

Decentralized Finance (DeFi) and Smart Contracts: Bridging the Gap in Global Financial Inclusion and Investment

Mohd Saleem¹, Md Sohrab², Matloob Ullah Khan³, and Faizan Khan Sherwani⁴

¹Assistant Professor, CCSIT, Teerthanker Mahaveer University, Moradabad, India

²Lecturer, College of Economics and Business Studies, Oman

³Assistant Professor (Finance), Department of Management; Jamia Hamdard, New Delhi

⁴Assistant Professor, Department of Management; Jamia Hamdard, New Delhi

Correspondence should be addressed to Rahul Dhyani;

Received: 2 May 2026;

Revised: 17 May 2026;

Accepted: 1 June 2026

Copyright © 2026 Made Mohd Saleem et al. This is an open-access article distributed under the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT: Key components of blockchain technology, DeFi represent a revolutionary advance in digital contracts and automated trades, and they are integrated into decentralized networks such as Ethereum. These self-executing contracts eliminate the need for middlemen by autonomously enforcing specified terms. This paper offers a thorough analysis of Decentralized Finance (DeFi), smart contracts, covering their underlying theories, technological foundations, wide range of applications, and ramifications in context of financial inclusion and investment. In order to clarify the workings and practical applications of such innovations, the research technique comprises a methodical evaluation of the literature, an examination of case studies, and an amalgamation of empirical data. This study evaluates their effects on efficiency, transparency, and trust in international transactions by looking at how they are revolutionizing industries like finance, and decentralized governance. It also thoroughly examines security considerations, including best practices and vulnerabilities, as well as regulatory issues and new developments.

KEYWORDS: Financial Inclusion, Investment, Decentralized Finance (DeFi), Smart Contracts, Blockchain, Bitcoin, Tokenization

I. INTRODUCTION

Through the use of blockchain technology, Decentralized Finance (DeFi) is transforming the financial industry by establishing an open, permission less, and trust less financial environment [1]. DeFi uses smart contracts on blockchain networks to enable financial transactions and services directly between participants, in contrast to traditional financial systems that rely on centralized middlemen like banks and brokers [2]. This paradigm change opens the door for a more democratic financial environment by providing previously unheard-of levels of inclusion, security, and openness [3]. DeFi's origins can be seen in the 2009 release of Bitcoin, which popularized the idea of a peer-to-peer, decentralized electronic currency system [4]. But the real potential for decentralized financial applications was unlocked in 2015 with the introduction of Ethereum and its Turing-complete smart

contract features [5]. In the last several years, DeFi has developed quickly, resulting in the emergence of a wide range of financial products and services, including yield farming, stable coins, and decentralized exchanges and lending platforms [6].

Through the promotion of an open innovation approach that fosters the free flow of knowledge across organizational boundaries in a strategically managed manner, Decentralized Finance, or "DeFi," is transforming the Fintech sector [7]. DeFi is a new paradigm in financial services creation, distribution, and use. It is founded on the idea that financial services shouldn't be dependent on centralized intermediaries such as insurers, banks, brokers, or stock exchanges [8]. DeFi, on the other hand, promotes the provision of financial services by users, for users, via decentralized software that is distributed throughout a peer-to-peer network, thereby doing away with counterparty risk [9]. The goal of this system is to enable people to deal with money directly, eliminating the need for middlemen. Examples of these transactions include lending and borrowing, diversification, asset speculation, generating returns, and acquiring insurance [10]. As such, DeFi is considered a logical progression of Fintech, enabling fresh, nimble players to join markets that have historically been dominated by authorized financial institutions [11] [12]. More products, greater inclusion, greater transparency, and improved risk management are all provided by these entrants [13]. DeFi is a prime illustration of the idea that technology is both changing and broadening the reach of markets. The financial services sector itself is expanding thanks to the technology that supports DeFi [14]. Automation and blockchain, in particular, are profoundly altering the development, delivery, and use of financial services. The history of automation in finance is extensive [15]. For many years, automated procedures including credit checks, standing orders, and security trading orders have functioned with little to no human involvement. Peer-to-peer money transfers were made possible by Nakamoto's 2008 unveiling of the initial Bitcoin blockchain, DeFi, which laid the groundwork for this technology [1]. Since then, the Ethereum network has expanded this capability by adding smart contracts to the blockchain. The "rise of peer-to-peer financial contracting" is made possible by this

programming logic, which makes it possible for commercial activities to be carried out without the need for middlemen [16]. The most extensively utilized technology in DeFi is the Ethereum protocol. Total value

of crypto-assets locked (TVL) in smart contracts, a measure of the capital employed in the DeFi ecosystem, is indicative of this [17].

Table 1: Comparative Benchmarks: Decentralized Finance V/s Centralized/Traditional Finance [3]

Comparative Benchmarks: Decentralized Finance V/s Centralized/Traditional Finance		
Features	Traditional Finance	DeFi - Decentralized Finance
Degree of automation	Low	High
Network Structure	Centralised	Decentralized
Self-custodial	No	Yes
Trust less	No	Yes
Technology importance	Low	High
Intermediary importance	High	Low
Costs of service	High	Low
Product Focus	High	Low
Single Point of failure	Yes	No
Counterparty risk	High	Low
Anonymous	No	Yes
Inclusive	No	Yes
Transparent	No	Yes
Open Source	No	Yes
Permission less	No	Yes
Flexibility	Low	High
Security	Low	High
Regulated	Yes	No

Distinctions between traditional finance and decentralized finance (DeFi):

