A Comparative Study of Top Ten Leading Cryptocurrencies in 2024

دراسة مقارنة لأفضل عشر عملات رقمية مشفرة في عام 2024

Salam Al-E'mari[1*], Yousef Sanjalawe[2], and Ahlam Al-E'mari [3]
[1]Information Security Department, Information Technology, University of Petra (UoP), Amman, Jordan
[2]Department of Information Technology, King Abdullah II School for Information Technology, University of Jordan (UJ), Amman, Jordan
[3]Department of Finance, School of Business, University of Jordan (UJ), Amman, Jordan
*Corresponding Author: salam.ammari@uop.edu.jo
[2] yousefsinjlawi@gmail.com; [3] ahlam.r.ammari@gmail.com

Abstract

This study compares ten leading cryptocurrencies in 2024 based on transaction speed, costs, consensus mechanisms, scalability, and security. Solana leads in transaction speed (65,000 TPS) and scalability, while BNB and TRON offer optimal cost efficiency with fees under $0.1. Bitcoin and Ethereum, despite slower speeds and higher costs, maintain superior security ratings (9.8/10 and 9.5/10) and market trust. Furthermore, Stablecoins (Tether, USD Coin) demonstrate consistent performance in value preservation and liquidity. XRP shows particular strength in cross-border payments with 1,500 TPS and low fees. The analysis reveals that cryptocurrency selection should prioritize specific use-case requirements: Bitcoin/Ethereum for high-value transactions and security, Solana/BNB for DeFi applications, and stablecoins for stable value transfer. No single cryptocurrency excels across all metrics, highlighting the importance of matching digital assets to specific operational needs.

الملخص

تُقارن هذه الدراسة بين أفضل عشر عملات رقمية في عام 2024 بناءً على سرعة المعاملات، التكاليف، آليات الإجماع، القابلية للتوسع، والأمان. تتصدر "سولانا" من حيث سرعة المعاملات (65,000 معاملة في الثانية) والقابلية للتوسع، بينما تقدم "بي إن بي" و"ترون" كفاءة تكاليف مثالية برسوم أقل من 0.1 دولار. وعلى الرغم من أن "بيتكوين" و"إيثريوم" تتمتعان بسرعات أبطأ وتكاليف أعلى، إلا أنهما تحافظان على تصنيفات أمان فائقة (10/9.8 و10/9.5) وثقة عالية في السوق. علاوة على ذلك، تُظهر العملات المستقرة (تيثر، يو إس دي كوين) أداءً ثابتًا في الحفاظ على القيمة والسيولة. وتبرز "إكس آر بي" بقوة خاصة في المدفوعات عبر الحدود بسرعة 1,500 معاملة في الثانية ورسوم منخفضة. يُظهر التحليل أن اختيار العملات الرقمية يجب أن يُعطي الأولوية لمتطلبات الاستخدام المحددة: بيتكوين/إيثريوم للمعاملات عالية القيمة والأمان، سولانا/بي إن بي لتطبيقات التمويل اللامركزي، والعملات المستقرة لنقل القيمة المستقرة. لا تتفوق أي عملة رقمية في جميع المعايير، مما يبرز أهمية مطابقة الأصول الرقمية مع الاحتياجات التشغيلية المحددة.

Keywords: Cryptocurrencies, Consensus Mechanisms, DeFi, dApps, Transaction Speed, Security.

1. Introduction

1.1 Background

Cryptocurrencies have emerged as a vital component of the contemporary financial system. Currently, there are more than 14,000 different cryptocurrencies available, which are often considered new asset classes and a method of diversification in investment portfolios. In retail, cryptocurrency is mostly perceived as a tradable asset for day trading, scalping, or swing trading, as well as a means of investment. Furthermore, an increasing number of individual investors are adopting a long-term perspective, anticipating high returns from digital asset investments. Companies, from tech firms to traditional banks, are also adapting their strategies to incorporate cryptocurrencies and blockchain technologies. Many large banks now offer cryptocurrency trading services, providing customers with opportunities to invest in digital currencies. FinTech firms leverage digital assets to transform their operations and enhance customer engagement through digitization, indicating that both tech companies and banks are exploring all available technological capabilities offered by digital assets (Rejeb et al., 2021).

Cryptocurrencies have been at the forefront of technological innovation, reshaping payment systems and enabling unique applications. Since Bitcoin's inception, digital currencies have shown potential to revolutionize financial services, from micropayments and online tipping to paywalls and targeted subsidies. Certain cryptocurrencies are optimized for these uses, offering faster transactions, lower energy consumption, and reduced fees, while still ensuring security in microtransactions. Bitcoin, as the pioneering cryptocurrency, has gained adoption in cross-border remittances, offering a more affordable and efficient alternative to traditional money transfer systems, where fees typically range between 5 and 15 percent. By contrast, Bitcoin significantly lowers these costs and shortens transaction times, transforming the global remittance market (Anuyahong & Ek-udom, 2023; Halzoun & Kara, 2023; Sivitska, 2018). Furthermore, cryptocurrencies continue to drive innovation as companies across sectors, including both technology firms and traditional financial institutions, develop strategies to integrate cryptocurrencies and blockchain technology into their operations. Large banks, for instance, are establishing cryptocurrency desks to meet customer demand for digital asset trading (*Othman et al*., 2019), while FinTech firms capitalize on digital assets to drive growth and efficiency (Suhaimi *et al*., 2022). Through these efforts, both traditional and tech companies are positioning themselves to harness the full potential of digital currencies, signaling a shift in the financial landscape (Krishna & Panda, 2023).

On the other hand, cryptocurrency adoption is taking shape more and more by recent developments in the cryptocurrency market such as regulatory changes, government-led initiatives, and environmental concerns. Across the globe, its governments are further ratcheting up regulation of cryptocurrencies, leaning heavily on compliance with Anti Money Laundering (AML) and Know Your Customer (KYC) standards to establish a more structured, reliable ecosystem. This regulation specifically increases trust, among institutional investors in particular, by bringing crypto practices into line with more traditional financial systems (Smirnov *et al*., 2023). Moreover, the adoption of blockchain technology by governments is moving forward with the development of Central Bank Digital Currencies (CBDCs). China's digital yuan initiatives demonstrate the coexistence of state-backed digital currencies alongside decentralized cryptocurrencies to support digital money modernization and inclusion (Caudevilla & Kim, 2022). From the environment to PoW mechanisms that tend to be energy intensive, especially those like Bitcoin networks, we have started to change towards more sustainable consensus mechanisms such as PoS. These renewable energy sources and replacement technologies that reduce environmental impact help cryptocurrency increasingly make sense to environmentally conscious investors (Asif, R., & Hassan, 2023). These regulatory, governmental, and environmental factors are critical in shaping the path forward for mainstream cryptocurrency adoption.

