DeFinance: Decentralised Lending and Borrowing of Digital Assets

Sanket Naikwadi
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
sanketnaikwadi81@gmail.com

Aman Pandey
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
amanpandey9038@gmail.com

Chinmay Patil
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
chinmayspatil@outlook.com

Hrugved Parab
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
hsparab13@gmail.com

Pranali Patil
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
pspatil@apsit.edu.in

Deepak Khachane
Department of Computer Engineering
A. P. Shah Institute of Technology
Mumbai, India
dskhachane@apsit.edu.in

***Abstract*—The financial landscape is rapidly evolving, presenting challenges for traditional systems. In response, the decentralised finance (DeFi) sector is emerging, driven by blockchain technology. This project, "DeFinance: Decentralised Lending and Borrowing of Digital Assets" aims to revolutionize financial services by providing an efficient, transparent, and inclusive lending and borrowing platform. Modules such as the dashboard, wallet connector, portfolio, markets, lending pool, and borrowing collectively offer users a comprehensive financial services platform. The key goals include trustless and transparent solutions, capital diversification, real-world asset tokenization, and seamless integration into the DeFi ecosystem. The project envisions a financial future marked by decentralization, inclusivity, and financial empowerment.**

Keywords—Decentralised finance (DeFi), Blockchain technology, Lending and Borrowing, Bitcoin, Peer-to-Peer, Assets, Tokens

I. Introduction

The financial world is undergoing a transformation fueled by cutting-edge technologies and a growing desire for financial inclusivity and transparency. At the core of this transformation is blockchain technology, a revolutionary innovation with the potential to reshape transactions, money, and financial intermediaries. This project, titled "DeFinance: Decentralised Lending and Borrowing of Digital Assets" leverages blockchain's power to create an efficient, transparent, and inclusive financial ecosystem.

A. The Evolution of Finance

Financial markets, crucial for modern economies, have faced challenges leading to underserved individuals and businesses. Centralised financial institutions and regulatory barriers limit access and create complexity. Blockchain technology, initially designed for cryptocurrencies like Bitcoin, has evolved into a distributed ledger operating on a decentralised network. It ensures transparency, security, and immutability, eliminating intermediaries and fostering a new era of financial innovation.

B. Traditional Lending and Borrowing

In the world of traditional lending and borrowing, it is a bit like making a financial arrangement with a bank. When you need some extra cash—maybe to buy a house, start a business, or cover unexpected expenses—you head over to your bank. They take a look at your financial track record, considering things like your credit history and how much money you make. If everything looks good, they agree to lend you the money. Of course, there is a catch: you have to pay them back, and they will charge you extra, called interest, for the favor. The terms of how much you will pay back each month and for how long are all laid out in an agreement. It is a pretty standard way people have been getting financial support for a long time, building a relationship with their local bank to make big things happen in their lives.

C. Digital Assets

Digital assets are like online versions of things you own or use, but they exist on the internet using a secure technology called blockchain. Examples include cryptocurrencies such as Bitcoin, which are like digital money, and tokens representing ownership in online networks. Unique digital items, like special edition digital art (called NFTs), also fall into this category. Digital assets make it possible to do things like trade, own, and use stuff in a secure and transparent way on the internet.

D. The Vision of the DeFinance.

The project emerges from the fusion of blockchain's capabilities and the vision to create a financial system serving everyone, regardless of geographical location or financial status. The primary objective is to address limitations in existing financial systems, fostering decentralisation, transparency, and inclusivity.

In response to challenges faced by traditional online money markets, the project seeks to establish a decentralised platform for peer-to-peer pool based lending and borrowing of digital assets. Smart contracts automate lending processes, guaranteeing transparency and reducing dispute risks. Through decentralised governance and community involvement, users can actively participate in platform decisions, fostering inclusivity.

The aim is to make financial services more accessible, efficient, and democratized. Users can securely lend their money and earn interest without credit checks or lengthy approval processes. Conversely, borrowing becomes swift and hassle-free, leveraging digital assets as collateral.