- **Wide Access:** DeFi platforms allow everyone to join without any barriers; therefore, no one entity can stop anyone from doing so. All consumers, developers, and validators of financial services are covered by this open access policy. DeFi uses pseudonymous identities in contrast to traditional financial services, which may call either customer screening or service provider licensing. This makes it possible for everyone to register for a free address and use it to access services without having to worry about being treated unfairly because of who they really are.
- **Deterministic and Transparent Rules:** DeFi works with infrastructures and contracts that are programmed in open, self-governing scripts called smart contracts. This guarantees the determinism and transparency of the rules. On the other hand, private contracts and norms that are susceptible to capricious choices are common in traditional finance.
- **Unsupervised Services:** After tying their crypto currency holdings to their public addresses, DeFi users maintain complete control over their holdings. In contrast, custodial services are usually used by financial intermediaries to manage the portfolios of their clients in traditional finance. Because users of DeFi do not have to give their assets to outside parties, there is less chance of fraud or poor asset management.
- **Compatible and Constructible Protocols:** To construct new solutions, DeFi protocols can be easily interfaced and merged. The open and public nature of

- DeFi protocols is inherently characterized by interoperability and composability, which are characteristics that have been carried over from the history of open-source systems in computer science. Since the traditional financial system does not enable the smooth integration and interfacing of various financial services in the same manner, it does not directly correspond to this dynamic.

Decentralized Finance (DeFi) Ecosystem: It consists of several key components, including (see Figure 1):

- **Blockchain Technology:** The foundation of DeFi is this decentralized ledger, which securely and transparently records transactions over a network of computers.
- **Smart Contracts:** By autonomously enforcing agreements without the need for middlemen, these self-executing contracts with coded terms enable trust less transactions.
- **Stablecoins** are particular types of cryptocurrencies that are intended to keep their value steady in relation to another asset, like the US dollar. Important protocols in this group consist of: USDC by Circle, USDT by Tether, and Dai by MakerDAO
- **Decentralized Exchanges (DEXs):** These are online marketplaces that operate automatically, enabling users to exchange tokens and provide liquidity to trading pools through smart contract technology. Notable instances consist of: Sushiswap, Curve, Uniswap
- **Credit Services:** In DeFi, credit is mostly given through liquidity pools that provide loans with collateral or quick loans, also referred to as flash loans.

Prominent protocols within this domain comprise: Compound, Aave

- **Insurance and Derivatives:** Futures, perpetual contracts, and synthetic exposure to crypto currency or physical assets are examples of DeFi's derivatives offerings. Similar to credit, these services are frequently offered via liquidity pools that have positions backed by collateral. Insurance services are still in their infancy, but they are starting to take shape

thanks to algorithms that recognize predefined events. Important procedures in this group include: dYdX, Synthetix

- **Portfolio Management:** DeFi provides asset management services that let customers incorporate "vaults," or collections of assets, that are controlled and supervised by rules embedded in smart contracts. Important guidelines in this field consist of: Set Protocol, PieDAO

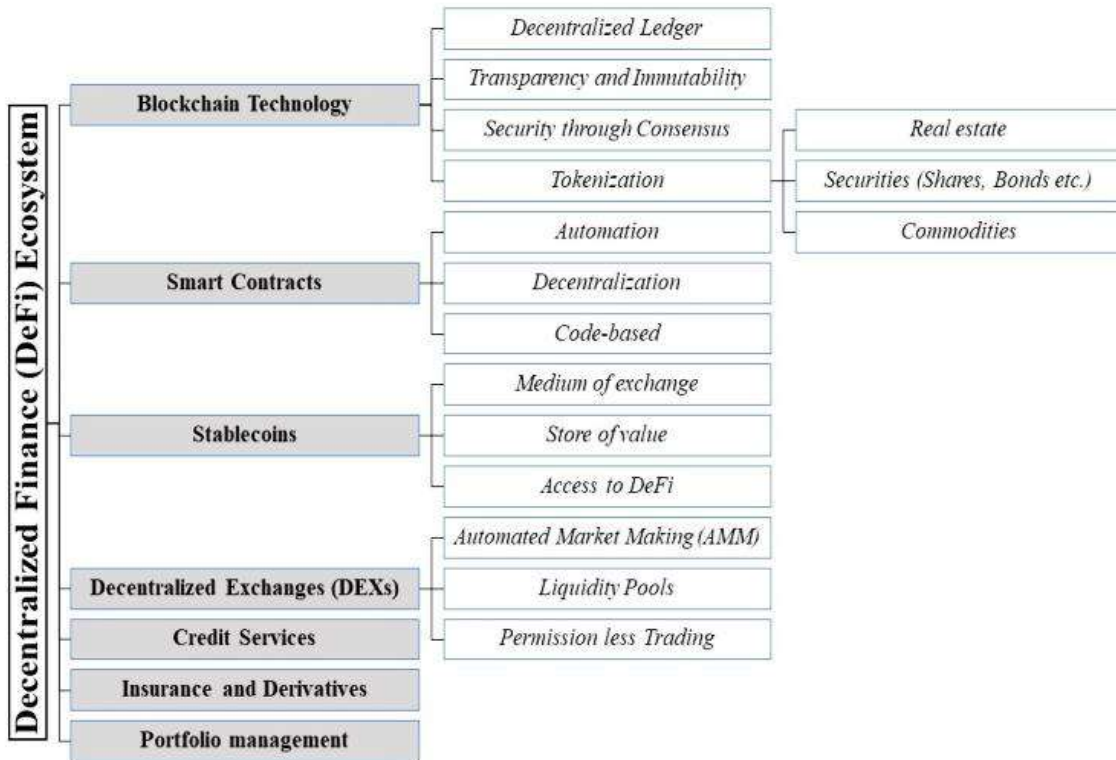


Figure 1: Decentralized Finance (DeFi) Ecosystem [18]

