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Blockchain platforms

Metropolia University of Applied Sciences

Bachelor of Engineering

Degree Programme in Information Technology

Bachelor's Thesis

3 November 2021

Abstract

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Title: Blockchain platforms
Number of Pages: 43 pages + 1 appendix
Date: 3 November 2021

Degree: Bachelor of Engineering
Degree Programme: Degree Programme in Information Technology
Professional Major: Name of the professional major
Supervisors: Janne Salonen, Head of School
Sonja Holappa, Principal Lecturer

The purpose of the study was to compare four cryptocurrencies, including Ethereum, Cardano, Polkadot and Solana, to establish the one with the most potential and possibility of surviving. Cryptocurrency is a relatively new technology that is changing how humans transact and share information.

The study is part of a thesis for the Bachelor of Engineering program. The research is based on theoretical research as Game theory is used to analyze cryptocurrencies and blockchain platforms. Existing research has already provided an overview of the four cryptocurrencies, and further research was needed to identify the opportunities in blockchain technology.

The result of the research is that Polkadot has the most potential for growth in the long term, considering that it will provide a link for all blockchains. Other platforms have limitations, and that is affecting their capabilities to grow and dominate the blockchain ecosystem.

The significant finding of the research is there needed to be a platform to link all the existing and upcoming blockchain projects. Current cryptocurrencies should adopt hard fork and cross-chain platforms to help them achieve success. Polkadot is implementing the concept, and that will likely have an impact on future blockchain technology. The findings can underpin future research on blockchain to ensure there is a breakthrough in the technology.

Keywords: Blockchain, Cardano, cryptocurrency, DeFi, Ethereum, game theory, interoperable, Polkadot, Solana

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List of Abbreviations

DeFi:	Decentralized Finance
IDE:	Integrated Development Environment
PoS:	Proof-of-Stake
PoW:	Proof-of-Work
UIAs:	User-Issued Assets
PoH:	Proof of History
TPS:	Transactions Per Second
DPoS:	Delegated-Proof-of-Stake
NPoS	Nominated-Proof-of-Stake
BFT:	Byzantine fault tolerance
EVM:	Ethereum Virtual Machine

1 Introduction

Bitcoin, invented by someone named Satoshi Nakamoto in 2008, is possibly the most hyped technology of the 21st century. Nobody knows who Satoshi Nakamoto is; it might even be a group of people. Bitcoin, and other cryptocurrencies in general, have many proponents and opponents, and the future of the cryptocurrency is impossible to predict. There are experts who claim that the value of Bitcoin will go back to zero soon, but other experts assure this will not happen and they predict a value close to or even much more than one million dollar per Bitcoin.

The innovative technology behind Bitcoin is the blockchain. Before Bitcoin, there was no such thing as blockchain. A Blockchain can be seen as a specific type of a distributed ledger that is immutable. With this relatively new technology, the opinions of experts differ quite a lot as well. There are people who think that Bitcoin is one of the biggest scams in history, and the blockchain technology is useless. Others argue that the block-chain technology is even more important than the internet.

Cryptocurrency refers to the aggregation of binary data that helps digital currencies to transact in a decentralized system. Blockchain technology is allowing digital cryptocurrencies to transact and store information through the distributed network [1 pp. 117134-117136]. The technology can be used in various sectors, and it is the reason it is attracting interest from people, organizations, and governments. Cryptocurrency will support future human operations, and its analysis is critical to understanding emerging trends in the blockchain environment.

2 Current State Analysis

A high number of people are adopting cryptocurrency, contributing to the growth of blockchain technology. However, new tokens emerge every time, and it is a challenge to identify the one with better functionality. The paper will analyze the blockchain platforms Ethereum, Cardano, Polkadot, and Solana in terms of technical aspects, speed, cost, pros/cons and possibilities for programmers to understand their future capabilities. The analysis will help gain insights that will inform the development of proposed solutions in the blockchain ecosystem.

3 Materials and Methods

The report will rely on scholarly research conducted by researchers in the cryptocurrency domain between 2017 and 2021. Besides, it will also utilize web articles that constantly provide information regarding what is taking place around blockchain technology. The resources will be sufficient in the research process and ensure the analysis will be credible and reliable.

4 Theoretical Background

Game theory is the theoretical concept that will be applied in this research. According to Park, Game Theory applies to cryptocurrency since individuals constantly seek information that will make them come up with the best decision [2 pp. 16-18]. Human behavior impacts the rational decisions human beings make and the ability of a cryptocurrency to gain or lose its market share. The theory will be critical in analyzing cryptocurrency concepts and identifying the platform with the greatest potential in the long term.

5 Ethereum

Ethereum is a cryptocurrency with the second-most value after Bitcoin, and its token, ether, was meant to be a fuel that will drive global computers [3 pp. 91]. Blockchain rise led to the development of the decentralized concept. Vitalik Buterin conceived Ethereum in 2013, and other programmers started developing applications and interacting with the platform after that. Over the years, upgrades have been released, and the value of Ethereum has been rising. Restrictions of the blockchain-based systems made Ethereum emerge as a good network for people to invest in digital assets. The unique features of Ethereum continue to make it the desired cryptocurrency, and its monetary values and interests have been rising.

5.1 Technical aspects

Ethereum is a public platform that allows other users to program it. Being open-source and decentralized means that programmers can develop decentralized applications that will be used on the Ethereum platform. According to Chen et al., eight smart contracts have already been deployed on Ethereum, and they have concentrated on invocation of smart contracts, development of decentralized applications, and money transfer [4 pp. 8].

The idea of Smart Contracts is not new. Nick Szabo introduced them already in 1996 and describes them as:

"A smart contract is an electronic transaction protocol that executes the terms of a contract. The general objectives are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitrations and enforcement costs, and other transaction costs." [5]

Ethereum works by manipulating digital units to gain value. Nodes that are able to maintain a similar view are able to engage mutually in the peer-to-peer network. A consensus algorithm ensures that data is evenly distributed in every

node within the blockchain network [6 pp. 2-3]. When the nodes agree, they will be able to get a consensus, and the state will allow a transaction to proceed. There are many copies of the transaction that exist in every node, and they help verify the authenticity of the transaction. Ethereum utilizes diverse consensus approaches such as Practical Byzantine Fault Tolerance (PBFT), Proof-of-Work (PoW), and Ripple [6 pp. 2-3]. PBFT is an approach that utilizes byzantine faults. Predefined nodes are utilized to validate data on the block in the network. PoW is a strategy that helps in calculating node's hash value and is based on the preceding block when it is matched and then appended on the new block. Generating the hash values requires high processing speed, and it helps in authenticating data transactions. Ripple is an algorithm where the client is only involved in transferring transactions while the server approves the consensus process. The server has a unique code, and when there are over 80% agreements, a transaction is approved in the Ethereum platform. Ethereum relies on these algorithms to perform transactions and ensure there is no lag in the network.

Lack of employing these technical aspects leads to problems in the Ethereum network. Blockchain relies on a logical order to perform operations, and reaching consensus is affected by the order of messages, leading to malicious replication faults [7 pp. 5]. Smart contracts are not completely fault-tolerant, and they depend on the set requirements to achieve the objectives of each transaction. The blockchain design and peer-to-peer network allow different processes to occur. The technical elements would not occur if the Ethereum Virtual Machine (EVM) did not exist. EVM is allowing Ethereum to be programmable, and through it, other programmers can develop their applications and deploy them on the platform. The system is protocol-based and reward-oriented, ensuring that practical applications and users exploit them in the blockchain. Technical aspects of Ethereum make it superior and for other stakeholders to be interested in enhancing the status of the cryptocurrency.

5.2 Speed

Speed is a critical factor to consider when investors and programmers want to select a cryptocurrency. It influences the rate at which a transaction takes to be recorded in the network. The shorter the time, the higher the chances of an individual investing in an alternate cryptocurrency. Besides, it affects how quickly one spends the ether in their digital wallets. According to Tezro, speed influences the waiting time and usability of digital coins, and it is measured in terms of minutes [8]. Table 1 below shows the TPS and average transaction confirmation time of several popular cryptocurrencies.