979-8-3503-7471-1/24/$31.00 ©2024 IEEE

E. The Promise of Blockchain Technology

The beauty of DeFi lies in its simplicity and user-friendly interface. Users deposit cryptocurrencies into smart contracts, creating a decentralised money market. They can choose to lend their funds, earning interest, or borrow against their assets at transparent rates. Blockchain's immutable nature ensures the security of assets, providing a trustworthy alternative to traditional banking.

Blockchain operates as a decentralised, peer-to-peer network, recording transactions across a visible ledger secured through advanced cryptographic techniques. Smart contracts automate financial transactions, enforcing agreements without intermediaries. Blockchain's global accessibility addresses financial exclusion, offering economic opportunities and security.

II. Background

A. Ethereum

Ethereum is like the wizard of the blockchain world. It is not just about digital money; it is about creating smart contracts, which are like self-executing agreements written in code. This means you can do all sorts of things on Ethereum, from creating your own cryptocurrency to building decentralised applications (DApps). What makes Ethereum stand out is its ability to bring smart contracts to life, allowing people to exchange things like money, property, or even votes without needing a middleman. This has significantly benefited the blockchain industry by making it more than just a ledger for transactions. Ethereum has opened a whole new world of possibilities.

Now, let us talk about the good stuff Ethereum has brought to the table. It is like the backbone of this decentralised revolution. First off, decentralised finance (DeFi) would not be without Ethereum. With smart contracts, people can lend, borrow, and trade digital assets without needing a bank. That is financial freedom right there. Plus, Ethereum is the reason for those NFTs (non-fungible tokens) where artists and creators can tokenize their work, proving ownership and selling digital art in a way that was never possible before. Ethereum is the platform behind decentralised applications that aim to make everything from social media to gaming more transparent and user-centric. Think of decentralised apps (DApps) — they are like apps on your phone, but no one person or company controls them. Ethereum powers these, making everything from social media to gaming more open and fairer. Ethereum is a game-changer in the blockchain world. It is like the spark that ignites new ideas and challenges how things are typically done.

B. DeFi

DeFi is like a financial revolution happening on the internet. It is all about making traditional financial services, like lending or trading, work without the need for banks or other middlemen. Instead of relying on a central authority, DeFi uses smart contracts on blockchains like Ethereum to automate and execute transactions. This means you can lend your crypto to someone across the globe and earn interest, or you can borrow without dealing with a bank. It is like turning the old-school finance system on its head, giving more people access to financial services and letting them be in control of their money. This innovation aims to democratize finance, providing global access to financial services while reducing reliance on centralised institutions. Fig. 1 represents the Total value locked and borrowed digital assets in USD source from defillama.

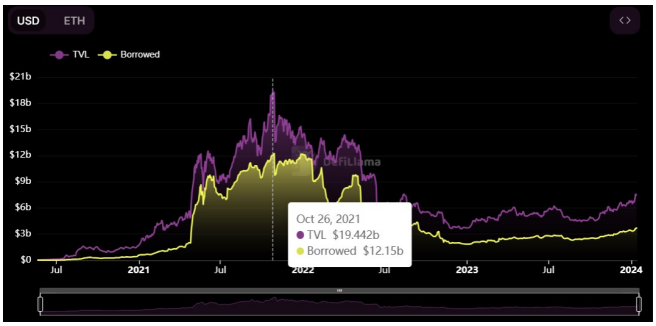

Fig. 1 AAVE Total Value Locked and Borrowed Digital Assets in USD.

III. Existing System

A. Limitation of Existing System

In examining the existing financial frameworks, it becomes imperative to acknowledge several challenges that pose constraints on their seamless operation. These challenges, while not insurmountable, underscore the complexities inherent in the integration of blockchain technology and DeFi. The "DeFinance: Decentralised Lending and Borrowing of Digital Assets" project seeks to address these challenges proactively, recognizing that overcoming them is pivotal for the project's success.

