

Global Trends and Future Outlooks in Centralized Exchange Research: A Comprehensive Bibliometric Review

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Abstract

Centralized exchanges (CEX) serve as the most widely adopted cryptocurrency trading platforms in Indonesia. However, research on this topic rarely positions Indonesia as the object of study. Therefore, this study analyzes the development and challenges of CEX through a systematic review supported by bibliometric analysis in order to map future research topics relevant to Indonesia. The literature search was conducted using the Scopus database with the following keywords: ("cryptocurrency" OR "crypto" OR "digital asset" OR "cryptocurrencies") AND ("centralize" OR "centralized exchange" OR "centralized crypto asset exchanges" OR "CEX" OR "trading platform" OR "FTX"). The findings indicate that Indonesia presents contrasting outcomes between its global cryptocurrency adoption rate and the volume of research examining this topic within the country. Consequently, future research directions on this subject should prioritize cross-border collaborative efforts and expand the discourse of centralized exchanges (CEX) within the domains of infrastructure and technology, risk and security, market dynamics, and cryptocurrency trading regulations.

Keywords: Centralized Exchange; Cryptocurrency; Bibliometric Analysis; Systematic Review.

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Abstrak

Centralized exchanges (CEX) menjadi platform jual beli cryptocurrency dengan adopsi terbesar di Indonesia. Namun, penelitian tentang ini sangat jarang menjadikan Indonesia sebagai objek penelitian. Oleh karena itu, penelitian ini menganalisis perkembangan dan tantangan CEX melalui systematic review yang didukung analisis bibliometrik guna memetakan topik riset masa depan bagi Indonesia. Pencarian literatur dilakukan dalam database Scopus dengan kata kunci ("cryptocurrency" OR "crypto" OR "digital asset" OR "cryptocurrencies") AND ("centralize" OR "centralized exchange" OR "centralized crypto asset exchanges" OR "CEX" OR "trading platform" OR "FTX"). Hasil penelitian menunjukkan Indonesia memiliki hasil yang kontras antara tingkat adopsi cryptocurrency di dunia dengan penelitian yang meneliti topik ini di Indonesia. Sehingga harapan pada penelitian masa depan terkait topik ini adalah mengedepankan kolaborasi antar negara dan mengembangkan topik CEX pada bidang infrastruktur dan teknologi, risiko dan keamanan, Dinamika Pasar, dan regulasi jual beli cryptocurrency.

Kata kunci: *Centralized Exchange; Cryptocurrency; Analisis Bibliometrik; Systematic Review.*

INTRODUCTION

Cryptocurrency is a digital asset that employs cryptographic technology in the implementation of its transactions, thereby eliminating the need for a third party. Consequently, cryptocurrency is considered secure, low-cost, and efficient. Cryptocurrency is also regarded as a virtual currency that has no physical form (Qaroush et al., 2022). Cryptocurrency was popularized by Satoshi Nakamoto through Bitcoin, and according to data from Coingecko (2026), there are currently 17,169 coins listed on the market.

Given the large number of listed coins, a transaction platform is required to facilitate the buying and selling of these coins, commonly referred to as a cryptocurrency exchange or crypto exchange. Within the crypto exchange ecosystem, there are two types: decentralized exchanges and centralized exchanges (CEX), each possessing its own advantages and disadvantages (Sadeghi et al., 2025). According to a report by the Asosiasi Blockchain Indonesia (2025), 93.5% of cryptocurrency investors use centralized exchanges to access cryptocurrency. The establishment of centralized exchanges in Indonesia has been regulated under POJK Number 23 of 2025, which amends POJK Number 27 of 2024. This indicates that centralized exchanges are legally recognized in Indonesia and play a significant role in the buying and selling of cryptocurrency within the country. Consequently, this situation presents a potential opportunity for further research on centralized exchanges in Indonesia.

Centralized exchanges play a pivotal role in cryptocurrency trading as they adopt traditional exchange mechanisms, such as order books, which allow investors to easily assess the supply and demand of a specific coin.

Furthermore, centralized exchanges offer user-friendly interfaces (Hägele, 2024). However, CEX also present inherent vulnerabilities, including cyberattacks, internal exchange fraud, and liquidity crises (Sadeghi et al., 2025). In prior literature, Steven & Lisana (2025) conducted a literature review on CEX using bibliometrics. Nonetheless, their findings predominantly focused on identifying the theories utilized in examining CEX as a research object.

Moreover, subsequent studies by De Vega (2026), Saputra (2025), and Thaha & Ruqayyah Yunus (2025) focused entirely on cryptocurrency as the primary subject within the frameworks of regulation, infrastructure, and market dynamics. Hence, building upon these previous studies, this research shifts its focus toward the centralized exchange (CEX) as the primary unit of analysis, rather than cryptocurrency. Consequently, this study offers significant academic value by providing a deeper exploration into the global research mapping and dominance regarding centralized exchanges, which will subsequently be adapted into the Indonesian research context.