Table 1. Comparison of speed of several popular cryptocurrencies [8]

Cryptocurrency	Transactions per Second	Average Transaction Confirmation Time
Bitcoin	3-7	60 min
Ethereum	15-25	6 min
Ripple	1500	4s
Bitcoin Cash	61	60 min
Stellar	1000	2-5 s
Litecoin	56	30 min
Monero	4	30 min
IOTA	1500	2 min

As depicted in table 1, Ethereum has a transaction speed of between 15-25 seconds, and the average confirmation time is six minutes. The transaction per second of Ethereum is higher as compared to Bitcoin, which is 3-7 seconds, while the conformation time is 60 minutes. However, the TPS of Ethereum is low compared to that of Ripple and Stellar, which have over 1,000 transactions executed in under a few seconds. The higher the transaction speed, the more the number of transactions that will be processed within a given time and it will grow with increase in functionality. It takes 15-25 seconds because the time

helps in preventing any congestion from occurring. On average, Ethereum has a good speed that prevents users from being affected by unexpected delays, making the blockchain inefficient. Theoretically, the speed is computed by dividing the maximum number of transactions that can be done per block by the data that is transferred through the network. Comparative analysis of Geth and Parity Ethereum shows that transaction speed influences the consistency of the network, time per transaction, and network scalability [9 pp. 2506 – 2507]. Temporary options such as increasing the size of the block have been identified to increase speed, but they are not effective in the long-term considering the demands that exist in a network. The limits in the network blocks mined per every period, the size of transactions, and the number of memory pools influences the cryptocurrency's speed. Ethereum does not have a limit to the number of transactions that can be processed in a single block, and they are faster in comparison to Bitcoin-based currencies, which are limited by the time and size of blocks [8]. The higher the number of miners in the Ethereum platform will translate to a higher transaction speed, which will be critical in making the cryptocurrency a preference of many globally.

5.3 Cost

Table 2 below compares the average fees between Bitcoin, a first-generation blockchain, and Ethereum, a second-generation blockchain.

Table 2. Comparison of cost of Bitcoin and Ethereum [8]

	1ST GENERATION BITCOIN (BTC)	2ND GENERATION ETHEREUM (ETH)
Transactions per Second	3+ TPS	12+ TPS
Average fee	\$2,99 USD	\$2,89 USD
Transactions confirmation	10 - 60 minutes	10 - 20 seconds

Table 2 above shows that it costs \$2.89 for every Ethereum transaction while for Bitcoin is \$2.99. The cost is high considering the time taken and the number of transactions taking place in the network. The miners can use less expensive materials to approve the transactions, reducing the level of competition. The increase in transaction speed helps to reduce the cost it takes for one Ethereum to be produced. As of November 3th, 2021, the current price for Ethereum was \$4474 [10]. The cost of cryptocurrency continues to increase as more smart contracts continue to be developed in the platform. The market value of Eth is increasing as more people are gaining interest in purchasing the coin.

5.4 Pros of Ethereum

5.4.1 Competent leadership

The visibility of Vitalik Buterin is enhancing the status of Ethereum. The founder has been using his vision to ensure that the value of Eth continues to increase in the coming years. Through that, it has been easy to attract competent developers who continue to develop interesting products. The stewardship of the leader continues to enhance the reputation and reliability of Ethereum in the cryptocurrency market. Governments have also been looking for ways to utilize Ethereum smart contracts considering it can be used in voting and gaming, among many other fields. The leader has not been found in any of the scandals, which is helping to enhance the reputation of the cryptocurrency. Through Vitalik's leadership, Ethereum will continue to achieve greater success in the future.

5.4.2 Potential functionality of the platform

Ethereum can be used in many ways, making it a go-to platform to utilize in the blockchain. Decentralized applications and smart contracts have been developed, and they highlight the functionality of the platform. Coming up with ICO tokens has also been significant as it helps to increase the markets where Ethereum can be utilized. For instance, the introduction of ICO tokens meant

that Eth could be used in the prediction and gaming markets. More functionalities will be introduced as the platform continues to expand. Financial analysts are optimistic about the potential uses that Ethereum can offer and term it as a good investment in the digital market. The low-risk investment seems to have great potential remunerations, making it gain more interest among the people.

5.4.3 Regulatory clarity

Self-regulation is helping to reduce manipulation of the crypto market, and Securities and Exchange Commission has commended the clarity of Ethereum and its impact on disruptive innovation [11 pp. 3-4]. There have been instances where people have lost their cryptocurrency investments. People have realized the potential that exists and is creating Ponzi schemes that make them steal from others. Regulation of Ethereum has helped it to maintain its status and an investment choice among individuals. Lack of regulatory clarity leads to unintended wrongs and fewer rewards for investors. As more people invest in digital assets, cryptocurrencies that have adopted the best regulations, such as Ethereum, will significantly benefit.

5.4.4 The backing by notable capitalists

Renowned venture capitalists have been funding research on Ethereum, and that is helping to increase its value. It is a critical information people look out for before choosing a cryptocurrency to invest in. The resources from the capitalists ensure that the network can be scaled, and investors will benefit from Ethereum in the future. The capitalists know how to recognize blind spots and only invest in domains that will bring them significant profits in the short or long term. The decision to invest in Ethereum has been inspired by its projects and growth curve. An increase in investment from the capitalists will make more of their followers invest in Ethereum, leading to a rise in value in the coming years.

5.5 Cons of Ethereum

5.5.1 Emerging competition

New cryptocurrencies have been introduced in the market, and they have enhanced functionality. They eliminated some of the flaws Bitcoin and Ethereum has, and they appear promising to the users. Their paradigms and functionality are superior, and they would disrupt the cryptocurrency market. A reduction in Ethereum market share will translate to losses for the investors and limit its opportunities in the future. In addition, they are cheaper than Ethereum, which influences the purchasing decisions of the people. The ability of the alternatives to be better than Ethereum is making the projects gain traction, and it is limiting the ability of the former to achieve growth.

5.5.2 Over-reliance on Buterin's fame

In the crypto world, Vitalik Buterin has an excellent reputation, helping to enhance the status of Ethereum. Any negative news from the founder will significantly affect the platform. Excessive dependence on Buterin is an issue, and it will negatively impact the sustainability of the coin in the future. The success of Ethereum can be attributed to Vitalik, and without his presence, the future looks bleak for the cryptocurrency. Ethereum needs to take advantage of the presence and mold other leaders to prevent the shortcomings that may arise in the future due to overreliance on its founder.

5.6 Possibilities for programmers

The process of developing smart contracts on the Ethereum platform has been made to be an easy process. It starts from the foundational concepts to the building of development stacks. According to Wohrer, Solidity is a programming language that utilizes if-then statements, and it provides solutions to running new applications on the blockchain [12 pp. 2-3]. The simplicity ensures that programmers can easily start learning about the platform and develop

decentralized applications. Accessibility also ensures that different businesses globally can innovate blockchain solutions relevant to their industries. Ethereum is open source, which means individuals can access documentation and information needed to learn about cryptocurrency. It simplifies the process of designing and coding Ethereum applications. Besides, the programmers can reuse some of the code written by their peers. The availability of resources also warrants that Ethereum has a community that helps enhance the platform's growth. Through that, programmers have emerged on this platform, and they seek to solve some of the world's problems. Bring community-driven ensures that there are opportunities for the programmers to explore, leading to increased functionality in the platform. The possibilities are making Ethereum the market leader in developing decentralized applications as there are a wide array of ways to use the platform. In the coming years, the trend will continue to be the same, and the wide array of opportunities for programmers would ensure Ethereum becomes the go-to cryptocurrency in the market.

5.7 Future expectations

Blockchain-based systems had many limitations, and the introduction of Ethereum provided many opportunities for the stakeholders. Research has focused on the possibilities that exist in the Ethereum network and the impact it will have on the blockchain ecosystem. According to Chen, most of the research on Ethereum has focused on maintenance-related concerns as efforts from the smart contract developers lead to Eth's fast growth [13 pp. 4-5]. Developing and deploying the smart contract in the platform is easy, but maintenance has proved to be a challenge. The aim is to make the technology to be attractive and for more users and developers alike. Besides, there is the aspect of security. More people continue to rely on Ethereum to purchase and store their digital assets. The 2016 cyber-attack on the platform made more researchers seek information to help them establish the root cause of the attack. The platform has unique characteristics and that makes it vulnerable to some cyber-attacks. Security will continue to be a critical factor of consideration in research and one that will influence the opportunities of Ethereum. Future research

direction will continue to focus on how the smart contract developers can maintain their projects and how it will improve the Ethereum ecosystem.