1) Technology Adoption Challenge: The adoption of blockchain technology, a cornerstone of the project's success, may encounter barriers for certain users. Factors such as technical intricacy, limited awareness, and resistance to change could impede the initial uptake of the platform.

2) Regulatory Dynamics: The regulatory environment surrounding blockchain and DeFi projects is dynamic and evolving. Navigating through these regulations poses challenges, and alterations in legal requirements could impact the operational landscape and scalability of the project.

3) Security Imperatives: Addressing security vulnerabilities is paramount for blockchain projects, encompassing concerns such as smart contract bugs and potential network attacks. Failure to mitigate these risks may result in financial losses and tarnish the project's reputation.

4) Scalability Considerations: Blockchain networks, contingent on their architecture, confront limitations in transaction processing speed and capacity. Implementing effective scalability solutions is crucial to accommodate increased demand and ensure optimal performance.

5) User Education Requirements: Users may necessitate a robust understanding of blockchain technology and DeFi concepts to engage with the platform effectively. Offering comprehensive educational resources, an intuitive user experience, and robust support mechanisms are indispensable to overcome this educational barrier.

6) Token Volatility Concerns: If the project involves a native token, its value may be subject to significant volatility. Addressing user concerns related to token price

fluctuations is imperative to foster confidence and participation.

7) Network Congestion Challenges: Blockchain networks may experience congestion during periods of high demand, leading to delays and increased transaction fees. Adequate preparation for such scenarios and optimizing network usage are essential considerations.

8) Liquidity Management Issues: Many existing systems falter in effectively managing liquidity and user positions, often due to insufficient market liquidity for specific tokens. This results in challenges where substantial transactions may not be settled accurately.

9) Failed Liquidaion Management: Several existing systems lack comprehensive liquidation management, resulting in bad debt on protocols. Strategies such as developing proprietary liquidation bots or incentivizing MEVs (Miner Extractable Value) to execute liquidations efficiently become crucial to mitigate this challenge.

B. Benefits of our System

1) Financial Inclusion: Anyone with an internet connection can participate, providing financial services to individuals who may not able to access traditional services due to limitations. As Decentralised platforms operate globally, allowing users from various regions to access financial services.

2) Elimination of Intermediaries: This system removes traditional intermediaries like banks which lowers transaction costs, making lending and borrowing more cost-effective for users. Smart contracts automate the processes, reducing the need for intermediaries.

3) Transparency and Security: Transactions recorded on the blockchain are irreversible & immutable, providing a transparent and auditable history of all activities which are happening in the system. Smart contracts, once deployed on the blockchain cannot be tampered so enhancing security and reducing the risk of fraud.

4) Flexibility and Choice: Users can lend and borrow a variety of digital assets beyond traditional currencies, cryptocurrencies, and tokenized real-world assets. This system does not limit itself with a fixed rate of interest based on any regulatory changes, interest rates vary based on demand and supply allowing users more flexibility.

5) Global Market Access: Decentralised platforms do not have a time limitations like traditional banking systems. as those are running on blockchain. it enables users to engage in lending and borrowing activities at any time, unlike traditional markets with opening hours.

6) Yield Opportunities: Lenders can earn interest on deposited assets, providing a source for passive income. Borrowers can access loans without the need for a traditional credit check, expanding opportunities for those with limited to none credit histories.

IV. PROPOSED SYSTEM

The proposed system for the "DeFinance: Decentralised Lending and Borrowing of Digital Assets" project involves a series of modules, each contributing to the breakdown and implementation of the platform.

A. Architecture Diagram

Fig. 2, architectural diagram visualizes the physical implementation of the software system. Users interact with the lending pool to lend, borrow, or repay assets, managed by the pool manager and liquidation manager contract. Tokenization of transactions ensures easy tracking and management. Real-time asset pricing is provided by the Price oracle, crucial for the lending pool data provider to calculate loan-to-value ratios and interest rates. The lending rate oracle, relying on a core library containing interest rate strategies, state data, and balances, sets the interest rates. The lending pool configurator oversees configurations, ensuring cohesive and secure system operation.