LITERATURE REVIEW

Cryptocurrency

According to Supriyanto et al. (2022), cryptocurrency is defined as a type of digital asset or virtual currency that employs cryptography for security purposes and as an anti-counterfeiting measure. Cryptography is also used to control the creation of additional value units and to verify asset transfers (Härdle et al., 2020). This virtual currency is intended to be used electronically or online (Supriyanto et al., 2022). Its core concept lies in the elimination of intermediaries—such as financial institutions—through the use of distributed ledger technology, or blockchain (Härdle et al., 2020; Vigna & Casey, 2015). In a decentralized system, network integrity replaces the need to trust the integrity of human participants, and the value of a currency such as Bitcoin depends on market supply and demand, similar to the trading of precious metals like gold and silver (Härdle et al., 2020; Supriyanto et al., 2022). The history of modern cryptocurrency began in 2008 when Satoshi Nakamoto published a white paper describing the implementation of a digital currency called Bitcoin, which utilizes blockchain technology (Härdle et al., 2020). Bitcoin was launched on January 3, 2009, when Nakamoto released its programming code, announcing a purely peer-to-peer electronic cash system that operates without a trusted third party (Supriyanto et al., 2022; Vigna & Casey, 2015).

Cryptocurrencies such as Bitcoin can be used as electronic transaction instruments, and their holders may also utilize them for investment or trading purposes (Supriyanto et al., 2022). The emergence of this digital currency presents challenges to monetary authorities (governments) and traditional central banks, as it eliminates intermediaries, including financial institutions (Härdle et al., 2020). Consequently, many central banks, including those in the United States and Europe, are considering the launch of their own national digital currencies, known as Central Bank Digital Currencies (CBDC) (Härdle et al., 2020). The current cryptocurrency market is highly diverse and can be categorized into seven broad types, including utility tokens, security tokens, and stablecoins (Härdle et al., 2020). Overall, cryptocurrency is regarded as a highly disruptive technology with the potential to fundamentally transform global trade and banking systems, despite the presence of significant risks and complex regulatory challenges (Vigna & Casey, 2015).

Centralized Exchange

A centralized exchange (CEX) is a centralized platform designed to facilitate cryptocurrency asset trading, operated by an entity that acts as an intermediary between users. CEX facilitate both peer-to-peer transactions and conversions with traditional fiat currencies, employing a limit order book (LOB) mechanism similar to that of conventional equity markets. Early platforms such as Mt. Gox established the initial framework for trading but were vulnerable to security breaches and regulatory challenges. As custodial exchanges, CEX require users to entrust their private keys to a collective wallet managed by a third party (Hägele, 2024). At present, CEX offer faster transaction speeds, higher liquidity, and a more user-friendly experience compared to decentralized platforms.

Operationally, CEX utilize hot wallets for rapid fund access and enforce know-your-customer (KYC) regulations to detect criminal activity. However, they face significant challenges, including security risks, high transaction fees, and limited transparency (Hägele, 2024). In many countries, CEX are required to comply with applicable laws to provide a sense of security and authenticity for their users. Major failures, such as the collapse of FTX in November 2022, have generated market uncertainty and raised regulatory concerns (Hägele, 2024; Nasir et al., 2025). This incident has compelled CEX to enhance transparency in the management of customer funds in order to strengthen user trust.

METHODS

This study employs a bibliometric approach combined with a systematic review to map the development of research on centralized

exchanges (CEX). The data were entirely obtained from the Scopus database using the search query ("**cryptocurrency**" OR "**crypto**" OR "**digital asset**" OR "**cryptocurrencies**") AND ("**centralized**" OR "**centralized exchange**" OR "**centralized crypto asset exchanges**" OR "**CEX**" OR "**trading platform**" OR "**FTX**"), yielding 268 relevant articles. The authors deliberately included the keyword "FTX" specifically because this topic caused a significant upheaval among cryptocurrency investors when the platform experienced bankruptcy, legal issues, and governance failures, making it an interesting inclusion as a trend in the analytical discussion. Furthermore, the scope of this study is deliberately confined to the Scopus database, as the author prioritizes the qualitative rigor and substantial scholarly impact of the literature within the academic community. This methodological restriction is also implemented to ensure formatting consistency and metadata uniformity when the retrieved dataset is subsequently processed using bibliometric software.