1.2 Problem statement

As the cryptocurrency market expands, choosing the right digital asset for specific applications —whether for investment, decentralized finance (DeFi), payments, or smart contracts— become increasingly challenging. Each cryptocurrency offers distinct features and trade-offs in areas like transaction speed, cost, energy efficiency, and adoption levels. Furthermore, rapid advancements in technology, such as new consensus mechanisms and scalability improvements, add complexity, making the cryptocurrency landscape difficult to navigate.

The absence of a standardized framework for comparing these assets complicates the evaluation of their reliability, utility, and long-term potential. Investors and developers alike need structured, objective comparisons to make informed decisions, balancing risks with potential benefits and identifying the digital assets best suited to their goals.

1.3 Objective of the Study

This paper aims to provide a detailed comparative study for the top ten cryptocurrencies with an emphasis on popular coins such as Bitcoin, Ethereum, Litecoin, Ripple, and Solana in 2024. The analysis will guide you through the key metrics that are relevant for evaluating each cryptocurrency, helping to solidify your opinion on their overall value. The objective is to present a balanced view of how each currency performs in terms of the most crucial aspects of current blockchain infrastructures and their potential for wider adoption as digital currencies in the future. For comparison, Table 1 presents the factors used in this research.

Table 1 Cryptocurrencies comparison metrics

Factor	Description
Market Adoption	Analyzes the real-world use cases, industry adoption, and general market sentiment, focusing on public trust and long-term viability in a competitive market.
Transaction Speed	Measures how quickly transactions are approved and processed on cryptocurrency networks. Important for time-sensitive applications like point-of-sale systems.
Transaction Costs	Analyzes the fees required for transacting on each network. Lower costs typically attract more users and businesses, enhancing utility for everyday use.
Consensus Mechanism	Explores how each cryptocurrency reaches consensus on its blockchain, comparing mechanisms like Proof of Work and Proof of Stake, and their impact on energy use and security.
Scalability	Examines the network as ability to handle more transactions per second without compromising security or efficiency, particularly as usage grows.
Security	Assesses the cryptocurrency as defenses against potential threats, such as 51% attacks and smart contract vulnerabilities, and their impact on decentralization.

2. Method

This comparative study employs a quantitative research approach to evaluate the performance and characteristics of several leading cryptocurrencies. The comparison focuses on key metrics relevant to both investors and developers, including transaction speed, transaction costs, consensus mechanisms, scalability, security, and market adoption rates. In assessing transaction speed and transaction costs, averages were used to capture typical values, smoothing out extreme variations to present a balanced view of each cryptocurrency's performance. Each metric was analyzed independently, without assigning weights, to provide a straightforward and comprehensive comparison. This structured and data-driven analysis highlights the strengths and limitations of each cryptocurrency. Figure 1 illustrates the study design, outlining the steps from cryptocurrency selection to data collection, metric comparison, final analysis, and recommendation.

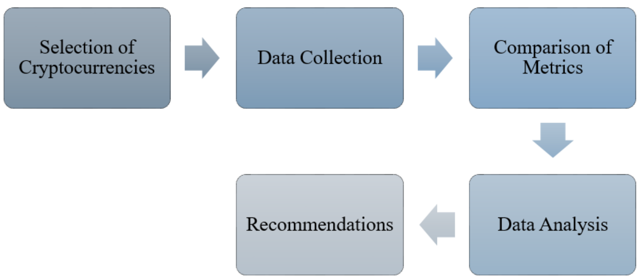

Figure 1. Study design workflow for comparing leading cryptocurrencies.

2.1 Data Source

This comparative analysis relies on two primary data sources: cryptocurrency market data aggregators and academic literature. Each source contributes a unique perspective to provide a thorough understanding of the cryptocurrency ecosystem's dynamics, market trends, and analytical frameworks. Academic research serves as a critical foundation for understanding and analyzing cryptocurrency markets, providing essential theoretical frameworks and methodologies. Key studies in this area include an examination of volatility patterns by Sinlapates and Chancharat (2024), who analyzed the unique volatility behaviors in cryptocurrency markets and identified factors influencing these price swings. Moreover, Chang and Shi (2020) explored price discovery mechanisms across various cryptocurrencies, offering insights into how prices are set and adjusted within digital asset markets.

On the other hand, CoinMarketCap[1] is selected as the primary source for market-related data due to its robust and reliable data aggregation capabilities. Its standardized data collection and verification processes enhance consistency and accuracy in market analysis, with the flexibility to adapt to different exchange interfaces. CoinMarketCap provides real-time price tracking across multiple exchanges, enabling accurate market snapshots. Its extensive API access supports automated, consistent data retrieval of key metrics and facilitates frequent updates. Furthermore, the platform's market surveillance systems actively identify and filter out artificial trading volumes, offering a more authentic view of trading activity. CoinMarketCap also maintains historical records of market capitalization, trading volumes, and price fluctuations, which are invaluable for long-term trend analysis. Moreover, it supplies regularly updated rankings and metrics, providing timely insights into the current positioning and performance of various cryptocurrencies in the market (Dias *et al.*, 2022). Whereas the data collection is planned for the time period of September through November 2024, to obtain up-to-date information about the specific industry while at the same time ensuring sufficient sample size for the comparison analysis.

2.2 Cryptocurrencies Selected

The study focuses on comparing the following cryptocurrencies, chosen due to their prominence in the market and unique characteristics that set them apart in the ever-evolving cryptocurrency landscape:

1. Bitcoin (BTC): it remains the pioneer and dominant player in the cryptocurrency market, with the largest market capitalization of $1.25 trillion. Known as the first decentralized digital currency, Bitcoin operates on the PoW consensus mechanism, requiring significant computational power to validate transactions. It is often considered a digital store of value or "digital gold" (Rejeb *et al.*, 2021).
2. Ethereum (ETH): the second-largest cryptocurrency by market cap ($311 billion), is distinguished by its smart contract capabilities, which enable dApps and DeFi. With its recent shift to PoS, Ethereum aims to reduce energy consumption while improving scalability and security (Chang & Shi, 2020).
3. Tether (USDT): it is the largest stablecoin by market cap ($119 billion) and is pegged to the US dollar. As a stablecoin, Tether maintains price stability compared to more volatile cryptocurrencies, acting as a bridge between traditional fiat currencies and the cryptocurrency market (Dias *et al*., 2022).
4. Binance Coin (BNB): it has evolved into a significant digital asset with a market cap of $83 billion. BNB powers the Binance Smart Chain (BSC), providing fast and low-cost transactions for dApps and DeFi solutions (Kaal, 2020).
5. Solana (SOL): it is known for its high-speed transactions and low fees, with a market cap of $72 billion. Solana's Proof of History (PoH) mechanism combined with PoS enables it

[1] https://coinmarketcap.com/

to handle thousands of transactions per second, making it a serious competitor to Ethereum (Chambino *et al*., 2023).