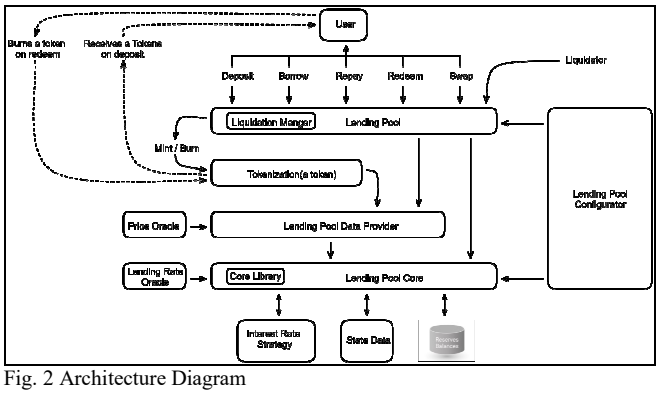

Fig. 2 Architecture Diagram

B. Potential Security Vulnerabilities and Mitigations

1) Smart Contracts & Audits: Smart Contracts could include bugs which are susceptible to coding errors or vulnerabilities, which can be exploited by attackers to drain funds or manipulate transactions. By doing regular audits via reputable security firms we can identify and mitigate potential vulnerabilities in smart contracts before deployment. Along with it we can conduct thorough code reviews and testing processes to identify and address potential vulnerabilities in smart contracts and platform infrastructure.

2) Oracle manipulation: Decentralized platforms rely on oracles to fetch external data for executing smart contracts. Malicious actors may manipulate or compromise oracles to provide false data, leading to inaccurate outcomes. By implementing multiple oracles from reputable sources and using decentralized oracle networks we can reduce the risk of oracle manipulation.

3) Flash loan attacks: Flash loans allow users to borrow funds without collateral as long as the borrowed amount is repaid within the same transaction & same block. Attackers can exploit flash loans to manipulate markets or exploit vulnerabilities in smart contracts. The platform can implement safeguards such as transaction guards or time locks to mitigate the risk of flash loan attacks.

4) Reentrancy Attack: It is another type of attack which exploits vulnerabilities in smart contracts that allow attackers to repeatedly call a function before the previous calls are completed, leading to unexpected behavior and potential fund loss. Platform can incentivize security researchers and developers to identify and report vulnerabilities through bug bounty programs. This

encourages community participation in identifying and fixing security issues.

C. Regulatory Compliance

1) Legal Consultation: We seek legal counsel from experts specialising in blockchain and regulatory compliance to navigate the complex regulatory landscape. Legal counsel can help our platform navigate regulatory issues and mitigate legal risks associated with operating in India. It includes understanding and adhering to financial regulations.

2) Transparency and Disclosure: We provide clean and transparent information about our regulatory compliance efforts, including disclosures on our website. It helps users understand the platform's commitment to regulatory compliance and its potential impact on their participation.

3) User Education: We educate users about regulatory requirements and the potential implications for their participation in decentralised lending and borrowing activities. It includes informing users about the need for compliance with their local regulations.

4) Engagement with Regulators: The platform engages with regulators and policymakers in India to foster dialogue and collaboration. This may involve participating in industry consultations, providing inputs on proposed regulations, and seeking clarifications on regulatory requirements.

5) Geographical Restrictions: The platform may implement geographical restrictions to limit access to users from jurisdictions where compliance with local regulations is challenging or uncertain. This helps mitigate the platform's legal and regulatory risks while ensuring compliance with applicable laws.

The absence of clear regulatory guidelines poses challenges for DeFi platforms operating in India. DeFi platforms need specific laws governing the activities to ensure compliance requirements and legal risks. This ambiguity can deter potential users and investors, impacting the growth and development of the DeFi ecosystem. While there have been discussions and proposals for regulatory frameworks, concrete measures are yet to be implemented. In the absence of specific regulations, we adopt a cautious approach, proactively engaging with regulators, and seek legal advice to navigate the regulatory landscape effectively.