The so-called Bitcoin payment system was the first instance of crypto-economic systems in history and a forerunner to the emergence of DeFi. Reorganizing information to facilitate digital transfers while maintaining anonymity in the lack of a centralized authority was one of the core value propositions presented in the Bitcoin White Paper (Nakamoto, 2008). The privacy value of transaction information really causes a major source of friction for digital payment systems: by default, the system should assume that users do not want their whole transaction history to be made public. There are two approaches to solving this issue:

- Bitcoin model and
- Conventional payment methods

Information is hidden from the parties engaged in the payment chain (sender, sender's bank, payment system,

receiver's bank, receiver) in a traditional digital payment. Unless authorization is obtained, third parties cannot access information about a specific transaction (e.g., government involvement or client transfer of information to third party apps). The data in Bitcoin is divided into two separate sets. On the one hand, the distributed ledger stores and makes available for public access all transaction-based data. Because of this, details regarding a transaction—such as its value, date, sender and recipient addresses—can be seen and confirmed by anybody. In accordance with our list of information requirements, a payment service is therefore feasible and implementable. However, no one is able to view any other type of data (such as the identities of the persons involved, the things that were bought, etc.)(See Figure 2).

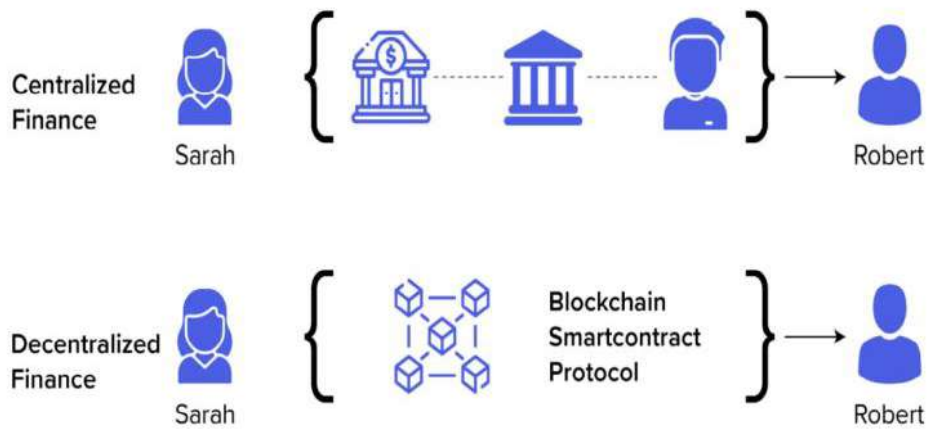


Figure 2: Centralized Finance vs Decentralized Finance Process [7]

Bitcoin and regular payments use different approaches to solving the privacy challenge. While the latter divides information between strictly private identity and public activities, the former depends on a trusted third party to keep information hidden from public view.

II. ADVANCEMENTS IN DECENTRALIZED FINANCE (DEFI)

A number of creative approaches that set Decentralized Finance (DeFi) apart from conventional financial systems have fuelled its explosive development and expansion. These developments have increased DeFi's usefulness and made it more appealing to a wider range of users. In this article, we examine four significant developments in the

DeFi space: tokenization, yield farming and liquidity mining, interoperability solutions, and decentralized exchanges (DEXs).

A. DEXs, or decentralized exchanges

Decentralized Exchanges (DEXs) are online marketplaces that enable peer-to-peer cryptocurrency trading without the use of middlemen [19]. DEXs function on smart contracts, which are self-executing contracts with the terms of the deal explicitly encoded into code, as opposed to traditional exchanges [20]. Due to this, there is no longer a need for a central body to monitor transactions, which increases transparency and lowers the possibility of fraud [21] (see Figure 3).



Figure 3: Decentralized Exchanges vs Centralized Exchanges[19]

It has several features over traditional approaches of exchange:

- **Automated Market Making (AMM):** Based on supply and demand, DEXs utilize AMM algorithms to set asset prices. This is in contrast to traditional exchanges' usage of the order book paradigm. AMM-based DEXs like Uniswap, Sushiswap, and Curve are widely used.
- **Liquidity Pools:** By contributing their assets to liquidity pools, users can give trading pairs liquidity. They receive a portion of the trading fees that the pool generates in exchange. By providing incentives for

consumers to provide liquidity, this method deepens the market overall and lowers price slippage.

- **Permission less Trading:** To promote financial inclusion, anyone with a cryptocurrency wallet and an internet connection can trade on DEXs without having to go through identification verification procedures.

B. Effects of DEXs

By reducing transaction costs and automating trade, Decentralized Exchanges (DEXs) greatly improve market efficiency by doing away with the need for

middlemen. In comparison to centralized exchanges, which are more vulnerable to fraud and hacking, this automation not only makes transactions faster but also guarantees that users retain ownership over their private keys and assets. DEXs also facilitate a more inclusive financial ecosystem by allowing users everywhere to access a wide range of financial services without being restricted by geography or regulations. This helps to advance global financial inclusion.