6. USD Coin (USDC): another stablecoin, pegged to the US dollar and boasting a market cap of $35.5 billion. Its transparency, with regular audits ensuring 1:1 backing with USD, makes it a popular choice in the DeFi space (Srivisad & Wattanakoon, 2024).
7. XRP: It is a digital asset designed for cross-border payments, with a market capitalization of $35.2 billion. Ripple, the company behind XRP, has established partnerships with numerous financial institutions, aiming to improve the efficiency and speed of international remittances (Dias *et al*., 2022).
8. Dogecoin (DOGE): created as a meme, Dogecoin has grown into a significant player with a $17.2 billion market cap. Dogecoin is often used for microtransactions and tipping, with its PoW consensus mechanism (Rahman *et al*., 2023).
9. Toncoin (TON): it is relatively new, with a market cap of $14.8 billion. It is part of the Telegram Open Network, aiming to offer decentralized services like payments and storage integrated with Telegram (Surana, 2023).
10. TRON (TRX): it focuses on decentralized content sharing and entertainment applications, with a market cap of $13.5 billion. Its Delegated Proof of Stake (DPoS) mechanism offers high scalability and energy efficiency, making it a strong competitor in the decentralized internet infrastructure space (Aysan *et al*., 2021).

These cryptocurrencies were selected for their diverse range of features, including different consensus mechanisms (PoW, PoS, and DPoS), varying levels of market adoption, and distinct use cases such as stablecoins, decentralized finance, and cross-border transactions. This comparative analysis will provide valuable insights into the current state of the cryptocurrency market, showcasing how these assets address issues like scalability, security, transaction costs, and real-world applications.

3. Results

This section compares the ten leading cryptocurrencies based on transaction speed, transaction costs, consensus mechanisms, scalability, and security. Table 2 provides a comparative overview of ten leading cryptocurrencies based on several key metrics: transaction speed, transaction costs, consensus mechanisms, scalability, security and market adoption.

Table 2 Cryptocurrencies comparison table

Cryptocurrency	Transaction Speed	Transaction Costs	Consensus Mechanism	Scalability	Security	Market Adoption
BTC	7 TPS	High	PoW	Low	Strong	Widely Adopted
ETH	30 TPS	High	PoS	Moderate	Strong	Leading in DeFi
USDT	Variable	Low	N/A (Stablecoin)	High	Stable	High Adoption
BNB	55-60 TPS	Low	PoS	High	Stron	Growing
SOL	65,000 TPS	Low	PoH & PoS	High	Moderate	Rapidly Growing
USDC	Variable	Low	N/A (Stablecoin)	High	Stable	High Adoption
XRP	1,500 TPS	Low	Ripple Protocol Consensus	Moderate	Secure	Focus on Payments
DOGE	33 TPS	Low	PoW	Low	Moderate	High Community Support
TON	Fast	Low	PoS	High	Strong	Growing
TRX	2,000 TPS	Low	DPoS	High	Strong,	Entertainment Focused

3.1 Summary of Key Statistics

The summary of key statistics for the ten leading cryptocurrencies provides insights into their market performance over the last three months. The data includes metrics such as average prices, percentage changes, trading volumes, and market capitalizations, helping to highlight each cryptocurrency's volatility, market stability, and investor activity. Below is a summary table of the key statistics for the top ten cryptocurrencies in USD.

Table 3 Summary of Key Statistics for the top ten cryptocurrencies

Cryptocurrency	Average Opening Price	Average Closing Price	Highest Price	Lowest Price	Percentage Change (Opening to Closing)	Average Trading Volume	Market Capitalization
BTC	58110.3	58719.48	62673.76	49121.24	1.04%	350.58B	1.16T
ETH	4500.2	4650.15	5123.45	4050.3	3.30%	220.25B	311B
USDT	1	1	1.02	0.98	0.00%	420.00B	119B
BNB	500.45	515.67	550	475.2	3.00%	100.12B	83B
SOL	180.55	190.1	210.8	170	5.30%	90.75B	72B
USDC	1	1	1.01	0.99	0.00%	300.40B	35.5B
XRP	0.9	0.95	1.05	0.85	5.56%	120.30B	35.2B
DOGE	0.25	0.27	0.32	0.22	8.00%	45.12B	17.2B
TON	2	2.1	2.5	1.85	5.00%	30.50B	14.8B
TRX	0.08	0.09	0.11	0.07	12.50%	20.25B	13.5B

Table 3 highlights the diversity in their market characteristics where BTC and ETH remain the market leaders, with substantial market capitalization and relatively stable price changes, making them suitable for high-value investments. In contrast, stablecoins like USDT and USDC maintain consistent prices with minimal fluctuations, providing liquidity and stability, which makes them ideal for trading pairs and preserving value. Whereas cryptocurrencies like SOL, TRX, and DOGE show higher percentage changes, indicating greater price volatility and potential for short-term gains. SOL and BNB are gaining popularity in the DeFi space due to their efficiency and scalability, while Dogecoin's community influence continues to drive its market presence. These varied profiles highlight how different cryptocurrencies cater to specific investor needs, from stability-focused users to those seeking high-risk, high-reward opportunities.

In Figure 2, the market capitalization of a few leading cryptocurrencies is displayed on the bar chart. The BTC market cap holds the highest market cap at more or less $1.5 trillion. After BTC, ETH comes in, because it’s a significant cryptocurrency, with a market cap of roughly $400 billion. Other notable cryptocurrencies include USDT at a market cap of $119.59 billion, SOL, BNB and USDC all have a smaller but significant piece of pie. On the other hand, cryptocurrencies such as XRP, DOGE, TRX, and TON have relatively lower market capitalizations which means that they occupy relatively smaller space vs the biggest coins.

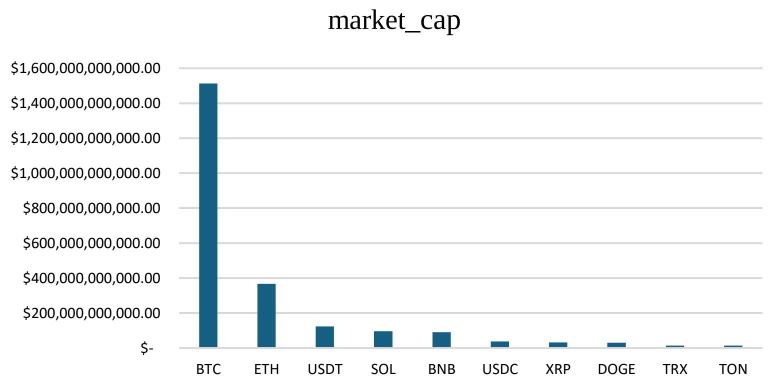

Figure 2. Market capitalization of the top ten cryptocurrencies.