Ethereum has a high possibility of surviving, but security threats and other issues need to be addressed to enhance its sustainability. Errors arise in the smart contracts, making it challenging to maintain the products and achieve monetary values [14 pp. 3]. The team needs to make the software more useable, and the performance of the running environment will improve. It will be hard for the Ethereum network to crash and it reduced the possibility of any cyber-attack occurring in the future. Addressing these challenges would require the team of developers to establish more standards and patterns that they will use in their source code and enhance the opportunities for their smart contracts. Ethereum contracts have been gaining attention from the government, and increased technology uptake will lead to enhanced adoption. The higher the number of decentralized applications that will be built on the Ethereum platform, the more opportunities will arise. It will help Ethereum fight off competition from other emerging cryptocurrencies and succeed in maintaining its position in the market. Industry players have been predicting that the value of Ethereum will double by the next five years, and the trend will continue in the coming years. The increase in value of the cryptocurrency will make more individuals interested in it, enhancing the chances of it surviving in the future market. Simply by being the first programmable blockchain platform, Ethereum has an extra high chance of surviving for the near foreseeable future.

6 Cardano

Cardano is categorized as the third generation of cryptocurrency whose aim is to expedite peer-to-peer transactions. Its coin is referred to as ADA and was established by one of the co-founders of Ethereum. Similar to Ethereum, it is open source and decentralized. It allows developers to build smart contracts on the platform. Cardano is the first cryptocurrency to utilize proof-of-stake blockchain, which is seen as the greener alternative to the existing protocols [15,97]. The initial release of ADA was done in 2017, while the stable coin was released in 2021. The cryptocurrency was built in five phases, and Cardano seeks to achieve sustainability and scalability of the blockchain network. The aim of the platform was to ensure there exist global solutions, and through collaborations, developers can provide opportunities through the Cardano platform.

6.1 Technical aspects

Cardano is considered an improvement of Ethereum, which has slower transaction times, increasing costs, and high energy use. The challenges have a great implication on the blockchain, and it was an inspiration for the development of Cardano. The cryptocurrency does not rely on a white paper but rather on research which helps to point out the challenges experienced by the competitors. The design principles aim to make the cryptocurrency seamless and maintain their privacy. Cardano utilizes the Ouroboros PoS consensus protocol, which is based on a research-based framework, and at the moment, the blockchain does not support smart contracts [16 pp. 5]. Insights from the peer reviews ensure that Cardano can utilize evidence-based methods to achieve its objectives. The Ada token is the primary cryptocurrency of the platform, and it is meant to support User-Issued Assets (UIAs) in the coming years.

The Ouroboros uses the concept of proof-of-work, which is a different protocol compared to the ones used in Ethereum and Bitcoin. In the protocol, there is a

settlement layer, and it works by recording all the transactions that take place in the Cardano network. The other is the computational layer which is meant to work the same way as Ethereum by allowing developers to develop smart contracts and decentralized applications. The aspect makes Cardano reliable and secure. The principle of the protocol is slots are allocated, and each is divided by time into epochs. They work by validating transactions and creating new blocks. The algorithm is connected with the pools, and that helps to save energy. For instance, the platform allows some blocks to be created even in events when one is offline. Mining of the blocks utilizes the Proof-of-Stake (PoS) algorithm, which saves energy of productions. Achieving this requires the algorithm to be incorporated with Proof-of-Work (PoW) that is used in Bitcoin. Figure 1 below depicts the deployment options available for sidechains in the Cardano network.

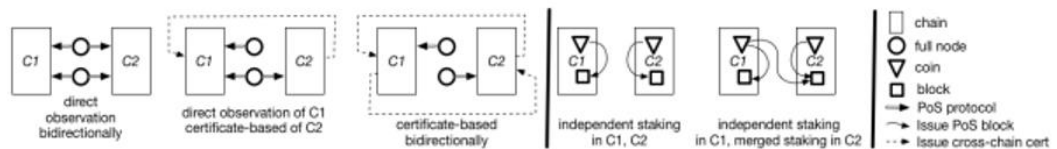


Figure 1. Deployment options for sidechains in Cardano [17 pp. 10]

As illustrated in Figure 1 above, there are four possible deployment options for sidechains in a Cardano network. The availability of different deployment options is meant to ensure individuals can deploy their decentralized applications in a sidechain that suits their preference [17 pp. 10]. Sidechains are parallel blockchains connected to the main blockchain. They could have their own consensus protocol and add new functionality and improvements [18]. The PoW design mechanism uses fewer computing resources, and that helps to reduce energy requirements [19 pp. 85730]. Recently, Cardano introduced its DeFi, which enhances the ability of developers to build applications on the Cardano network. The Cardano team has also worked hard to develop a smart contract language that is intended to allow developers to build their applications and conduct end-to-end tests without leaving the IDE. It means that one can

deploy their applications on the platform without relying on third-party applications. Through these technical aspects, some of the products have been developed in Cardano, including Atala Prism, Atala Scan, and Atala trace.

6.2 Speed

According to Rousey, the transaction speed of Cardano is 1,000 TPS, and it is one of the highest in the cryptocurrency market [20]. The proof-of-Stake algorithm influences the speed of Cardano as it is meant to solve the scalability problem previously experienced by other competitors. On average, Cardano can handle about seven transactions in one second, which is low compared to Ethereum, which handles about 12 transactions per second. Transparency and security are the main features of Cardano, and that is achieved at the expense of a slower transaction time. In comparison, EOS has the highest speed of 3,000 TPS, followed by Tron with 2,000 TPS, and then Ripple with 1,700TPS [20]. Change of some parameters could make the transaction speed of Cardano improve. For instance, improving the movement of data between the different payers in the network will help improve the speed of Cardano in the future.

6.3 Cost

Laura highlights that by 2021, Cardano was among the ten cryptocurrencies with the highest market capitalization, and from launch to 3 months, there was a 6000% growth, and the value grew to \$31 billion [21]. The cryptocurrency became very popular after its launch, and that was a result of the credibility of the development team as well as the technological advancement the coin had made. Analysts predict that the value of Cardano will continue to increase in the coming year as more advancements are made despite the rise in competition in this market. The superior technology and the platform being open-source will contribute to the growth in value of Cardano. Technical aspects provide a strong case for Cardano, and it means the cost of production and maintenance of the platform will reduce with an increase in trade volumes, while the cost of ADA

will increase significantly. Relying on the same vision is critical as it would make Cardano be the next generation of cryptocurrency.

6.4 Pros of Cardano

6.4.1 Dual layer functionality

The dual-layer is what makes Cardano different from other cryptocurrencies that exist in the market. The layers allow Cardano to authenticate transactions simultaneously, and through that, it will be easy for the decentralized applications to become successful. The latter's functions are split into two, and it increases the speed of authorization and reduces the complexity of the system. The functionality has ensured that one can send ADA to another individual with fewer issues. Besides, there is more extraordinary adaptability in this system, and changes can be introduced to meet the users' needs. The second layer, which is computational in nature, promises to allow smart contracts with the need to operate efficiently, and third parties can use it.

6.4.2 Scalability

Originally, the aim of developing Cardano was to create a scalable platform, and its design and development would ensure it meets its objectives [22 pp. 6]. Past cryptocurrency such as Bitcoin and Ethereum was affected by the aspect of scalability, and that is limiting their growth. While the initial currencies were able to perform some transactions per a given period, it was challenging to introduce new developments in their network. Refining the technology ensured that Cardano would provide a platform for decentralized applications to scale and be in a position to allow thousands of transactions to take place in one second. Scalability has been a factor that has led to the success of Cardano in the market.

6.4.3 Equality

According to Hartmann, the Ouroboros protocol in the Cardano network chooses validators randomly, and that ensures that there is an opportunity for everyone to get a reward [23]. Achieving equality is vital as it will help the users and developers select it instead of the others. The protocol works by ensuring those with enormous stakes will not take advantage of the system to create an unfair playing ground. There is a chance for all to contribute and lead to the growth of the platform. Being transparent in its operations makes Cardano be a preference of many. The benefits increase with the enhancement of transparency.

6.4.4 Eco-friendliness

Energy consumption has been an element that Cardano sought to solve since its inception. Cryptocurrency has been highlighted as one of the primary energy consumers. The large blocks of code and transactions that take place in the complex network translate to more computing power. Resources end up being exhausted and contributing to pollution in the world. The proof-of-stake concept ensures that verifying transactions will not lead to the consumption of energy as there are validators. Individuals want to be associated with projects that contribute to environmental conservation, and it will be a critical factor in helping users differentiate Cardano from other cryptocurrencies.