C. Yield Farming and Liquidity Mining

Yield farming and liquidity mining are two cutting-edge tactics that have greatly aided in DeFi's expansion. By offering incentives, usually in the form of extra tokens, these systems encourage users to contribute their assets to DeFi protocols. Giving liquidity to DeFi protocols—like lending platforms or DEXs—in exchange for interest or more tokens is known as yield farming [11]. By strategically shifting their assets across several platforms to take advantage of the highest yield prospects, users can optimize their profits. In particular, users that add liquidity to DEXs or other DeFi platforms are rewarded through liquidity mining [22]. Liquidity providers receive governance tokens, which give them voting rights and a portion of the protocol's revenues, in addition to trading fees. It has highlighted features:

- **High yields:** A huge number of participants are drawn to yield farming and liquidity mining because to their much greater yields as compared to standard savings accounts or investments.
- **Protocol Growth:** Liquidity is necessary for DeFi protocols to function and expand, and these processes aid in attracting and retaining it.
- **Community Involvement:** Protocols can decentralize decision-making and involve their communities in the development process by giving governance tokens to liquidity providers.
- **Problems:** The hazards associated with yield farming and liquidity mining in DeFi are distinct. Impermanent loss is one significant risk that arises when the value of assets deposited by liquidity provider's changes in relation to one another. This can result in lower returns than if the assets were held independently. Furthermore, security issues are a major worry because DeFi protocols are susceptible to hacking and flaws in smart contracts, which might cause liquidity providers to suffer large losses. These dangers emphasize how crucial it is to use caution and limit hazards when taking part in DeFi activities.

D. Tokenization

The process of transforming physical assets or money instruments into digital tokens on a blockchain is known as tokenization [23]. This invention improves accessibility, transparency, and liquidity, making it possible to trade and manage a variety of assets more effectively [24].

Different Tokenized Asset Types [25]:

- **Real estate:** Tokenizing properties makes fractional ownership and transferability easier. As

a result, investors have a reduced entrance hurdle and the real estate market is more liquid.

- **Securities:** Tokenization makes it possible for stocks, bonds, and other financial instruments to be traded and settled more quickly. Moreover, tokenized securities provide lower transaction costs and increased transparency.
- **Commodities:** Digital tokens can be used to represent precious metals, oil, and other commodities, making trading simpler and more transparent.

Benefits of Tokenization

- **Enhanced Liquidity:** Tokenization makes fractional ownership possible, opening up markets that were closed to smaller investors. This expands the pool of potential investors and improves liquidity.
- **Enhanced Transparency:** Blockchain technology lowers the risk of fraud and increases trust by ensuring that all transactions and ownership records are transparent and unchangeable.
- **Decreased Costs:** Tokenization lowers transaction costs and expedites settlement times by doing away with middlemen and automating procedures.

Challenges

In DeFi, tokenization has many obstacles. Since the legal requirements and compliance obligations for tokenized assets are still developing and raising concerns about their regulation, regulatory uncertainty is a serious worry. Technical complexity also presents a challenge because tokenization implementation calls for a strong technology foundation and specialized knowledge, both of which might be challenging for certain firms to obtain. To fully exploit the promise of tokenization in revolutionizing financial markets, several obstacles must be overcome.

E. Interoperability Solutions

The goal of interoperability solutions is to facilitate smooth transactions and communication between various blockchain networks [26]. This invention facilitates the free flow of assets and data across several platforms, hence mitigating the fragmentation within the DeFi ecosystem [27].

Key Interoperability Solutions [28]:

- **Cross-Chain Bridges:** These are technologies that let data and assets move between various blockchains more easily. Chainlink, Polkadot, and Cosmos are a few examples.
- Tokens that symbolize assets from one blockchain on another are known as wrapped tokens. Holders of Bitcoin can take part in DeFi on Ethereum thanks to Wrapped Bitcoin (WBTC), which acts as Bitcoin's representative on the Ethereum network.
- **Atomic Swaps:** These are direct, peer-to-peer crypto currency trades between several blockchain that don't require middlemen. Atomic swaps remove counterparty risk by guaranteeing that transactions are either fully completed or not at all.

The advantages of interoperability

- *Improved Connectivity:* Interoperability solutions make the DeFi ecosystem more coherent and linked, giving consumers access to a wider range of resources and services.
- *Enhanced Efficiency:* Through the facilitation of smooth transfers and communication between blockchain, interoperability solutions lower barriers to entry and improve the DeFi ecosystem's overall efficiency.
- *Increased Innovation:* By combining the advantages of several blockchain, interoperability allows programmers to design more intricate and inventive solutions.

Challenges

DeFi interoperability solutions entail inherent security risks, particularly with regard to cross-chain bridges, which are vulnerable to security flaws and attacks that could jeopardize user assets. Furthermore, from a technological point of view, the complexity and scalability of putting these solutions into practice and keeping them up to date rise with the number of interconnected blockchain. It is imperative to tackle these concerns in order to guarantee the safe and effective operation of the cross-platform DeFi ecosystem.

To sum up, the technologies that are leading DeFi's quick growth and evolution include Yield Farming and Liquidity Mining, Decentralized Exchanges, Tokenization, and Interoperability Solutions. They not only set DeFi apart from conventional finance but also increase its allure, reach, and capacity to have a revolutionary effect on the world financial system.

III. IMPACT ON THE FINANCIAL ECOSYSTEM

There are significant ramifications for the established financial ecosystem from the rise of Decentralized Finance (DeFi). DeFi brings about a number of revolutionary components that alter the way financial services are accessible, administered, and controlled by utilizing blockchain technology and smart contracts. The effects of DeFi on financial inclusion, intermediary reduction, risk and security, and regulatory issues are examined in this section.

A. Financial Inclusion

DeFi democratizes access to financial services, which greatly improves financial inclusion. Individuals without the required papers, credit history, or physical accessibility to banking facilities are frequently left out of traditional financial systems [29]. DeFi platforms, in contrast, function in a permission less manner, making participation open to anybody with an internet connection and a cryptocurrency wallet [30].