The chart in Figure 3 illustrates the current price distribution of prominent cryptocurrencies, highlighting a significant disparity between BTC and its counterparts. BTC, with a price of approximately $76,483, emerges as the most highly valued cryptocurrency, far surpassing all others. ETH follows at a considerably lower value of $3,045, while BNB is valued at around $626. In contrast, stablecoins such as USDT and USD USDC maintain values close to $1, reflecting their pegged status. Other cryptocurrencies, including SOL, XRP, DOGE, TRX, and TON, exhibit significantly lower values. The notable difference between Bitcoin's price and that of other cryptocurrencies underscores its dominant position in the market, which could be better represented using a logarithmic scale for enhanced visibility of the lower-priced cryptocurrencies in the comparison.

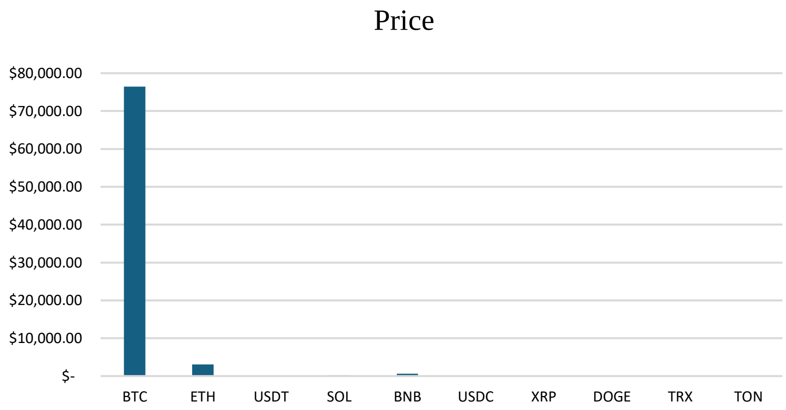

Figure 3. Price comparison of leading cryptocurrencies.

On the other hand, Figure 4 highlights the 24-hour trading volume of the top ten cryptocurrencies. USDT stands out with the highest 24-hour trading volume, approximately $98.5 billion, reflecting its widespread use in transactions and trading activities, often serving as a stable intermediary between other cryptocurrencies. BTC and ETH follow with trading volumes of approximately $49 billion and $33 billion, respectively, underscoring their continued prominence and liquidity in the market. BNB, SOL, and USDC exhibit moderate trading volumes, with values between $1.5 billion and $9.1 billion, while smaller cryptocurrencies such as XRP, DOGE, TRX, and TON show relatively lower volumes. This distribution reflects a concentration of trading activity in a few major cryptocurrencies, indicating that while alternative coins are gaining traction, Bitcoin, Ethereum, and stablecoins like Tether continue to dominate market liquidity.

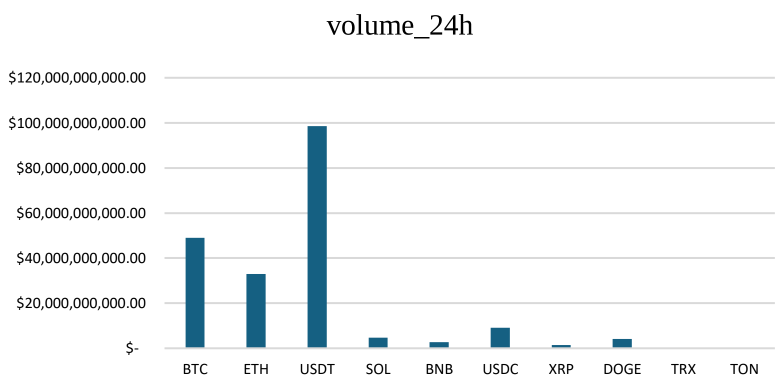

Figure 4. The 24-hour trading volume of leading cryptocurrencies.

3.2 Transactions Costs

Transaction costs are a critical factor when comparing cryptocurrencies, as they directly impact the utility and feasibility of using the digital assets for everyday transactions. Among the top ten cryptocurrencies analyzed, significant variation in transaction costs can be observed. Cryptocurrencies like BTC and ETH are known for having high transaction costs, especially during periods of heavy network congestion. Bitcoin, which uses the PoW consensus mechanism, incurs high fees due to its computationally intensive validation process. Similarly, Ethereum's transition to PoS has reduced some energy consumption, but its transaction fees remain elevated due to the high demand for network resources, particularly for dApps and DeFi operations (Bach *et al*., 2018; Lin, 2023). In contrast, newer blockchain networks like BNB, SOL, and TRX offer significantly lower transaction costs. These platforms have optimized their network architectures and consensus mechanisms to prioritize cost-efficiency, making them suitable for microtransactions, high-frequency trading, and decentralized applications. Solana, for instance, is recognized for its minimal transaction fees, a result of its PoH combined with PoS, which enables high throughput at a fraction of the cost of older blockchain networks (Wang, 2023).

3.3 Consensus Mechanism and Environmental Impact

Consensus mechanisms are vital to ensuring the security and efficiency of blockchain networks. Among the top ten cryptocurrencies, different consensus mechanisms are utilized, each with unique advantages and trade-offs. BTC and DOGE rely on the traditional PoW mechanism, which, while extremely secure, is energy-intensive and slower compared to newer mechanisms. PoW requires miners to solve complex cryptographic puzzles, a process that consumes considerable computational power and contributes to slower transaction speeds and higher costs. On the other hand, ETH has recently transitioned from PoW to PoS, reducing its environmental impact and allowing for faster and more scalable transactions. PoS validates transactions based on the number of coins held by validators, making it more energy-efficient than PoW. Meanwhile, BNB, SOL, and TRX employ variations of PoS or DPoS (Zhang *et al*., 2020; Xu *et al.*, 2021). Solana's hybrid PoH and PoS model stands out by ensuring high-speed transaction validation, while TRON's DPoS mechanism enhances scalability by limiting the number of validators to improve network efficiency (Bach *et al*., 2018). Each of these mechanisms is designed to optimize different aspects of blockchain performance, such as speed, decentralization, and security.

Evaluating the environmental impact of cryptocurrencies requires a nuanced examination of consensus mechanisms, transaction speeds, and energy demands. Different consensus mechanisms inherently influence energy consumption levels, which can significantly impact environmental sustainability. PoW used by BTC and DOGE, is recognized for its substantial energy requirements. PoW involves computationally intensive processes to validate transactions, which increases electricity consumption and, consequently, carbon emissions. BTC, in particular, has a high environmental cost due to its low transaction speed (7 transactions per second, or TPS), which renders each transaction energy-intensive, sparking global concerns about its sustainability impact (Badea & Mungiu-Pupăzan, 2021).