V. Methodology

A. Oracle

Smart contracts serve as self-executing pieces of code, automating predefined tasks based on specific conditions. Deployed on a blockchain, they operate in a deterministic and isolated manner, lacking direct access to information beyond the blockchain network. This inherent limitation hinders their ability to interact with real-world data, which is often a crucial requirement for executing complex tasks and applications. To address this limitation, oracles function as intermediaries that facilitate the integration of real-world data into smart contracts. These oracles act as connectors between the isolated nature of smart contracts and the dynamic, external information they may depend on for proper execution. By fetching, validating, and transmitting external data to smart contracts, oracles bridge the gap between the deterministic code of smart contracts and the ever-changing conditions of the external world.

One of the popular oracle service providers is ChainLink which works on the concept of oracle consensus by which multiple independent oracle nodes collectively agree on the accurate value of an external data point, such as a cryptocurrency price. This consensus mechanism is crucial for ensuring the reliability and integrity of the data provided to smart contracts on the blockchain.

B. Modules

1) Dashboard: The dashboard serves as the central control hub of the project, providing users with an overview of their financial activities and investments. It acts as a go-to place for tracking assets, loans, and market information.

2) Wallet Connector: This module ensures a secure connection between users' wallets and the platform, facilitating easy transactions and providing a gateway for managing digital assets securely.

3) Portfolio: The portfolio module enables users to monitor their investments and assets. It offers real-time insights into the performance of their holdings, helping them make informed financial decisions.

4) Markets: The markets module is where users can explore a variety of digital assets, monitor their prices, and execute trades. It acts as a gateway to the world of cryptocurrency trading and investment.

5) Lending Pool: In the lending pool, users can offer their digital assets for lending, earning interest in return. This feature promotes financial inclusion by allowing users to grow their assets through lending.

6) Borrowing: The borrowing module allows users to secure loans by using their digital assets as collateral. It provides a means to access funds while retaining ownership of their assets, enhancing financial flexibility.

VI. Experimental Setup and Perfromance Analysis

A. Software Requirement

For the Ethereum development environment, several specific tools are required to support Solidity-based smart contract development and deployment:

1) Ethereum Client: Software such as Geth or Parity is necessary to connect to the Ethereum network.

2) Remix: An in-browser Solidity IDE for writing, testing, and deploying smart contracts.

3) MetaMask: A browser extension used for managing Ethereum accounts and interacting with Ethereum-based decentralized applications (DApps).

4) VS Code: Integrated Development Environment (IDE)

5) GIT: For version control.

6) Node.js: For running JavaScript code and managing dependencies.

B. Hardware Requirements

To ensure optimal performance and development efficiency, the following hardware specifications are recommended:

1) Computer: Operating System: Windows, macOS, or Linux. Linux is often preferred for server environments.

2) Processor: A multi-core CPU, such as Intel Core i5 or equivalent, is sufficient.

3) RAM: At least 8 GB of RAM is recommended, though more is beneficial for faster development.

4) Storage: A minimum of 5 GB of free storage is required. A Solid-State Drive (SSD) is recommended for better performance.

5) Internet Connection: A stable and reasonably fast internet connection is essential, especially when interacting with remote blockchain networks.

6) Virtual Machine: If using virtualization for development or testing, ensure your host system meets the above requirements.

C. Performance Metrics

1) Total Value Locked (TVL): Our platform's TVL is a crucial indicator of its popularity and user engagement. By measuring the total value of assets locked in our smart contracts, we can gauge the overall health of our ecosystem and track changes in user activity over time.

2) Total Borrowed Amount: Evaluating the total amount of assets borrowed by users provides valuable insights into the demand for borrowing services on our platform. This metric helps us understand user behavior and preferences, allowing us to optimize our lending options accordingly.

3) Interest Rates: Analyzing the interest rates offered for lending and borrowing activities is essential for understanding market dynamics and user behavior. By monitoring changes in interest rates over time, we can adjust our rates to remain competitive and attractive to users while ensuring sustainable growth for our platform.