- *Universal Access:* DeFi platforms allow people in underserved and unbanked areas to participate because they do not require users to go through lengthy identification verification processes. Users using pseudonymous identities can interact with banking services and create addresses for free without having to worry about rules that discriminate against their true identities.

- *Reduced expenses:* DeFi lowers transaction and operating expenses by doing away with middlemen, which enables customers to purchase financial services at a lower rate. People who live in developing nations, where banking costs can be unaffordably high, will especially benefit from this.
- *Innovative Financial Products:* To meet the requirements of the unbanked and underbanked communities, DeFi provides a range of financial products, including microloans, savings accounts, and remittances. Comparing these products to typical banking services, more comprehensive financial solutions are offered.

B. Removal of intermediaries

The removal of middlemen from financial transactions is one of DeFi's key tenets. Conventional finance places a great deal of reliance on middlemen to handle transactions, such as banks, brokers, and payment processors [4]. This approach increases costs, complexity, and failure points.

- *Cost-effectiveness:* DeFi uses smart contracts to automate procedures, which lowers transaction costs. Users benefit from this cost effectiveness, which drives down the cost of financial services.
- *Enhanced Transparency:* Financial transactions are more transparent thanks to smart contracts that run on public blockchain. Because all transactions are publicly verifiable, this transparency lowers the danger of fraud and corruption.
- *Empowerment of Users:* DeFi gives users complete control over their financial resources and choices by doing away with middlemen. Users' sense of ownership and accountability is increased by this decentralization, which promotes more responsible and knowledgeable financial conduct.

C. Risk and Security

Although DeFi has many advantages, there are also new hazards and security issues that must be resolved for long-term growth. Because DeFi systems are decentralized, users are more accountable for overseeing their funds and being aware of the hazards involved [31].

- *Vulnerabilities in Smart Contracts:* DeFi protocols are dependent on smart contracts, which are prone to faults and coding problems. As seen by several well-publicized breaches, taking advantage of these vulnerabilities can result in large financial losses.
- *Hacking Risks:* DeFi platforms are appealing targets for hackers due to blockchain technology's open and transparent nature. To reduce these risks, strong security measures must be implemented, such as frequent audits and bug bounties.
- *Impermanent Loss:* When the value of their deposited assets varies in relation to one another, liquidity providers in DeFi protocols run the danger of experiencing impermanent loss. Lower returns may arise from this as opposed to holding the assets independently.

D. Regulatory Challenges

DeFi's regulatory environment is still changing, which poses difficulties and uncertainty for both creators and players. Maintaining the long-term

sustainability of the DeFi ecosystem requires striking a balance between innovation and regulatory obedience [32].

- *Observance and Lawful Requirements:* Regulators from all around the world are becoming more interested in DeFi platforms as they gain popularity. One of the biggest challenges for DeFi projects is navigating the many and varying regulatory requirements across different jurisdictions.
- *Consumer Protection:* Regulators place a high premium on protecting consumers from fraud, scams, and other hazards. It takes careful balance to implement consumer protection laws while upholding DeFi's decentralized philosophy.
- *Know Your Customer (KYC) and Anti-Money Laundering (AML):* To stop illicit activity, traditional financial institutions must abide by strict KYC and AML rules. A crucial regulatory difficulty is modifying these frameworks to account for the permission less and pseudonymous nature of DeFi.

In conclusion, DeFi has a complex effect on the financial ecosystem that presents both new risks and regulatory obstacles in addition to major advantages like increased financial inclusion and decreased reliance on intermediaries. Realizing the full potential of DeFi and promoting a safe, welcoming, and creative financial ecosystem will depend on resolving these problems.

IV. EXAMPLES FROM THE REAL WORLD AND CASE STUDIES

A. Achievements in DeFi Projects

DeFi has seen the emergence of several noteworthy initiatives that show its potential to completely transform the financial services industry. Innovative financial solutions like loan and borrowing protocols, decentralized exchanges (DEXs), and liquidity provisioning techniques have been pioneered by projects like Aave, Compound, and Uniswap. Using smart contracts, these platforms run independently and provide consumers with higher yields and more control over their money than traditional financial services (see Table 2) (see Figure 4).

Table 2: Global DeFi Adoption Index Top 20 (21-22) [33]

Global DeFi Adoption Index Top 20 (21-22)					
Country	Ranking	Index score	On-chain DeFi value received	On-chain number of DeFi deposits	On-chain retail DeFi value received
United States	1	1	3	47	4
Vietnam	2	0.82	4	64	3
Thailand	3	0.68	5	46	5
China	4	0.62	2	113	2
United Kingdom	5	0.6	9	40	6
India	6	0.59	1	120	1
Netherlands	7	0.55	24	11	18
Canada	8	0.52	17	30	15
Ukraine	9	0.49	11	50	7
Poland	10	0.46	18	36	17
France	11	0.46	14	44	16
Australia	12	0.41	27	26	23
Turkey	13	0.4	13	61	14
Switzerland	14	0.38	31	8	34
Russia	15	0.36	10	77	12
Argentina	16	0.34	12	65	21
Brazil	17	0.32	6	110	13
Portugal	18	0.31	34	22	33
Hong Kong	19	0.3	33	14	47
Togo	20	0.3	32	34	29

Global DeFi Adoption Index Top 20 (21-22)