Subsequently, all retrieved articles were exported in CSV format. The analysis was conducted using bibliometric software, which included thematic evolution analysis, thematic mapping, collaborative world mapping, country production analysis, and countries' production over time to map the research directions. The bibliometric results were then integrated with a systematic review to interpret the development trends of the most prominent topics and the dominant themes emerging in the literature. This approach provides a comprehensive yet measurable structural and evolutionary overview of CEX research based on the Scopus dataset (Figure 1).

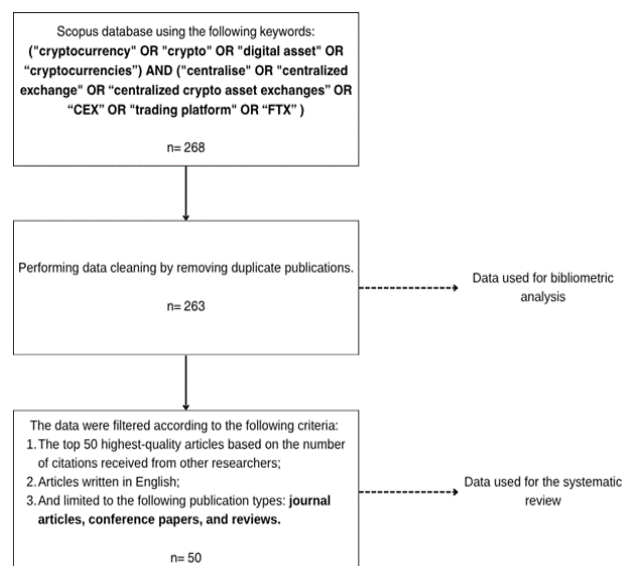


Figure 1. Research Method

Source: Processed by the author

RESULT AND DISCUSSION

Result

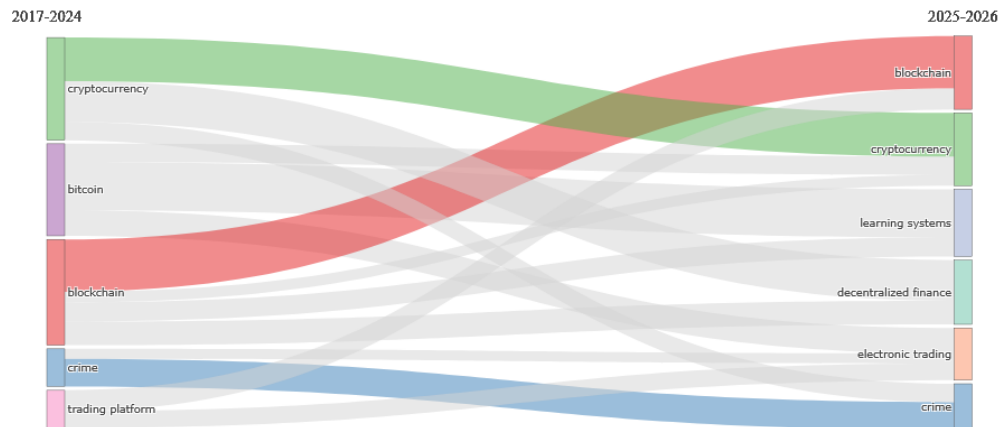


Figure 2. Thematic evolution

Source: Processed by the author using bibliometrix

The thematic evolution presented in Figure 2 illustrates the development of research themes over time, divided into two phases. In the first phase (2017–2024), the dominant themes were Bitcoin, crime, blockchain, cryptocurrency, and trading platforms, reflecting the initial focus of CEX research. Entering the second phase (2025–2026), research themes have further expanded to include topics such as learning systems, decentralized finance, and electronic trading. In this phase, the discussion of crime from the first phase broadens into the topic of electronic trading in the second phase, indicating that discussions of criminal activity within the cryptocurrency domain have extended into the realm of trading platforms.