6.5 Cons of Cardano

6.5.1 Existing dominant players

The success of Cardano will be measured by its ability to eliminate some of the completion from the existing players. New initiatives are needed to allow the project to gain momentum and for the team to capitalize on the opportunities. New entrant continues to launch exciting projects, which can lead to slow progress of the Cardano Platform. The dominant cryptocurrencies continue to

increase their market share, and that will affect the success of Cardano in the coming years.

6.5.2 Cardano has no proven use case

The Cardano team has launched its programming language, and the lack of a use case makes it challenging for users to try a new concept. It is a unique platform, and the lack of a track record is a challenge to the founder's vision. Users prefer a tested and working platform and would not be willing to invest their time and resources on new ideas.

6.5.3 Challenges with centralization

The Proof-of-Stake protocol eliminated the challenges of mining encountered by other cryptocurrencies. However, the issue is with validation which is needed to approve transactions. There are a few validators who decides the block that will be validated on the Cardano network. If the users perceive the system as not fair, they will abandon the cryptocurrency and select to invest in the competitors. It is an issue that will continue to affect Cardano as its design is meant to remain this way.

6.6 Possibilities for programmers

Cardano has been launching new projects, and that will make it attract more programmers. For instance, it recently launched its DeFi application, which appears to be unique and will attract a pool of developers into its ecosystem. It is expected that revolutionary applications will be developed in the platform, and that will create more possibilities. Brent indicates that Cardano has a high degree of decentralization, and it provides great opportunities for the development environment [24 pp. 2-5]. The viable alternative for developing decentralized applications still runs on Ethereum virtual machines, limiting the potential of growing the blockchain network. It means that all the decentralized applications have to rely on Ethereum, which is a risk in case of any crash or

market failure. Cardano and its unique characteristics have succeeded in attracting great developers, and through their efforts, they are helping the platform grow much faster. From the pool of developer community, more people will start utilizing the technology and leading to the success of the Cardano ecosystem. Existing support ensure new programmers will face fewer issues and start to appreciate the system. In addition, Cardano's platform promises to add support for other cryptocurrencies. It will be a game-changer as it will make more developers use the platform to develop unique applications. Security has been a key feature in the development cycle, and the fewer the vulnerabilities, the higher the number of people who will be interested in the platform. Cyber-attacks make a project experience negative news, affecting the adoption rate by users and programmers. The world will likely witness unprecedented projects from Cardano, and unlike other platforms, they will be superior. Programmers appreciate such platforms as it gives them a chance to grow their possibilities. If the founders' vision remains the same, Cardano will scale much faster, and programmers will want to be associated with the cryptocurrency and its future projects.

6.7 Future expectations

One of the research that has been conducted on Cardano is on its programming paradigms. According to research by Brünjes, the blockchain's design of a cryptocurrency is influenced by its paradigms, which define its characteristics [25 pp. 1-2]. The programmability of a platform is critical as that would determine the number of applications built and success in the short and long term. The research has focused on determining the difference between the programming paradigm of Cardano in comparison to that of Ethereum since both are used to develop decentralized applications. It has helped in illuminating the unique elements in the blockchain and the capabilities they have. The Ethereum paradigm has been termed buggy, and that has led to challenges in the underlying systems. That is affecting the mission of the cryptocurrency as well as its monetary and regulatory policies. When the programmers lack control over a system, they will switch their interests to projects that will help

them enhance their programming. Cardano has been trying to improve its paradigm to avoid some of the challenges experienced in preceding projects. The research has helped highlight the burden for the programmers and the tradeoff that will exist in such a system.

Another critical research has been on the level of interconnection between cryptocurrencies. There is a strong relationship between the major six cryptocurrencies and the network influences their prices over time [26 pp. 2]. Understanding the interconnection is critical as it will provide insights into the impact on people's perception and their influence on prices. Besides, it will help to unearth the diversity that exists and how the unique characteristics shape the development of cryptocurrencies. Despite Cardano being unique, it borrows some of the concepts from its predecessors, and understanding this is critical to explore its trend in the coming years. Risks within an ecosystem can be understood by analysis of the interconnection. Individuals continue to invest in digital assets, and analysis of risks is vital to influencing investment decisions. People have been generalizing cryptocurrencies for a long time, and the findings of correlation are relevant in this market. Future research should also continue to explore the correlations between Cardano and other cryptocurrencies, and the insights will inform the trend of digital coins.

Cardano is dominant in the current market, and its future will depend on different elements. There are over twelve thousand altcoins in the market, and Cardano has withstood the intense competition to gain a market share. The design of the proof-of-stake protocol is that the more coins one possess, the greater the power they will have in the network. It is one of the factors that will influence the level of survivability of Cardano. New cryptocurrencies continue to be introduced in the market, and they offer more possibilities for users and developers. The acceptance of new concepts and the ability of Cardano to remain resilient will influence its position in the future market. The current mainstream media continues to promote sustainable investment such as Cardano's, and the rise of the trend will benefit the cryptocurrency in the coming years. The idea of using less energy to mine Cardano makes it a viable option.

Energy demand across the globe is increasing, and with more people becoming more environmentally conscious, the green investments by Cardano may finally pay off in the future. People might be forced to ditch other cryptocurrencies due to their damage to the environment and prefer Cardano. Without the development of an efficient mining system, the increasing carbon footprint will influence trading decisions people will make in the coming years.

7 Polkadot

Polkadot is a blockchain protocol that was developed and released in 2020. The technology can connect different chains in the network, which will allow the blockchain to have different but specific purposes. Gavin Wood started the idea of Polkadot in 2016 and has, over time, managed to develop the concept into a viable product. Despite the differences, the chains work efficiently, and security will be a guarantee. Polkadot developers aimed to address some of the existing challenges in the blockchain by providing a scalable framework [27 pp. 7-9]. The multiple chains will be interoperable, and their security will be achieved by collecting different network elements. It is different from other cryptocurrencies as it will allow users to control their blockchain. The ecosystem will receive competitions from EOS and Ethereum, which have already created their blockchain and are aiming to introduce new features that will enable them to succeed in the market.

7.1 Technical aspects

The multi-chain in Polkadot seeks to make the technology an Internet of Blockchains. The public network will have the capability to connect different blockchains and ensure communication can take place seamlessly. The network will have the ability to transfer information and tokens, allowing faster transactions to take place. In Polkadot's network, there will be two types of blockchains. The relay chain and parachains (cross-chains) can be customized to meet the users' needs and allow transactions to occur. Bridges will exist to connect the network to other blockchains, and tokens will be swapped from a central point. Cross-parachain interoperability is a new concept in the blockchain world, and Polkadot design will help users create unique sidechains in seconds [28 pp. 1-3]. Domains will be used to develop the sidechain, and all the data will be stored in the Blockchain's registry. Only authorized personnel will be allowed to join the sidechain, and the owners have the power to remove users from the platform. Polkadot sidechains rely on non-repudiation properties to allow users to call functions and update new features. The unique element of

this platform is that it will enable individuals to create private blockchains, which will allow transactions to occur more securely and efficiently. Through that, a high number of transactions can occur, and there will be no threats to performance. Figure 2 below shows the relay chain and parachain that exist in the Polkadot platform.