4) User Adoption and Growth: Tracking the number of users and accounts interacting with our platform is vital for assessing its popularity and scalability. By monitoring user growth rates and identifying trends in user adoption, we can tailor our marketing and outreach efforts to attract and retain users effectively.

5) Security and Audits: Ensuring the security of our users' assets is paramount. Any security incidents or vulnerabilities are promptly addressed, and we prioritize the safety and protection of our users' funds.

6) User Experience: Providing a seamless and user-friendly experience is key to retaining and attracting users to our platform. We regularly gather user feedback and reviews to identify areas for improvement in terms of ease of use, platform reliability, and customer support. By prioritizing user experience, we aim to enhance user satisfaction and loyalty.

VII. Conclusion and Future Work

A. Conclusion

The 'DeFinance: Decentralised Lending and Borrowing of Digital Assets' project represents a significant step towards redefining the landscape of financial services. Grounded in blockchain technology, the project envisions a future where finance is decentralised, transparent, and accessible to all. The journey from the evolution of finance to the promises of blockchain technology has shaped the core objectives of the project.

By addressing the limitations of existing financial systems, the project aims to provide a DeFi platform that facilitates peer-to-peer lending and borrowing of digital assets. The utilization of smart contracts powered by blockchain ensures transparency, automates financial processes, and eliminates the need for intermediaries. Through decentralised governance and community involvement, the project fosters inclusivity, giving users a stake in platform decisions.

The simplicity and user-friendly interface of the 'DeFinance: Decentralised Lending and Borrowing of Digital Assets' project offer a transformative experience. Users can seamlessly deposit, lend, borrow, and monitor their financial activities in real-time. The tokenization of transactions adds an extra layer of security and efficiency to the financial processes conducted on the platform.

The expected outcomes, including user-friendly UI, transparent interest rates, and tokenized transactions, align with the project's broader goal of democratizing finance. By making financial services more accessible, efficient, and user-centric, the project aims to contribute to a future where financial empowerment is not confined by geographical borders or traditional banking systems.

In conclusion, the 'DeFinance: Decentralised Lending and Borrowing of Digital Assets' project is a testament to the transformative power of blockchain technology in reshaping financial systems. As we embark on the journey towards DeFi, we acknowledge the collaborative efforts of all those involved in making this project a reality.

B. Future Work

1) Cross-Chain Integration: DeFi can expand its reach through cross-chain integration, connecting seamlessly with multiple blockchain networks. This feature can enable users to leverage assets from various blockchains, fostering a more diverse and interconnected ecosystem. The implementation involves integrating with interoperability protocols and developing smart contracts compatible with different blockchain standards.

2) Interest Rate Models: In our project, interest rate models are based on demand & supply. By implementing more sophisticated models, potentially influenced by real-time market data, we can ensure dynamic and optimized interest rates. This approach can enhance market responsiveness and efficiency.

3) Insurance Mechanism: An insurance mechanism can also be introduced offering protection against unexpected events like smart contract exploits or market downturns. This risk mitigation strategy not only safeguards users but also sets our platform apart by providing a safety net. This involves partnerships with decentralised insurance protocols and the development of insurance-related smart contracts.

4) Integration with Real-World Assets: Tokenizing the real-world assets expands the array of collateral options for users. By allowing borrowing against or lending real estate, commodities, and other tangible assets, platform can offer increased diversity and exposure. This feature aligns with the growing trend of bringing traditional assets into the DeFi landscape.

5) Integration with Central Bank Digital Currencies: The integration of Central Bank Digital Currencies (CBDCs), can bridge the gap between traditional finance

and DeFi. Users gain the advantage of interacting with digital representations of fiat currencies, potentially attracting a broader user base. Compliance with regulatory requirements and establishing partnerships with entities involved in CBDC initiatives are crucial steps in this integration.