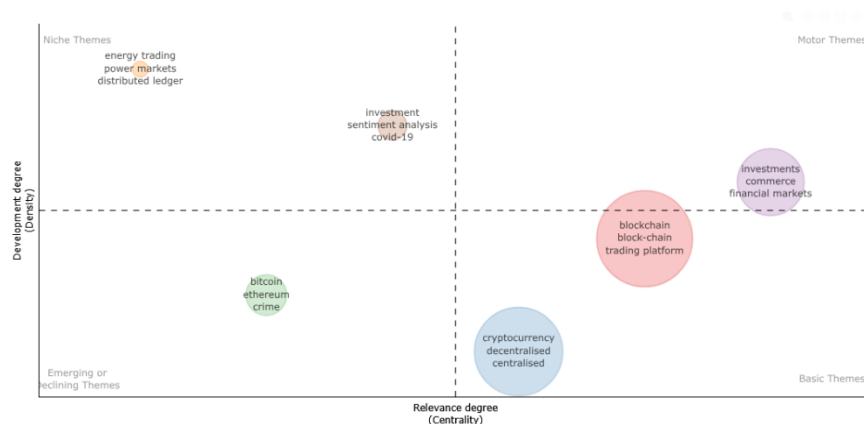


Figure 3. Thematic Map

Source: Processed by the author using bibliometrix

Furthermore, Figure 3 (thematic map) categorizes the main topics into four quadrants: motor themes, niche themes, emerging or declining themes, and basic themes. In the motor theme quadrant, which represents the primary drivers of research on centralized exchanges, three main areas of discussion are identified: investment, financial markets, and commerce. This indicates that aspects of investment and financial market dynamics constitute the central focus and serve as the foundational research areas for future CEX-related topics. In the niche theme quadrant, which comprises specific and limited themes, there are six main areas of discussion: energy trading, power markets, distributed ledger, investments, sentiment analysis, and COVID-19. This suggests that these topics, which generally address technical aspects of CEX and cryptocurrency sentiment, remain limited in terms of research coverage. Next, in the emerging or declining theme quadrant, which encompasses themes that are either developing or beginning to decline, three main topics are identified: crime, Bitcoin, and Ethereum. This indicates that issues of financial crime and the two largest coins are receiving attention, with research trends showing relative dynamism. Finally, in the basic themes quadrant, which represents supporting foundational themes, there are six main areas of discussion: blockchain, block-chain, trading platform, decentralized, centralized, and cryptocurrency. This confirms that blockchain technology, as well as the debate between centralized and decentralized models, remains a fundamental foundation for research in this field. Within this thematic map, consistent with the phenomena observed in the thematic evolution, the topic of crime —particularly as an emerging theme in the most recent phase (2025–2026)— reflects a response to the increasing number of fraud cases on CEX.

Table 1. Country Production

No.	Country	Freq	No.	Country	Freq
1	China	93	8	Germany	18
2	Usa	71	9	Australia	17
3	India	51	10	South Korea	15
4	Uk	49	11	Canada	12
5	France	20	12	Poland	11
6	Italy	19	13	Iraq	9
7	Ukraine	19	14	Portugal	9

No.	Country	Freq	No.	Country	Freq
15	Ireland	8	38	Israel	2
16	Singapore	8	39	Japan	2
17	Spain	8	40	Malaysia	2
18	Turkey	8	41	Monaco	2
19	Denmark	7	42	Slovakia	2
20	Iran	7	43	South Africa	2
21	United Arab Emirates	6	44	Tunisia	2
22	Bangladesh	5	45	Brazil	1
23	Indonesia	5	46	Colombia	1
24	Netherlands	5	47	Croatia	1
25	Romania	5	48	Finland	1
26	Austria	4	49	Jordan	1
27	New Zealand	4	50	Kazakhstan	1
28	Saudi Arabia	4	51	Kyrgyzstan	1
29	Switzerland	4	52	Liechtenstein	1
30	Bulgaria	3	53	Luxembourg	1
31	Lebanon	3	54	Mexico	1
32	Pakistan	3	55	Morocco	1
33	Thailand	3	56	Oman	1
34	Azerbaijan	2	57	Peru	1
35	Belgium	2	58	Saint Lucia	1
36	Czech Republic	2	59	Sri Lanka	1
37	Hungary	2	60	Sweden	1

Source: Processed by the author using bibliometrix

Next, examining the number of publications on CEX presented in Table 1, China emerges as the leading contributor, ranking first with a frequency of 93 publications, accounting for 17 percent of the total publications worldwide. China is followed by the United States with 71 publications, and India with 51 publications. Indonesia itself ranks 23rd with 5 publications. The number of Indonesian publications stands in contrast to the phenomenon of Indonesia ranking 7th globally in the overall index of crypto adoption ranking (Chainalysis, 2025). Furthermore, this phenomenon indicates that research on centralized exchanges and the cryptocurrency ecosystem remains dominated by countries with advanced research activities and financial industries, particularly China and the United States.

Table 2. Countries' Collaboration World Map

From	To	Freq
Indonesia	Japan	1
China	Indonesia	1
Singapore	Indonesia	1

Source: Processed by the author using bibliometrix

Table 2 (Countries' Collaboration World Map) above indicates that research collaboration on CEX involving Indonesia remains limited. Indonesia is recorded as having collaborations with Japan, China, and Singapore, each with a frequency of one occurrence. Consistent with the total number of publications in Indonesia, which stands at only five, the number of collaborative publications is likewise low. This suggests that Indonesia not only has a limited volume of publications but also exhibits a low level of cross-country collaborative networks, which have yet to expand broadly and remain concentrated among countries in East and Southeast Asia.