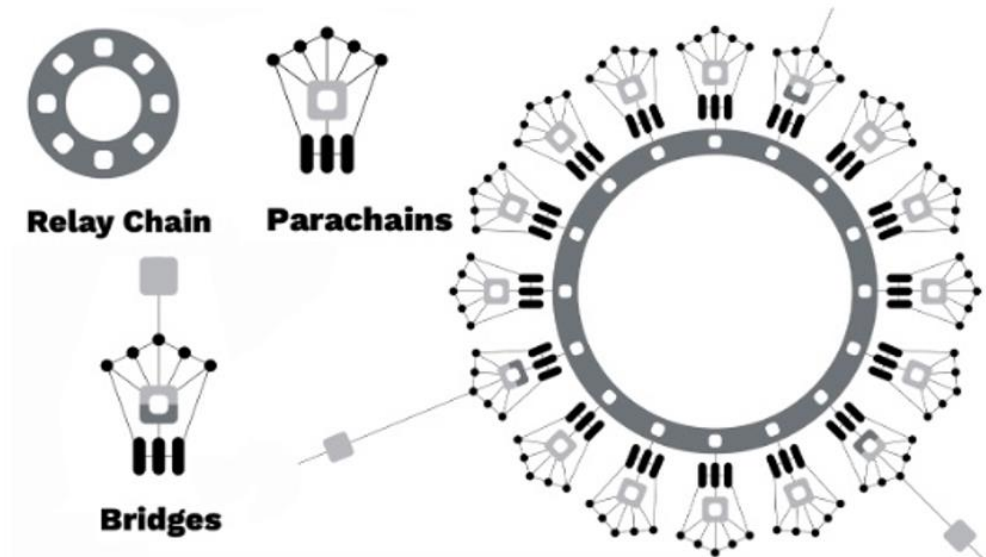


Figure 2. Relay chain and parachain in Polkadot [29]

Figure 2 above illustrates how Polkadot can develop a chain of blockchains. Cross-chain interoperability is achieved when a network of blockchains is interconnected, and each has its own tokens that can be optimized for unique use cases [29]. Polkadot will rely on DOT cryptocurrency for the people to conduct transactions. For agreements to occur, the technology depend on nominated-proof-of-stake (NPoS), which is a type of proof-of-stake (PoS). The consensus allows all individuals to have a right in the network and be part of the team to develop innovative features. Transactions from cross-parachain are similar to those in external accounts, allowing tokens to be exchanged in the ecosystem [30 pp. 5-6]. The same consensus algorithm is utilized, which guarantees that communication will continue to occur despite challenges in the sub-chains. Security will be achieved since it will be challenging for the attacker

to produce a similar cross-parachain, making its mining difficult. Through that, it will not guarantee that a malicious fork can occur in the network. Allocating resources will be an easy task as the bridges will be used to connect the sub-chains. When one has purchased DOT, they are allowed to be validators, nominators, collators, and fishermen within the network. Polkadot has governance which consists of the DOT holders, the council, and a technical committee. Staking is a critical concept in the technology, and it allows the subchains to leverage resources from the main network. Cross-chain communication has been advertised as the future of blockchain as users are restricted by utilizing only one platform. The cryptographically verifiable proof will allow users from different platforms to participate in Polkadot, and there will be rewards for the team. The concept by Polkadot will be a game-changer and contribute to the advancement in technology in the cryptocurrency ecosystem.

7.2 Speed

According to Pratik, Polkadot has a transaction speed of 1,000, which is fast compared to Bitcoin and Ethereum [31]. It has the same speed as Cardano but ten times the speed of Ethereum. New measures continue to be explored on ways to increase the speed, and parachute auctions are set to improve inter-chain interaction. Through that, the TPS in the Polkadot network will significantly increase. The NPoS consensus is a unique method that helps to reduce redundancy and ensure there is a fast speed in the chain networks. The transactions are parallel, and that allows the relay chains to achieve fast speeds. It guarantees that there is no competition for resources, and the collaboration warrants that the network can add value to each other. Besides, the customized blockchains are heterogeneous, and their features safeguard there is high optimization. Users can set their features, which increases the speed of transactions without relying on the performance of the preceding networks. The system can achieve specialized goals since they enforce different rules and regulations, which are better than those of other platforms. The interconnection Polkadot provides will ensure that the speed of Bitcoin and Ethereum will improve. The networks will be able to interact and access various

resources from the best network. Future upgrades will make sure that the speed of Polkadot continues to increase, and future users will benefit from the network.

7.3 Cost

Pratik highlights that the transaction cost of each transaction in the Polkadot network is \$0.15, and is low compared to Ethereum, which has a double or triple-digit cost based on the size of the transaction [31]. Despite their design and feature being similar, Polkadot has succeeded in maintaining a low transaction cost. The cost can be low since the platform allows the users to concentrate on building their products as opposed to constructing the infrastructure. That adds value to the network. The dual-enabling technology is also cheap to maintain, and it provides a reason for many organizations to choose the platform to develop their products. Utilizing “spoke and hub” provides significant benefits as many blockchains can be attached to the network, and fewer resources are needed. Considering that users can achieve seamless connection, it becomes easier and cheaper to handle transactions. The cost of similar projects from other cryptocurrencies is failing because they are not providing connection, which makes the cost of developing the infrastructure much costly. The exciting project being developed on Polkadot’s network are making the value of the platform increase. For instance, Rococo, a testing parachain feature, allows anyone to develop an idea and implement it in the network. As a result, the cost of transactions will reduce while the value of DOT and Polkadot will increase in the future.

7.4 Pros of Polkadot

7.4.1 Fully shared architecture

According to Pang, the cross-chain architecture has different points that help boost the token network and enhance the performance of parachains [32 pp. 153720-153721]. The shared architecture ensures that tokens can easily move

from the relay chains to the sub chain, and fewer resources are needed since the process occurs in parallel and it is in the same network. Despite the number of users that are growing in the network, the platform is not affected. By allowing scaling, Polkadot can achieve its objectives and eliminate previously experienced constraints by other blockchains.

7.4.2 All parachains are entirely interoperable.

Polkadot is trying to connect all the distinct elements together, and that will safeguard there is communication that occurs between blockchains. As long as there is a bridge, communication can occur, and the exchange of information is critical for any cryptocurrency. When Polkadot manages to integrate its network to that of Ethereum, Bitcoin and other platforms, there will be significant benefits. One will not be required to create an entirely new chain but utilize forking to access all the resources they need on the network. Interoperability gives the platform an upper edge over other projects in the industry.

7.4.3 Existing completed projects

Some blockchain projects are already completed, and users are only required to join the parachain slots and start working on their objectives. The design has been made to be simple, which guarantees that new developers or users will not need to build the entire project from the beginning. Utilizing this concept helps in reducing the time people spend, and they focus more on solving problems. Organizations will prefer this as it reduces the time and resources that they spend on developing blockchain projects.

7.4.4 Polkadot security is pooled.

When a parachain is compatible with the Polkadot network, it will utilize the consensus mechanisms to achieve security [33 pp. 3-5]. Bridges help connect new users to the network, and one will require authorization from validators and fishermen to access any resource. Pooling of resources helps to guarantee that

security will always be achieved and there will be fewer risks in the entire network. It is easy to maximize the privacy features offered on the relay chain, reducing the complexity of users providing their security. Collective security is necessary and helps to address all the weak points in the network.

7.4.5 Passionate community

Polkadot has succeeded to build a community of users and developers. Through their support, the cryptocurrency can address some of the challenges and utilize existing opportunities to offer more solutions to the people. Despite the project being new, the concept has attracted and retained people who want to participate in the exciting ideas. The community will continue to play a significant part in the success of Polkadot in the future, even as more cryptocurrencies are introduced.

7.5 Cons of Polkadot

7.5.1 Limits of parachain

There is a limit of 100 parachain, which affects individuals who want to scale their projects. According to Madine, the fundamental concept of Polkadot is interconnecting different nodes and placing limitations will affect the ability of enterprise developers [34 pp. 88778-88779]. Users have different projects, and to solve problems, and they require unique solutions. The limitations can make users unable to differentiate Polkadot's network and that of other cryptocurrencies. It would restrict developers' imagination and make them lack the incentive to utilize the platform for future projects.

7.5.2 The majority of Polkadot's projects are not live

There is no proof of concept for some of the ideas Polkadot is proposing, and there is a possibility they may not come to realization. Users may choose other platforms such as Ethereum that have already been tried and tested to reduce

the risk of wasting time and losing their resources when the idea will not work. The Polkadot team needs to invest more resources to ensure the projects become operational. That will prove many users may want to try utilizing the resources to solve different challenges.

7.5.3 Unknown network fees

The majority of the concepts Polkadot is proposing have not yet been implemented, and therefore, they are not able to set the network fees. An increase in operational and cryptographic constraints can make the cost rise. The higher the cost, the less attractive the platform will be to users in the coming years. More developers may currently be utilizing other platforms which have known costs to avoid risks that may emerge in the future from new concepts Polkadot want to bring to the market. Besides, cost influences the switching decisions of users as there will be cheaper and more efficient alternatives that will be developed in the future as the blockchain technology evolves.