6) Flash Loans: Flash Loans enable borrowing any available amount of assets without collateral, provided liquidity is returned to the protocol within one block transaction. It involves building a contract by the borrower, that requests a flash loan, executing instructed steps, and repaying the loan.

ACKNOWLEDGMENT

The successful completion of the 'DeFinance: Decentralised Lending and Borrowing of Digital Assets' project has been a collaborative effort, and we would like to express our gratitude to those who have contributed to its realization. Our sincere thanks go to A. P. Shah Institute of Technology for providing the academic environment and resources essential for this undertaking. Additionally, we extend our appreciation to the guide who have offered valuable guidance and insights throughout the project's development.

REFERENCES

[1] S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," in Bitcoin, October 2009.

[2] F. Schär, "Decentralised Finance: On Blockchain- and Smart Contract-Based Financial Markets," Federal Reserve Bank of St. Louis Review, Second Quarter 2021, vol. 103, no. 2, pp. 153-74, April 2021.

[3] L. Gudgeon, S. Werner, D. Perez, and W. J. Knottenbelt, "DeFi Protocols for Loanable Funds: Interest Rates, Liquidity, and Market Efficiency," arXiv:2006.13922, October 2020.

[4] "AAVE Protocol Whitepaper V2," [Online]. Available: https://github.com/aave/protocol-v2/blob/master/aave-v2-whitepaper.pdf

[5] V. K. Manda and S. Yamijala, "Peer-to-Peer Lending using Blockchain," in International Journal Of Advance Research And Innovative Ideas In Education, vol. 6, no. 1, March 2019, pp. 61-66.

[6] A. U. Sable, A. Patil, P. Nimbalkar, K. Pathare, and Prof. T. Rane, "Decentralised Borrow and Lending of Crypto Assets," in International Journal of Research Publication and Reviews, vol. 4, no. 5, May 2023, pp. 4289-4295.

[7] F. Carapella, E. Dumas, J. Gerszten, N. Swem, and L. Wall, "Decentralised Finance (DeFi): Transformative Potential & Associated Risks," Washington: Board of Governors of the Federal Reserve System, 2022.

[8] R. Auer, B. Haslhofer, S. Kitzler, P. Saggese, and F. Victor, "The Technology of Decentralised Finance (DeFi)," BIS Working Papers 1066, Bank for International Settlements, January 2023.

[9] Z. Ao, G. Horvath, and L. Zhang, "Is decentralised finance actually decentralised? A social network analysis of the Aave protocol on the Ethereum blockchain," in arXiv:2206.08401, January 2023.

[10] J. Xu and N. Vadgama, "From banks to DeFi: the evolution of the lending market," in arXiv:2104.00970, December 2022.

[11] A. Beniiche, "A Study of Blockchain Oracles," in arXiv:2004.07140, July 2020.

[12] H. Patel, "A blockchain-based decentralised exchange," Cryptology ePrint Archive, 2014.

[13] S. Jaiswal, H. Gunwant, S. Shivam, and Asst. Prof. K. Dahiya, "Decentralised Finance," in International Journal for Research in Applied Science & Engineering Technology, vol. 11, issue I, ISSN: 2321-9653, January 2023.

[14] D. Gogel, S. Deshmukh, A. Geest, D. Resas, C. Sillaber, K. Werbach, T. Baker-Taylor, A. S. Cloots, B. Forster, J. L. Gustave, F. Schär, and L. Sokolin, "DeFi Beyond the Hype," Wharton School (UPenn) and World Economic Forum, May 2021.

[15] J. Yin and M. Ren, "On Liquidity Mining for Uniswap v3," in arXiv:2108.05800 [cs.AI], August 2021.

[16] OECD, "Why Decentralised Finance (DeFi) Matters and the Policy Implications," OECD Paris, January 2022. Decentralised-Finance-DeFi-Matters-and-the-Policy-Implications.

[17] Steve Ellis, Ari Juels†, and Sergey Nazarov, "ChainLink A Decentralised Oracle Network Whitepaper V1," [Online], September 2017.