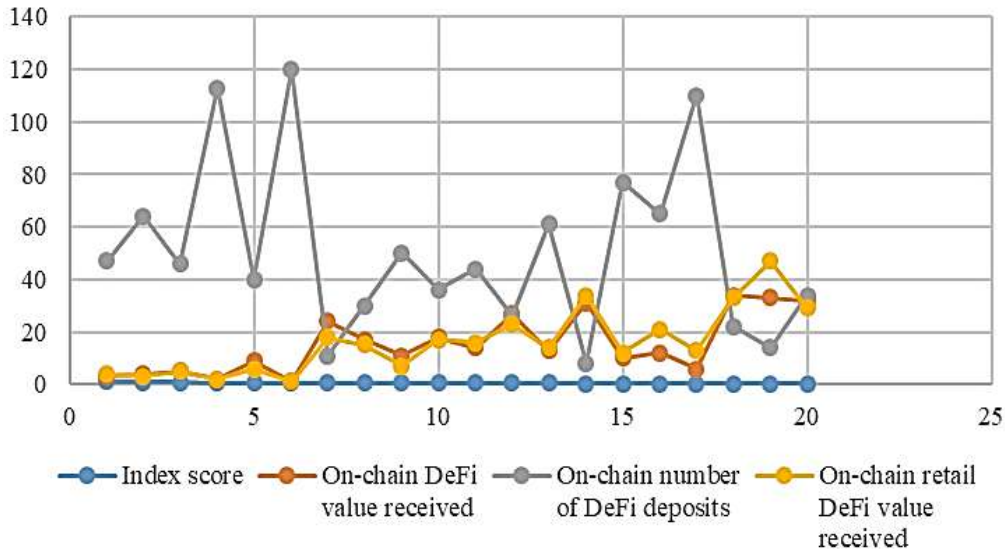


Figure 4: Global DeFi Adoption Index Top 20 (21-22) [33]

B. User Perspectives

When using DeFi platforms, users frequently emphasize the advantages of smooth transactions, lower fees, and increased transparency. Liquidity providers, for instance, can earn fees and governance tokens by taking part in liquidity pools on DEXs like

Uniswap. Produce producers take advantage of systems such as Compound and Aave to get interest on assets deposited or to borrow money directly from the source. These incidents demonstrate how DeFi can empower people everywhere, irrespective of their financial situation or place of residence (see Figure 5).

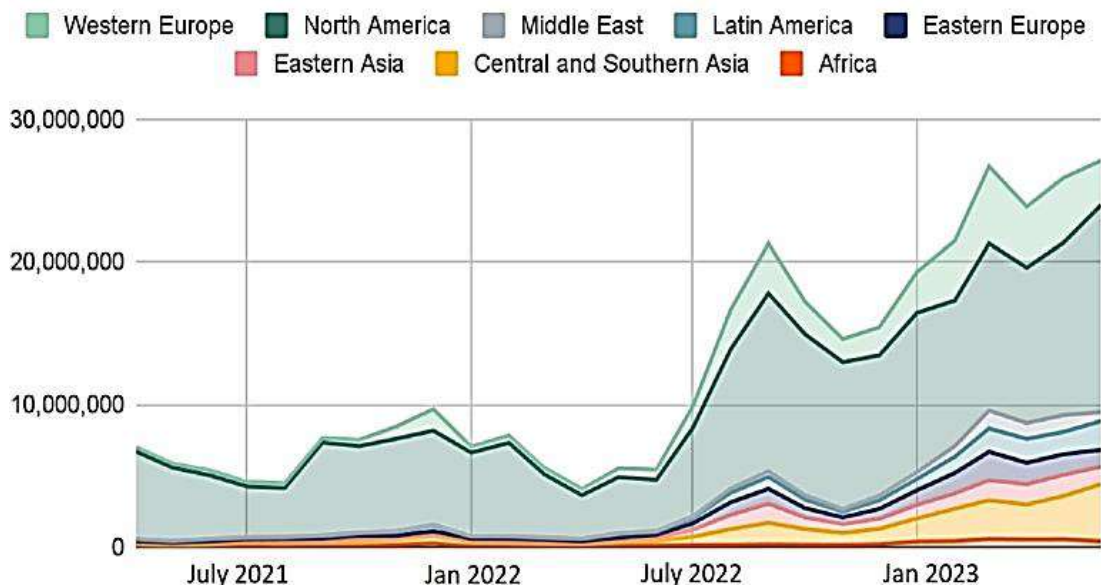


Figure 5: Month wise DeFi Platform's Visits

C. Partnerships with Conventional Finance

Collaborations and integrations are making the junction of DeFi and traditional banking more apparent. Well-known financial institutions are investigating DeFi protocols and blockchain technology in order to simplify operations, cut expenses, and enter new markets. Initiatives such as this one, which bridge the divide between decentralized and centralized finance, offer diversified investment opportunities by fusing traditional asset management with decentralized lending protocols [7].

Successful DeFi initiatives serve as examples of how blockchain technology has the ability to completely change the financial services industry. User experiences draw attention to the advantages of openness and accessibility, and partnerships with traditional finance open the door to creative financial solutions that serve a worldwide clientele. These advancements highlight DeFi's expanding impact on how finance is shaped going forward.

V. CONCLUSION AND FUTURE TRENDS

Future developments in smart contracts and blockchain technology will probably improve the functionality of DeFi platforms. Enhancements in DeFi's scalability, interoperability, and privacy characteristics will allow it to accommodate a greater variety of financial applications and manage higher transaction volumes. In order to scale DeFi platforms to meet increasing demand, innovations like Layer 2 solutions—which try to increase transaction speed and lower costs on current blockchains like Ethereum—will be essential.

It is anticipated that the DeFi ecosystem will keep growing quickly due to rising popularity and the introduction of additional decentralized apps (DApps). The development of lending and borrowing protocols, the spread of decentralized exchanges (DEXs), and the introduction of novel financial products like derivatives and tokenized assets are important market trends. Institutional investors will need to see regulatory certainty and compliance frameworks in order to maintain DeFi's development.