7.6 Possibilities for programmers

There is research to find ways of making the Polkadot network interoperable. It is an exciting concept that would change the whole cryptocurrency market. The dual-enabling technology increases the number of properties for Polkadot and contributes to distributed ledger interoperability [35 pp. 3-4]. The platform solved some of the challenges experienced in Ethereum, and interest will not shift to this new concept. There will be many solutions that will emerge for the programmers, making them choose Polkadot as their preferred cryptocurrency. Besides, allowing programmers to use custom blockchain designs will attract more users to the ecosystem. It reduces the complexity of learning a concept from the beginning, leading to the deployment of more applications on the blockchain. Organizations will find it easy to develop their unique blockchains and connect them to others in the network. That will call for all developers to learn about Polkadot and utilize it in their future blockchain projects. Another

possibility of Polkadot is that it provides an opportunity for future network expansion. The relay chains and parachain will ensure that Polkadot can be connected to other blockchains. The seamless connection will excite programmers and make them rely on the network to develop different solutions. Connecting the network to more databases in and outside the blockchain will make the cryptocurrency the go-to platform for any new and experienced programmer.

7.7 Future expectations

One of the research that has been conducted has been on the impact of inter blockchain communication. Challenges have been highlighted in the risks of standalone blockchains and their impact on the cryptocurrency environment. According to Qasse, a high number of decentralized applications and blockchain platforms are being developed, and cross-blockchain communication will increase scalability and opportunities in this ecosystem [36 pp. 1-2]. The higher the number of the platform, the more they need it will be for them to communicate. Polkadot and its cross-platform concept will help in eliminating some of the barriers currently affecting the blockchain. The research by Qasse proposes some of the architectures that can help group the homogeneous or heterogonous platforms. Transactions in the distributed ledger will increase when the concept comes to realization. There will be data exchange and contribute to many use cases in the system. Users will be able to utilize the digital assets to grow the blockchain network, and new features will emerge as a result [36 pp. 1-2]. The research shows blockchain developers where they need to focus and the opportunities that they can achieve by exploiting the gap in the market.

The sustainability of Polkadot will depend on the ability to implement some of the new concepts the team has proposed. Research by Belchior points out that Polkadot allows developers to write smart contracts in languages including JavaScrip, C++, and Go, which will influence the compatibility of its projects [37 pp. 20]. Developers will not be required to learn new programming languages.

Using their current knowledge, they will be able to identify opportunities in the Polkadot ecosystem and develop smart contracts that solve some of the existing challenges in the world. When compatible programs are developed, they can easily be integrated into the Polkadot network, leading to the achievement of the platform's goals. New features will emerge, and the end-users will benefit from the projects. The flexibility Polkadot offers will ensure that the project becomes a success and the cryptocurrency platform of the future. Other platforms will be developed, but since they will rely on Polkadot's architecture, it will be difficult to replace the technology.

8 Solana

Solana is a new cryptocurrency in the blockchain ecosystem that incorporates new features and promises to be the best. Anatoly Yakovenko, a compression algorithms expert, is the brain behind the project launched in 2017. Similar to Ethereum and Polkadot, Solana is open source and allows developers to develop decentralized applications. It relies on both proof of consensus and proof-of-work to achieve its objectives, and its cryptocurrency is SOL. It is founded on the paradigm that blockchain will be easy to operate when there exist a high number of computing workstations and nodes in the network. The Solana blockchain is performance-optimized, and it promises to allow instant transactions but at a high cost [38 pp. 1281]. The transactions can run up to 50,000 TPS, making it the fastest in the market. The purpose of developing the project was to make sure blockchains could be more permissioned and decentralized. It is a drastic improvement of the Proof-of-Work concept adopted by Bitcoin and Ethereum as the functionality will increase. Through Solana, it will be easy to apply business logic and ensure they help solve everyday challenges experienced in the world. The effectiveness of the DeFi platform will determine the long-term success of Solana and its ability to fight off competition from other cryptocurrencies.

8.1 Technical aspects

The Solana whitepaper by Yakovenko indicates that Solana operates by the Proof-of-History (PoH) architecture which verifies transactions based on periods between events [39 pp. 1-2] The design ensures that data structures will be the only elements appended in the network and can be utilized together with Proof-of-Stake (PoS) and Proof-of-Work (PoW). The majority of the public blockchains available in the market do not rely on time, which affects their capabilities. Every node has its own time and, therefore, a constrain to the platform's performance. In Solana, time is critical as it provides a timestamp for each transaction that takes place. A developer requires to create an application that will run on the Solana cluster. Through the instructions, they can be in a position to send and

obtain transactions. The culture runs on the functional architecture of Solana. Applications utilizing Solana have polylogarithmic-time verification to ensure they run parallel and are sufficient to ensure programs are effective [40 pp. 6]. The transactional engines are placed horizontally. It means that transactions within a chain can be run concurrently, increasing the overall speed of the network. Besides, there is better runtime in all the transaction pools. Validators are responsible for keeping the network safe, which is achieved by connecting to the security features. However, the distribution schedule is making Solana unattractive to the users and developers. Transactions are executed before time, and it leads to a reduction in confirmation time. The memory requirement with therefore reduce as fewer resources will be needed after validation. Figure 3 below show the transaction processes that occur in a Solana network.

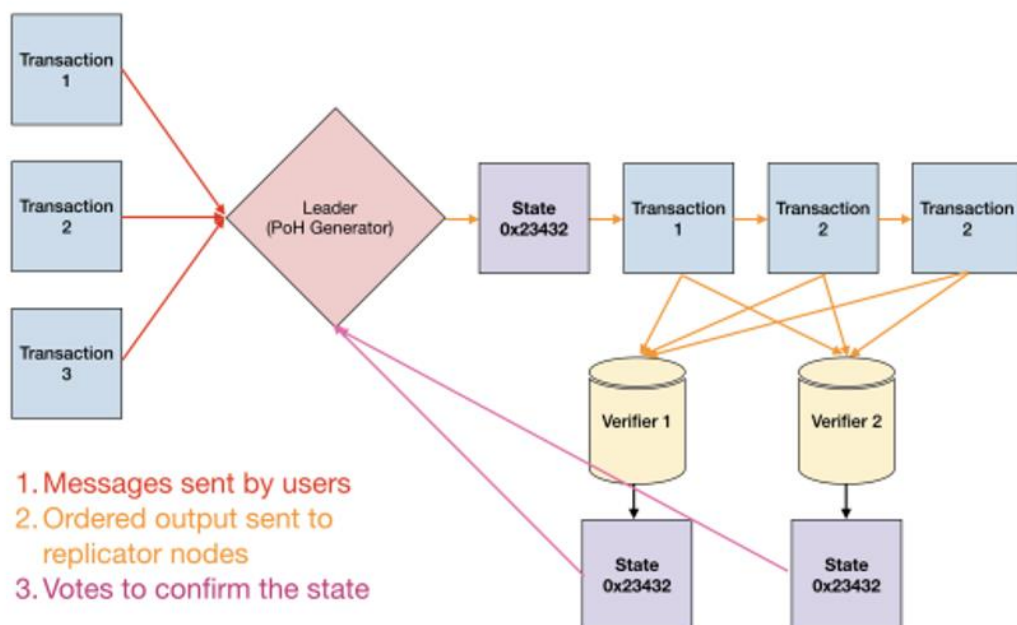


Figure 3. Transaction processes in Solana [39]

As illustrated in Figure 3 above, Solana utilizes a pipeline mechanism, which is how it can achieve transaction processing. Parallelized transaction processing ensures that concurrent transactions occur in the same chain, and the network can achieve a better runtime [39]. The blockchain has zk-SNARKS

cryptography, which helps to guarantee the privacy of all transactions. The privacy features guarantee users that third parties will not snoop into the network, and the greater credibility helps enhance the status of the cryptocurrency. That will give Solana the ability to meet the demands of individuals and organizations. Besides, Solana also utilizes Tower BFT (Byzantine fault tolerance), an algorithm that helps individuals manipulate the cryptographic clock. Using BFT, a transaction can reach a consensus faster by efficiently transferring messages to the nodes. That will lead to an improvement in the speed of transactions. A propagation protocol is also utilized, and it helps to break down data into small portions. The data will therefore be easier to transfer to the target nodes. Considering that time is of the essence, the turbine protocol helps the platform handle any issues related to bandwidth.