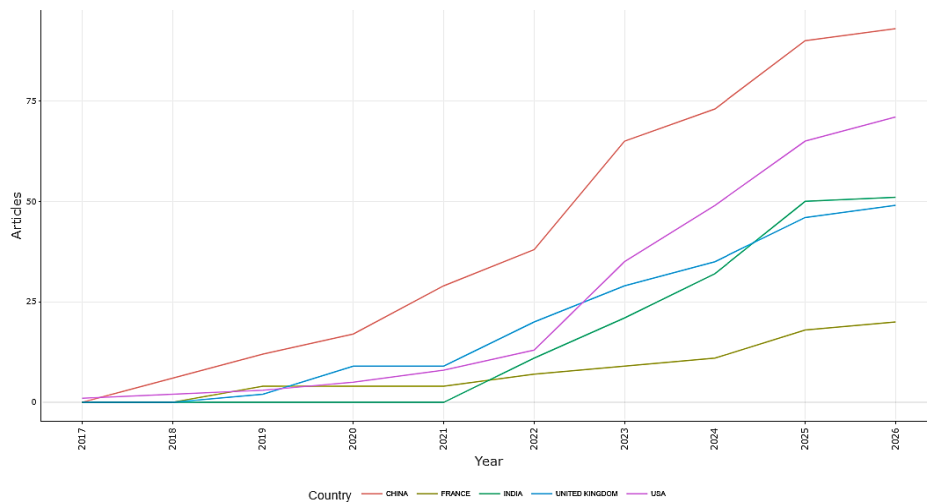


Figure 4. Countries' Production Over Time

Source: Processed by the author using bibliometrix

Figure 4 above presents the trends in scientific publications from countries with the highest contributions over time. China demonstrates a very significant increase in publications since 2021, reflecting the intensity of research on centralized exchanges in that country. The United States and India also show consistently increasing trends, albeit on a smaller scale

compared to China. Meanwhile, the United Kingdom and France exhibit relatively stable growth.

Table 3. Top 50 Article Topics

Topic Types	Freq	Article
Infrastructure and Technology	14	(Baum et al., 2021; Bentov et al., 2019; Galal & Youssef, 2020; Heilman et al., 2020; Lu et al., 2021; Luo et al., 2019, 2025; Ma et al., 2020; Shahinzadeh et al., 2022; Tian et al., 2021; Umar et al., 2022; Yu et al., 2019; Zamyatin et al., 2019; Zie et al., 2019)
Investor Behavior	4	(Diaconășu et al., 2022; Oksanen et al., 2022; Rahardja et al., 2023; Scuri et al., 2019)
Market	12	(Alexakis et al., 2024; Alexander et al., 2020; Bianchi et al., 2022; Borri & Shakhnov, 2022; Briola & Aste, 2022; Drożdż et al., 2019; Fang et al., 2022; Hansen et al., 2022; Kwapień et al., 2022; Liu & Valcarcel, 2024; Polat, 2024; I. Yousaf et al., 2023)
Regulation	2	(Alibašić, 2023; Chen & Liu, 2022)
Risk and security	14	(Bouri et al., 2023; Cong et al., 2023; Conlon et al., 2023, 2024; Esparcia et al., 2024; Galati et al., 2024; He et al., 2023; Jalan & Matkovskyy, 2023; Kerr et al., 2023; Khan et al., 2025; Vidal-Tomás et al., 2023; Xia et al., 2020; H. Yousaf et al., 2019; I. Yousaf & Goodell, 2023)
Comparative Studies	4	(Aspris et al., 2021; Barbereau et al., 2022; Hägele, 2024; Makridis et al., 2023)

Source: Processed by the author

Table 3 presents a breakdown of the top 50 articles based on citation count. These articles are classified into six main categories: Infrastructure and Technology, Investor Behavior, Market, Regulation, Risk and Security, and Comparative Studies. Of the total 50 articles, the Infrastructure and Technology and Risk and Security categories are the most dominant, each comprising 14 articles. This indicates that research focus remains divided between the development of technical solutions, such as cross-chain protocols and smart contracts, and risk mitigation efforts, including scam detection and platform vulnerability analysis. The Market category ranks second with 12 articles, reflecting substantial attention to market dynamics, liquidity, and pricing. Meanwhile, the Investor Behavior and Comparative

Studies categories each contain 4 articles, suggesting that research on user behavior and comparisons between CEX and DEX, while important, remains limited in scope.

The final category is Regulation, which has the smallest number of articles, with only 2. This indicates that although regulatory issues are becoming increasingly prominent, academic studies specifically addressing legal frameworks and policies for CEX remain relatively limited compared to technological and risk-related aspects. Nevertheless, this phenomenon suggests that current research, which is oriented toward risk and past criminal incidents, may serve as a foundation for regulating cryptocurrency within an institutional framework.