The adoption of DeFi poses both strategic opportunities and challenges for financial institutions and enterprises. Financial transaction transparency can be improved, operations can be streamlined, and costs can be decreased by combining blockchain technology with DeFi protocols. However, reducing the risks connected with DeFi would require managing legislative complications and making sure that strong security measures are in place. Cooperation between DeFi initiatives and traditional finance will probably spur innovation and lead to the creation of hybrid financial solutions that draw on the advantages of both ecosystems.

To sum up, the future of DeFi seems promising in terms of technology development, industry expansion, and strategic ramifications for companies and financial institutions. To fully realize the potential of decentralized banking in revolutionizing the global financial ecosystem, it will be imperative to acknowledge and tackle regulatory obstacles while welcoming innovation. The present centralized finance (CeFi) system may be replaced by decentralized finance (DeFi). But politicians will oppose an attempt to totally reform centralized finance. Who seek to maintain control over the financial system in order to keep an eye on and stop financial crimes from taking place there. Since there won't be much of a risk to their ability to oversee the financial system, policymakers may be open to CeFi and DeFi coexisting. Future research ought to look into the possible coexistence and mutual enhancement of CeFi and DeFi.

ANNEXURE I

Figure 1. Decentralized Finance (DeFi) Ecosystem (Dos Santos et al., 2022)
 Figure 2. Centralized Finance vs Decentralized Finance Process (Qin et al., 2021).....
 Figure 3. Decentralized Exchanges vs Centralized Exchanges (Lehar & Parlour, 2021).....
 Figure 4. Global DeFi Adoption Index Top 20 (21-22) (Ozili, 2022)
 Figure 5. Month wise DeFi Platform's Visits.....

CONFLICTS OF INTEREST

I, Mohd Saleem, declare that there are no conflicts of interest regarding the publication of the manuscript titled "Decentralized Finance (DeFi) and Smart Contracts: Bridging the Gap in Global Financial Inclusion and Investment". I have no financial, personal, or professional affiliations that could influence or bias the content of this work. I confirm that all funding sources, if any, have been appropriately acknowledged within the manuscript, and I have disclosed any relationships or activities that could be perceived as potential conflicts of interest. I affirm that the conclusions and opinions expressed in this work are my own and have not been influenced by external pressures or interests.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to my co-author for his collaborative efforts and valuable insights in completing this work titled "Decentralized Finance (DeFi) and Smart Contracts: Bridging the Gap in Global Financial Inclusion and Investment". I am deeply thankful to my organization for providing the necessary resources and a supportive environment that enabled us to carry out this research. Our appreciation also auditors whose works and reviews have guided us throughout this project. Lastly, we extend our thanks to publisher for offering the opportunity to publish this work and for their support in sharing our research with a wider audience.

REFERENCES

[1] E. A. Boakye, H. Zhao, and B. N. K. Ahia, "Emerging research on blockchain technology in finance: Conveyed evidence of bibliometric-based evaluations," *J. High Technol. Manag. Res.*, vol. 33, no. 2, p. 100437, 2022. Available from: <https://doi.org/10.1016/j.hitech.2022.100437>

[2] Makarov and A. Schoar, "Cryptocurrencies and Decentralized Finance (DeFi)," *Brookings Papers on Economic Activity*, vol. 2022, no. 1, pp. 141–215, 2022. Available from: <https://www.brookings.edu/bpea-articles/cryptocurrencies-and-decentralized-finance-defi/>

[3] P. Schueffel, "DeFi: Decentralized Finance—An Introduction and Overview," *J. Innov. Manag.*, vol. 9, no. 3, pp. I–XI, Nov. 2021. Available from: https://journalsojs3.fe.up.pt/index.php/jim/article/view/2183-0606_009.003_0001

[4] C. R. Harvey, A. Ramachandran, and J. Santoro, *DeFi and the Future of Finance*. Hoboken, NJ, USA: John Wiley & Sons, 2021. Available from: https://books.google.com/books?id=YCY_EAAAQBAJ

[5] J. R. Jensen, V. von Wachter, and O. Ross, "An Introduction to Decentralized Finance (DeFi)," *Complex Syst. Inform. Model. Q.*, no. 26, pp. 46–54, 2021. Available from: <https://pdfs.semanticscholar.org/a4f6/341b281923a773f6510dd6ee7c2ee7ef5693.pdf>

[6] S. Werner; D. Perez; L. Gudgeon; A. Klages-Mundt; D. Harz; and W. Knottenbelt, "SoK: Decentralized Finance (DeFi)," in *Proc. 4th ACM Conf. Adv. Financial Technol. (AFT)*, 31 Cambridge, MA, USA, Sep. 2022, pp. 30–46. Available from: <https://doi.org/10.1145/3558535.3559780>

[7] K. Qin, L. Zhou, Y. Afonin, L. Lazzaretti, and A. Gervais, "CeFi vs. DeFi—Comparing Centralized to Decentralized Finance," arXiv:2106.08157, Jun. 2021. Available from: <https://arxiv.org/abs/2106.08157>

[8] S. Aramonte, W. Huang, and A. Schrimpf, "DeFi Risks and the Decentralisation Illusion," *BIS Quarterly Review*, Dec.