8.2 Speed

Solana is visualized to clock over 50,00 transactions in one second to make it the fastest network in the cryptocurrency market. The simple interface and high speeds on the blockchain help make the transaction fees low, and it gives more power to the users [41]. In the current crypto market, people are forced to wait for minutes for a transaction to be approved, and the game-changing concept by Solana will give people a good reason to adopt it. The aggressive strategies by Solana will help the platform grow and achieve even greater transaction speeds in the future.

8.3 Cost

The gas fees for Solana can be as low as \$0.00025, and that is relatively low in comparison to Ethereum, whose fees can go up to \$1,000 for a transaction [42]. The fast speed of transactions helps reduce the resources required, which is critical in influencing the cost of every transaction. The cost cannot be compared to that of the competitors, which will influence the switching decisions in the coming years. From August 1st to the 31st, the price of Solana went from \$35 to \$130 despite the platform being in beta [42]. More people are

discovering the opportunities Solana will have, making the value of the cryptocurrency increase while the cost of transactions will reduce.

8.4 Pros of Solana

8.4.1 High transaction speed at low costs

The extremely high speed ensures Solana gets an economy of scale. Solana utilizes the Delegated-Proof-of-Stake (DPoS) protocol, unlike the PoS mechanism employed by other competitors. Users are allowed to confirm the transactions on the blockchain, which provides significant benefits for the project. In other platforms, authentication protocols affect the verification process and, therefore, the speed of transactions. It takes an average of 1.6 seconds for a transaction to be verified, while it can take minutes on other platforms. The people are paid to verify transactions, which is a great incentive to ensure there will always be high transactions on the platform. They allow everyone to participate, which is critical to building a great network in the cryptocurrency world.

8.4.2 Lack of censorship

Anyone in the Solana network can participate in the processes. That makes it easier, cheaper, and the transactional speed remains high. Removing censorship ensures that there will be no organization or individual that will control the entire process. The validators and delegators will come from diverse regions of the world and contribute to the efficiency of the chain's transactions. Therefore, there is no biasness and no misuse of the system.

8.4.3 High level of scalability

The utilization of the Proof-of-History is allowing Solana to scale and provide more opportunities for the people. Inconsistencies arise when individuals want to scale their projects in other blockchains, which is not the case for Solana.

The network's computational power allows processes to be quickly transacted, and they have fewer dilemmas to solve. According to Mishra, the computational state of parties is first checked before they are allowed to publish on the network, which allows the privacy perspective to be maintained [43 pp. 1-2]. When there is a guarantee of privacy, it is easy to win the trust of the stakeholders, and their support is necessary to scale Solana to greater heights.

8.5 Cons of Solana

8.5.1 Implementation awaits the launch of the Beta version.

The existing prototype has viable functionality to allow users to circulate tokens, but questions are raised on preventing fraudulent activities during the transfer of the current projects to the Beta version [44 pp. 692] Solana is still a concept under trial, and there is no proof that it will be successful. The 50,000 TPS are achieved under simulation, which may not be the case in the real-world environment. It may take years for the Beta version to be released and the users to be guaranteed that the same features will be maintained.

8.5.2 High cost of setting up Solana hardware

Running and maintaining the Solana platform will prove to be costly for developers and validators. High-performance machines are needed, and that makes the cost of operation to be high. The computation of the transactions will depend on the devices used. Networking is also an initial cost that should be considered. Slow machines will be ineffective in performing the discrete logarithm, which is time conscious. The high costs will mean that there will be fewer validator nodes in the network, and that is a constraint to decentralization. Besides, there are fees paid for voting, and they can run up to the value of 1 SOL per day.

8.5.3 Criticism of not being fully centralized

For one to participate in the token swap program, users need to rent deposits and pay for the transaction fees. The resources are used for providing liquidity that will allow the execution of the projects. The lending protocol limits a high percentage of people, especially those who don't have the resources to pay for renting services. Blockchain aimed to achieve a highly decentralized platform that would provide people with freedom, and such limitations can make people avoid utilizing Solana for their projects.

8.6 Possibilities for programmers

Solana has a developers' community, and that is a good reason for one to choose cryptocurrency. The community has white papers on how to come up with development workflows, clients' SDKs, and decentralized applications on the Solana network. The materials are necessary as they help one learn about the framework and identify how they will benefit from the system. It helps to eliminate a lot of abstractions, limiting the amount of information people will have from the beginning. The developers' resources would help developers understand the Solana ecosystem. It is also an incentive for the organization to choose Solana for its blockchain projects.

The scalability options Solana provides should also make programmers et interested in the platform. Solana constantly seeks to intuitively improve the platform, which will help reduce transaction costs while increasing the speeds. It means that developers can rely on Solana to launch their higher frequency applications, and cost will not be an issue. Besides, Solana has adopted security features, which guarantees that clients' data will always be secure. Eliminating such issues is critical as it increases the chances of a programmer concentrating on their projects. More possibilities for programmers will emerge in the future as Solana continues to explore ways to add more features to the DeFi protocol.

8.7 Future expectations

One research that has been done on Solana is on wrapped tokens. According to Caldarelli, blockchains count on a third-party to manage extrinsic data, which is a single point of failure for many smart contracts [44]. Transaction speed is still an issue for most top-tier blockchains, making them depend on third parties to deal with some of their data requests. With a transaction speed of 50,000, Solana is set to eliminate this point of failure as there will be no need for another party to handle data when it is in production or transit. Investigating the concept of wrapped tokens is a great idea, and it will help improve communication and security between blockchains. Solana's development team shows the intention of eliminating the third parties and ensuring users only utilize their platform for all the transactions. The transaction fees will also be low when wrapped tokens are used as there will be no third party to manipulate the process. The research by Caldarelli is critical as it shows the direction for cryptocurrency and the need for eliminating some of the existing challenges.

Solana will survive in the coming years due to the effectiveness of its parallel programming model. The paradigm is different from the EVM system, which is currently used by most cryptocurrencies in the market. EVM utilizes a single-threaded operating system, limiting the transaction speed and scalability options for the users. It is a game-changing concept, and it shows Solana is way ahead of the competitors. The execution logic in Solana smart contracts promises to offer high speeds despite the transaction volumes. Competitors have not yet succeeded in achieving a tenth of the speed, and a complete overhaul of their system will lead to more issues for their blockchain. The possibility for Solana to survive will all depend on its success immediately after the Beta launch. The event will help developers and users to differentiate it from other existing platforms and give them a reason to select it as their preferred platform. Therefore, there are high chances Solana will survive in the future cryptocurrency ecosystem.

9 Cryptocurrency with the most potential

Polkadot is the cryptocurrency with the greatest potential of the four. There are over twelve thousand coins in the current market, and more tokens continue to emerge daily. Interconnection between these blockchains will be needed as the platforms have different features and capabilities and need to communicate. The limitless capability offered by Polkadot due to its structure and adaptable consensus mechanism makes it different from the rest. The framework will support all the other blockchains and ensure there is communication occurring. Polkadot is leveraging on this gap in the market to achieve its objectives. All blockchains, including Bitcoin and Ethereum, will rely on this platform as their opportunities to scale are minimal. More breakthroughs will emerge when Polkadot finds a means to increase its transaction speed to accommodate the needs of other blockchains. The integration the platform will offer makes Polkadot's concept very promising, and it will be the top-ranking cryptocurrency in the future.

Solana is another cryptocurrency of the four with the most potential. The parallel processing capabilities help increase the speed of transactions, and it is not affected by the volumes of data. The concept helps to reduce the cost of transactions, and it will go on to change with improvements in the platform. The highest speed the competitors have managed to achieve is 5,000 TPS, indicating Solana is way ahead of the game. The value for Solana increases by the day as more people are attracted to the platform, which will change the dynamics of the cryptocurrency environment. The potential will increase after the Beta version launch, and Solana will manage to be a top-tier cryptocurrency in the future.

10 Proposed Solutions

Blockchain ecosystems were built using specific designs, and flexibility is needed to ensure they meet the future needs of the people. Scalability is one factor that affects Bitcoin and Ethereum and will make users switch to other platforms due to the existing restrictions. The platforms need to direct their focus away from their initial ideas, leading to more possibilities. Besides, it will help eliminate the issue of slow transaction speed and high costs the blockchains are experiencing. If a new technology has emerged, the platforms need to examine it and find a way of integrating it into their systems. For instance, Solana is implementing proof-of-history into their system, making them achieve a transaction speed of 50,000TPS. Ethereum has a TPS of 25 and needs to explore utilizing the PoW concept to increase its transaction speed. Remaining rigid to its initial ideas does not help the platforms as the users' needs are changing, and competitors are coming up with innovative ideas that will change the cryptocurrency ecosystem.