Discussion

Infrastructure and Technology

Fundamentally, a CEX is defined as a trading platform where users must transfer their digital assets to addresses provided by the exchange, which are subsequently accessed using the user's identity and password (Luo et al., 2019). This infrastructure positions the exchange as a trusted intermediary or third party that manages the order book and facilitates internal transaction matching (Tian et al., 2021; Zamyatin et al., 2019; Zie et al., 2019). The primary technological advantage of CEX over decentralized exchanges (DEX) is its capacity to offer real-time trading with low latency and deep liquidity, which is crucial for high-frequency traders (Bentov et al., 2019; Heilman et al., 2020; Luo et al., 2019). Nevertheless, this model inherently creates a single point of failure risk, wherein the security of funds depends entirely on the integrity and technical capabilities of the exchange's managers (Ma et al., 2020; Tian et al., 2021).

Research developments indicate a technological shift toward addressing platform vulnerabilities in CEX, such as massive hacking incidents that have resulted in billions of dollars in losses (Baum et al., 2021; Luo et al., 2025). One significant breakthrough is the use of trusted execution environments (TEEs), implemented in protocols such as Tesseract to combine the execution speed of CEX with the technical security guarantees of DEX (Bentov et al., 2019; Galal & Youssef, 2020). Furthermore, the emergence of Layer-2 protocols, such as those developed by Arwen, enables users to trade on CEX without relinquishing custody of their assets to the exchange, thereby significantly mitigating counterparty risk (Heilman et al., 2020).

Infrastructure models are also evolving toward hybrid forms, known as hybrid decentralized exchanges (HEX). This technology employs payment channels to handle high-frequency transactions off-chain while maintaining final settlement on the blockchain, aiming to reduce gas fees and network congestion (Luo et al., 2019, 2025). On the other hand, protocol standardization, such as ERC-20 tokens and the use of chain relays, has facilitated cross-chain interoperability, which was previously the exclusive domain of CEX infrastructure (Luo et al., 2025; Tian et al., 2021; Zamyatin et al., 2019). Smart contract security has also become a major focus in the development of this infrastructure, with analytical tools such as NeuCheck being developed to detect vulnerabilities before the system is deployed to the public (Lu et al., 2021).

The future of research in crypto trading infrastructure is predicted to increasingly integrate artificial intelligence (AI) and the Internet of Things (IoT) to enhance system capabilities and market liquidity (Shahinzadeh et al., 2022). Future network architecture concepts, such as "Cybertwin," propose a model in which digital assistants act as digital asset owners and data recorders, creating a distributed yet efficient resource trading system (Yu et al., 2019). Furthermore, research into advanced cryptographic techniques, such as multi-party computation (MPC) and privacy-preserving auctions, will be key to eliminating market manipulation practices such as front-running, which are frequently encountered on current trading platforms (Baum et al., 2021; Galal & Youssef, 2020).

Risk and security

A CEX is defined as a centralized entity that functions as the primary gateway between fiat currency and the cryptocurrency system, wherein full control over user assets resides with the exchange's managers (Kerr et al., 2023; I. Yousaf & Goodell, 2023). In contrast to decentralized exchanges (DEX), which are operated by algorithms, CEX are controlled by human actors, which can create a risk of investor fund appropriation by the exchange's management itself (I. Yousaf & Goodell, 2023). This phenomenon represents one of the most critical vulnerabilities, wherein unregulated entities hold a dominant position yet lack transparency and accountability (Vidal-Tomás et al., 2023). This lack of oversight enables exchanges to act simultaneously as regulators and market participants, ultimately undermining market integrity (Xia et al., 2020).

Research developments indicate that threats to CEX have evolved from mere technical hacking to highly organized market manipulation schemes and fraudulent activities. One of the most prominent findings is the prevalence of wash trading, whereby unregulated exchanges falsify more than 70% of their trading volume to manipulate rankings and attract more

users (Cong et al., 2023). In addition to volume manipulation, cyber threats in the form of typosquatting (fake domains) and counterfeit mobile applications have targeted major exchanges such as Binance and Coinbase, resulting in significant financial losses for users (Xia et al., 2020).

Recent studies have also identified the emergence of TxPhish (transaction-based phishing) on the Ethereum network, in which scammers trap users into signing transactions that enable the illegal withdrawal of assets. It was found that 54% of the funds obtained from such phishing schemes flow back to CEX as a means of money laundering (He et al., 2023). Furthermore, research on cross-ledger transaction tracing has revealed that automated trading platforms are frequently used by criminals to obfuscate the trail of illicit funds (H. Yousaf et al., 2019).