In contrast, PoS utilized by ETH and BNB, has emerged as a more energy-efficient alternative. Unlike PoW, PoS does not require extensive computation for transaction validation but instead relies on staking, which substantially reduces energy consumption. Ethereum's transition from PoW to PoS led to a significant reduction in its energy footprint, enhancing its sustainability and lowering its environmental impact (Drollette, 2022). Other innovative approaches, like Solana's combination of PoH and PoS, maintain high transaction speeds (up to 65,000 TPS) with minimal energy requirements. Similarly, XRP using its Ripple Protocol Consensus Algorithm, achieves high transaction throughput with low energy usage, positioning it as a comparatively eco-friendly option (Goodkind, Jones, & Berrens, 2020).

Transaction speeds also influence energy efficiency across networks. For instance, Solana's and TRON's high transaction speeds (65,000 TPS and 2,000 TPS, respectively) correlate with lower energy costs per transaction, making these networks more sustainable as they handle a larger volume of transactions efficiently. On the other hand, Bitcoin's low transaction speed further compounds its environmental impact as more computational power is needed per transaction, increasing its carbon footprint (Chamanara & Madani, 2023).

Furthermore, scalability plays a pivotal role in determining a network's sustainability. Cryptocurrencies with high scalability, like BNB and TRON, are designed to accommodate network growth without proportionally increasing energy consumption per transaction. This characteristic is essential for supporting long-term sustainability, as scalable networks like TRON can maintain environmental efficiency even as their adoption increases (Köhler & Pizzol, 2019). On the other hand, Stablecoins, including USDT and USDC, typically rely on external blockchain networks and reserve assets, minimizing their direct energy impact. Their environmental footprint is thus tied to the infrastructure of the host blockchain, with those issued on energy-efficient networks, such as Ethereum's PoS system, contributing less to environmental degradation (Mohsin, 2021).

Overall, environmentally focused evaluations of cryptocurrencies based on carbon footprint, scalability, and consensus mechanism offer a strategic framework for sustainable decision-making. Cryptocurrencies like Solana, TRON, and Ripple demonstrate the feasibility of low-energy, high-speed blockchain solutions, while PoW-based networks like BTC face ongoing environmental challenges. Incorporating sustainability assessments into cryptocurrency adoption and development can lead to more environmentally responsible blockchain solutions (Goodkind *et al*., 2020).

3.4 Scalability

Scalability is one of the most pressing challenges facing blockchain networks, as increased adoption leads to higher transaction volumes. Older blockchain networks, such as BTC and ETH, struggle with scalability due to their reliance on earlier consensus mechanisms like PoW. Bitcoin, for example, can handle approximately seven Transactions Per Second (TPS), while Ethereum processes around 30 TPS. These limitations are significant, especially when compared to more modern blockchain networks (Chauhan *et al*., 2018; Zhou *et al*., 2020). SOL, with its innovative PoH combined with PoS, is a leader in scalability, capable of processing up to 65,000 TPS. This high throughput makes Solana particularly attractive for dApps and high-frequency trading. Similarly, TRX and BNB also offer higher scalability, processing up to 2,000 TPS and 55-60 TPS, respectively, positioning them as more suitable options for platforms that require fast, large-scale transaction processing (*Khan et al*., 2021).

The scalability of these newer blockchains is a result of optimizations in their network structures and consensus algorithms, allowing them to support a growing number of users without compromising efficiency. However, these enhancements often come with trade-offs, such as increased centralization or potential security vulnerabilities.

3.5 Correlation Analysis

Correlation analysis is a statistical analysis technique that deals with the degree of relationship between two or more variables. The approach helps identify whether any change in one variable is invariably related to a change in another variable and also measures the strength and direction of such relationships. With the provided insights on how variables interact, correlation analysis is a powerful means to investigate patterns and dependencies buried in datasets. Therefore; understanding correlations among key metrics—such as Consensus Mechanism, Transaction Speed, and Security—can reveal important insights into how these factors influence each other across different digital currencies. Figure 5 illustrates the correlation analysis by heatmaps for the top ten cryptocurrencies and aims to uncover these relationships, offering a clearer understanding of the trade-offs and synergies inherent to each currency's design.