Users and organizations are constantly coming up with new ideas to solve world problems. It takes time and resources to invest in one blockchain platform, and when ones' objectives are not met, it will be a loss for the user. There is a reluctance to join the blockchain bandwagon due to integration issues. A brand that will offer cross-chain transactions will significantly benefit from this gap in the market. People will not fear developing their products on different platforms as they are guaranteed they can always switch. The interoperability will lead to the transfer of value, and all stakeholders in the value chain will significantly benefit. More functionalities will emerge as cross-chain communication will open doors for many innovative concepts.

The concept by Polkadot is not fully operational, but it will solve an existing problem. Cross-chain will help platforms communicate with their external networks, and it will revolutionize blockchain technology. It is a proprietary technology that will forever change the blockchain and influence how people will utilize the technology in the future.

11 Conclusions

Cryptocurrency is a novel concept that has arisen in the technological space, and it allows people to use digital currencies to buy digital assets. Game theory was used in assessing the four cryptocurrencies and establishing the one with the greatest potential. Bitcoin was the first cryptocurrency to be launched in the market, and it has succeeded in maintaining its number one status in the market. Ethereum was later launched, and currently, it has the second-most value after Bitcoin. Ethereum is open-source and utilizes a consensus algorithm to allow peer-to-peer communication on the network. It has a TPS of 25 and a confirmation time of 60 minutes. Ethereum transactions cost \$2.89. Competent leadership, potential functionality of the platform, regulatory clarity and backing by notable capitalists are the strengths of Ethereum. However, it is affected by issues such as emerging competition and over-reliance on Buterin's fame. There are possibilities for programmers as they can develop smart contracts on the platform. Research shows Ethereum network is critical in the current ecosystem as it made people move away from blockchain-based systems. Ethereum has a high possibility of surviving as long as it implements new ideas to fight competition from new entrants.

Cardano is a third generation of cryptocurrency that utilizes proof-of-stake blockchain. It adopts a greener initiative that will lead to energy conservation. It emerged as a research-based framework that implements insights from peer reviews. Cardano has a TPS of 1,000, and it managed to achieve its objective of enhancing scalability. The superior technology helps to make the cost of production and maintaining its systems to be minimal. Dual-layer functionality, scalability, eco-friendliness and equality are the advantages of Cardano. Nevertheless, it is affected by existing dominant players, no proven use case, and issues with centralization. Its DeFi application provides great opportunities for programmers as it is fast and has an easy development cycle. Research on this cryptocurrency has focused on programming paradigms and interconnection between cryptocurrencies. Proof-of-stake protocol and novel ideas will make Cardano survive in the future market.

Polkadot is a new blockchain protocol released in 2020, and it helps to connect different nodes on the network. It is different from other cryptocurrencies as it has chains to allow internal communication and explores ways to interlink blockchains. There are relay chains and parachains that can be customized to meet users' needs, and it relies on a consensus algorithm to allow transactions to occur. There are validators, nominators, collators, and fishermen who play different roles within the network. The platform has a TPS of 1,000, and the high speed is due to NPoS consensus, which helps reduce redundancy.

Transactions on Polkadot cost \$0.15 and are significantly low in comparison to Ethereum. Fully shared architecture, parachains being interoperable, existing completed projects and pooling of security are the system's benefits. Limits in the parachain, unknown network fees and the majority of Polkadot's projects are not live are its disadvantages. Research around Polkadot is focused on finding how the network will remain interoperable. There are possibilities for programmers since Polkadot is exploring ways of interlining blockchain networks. Polkadot's sustainability will depend on the ability to implement some of its proposed ideas.

Solana is the newest cryptocurrency among the four. Anatoly Yakovenko came up with the idea, and it uses Proof-of-History, Proof-of-Work and Proof-of-Stake protocols. It relies on time to enhance its capabilities, such as allowing instant transactions. Its transactional engines are placed horizontally, and that allows operations to run concurrently. The platform has a TPS of 50,000. The transaction cost can go as low as \$0.00025. Its advantages are high transaction speed at low costs, lack of censorship, and a high level of scalability. However, it is affected by aspects such as implementation awaits the launch of the Beta version, the high cost of setting up Solana hardware, and criticism of not being fully centralized. Solana has a developers' community and scalability options, which provides more possibilities for programmers. Research around Solana has focused on wrapped tokens. The parallel programming model adopted by the platform will ensure Solana remains sustainable.

Polkadot has the greatest potential, followed by Solana. It is because many tokens and cryptocurrencies are introduced, and they will need to be linked. It has promising concepts, and that will ensure it becomes a top-tier cryptocurrency in the long term. Hard fork and cross-chain platforms are the proposed solutions, and they will ensure the currency blockchains eliminate their challenges and succeed in future ecosystems.

However, Ethereum might remain most important for the near foreseeable future, simply because it was the first programmable blockchain and because of the backing by notable capitalists and the new interesting decentralized applications that are continuously being built on the Ethereum platform.

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Appendix

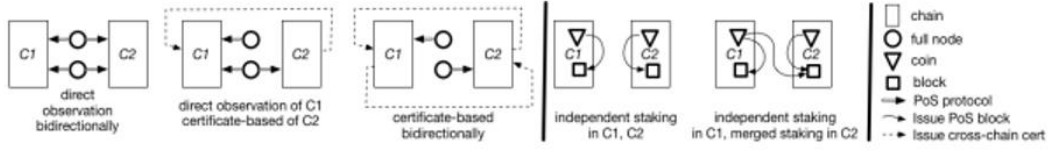
1. Comparison of speed of several popular cryptocurrencies

Cryptocurrency	Transactions per Second	Average Transaction Confirmation Time
Bitcoin	3-7	60 min
Ethereum	15-25	6 min
Ripple	1500	4s
Bitcoin Cash	61	60 min
Stellar	1000	2-5 s
Litecoin	56	30 min
Monero	4	30 min
IOTA	1500	2 min

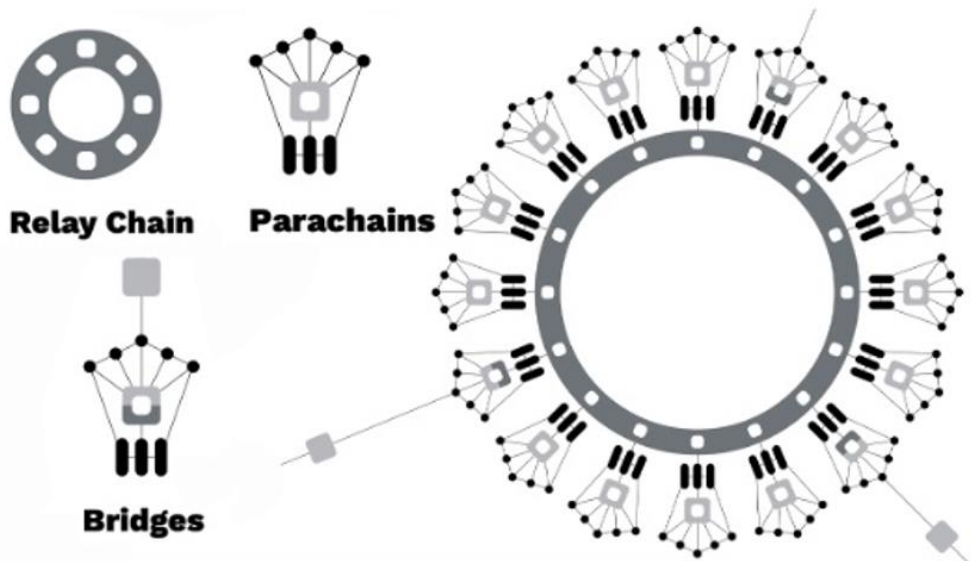
2. Comparison of cost of Bitcoin and Ethereum

	1ST GENERATION BITCOIN (BTC)	2ND GENERATION ETHEREUM (ETH)
Transactions per Second	3+ TPS	12+ TPS
Average fee	\$2,99 USD	\$2,89 USD
Transactions confirmation	10 - 60 minutes	10 - 20 seconds

3. Deployment options for sidechains in Cardano



4. Relay Chain and parachains in Polkadot



5. Transaction processes in Solana