The collapse of the FTX exchange has become a turning point in CEX security research, identified not as a failure of cryptocurrency technology itself, but rather as an acute failure in risk management and corporate governance (Conlon et al., 2023; Jalan & Matkovskyy, 2023). This failure was rooted in the misuse of the exchange's native token (FTT), which lacked backing by real assets yet was used as collateral for excessive leverage (Vidal-Tomás et al., 2023). This asset-liability imbalance triggered widespread financial contagion, leading to extreme price volatility in assets closely associated with the exchange's ecosystem (Bouri et al., 2023; Galati et al., 2024).

The impact of the collapse of a major CEX is not limited to capital losses but also induces reputational contagion, whereby investor confidence in all types of tokens (both CEX and DEX) declines sharply (I. Yousaf & Goodell, 2023). This is evidenced by the fact that exchange tokens lacking intrinsic value can affect stock prices in traditional markets (e.g., Robinhood), indicating increasingly deeper risk interconnections between digital and traditional finance (Conlon et al., 2024).

The future of research in the field of CEX risk appears poised to focus on the development of causal estimation models and high-frequency volatility analysis to detect early warning signs of exchange insolvency (Esparcia et al., 2024; Khan et al., 2025). There is an urgent need to adopt privacy-preserving yet auditable technologies, such as zero-knowledge proofs, to ensure that asset-to-liability ratios remain within safe limits without disclosing sensitive data (Khan et al., 2025). Furthermore, research on coordinated international regulation is becoming increasingly crucial to prevent the misuse of AI and machine learning (ML) in market manipulation practices that harm retail investors (Conlon et al., 2023; Kerr et al., 2023).

Market Dynamics

In the context of digital asset markets, a CEX is defined as a primary hub for price discovery and liquidity provision, where trading volumes typically far exceed those of decentralized exchanges (Alexander et al., 2020; Hansen et al., 2022). These market dynamics are characterized by continuously evolving efficiency, yet they still leave room for inefficiencies that are exploited through cross-exchange arbitrage strategies (Fang et al., 2022). Fundamentally, price movements on CEX often exhibit non-random, recurrent behavior over the long term, reflecting complex market microstructure (Drożdż et al., 2019; Kwapień et al., 2022). This indicates that although CEX operate similarly to traditional financial markets, they possess unique features in terms of extremely fast transaction times and the availability of massive tick-by-tick data (Briola & Aste, 2022; Kwapień et al., 2022).

Research developments indicate that cryptocurrency markets on CEX have begun to exhibit signs of maturity, whereby their statistical characteristics increasingly resemble those of traditional foreign exchange (Forex) markets (Drożdż et al., 2019). However, this maturity is often distorted by market manipulation practices such as wash trading, in which transaction volumes are falsified to create an illusion of high liquidity, particularly on unregulated exchanges (Kwapień et al., 2022). The phenomenon of short-term reversal strategies also constitutes part of the liquidity provision dynamics on CEX, where profits tend to be concentrated in highly volatile, low-activity assets (Bianchi et al., 2022).

The market dynamics of CEX are also highly susceptible to internal industry shocks. The collapse of major exchanges such as FTX and Luna serves as tangible evidence of the fragility of the centralized model, triggering risk contagion across digital assets (Polat, 2024; I. Yousaf et al., 2023). These crises have led to drastic changes in investor behavior, characterized by a capital flight from cryptocurrencies toward traditional safe-haven assets such as gold and silver (I. Yousaf et al., 2023). Furthermore, recent research indicates that centralized derivative exchanges such as BitMEX now play a dominant role in leading spot prices, surpassing conventional spot exchanges in the price discovery process (Alexander et al., 2020).

Future research on CEX market dynamics is predicted to focus increasingly on the role of cryptocurrencies as geopolitical instruments and hedges against inflation. The use of cryptocurrencies as "conflict currencies" during geopolitical tensions (e.g., the Russia-Ukraine case) demonstrates that CEX serve as primary gateways for individuals to protect their wealth when domestic fiat currencies are devalued or subjected to

sanctions (Alexakis et al., 2024). Moreover, the effectiveness of centralized futures exchanges (e.g., CME) in hedging inflation expectations constitutes a crucial area of inquiry, although this capacity may erode during periods of extreme systemic stress (Liu & Valcarcel, 2024).