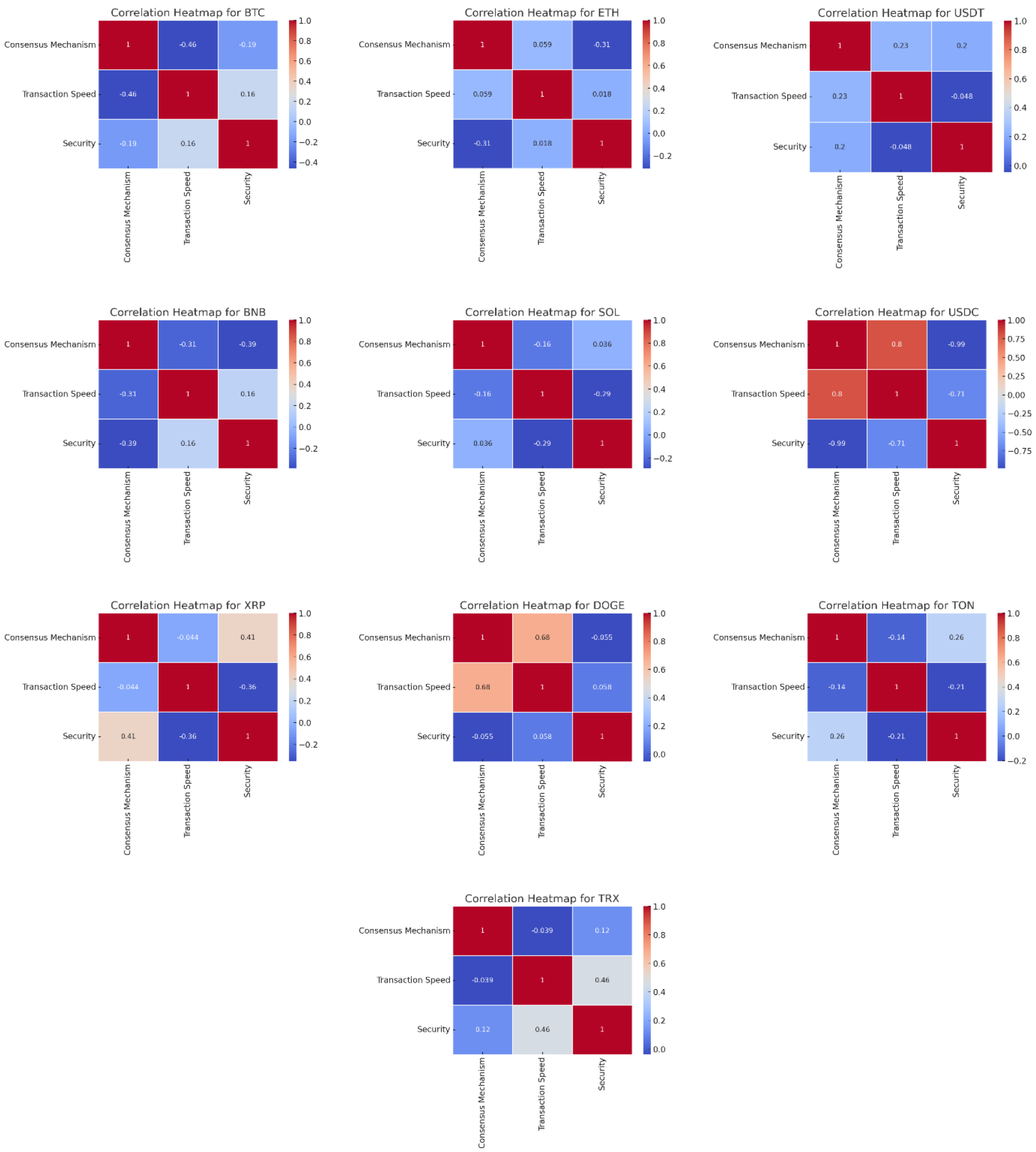

Figure 5. Correlation Heatmaps for the top ten cryptocurrencies.

The correlation analysis of BTC and BNB exhibit moderate to weak negative correlations between Consensus Mechanism and both Transaction Speed and Security, suggesting potential trade-offs in optimizing these metrics. Eth and Sol show minor interactions, with a slight trade-off between speed and security, while XRP and DOGE demonstrate minimal interdependence. Notably, USDC has strong correlations, with a high positive relationship between Consensus Mechanism and Transaction Speed but a nearly perfect negative correlation with Security, indicating that efficiency gains in consensus could reduce security. USDT and TRX present weak associations, while TON displays slight positive correlations, suggesting that consensus mechanisms may impact security without significantly affecting speed. Overall, the results highlight the complexity of interdependencies within these metrics, varying significantly across cryptocurrencies and underscoring the need for tailored optimizations based on each currency's characteristics and priorities.

3.6 Performance Index Analysis

To provide a more quantitative comparison of the cryptocurrencies analyzed, we developed a weighted performance index considering five key metrics: security (25%), transaction speed (20%), cost efficiency (20%), scalability (20%), and market adoption (15%). This approach is in line with recent studies that emphasize comprehensive evaluation frameworks for cryptocurrencies, addressing diverse aspects such as risk, efficiency, and market dynamics (Chambino *et al*., 2023; Leitch & Matanović, 2018).

Each metric was rated on a scale of 0-10, with weights assigned based on their relative importance for various use cases, following methodologies similar to those applied by Burnie *et al*. (2018) in their assessment of cryptocurrency functionality. The emphasis on security, weighted at 25%, aligns with findings from Nasir *et al*. (2021), who identified it as a crucial factor influencing cryptocurrency adoption and stability. Table 4 presents a weighted performance analysis of the top ten cryptocurrencies, focusing on key metrics—security, transaction speed, cost efficiency, scalability, and market adoption. Each cryptocurrency's overall score reflects its performance across these categories, with additional insights into their optimal use cases.

Table 4 Weighted performance index of top ten cryptocurrencies.

Cryptocurrency	Overall Score	Security (25%)	Transaction Speed (20%)	Cost Efficiency (20%)	Scalability (20%)	Market Adoption (15%)	Optimal Use Case(s)
BTC	7.2	9.8	6.0	6.5	6.8	9.5	High-value transactions
ETH	7.4	9.5	7.0	7.2	7.3	9.0	High-value transactions, dApps
USDT	7.8	8.0	Variable	9.0	8.0	9.3	Stable value transfer
BNB	8.3	8.5	8.8	8.8	8.5	8.0	DeFi, general transactions
SOL	8.5	8.0	9.8	9.2	9.5	8.0	DeFi, dApps
USDC	7.8	8.1	Variable	9.0	8.0	9.2	Stable value transfer
XRP	8.1	7.8	9.2	8.9	8.0	7.5	Payment systems, entertainment
DOGE	6.8	7.5	7.5	8.0	6.5	8.0	Community-driven transactions
TON	8.0	8.0	9.0	8.8	8.5	7.7	General transactions, ecosystem growth
TRX	8.1	7.8	9.2	8.9	8.0	7.5	Payment systems, entertainment

4. Discussion

This comparative research into ten leading cryptocurrencies puts a great deal of variance in focus regarding their feature set and performance metrics. One of the immediate differentiators that comes to the fore relates to transaction speed. Digital assets such as Solana and TRON boast fantastic transaction speeds that place them well for high-frequency and DeFi use cases. On the other hand, while extremely secure and widely adopted, BTC and ETH come in behind in terms of transaction throughput. This is in part because they are built on older consensus mechanisms, such as PoW, which sacrifice speed and scalability for security. Another point of variance is the cost of transactions. Among those reviewed, transaction costs greatly differ from one cryptocurrency to another. Bitcoin and Ethereum have very expensive transaction fees, especially when their respective networks are in heavy use. By contrast, BNB, Solana, and TRON have much cheaper transaction fees and, therefore, are better for small and frequent transactions. Most of the efficiency in cost for these newer blockchain networks is because of their more energy-efficient and scalable PoS or hybrid mechanisms.

The above comparison has shown that different advantages and disadvantages are open to a range of diverse characteristics of cryptocurrency in various industries and applications. While Bitcoin and Ethereum represent the pinnacle of security and decentralization, slower transaction times, combined with higher costs, may be prohibitively impossible for utility in fast, low-value use cases—or, in other words, high frequency and low value. Younger blockchain networks, like Solana and TRON, are designed with scalability and efficiency in mind; these are intended to solve content creators' problems and those using such platforms for high throughput and low fees. From high-frequency trading platforms to applications requiring near-instant transaction processing, such as in-game microtransactions for gaming dApps, Solana is used for its high throughput of 65,000 TPS. In the same way, BNB Chain's low transaction cost can power micro-transactions and payments that burden small amounts. These include, for instance, micropayments created inside games without fees stripping the small purchase. Furthermore, XRP was committed to affordable, speedy international remittances, which spoke to attributes of remittance companies wanting to provide users with the ability to make speedy and cheap international money transfers. Such nuances become very important to comprehend as industries take on more of the adoption of blockchain technology and as businesses assess available platforms. We consider the security, efficiency, interoperability, adherence to regulatory needs taken into consideration, and, above all, support from the developer ecosystem, according to a particular requirement of the selected use case.

