation.
Global Investor Connectivity	Social media platforms have a vast user base and can connect investors globally. Blockchain technology facilitates easier access to international real estate investment opportunities. This increased accessibility to global markets may stimulate industry diversification and expansion, thereby supporting blockchain-based real estate investment.
Tokenization of Real Estate Assets	Blockchain enables the tokenization and fractional ownership of real estate assets. By removing traditional barriers such as high capital requirements, investors can participate in real estate investment with smaller amounts. These digital tokens can be traded and exchanged through social media channels, making real estate investing more accessible and appealing to a broader audience.
Lower Costs and More Efficient Transactions	Blockchain technology enables peer-to-peer transactions, eliminating the need for intermediaries and their associated fees. By

Relevance	Interpretation
	bypassing middlemen such as brokers or banks, real estate transactions on social media platforms can be faster, more efficient, and cost-effective. The efficiency and cost savings associated with blockchain-based real estate investment opportunities may attract investors.

The application of blockchain technology in real estate investment on social media platforms could lead to positive sentiment and contribute to the industry's growth in the post-COVID-19 era. Blockchain's ability to provide increased trust, transparency, security, efficiency, global accessibility, fractional ownership, and cost-effectiveness had the potential to revolutionize real estate investment and attract a broader range of investors. The results of the sentiment analysis were interpreted to identify patterns, common themes, and significant shifts in sentiment. Positive and negative sentiments were analyzed separately, with a focus on the key aspects driving each sentiment as follows:

3.3.1. Positive Sentiment:

- a) **Transparency and Security:** Users noted that blockchain offered enhanced transparency, which increased confidence among investors in the real estate investment industry. The immutability and decentralized structure of blockchain were viewed as viable solutions to reduce fraud and improve transaction security.
- b) **Improving Efficiency and Reducing Costs:** Blockchain technology was seen to automate procedures and eliminate middlemen in real estate transactions, leading to enhanced efficiency and cost reduction for investors, developers, and buyers.
- c) Users observed that blockchain technology had the potential to democratize real estate investment by allowing fractional ownership and enabling greater market participation. This feature was enthusiastically embraced and viewed as an opportunity to promote more diversity in the industry and enhance transaction security.

3.3.2. Challenges and Concerns:

- a) **Regulation and Compliance:** Users expressed concerns regarding the regulatory frameworks governing the use of blockchain technology in the real estate sector. There were worries about ensuring compliance with the law and the need for appropriate regulations to manage potential risks and ensure ethical behavior.
- b) **Standardization and Interoperability:** Several users emphasized the importance of standardization and interoperability across blockchain platforms to facilitate seamless integration and data sharing within the real estate

industry. The lack of standardization was identified as a potential barrier to widespread acceptance.

4. Conclusion

The sentiment expressed by users, investors, and industry professionals regarding the application of blockchain technology in real estate investment carries significant implications. The sentiment analysis conducted in this study provides valuable insights into the overall sentiment polarity, identifies emerging trends, and offers an understanding of the implications for the industry. In the post-COVID-19 era, the sentiment analysis of social media data revealed a broad spectrum of viewpoints on the use of blockchain technology in real estate investment. The majority of opinions leaned towards favorability, highlighting the potential advantages of blockchain such as real estate asset tokenization and improved security and efficiency. Users' expressed enthusiasm for the increased accessibility and fractional ownership opportunities facilitated by blockchain. However, concerns arise regarding the feasibility and scalability of blockchain in the real estate sector, particularly concerning regulatory frameworks, data privacy, and interoperability. The positive sentiment expressed by social media users signifies a growing interest in the transformative potential of blockchain technology in real estate investment. Blockchain's capacity to enhance security and transparency contributed to building trust among customers, developers, and investors. Moreover, streamlined transactions and cost reductions could be achieved through process automation and the elimination of intermediaries. Nevertheless, challenges related to legislation, standards, and interoperability might be addressed to effectively harness the benefits of blockchain technology. Collaboration among industry players, legislators, and technology developers played a crucial role in establishing robust frameworks that ensured data privacy, security, and legal compliance. In conclusion, the sentiment analysis of social media data in the post-COVID-19 period revealed diverse opinions, with the majority expressing enthusiasm and optimism toward the application of blockchain technology in real estate investing. The article emphasized the potential benefits offered by blockchain and underscored the necessity of addressing associated challenges for its widespread adoption. By incorporating the outcomes of sentiment analysis and supporting evidence from data analysis, this

paper provided valuable insights into the industry and paved the way for further exploration and innovation at the intersection of blockchain and real estate.

Acknowledgements

The authors are very grateful to acknowledge the support from the International College of Digital Innovation at Chiang Mai University, and thanks to all the support and suggestions for improving the article.

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Biographies Of Authors

	<p>Supharoek Siriphen  received a bachelor's degree in computer engineering from Rajamangala University of Technology and Science University, Chiang Mai, Thailand in 2019. Currently, he is pursuing a Master of Science in Digital Innovation and Financial Technology at the Faculty of International College of Digital Innovation, Chiang Mai University, Chiang Mai, Thailand. His research interests encompass financial technology, innovation, blockchain, and the Internet of Things (IoT). For further inquiries, he can be contacted via email at supharoek_siriphen@cmu.ac.th. [First Author]</p>
	<p>Siva Shankar Ramasamy    received a Master of Computer Applications and a Doctoral degree from Gandhigram Rural Institute [Ministry of Human Resource Development-India], Tamil Nadu, India. He has worked at the National Institute of Technology-Trichy and Madanapalle Institute of Technology & Science in India. He is a Life Member of the "Computer Society of India" and the "International Association of Engineers." Currently, he is affiliated with the International College of Digital Innovation-Chiang Mai University in Thailand. He has made significant contributions to research, including three research patents and over 25 research articles. His research interests encompass Sustainability Development, Medical Image Segmentation, IoT, Rural Reconstruction, Digital Business, and Blue Economy. He is supervising 4 Ph.D Scholars and 4 Master’s students now. He can be contacted via email at arjunshankar@gmail.com and sivashankar.r@cmu.ac.th. [Corresponding Author]</p>



Ahmad Yahya Dawod    is an academic professor at the Department of Digital Innovation and Financial Technology, International College of Digital Innovation, Chiang Mai University, Chiang Mai, Thailand. He received a B.Sc. degree in Computer Science from the University of Mustansiriyah, Baghdad, Iraq, an M.Sc. degree in the Faculty of Computing and Informatics (FCI) from Multimedia University in Malaysia (MMU), and a Ph.D. degree in the Faculty of Information Science and Technology (FTSM) from the National University of Malaysia (UKM). He has been working as a lecturer at the International College of Digital Innovation, Chiang Mai University since 2019. With extensive experience, he has supervised and Co-Supervised more than seven master's and six Ph.D. students. His research interests encompass artificial intelligence, computer vision, image processing, natural language processing (NLP), robotics, and machine learning. He actively serves as a reviewer for several international journals and conferences. For further inquiries, he can be reached via email at ahmadyahyadawod.a@cmu.ac.th.