Regulation

Despite the limited volume of literature retrieved from the database regarding this subject, it constitutes the most critical focal point of this research, as exemplified by the discourse surrounding CEX regulations in China. The regulatory interventions imposed by the Chinese government on centralized cryptocurrency exchanges (CEX) represent some of the most radical measures in the history of digital finance, driven by profound concerns over Bitcoin's extreme volatility, which caused it to resemble a speculative instrument rather than a functional currency. In September 2017, seven central regulatory authorities—including the People's Bank of China (PBOC)—jointly issued a mandate to shut down all domestic cryptocurrency trading platforms, citing investor protection and the mitigation of systemic risks that could jeopardize national economic stability. This measure was implemented because the inherent anonymity of crypto transactions was perceived as a significant loophole for criminal activities, such as money laundering and the illicit trade of contraband, which are inherently difficult for traditional financial authorities to track. Paradoxically, while the closure of CEX theoretically should have severed market access for domestic investors, this study highlights the persistent and robust influence of Chinese investor attention on global Bitcoin price formation, quantified via search frequencies on the Baidu search engine (Chen & Liu, 2022).

In addition, trading volume data presented by Chen & Liu reveal that following the closure of Yuan-based (CNY) exchanges, a sharp surge occurred in the utilization of Tether (USDT) as the primary intermediary to acquire Bitcoin, effectively substituting the role of the Yuan in the international market. This phenomenon underscores that the global CEX ecosystem remains accessible to individual investors through cross-currency mechanisms that obscure national jurisdictional boundaries. These empirical findings present a compelling contrast, given that China remains the leading country in terms of scholarly publications on this subject (Table 1). Consequently, a dedicated and in-depth literature review focusing specifically on the CEX discourse within China is warranted to establish a

comprehensive overview of the developmental trajectory and future research directions within this specific national context.

Of equal importance, separate scholarly inquiries into the integration of artificial intelligence (AI) and machine learning (ML) within CEX operations demonstrate that while these technologies have forged a new paradigm in trading efficiency, they simultaneously engender unprecedented ethical dilemmas regarding system transparency and accountability. The deployment of sophisticated algorithms occasionally surpasses human cognitive capacity, thereby creating pronounced information asymmetry between technology proprietors and retail investors. Consequently, retail investors are frequently disadvantaged relative to these technological developers. Grounded in the ethical framework of consequentialism, the primary objective of this research is to evaluate whether the ultimate outcomes of AI utilization genuinely maximize societal welfare or, conversely, merely enrich a select group of actors through market manipulation and insider trading masked behind the complexity of the code. The catastrophic collapse of the FTX exchange and the actions of Sam Bankman-Fried (SBF) serve as a stark testament to how opacity and transaction manipulation—particularly when weaponized in the era of AI and ML—can be systematically exploited to defraud clients and abuse confidential data for illicit corporate gain (Alibašić, 2023).

Alibašić proposes a framework emphasizing the necessity of regulatory measures that transcend mere technical parameters to address the ethical implications of the social outcomes engendered by digital trading activities. Within the paradigm of rule consequentialism, CEX operations must be legally mandated to undergo periodic algorithmic audits and utilize open-source software, thereby preempting "hedonistic egoistic" behavior that exclusively pursues short-term profitability while disregarding systemic risks. The ramifications of the FTX crisis demonstrate that ethical and governance failures within centralized exchanges can precipitate widespread reputational damage, trigger risk contagion into traditional financial markets, and fundamentally shatter public trust in financial innovation as a whole.

CONCLUSION

Based on the findings of this study, Indonesia possesses substantial potential to serve as a research object concerning centralized exchanges (CEX), given that Indonesia ranks among the top ten countries with the highest cryptocurrency adoption rates according to the Chainalysis report. Considering existing research trends, at least three main topics can become focal points for future CEX research in Indonesia: the readiness of CEX infrastructure and regulation in Indonesia, the level of investment risk

associated with CEX platforms in Indonesia, and the dynamics of the cryptocurrency market in Indonesia through CEX. Furthermore, strengthening global research networks on CEX is necessary, particularly by positioning Indonesia as a relevant research subject on an international scale.

From a regulatory perspective, regarding the regulatory implications for Indonesia, policymakers must exercise strategic caution when formulating frameworks for the cryptocurrency market. This is particularly crucial given that major economies, such as China, maintain a stringent prohibition to date, driven by profound apprehensions surrounding money laundering, market manipulation, and other illicit activities. Moreover, in the contemporary era characterized by the rapid proliferation of AI and ML, the government must proactively investigate preventive measures against potential algorithmic market manipulation in the future. Nevertheless, rather than instituting an outright ban on cryptocurrencies, Indonesia's regulatory stance should focus primarily on robust risk mitigation. This balanced approach is warranted considering that Indonesia commands a significantly large market share within the global cryptocurrency ecosystem.

A limitation of this study is that the data sources were exclusively derived from the Scopus database, potentially overlooking scientific publications outside the Scopus index. Additionally, the limited number of articles used to classify research topics may influence the resulting thematic trends. Therefore, future research is expected to employ a broader data scope in order to produce a comprehensive research roadmap on CEX and cryptocurrency in general for Indonesia.

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