Moreover, consensus mechanisms underpin the ever-emerging face of cryptocurrencies. Although PoW remains the most secure system for transaction validation—as seen in Bitcoin—it is energy-intensive and slow. Therefore, methods such as PoS and hybrid mechanisms look promising for Solana and BNB; they greatly improve scalability while reducing energy consumption. These newer mechanisms have come into prominence because of environmental concerns with blockchain technology and the need for greener alternatives. The second highly important mechanism constituting the long-term viability of a cryptocurrency pertains to scalability. Older blockchains have a hard time processing higher transaction volumes without compromising on efficiency, whereas Solana, BNB, and TRON do a great job because of their advanced consensus algorithms, allowing for tens of times more transactions per second compared to Bitcoin and Ethereum. However, this scalability often comes with a trade-off between decentralization and security: as many of the new platforms make much faster transaction processing abilities possible, it might involve more security risks or larger centralization challenges than some of the more established networks.

In terms of security and market adoption, BTC and ETH remain the most trusted and secure digital assets due to their long-standing presence and widespread developer and user communities. Solana and BNB, though newer, have rapidly gained market share and are backed by strong ecosystems. However, issues such as Solana’s occasional network outages suggest that newer platforms may still need to address reliability concerns as they scale. The differences in market adoption highlight how each cryptocurrency is positioned within specific use cases. Bitcoin is widely regarded as a store of value, often referred to as "digital gold," while Ethereum leads in DeFi and smart contract functionality. XRP is uniquely focused on cross-border payments, leveraging partnerships with financial institutions, while TRON is more centered around content-sharing and entertainment applications. Tether and USD Coin, as stablecoins, have carved out their niche by providing stability and liquidity in the highly volatile cryptocurrency market, making them essential tools for traders and investors.

Furthermore, Table 3 provides a comprehensive comparison of the top ten cryptocurrencies, emphasizing their strengths and ideal applications based on weighted performance metrics. BTC and ETH lead in security (9.8 and 9.5) and market adoption, making them suitable for high-value transactions despite their lower ratings in speed and cost efficiency. SOL and BNB achieve high overall scores (8.5 and 8.3) due to their superior transaction speeds, cost efficiency, and scalability, making them ideal for DeFi and dApps. TRX and XRP excel in speed and low transaction costs, making them optimal for payment systems. Stablecoins like USDT and USD Coin USDC perform well in market adoption and cost efficiency, making them preferred choices for stable value transfers. DOGE and TON offer balanced performance, with DOGE benefiting from community support and TON excelling in general transaction capabilities. This analysis illustrates how different cryptocurrencies align with specific use cases, providing a clear framework for stakeholders to select the best-suited digital assets based on their needs.

In conclusion, the comparative analysis reveals that no single cryptocurrency excels across all metrics. Each digital asset has been optimized for specific strengths, whether it's transaction speed, cost efficiency, scalability, security, or market adoption. Investors and developers must carefully consider these trade-offs when selecting a cryptocurrency for specific use cases.

5. Recommendation

Based on our comparative analysis, recommendations are tailored to three primary stakeholder groups: institutional investors, developers, and retail investors, each with distinct needs and priorities in the cryptocurrency ecosystem.

For institutional investors, we recommend a structured portfolio approach prioritizing security and market stability. BTC and Eth, with their superior security ratings (9.8/10 and 9.5/10 respectively) and high market adoption metrics, should constitute 60-70% of institutional cryptocurrency holdings. This allocation provides a strong foundation for established assets with proven security track records. Complementing these core holdings, we recommend a 20-25% allocation to stablecoins, specifically USDT and USDC (both with 8.5/10 security ratings), for liquidity management and risk mitigation. The remaining 10-15% can be allocated to high-performance platforms like Solana (an overall score 8.5/10) and BNB (8.3/10) for exposure to technological growth potential. This balanced approach allows institutions to maintain security while capturing emerging opportunities in the digital asset space.

Retail investors require recommendations balancing accessibility, usability, and risk management. For long-term investment strategies, BTC and Eth remain the most reliable choices, supported by their high security and market adoption metrics. We recommend implementing dollar-cost averaging strategies with a minimum 2-3 year holding period for these assets. Active traders should consider Solana and BNB, which offer optimal performance in transaction speed and cost efficiency, essential for frequent trading activities. For stable value transfer and risk management, USDT and USDC provide the necessary price stability and liquidity, making them ideal for trading pairs and value preservation.

Cross-cutting these recommendations, several key principles emerge. First, security ratings should be weighted more heavily for long-term holdings and institutional investments, while transaction speed and cost efficiency become more critical for active trading and development platforms. Second, market adoption metrics (particularly important for stablecoins USDT and USDC) should influence liquidity-dependent decisions. Third, scalability considerations, especially strong in platforms like Solana (9.5/10) and TRON (9.0/10), should factor into forward-looking technology choices.

These recommendations should be regularly reassessed as the cryptocurrency ecosystem evolves. The rapid pace of technological advancement and changing regulatory landscapes necessitates dynamic adjustment of investment and development strategies. Additionally, stakeholders should consider their specific regulatory requirements, risk tolerance, and use case demands when implementing these recommendations. The performance metrics and weightings provided in our analysis serve as guidelines rather than absolute rules and should be contextualized within each stakeholder's unique circumstances and objectives. Where the developers should focus on platforms that offer optimal technical capabilities and robust development ecosystems. For DeFi applications, Solana and BNB emerge as leading choices, offering superior transaction speeds

(9.8/10 and 8.5/10 respectively) and cost efficiency (9.2/10 and 8.8/10). These platforms provide comprehensive SDK support and active developer communities essential for DeFi innovation. Enterprise solution developers should prioritize Ethereum and BNB for their established smart contract capabilities and enterprise-grade security features (ETH: 9.5/10 security rating). For payment system development, XRP and TRON offer specialized advantages with their high transaction speeds (9.0/10 and 9.2/10 respectively) and payment-focused APIs, making them ideal for financial technology integration.

In summary, there is no one-size-fits-all cryptocurrency. The optimal choice depends on the specific priorities of speed, security, cost, or scalability. Stakeholders should tailor their selection based on the specific needs of their projects, weighing the trade-offs between performance, cost, and market trust.

Declaration

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Anuyahong, B., & Ek-udom, N. (2023). The Impact of Cryptocurrency on Global Trade and Commerce. *International Journal of Current Science Research and Review*, *6*(4), 2543-2553.

Asif, R., & Hassan, S. R. (2023). Shaping the future of Ethereum: Exploring energy consumption in Proof-of-Work and Proof-of-Stake consensus. *Frontiers in Blockchain*, *6*, 1151724.

Aysan, A. F., Khan, A. U. I., & Topuz, H. (2021). Bitcoin and altcoins price dependency: Resilience and portfolio allocation in COVID-19 outbreak. *Risks*, *9*(4), 74.

Bach, L. M., Mihaljevic, B., & Zagar, M. (2018, May). Comparative analysis of blockchain consensus algorithms. In *2018 41st international convention on information and communication technology, electronics and microelectronics (MIPRO)* (pp. 1545-1550). IEEE.

Badea, L., & Mungiu-Pupăzan, M. C. (2021). The economic and environmental impact of bitcoin. *IEEE access*, *9*, 48091-48104.

Burnie, A., Burnie, J., & Henderson, A. (2018). Developing a cryptocurrency assessment framework: function over form. *Ledger*, *3*.

Caudevilla, O., & Kim, H. M. (2022). The Digital Yuan and Cross-Border Payments: China's Rollout of Its Central Bank Digital Currency. *University of Hong Kong Faculty of Law Research Paper*, (2023/30).

Chamanara, S., & Mada, K. (2023). The Hidden Environmental Cost of Cryptocurrency: How Bitcoin Mining Impacts Climate, Water and Land. *United Nations University Institute for Water, Environment and Health (UNU-INWEH), Hamilton, Ontario, Canada*.

Chambino, M., Dias, R. M. T., & Horta, N. R. (2023). Asymmetric efficiency of cryptocurrencies during the 2020 and 2022 events. *Economic Analysis Letters*, *2*(2), 23-33.

Chang, L., & Shi, Y. (2020). Does Bitcoin dominate the price discovery of the Cryptocurrencies market? A time-varying information share analysis. *Operations Research Letters*, *48*(5), 641-645.

Chauhan, A., Malviya, O. P., Verma, M., & Mor, T. S. (2018, July). Blockchain and scalability. In *2018 IEEE international conference on software quality, reliability and security companion (QRS-C)* (pp. 122-128). IEEE.

Dias, R., Horta, N., Chambino, M., Alexandre, P., & Heliodoro, P. A Survey on Efficiency and Profitable Trading Opportunities in the Cryptocurrency Markets: An Approach in the Context of the War of 2022. *LIMEN 2022*, 19.

Drollette Jr, D. (2022). Introduction: The unintended—and undermanaged—consequences of blockchain and cryptocurrency. *Bulletin of the Atomic Scientists*, *78*(4), 185-186.

Goodkind, A. L., Jones, B. A., & Berrens, R. P. (2020). Cryptodamages: Monetary value estimates of the air pollution and human health impacts of cryptocurrency mining. *Energy Research & Social Science*, *59*, 101281.

Halzoun, A., & Rabah, K. A. R. A (2023). Cryptocurrency Expansion and Development: A Competitive Modern Banking Investment and Payment Option. *International Journal of Humanities and Social Sciences*, *5*(1),703-714.

Kaal, W. A. (2020). Digital asset market evolution. *J. Corp. L.*, *46*, 909.

Khan, D., Jung, L. T., & Hashmani, M. A. (2021). Systematic literature review of challenges in blockchain scalability. *Applied Sciences*, *11*(20), 9372.

Köhler, S., & Pizzol, M. (2019). Life cycle assessment of bitcoin mining. *Environmental science & technology*, *53*(23), 13598-13606.

Krishna, S. J. S., Panda, A., & Sindhuja, P. (2023). Cryptocurrency adoption and its influence on traditional financial markets. *dynamics*, *8*, 11.

Leitch, M., & Matanović, A. (2018). Control frameworks for cryptocurrencies: an initial evaluation. *On-line Simulation for Cryptocurrencies-Long Finance*.

Lin, S. (2023). Proof of work vs. Proof of stake in cryptocurrency. *Highlights in Science, Engineering and Technology*, *39*, 953-961.

Nasir, A., Shaukat, K., Khan, K. I., Hameed, I. A., Alam, T. M., & Luo, S. (2020). What is core and what future holds for blockchain technologies and cryptocurrencies: A bibliometric analysis. *IEEE Access*, *9*, 989-1004.

Othman, A. H. A., Alhabshi, S. M., Haron, R., & Noor, A. B. M. (2019). The future of the banking system under the dominance and development of the cryptocurrency industry: empirical evidence from cointegration analysis. *The Journal of Wealth Management*, *22*(2), 109-127.

Rahman, I. A., Indrakusuma, T., Widodo, A., & Nuryadin, D. (2023). Dogecoin Price Volatility After Economic Recovery on COVID-19 Pandemic. *International Journal of Advanced Economics*, *5*(6), 129-137.

Rejeb, A., Rejeb, K., & Keogh, J. G. (2021). Cryptocurrencies in modern finance: a literature review. *Etikonomi*, *20*(1), 93-118.

Sinlapates, P., & Chancharat, S. (2024). Persistence and volatility spillovers of Bitcoin to other leading cryptocurrencies: a BEKK-GARCH analysis. *foresight*, *26*(1), 84-97.

Sivicka, J. O. (2018). The influence of cryptocurrency on the future of the international financial payment system through the example of a bitcoin. *Економічний простір*, (134), 40-55.

Smirnov, D., Baklanova, O., Sagalaeva, E., Zhukov, A., Tereshchenko, E., & Dolgopolov, K. (2023). Role of Legal Regulation in Preventing Corruption in the Market of Digital Financial Assets in the Context of Sustainable Development. *Journal of Law and Sustainable Development*, *11*(5), e557-e557.

Srivisad, N., & Wattanakoon, P. (2024). Assessing Price Stability in Fiat-Backed Stablecoins: Implications for Financial Regulation and Market Dynamics. *Available at SSRN 4977810*.

Ssaharti, M. (2022). The impact of crypto currencies on the economy and the financial industry. *Journal of Advances in Humanities Research*, *1*(1), 60-69.

Suhaimi, S., Hui, L. Y., Shafee, N. B., Hashim, H., Huda, S. N., & Othman, M. M. A. (2022, December). Financial Technologies for Accepting Transaction Using Cryptocurrency. In *2022 International Conference on Digital Transformation and Intelligence (ICDI)* (pp. 209-213). IEEE.

Surana, L. (2023). Uncovering Systematic Risk in Crypto currency Markets: An Empirical Investigation Using DCC-GARCH Model. *ANUSANDHAN – NDIM's Journal of Business and Management Research*, *5*(2), 11–26.

Wang, Z. (2023). The Performance Comparison between PoSpace and PoW. *Highlights in Science, Engineering and Technology*, *57*, 148-153.

Xu, Y., Yang, X., Zhang, J., Zhu, J., Sun, M., & Chen, B. (2021). Proof of engagement: a flexible blockchain consensus mechanism. *Wireless Communications and Mobile Computing*, *2021*(1), 6185910.

Zhang, C., Wu, C., & Wang, X. (2020). Overview of blockchain consensus mechanism. In *Proceedings of the 2020 2nd International Conference on Big Data Engineering* (pp. 7-12).

Zhou, Q., Huang, H., Zheng, Z., & Bian, J. (2020). Solutions to scalability of blockchain: A survey. *IEEE Access*, *8*, 16440-16455.