2021. Available from: https://www.bis.org/publ/qtrpdf/r_qt2112b.htm
- [9] L. Gudgeon, S. Werner, D. Perez, and W. J. Knottenbelt, "DeFi Protocols for Loanable Funds: Interest Rates, Liquidity and Market Efficiency," in *Proc. 2nd ACM Conf. Adv. Financial Technol. (AFT)*, New York, NY, USA, Oct. 2020, pp. 92–112. Available from: <https://doi.org/10.1145/3419614.3423254>
- [10] Makarov and A. Schoar, "Cryptocurrencies and Decentralized Finance (DeFi)," *Brookings Papers on Economic Activity*, vol. 2022, no. 1, pp. 141–215, 2022. Available from: <https://www.brookings.edu/bpea-articles/cryptocurrencies-and-decentralized-finance-defi/>
- [11] V. Mohan, "Automated Market Makers and Decentralized Exchanges: A DeFi Primer," *Financ. Innov.*, vol. 8, no. 1, p. 20, Dec. 2022. Available from: <https://doi.org/10.1186/s40854-021-00314-5>
- [12] M. Saleem, M. U. Khan, and D. Ather, "Fintech Startups and Banks: Adoption, Incentives, Competition, and Regulations," *Int. J. Glob. Bus. Manag. Res.*, vol. 10, no. 2, pp. 21–28, 2021.
- [13] U. W. Chohan, "Decentralized Finance (DeFi): An Emergent Alternative Financial Architecture," *CBRI Working Paper*, 2021. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3791921
- [14] Yaish, M. Dotan, K. Qin, A. Zohar, and A. Gervais, "Suboptimality in DeFi," *IACR Cryptology ePrint Archive*, 2023. Available from: <https://eprint.iacr.org/2023/892>
- [15] H. Amler, L. Eckey, S. Faust, M. Kaiser, P. Sandner, and B. Schlosser, "DeFi-ning DeFi: Challenges & Pathway," in *Proc. 3rd Conf. Blockchain Res. Appl. Innov. Netw. Serv. (BRAINS)*, 2021, pp. 181–184. Available from: <https://doi.org/10.1109/BRAINS52497.2021.9569795>
- [16] M. J. Casey and P. Vigna, "In Blockchain We Trust," *MIT Technol. Rev.*, vol. 121, no. 3, pp. 10–16, 2018.
- [17] J. Almeida and T. C. Gonçalves, "A Systematic Literature Review of Investor Behavior in the Cryptocurrency Markets," *J. Behav. Exp. Finance*, p. 100785, 2023. Available from: <https://doi.org/10.1016/j.jbef.2023.100785>
- [18] S. Dos Santos, J. Singh, R. K. Thulasiram, S. Kamali, L. Sirico, and L. Loud, "A New Era of Blockchain-Powered Decentralized Finance (DeFi)—A Review," in *Proc. IEEE 46th Annual Computers, Software, and Applications Conf. (COMPSAC)*, 2022, pp. 1286–1292. Available from: <https://doi.org/10.1109/COMPSAC54236.2022.00203>
- [19] Lehar and C. A. Parlour, "Decentralized Exchanges," SSRN Working Paper No. 3905316, 2021. Available from: http://ewfs.org/wp-content/uploads/2022/01/228_01.pdf
- [20] S. Malamud and M. Rostek, "Decentralized Exchange," *Amer. Econ. Rev.*, vol. 107, no. 11, pp. 3320–3362, 2017.
- [21] L. X. Lin, "Deconstructing Decentralized Exchanges," *Stanford Journal of Blockchain Law & Policy*, vol. 2, p. 58, 2019. Available from: <https://stanford-jblp.pubpub.org/pub/deconstructing-decentralized-exchanges>
- [22] L. Heimbach, Y. Wang, and R. Wattenhofer, "Behavior of Liquidity Providers in Decentralized Exchanges," arXiv:2105.13822, Oct. 2021. Available from: <https://arxiv.org/abs/2105.13822>
- [23] X. Li, X. Wu, X. Pei, and Z. Yao, "Tokenization: Open Asset Protocol on Blockchain," in *Proc. IEEE 2nd Int. Conf. Inf. Comput. Technol. (ICICT)*, 2019, pp. 204–209. Available from: <https://doi.org/10.1109/INFOCT.2019.8711021>
- [24] M. J. Morrow and M. Zarrebini, "Blockchain and the Tokenization of the Individual: Societal Implications," *Future Internet*, vol. 11, no. 10, p. 220, 2019. Available from: <https://www.mdpi.com/1999-5903/11/10/220>
- [25] Y. Tian, Z. Lu, P. Adriaens, R. E. Minchin, A. Caithness, and J. Woo, "Finance Infrastructure Through Blockchain-Based Tokenization," *Front. Eng. Manag.*, vol. 7, no. 4, pp. 485–499, Dec. 2020. Available from: <https://link.springer.com/article/10.1007/s42524-020-0140-2>
- [26] R. Bhatia, "Interoperability Solutions for Blockchain," in *Proc. Int. Conf. Smart Technol. Comput., Electr. Electron. (ICSTCEE)*, 2020, pp. 381–385. Available from: <https://doi.org/10.1109/ICSTCEE49637.2020.9277054>
- [27] R. Belchior, A. Vasconcelos, S. Guerreiro, and M. Correia, "A Survey on Blockchain Interoperability: Past, Present, and Future Trends," *ACM Comput. Surv.*, vol. 54, no. 8, pp. 1–41, Nov. 2022. Available from: <https://dl.acm.org/doi/10.1145/3471140>
- [28] S. Schulte, M. Sigwart, P. Frauenthaler, and M. Borkowski, "Towards Blockchain Interoperability," in *Business Process Management: Blockchain and Central and Eastern Europe Forum*, vol. 361, Lecture Notes in Business Information Processing, Cham, Switzerland: Springer, 2019, pp. 3–10. Available from: https://link.springer.com/chapter/10.1007/978-3-030-30429-4_1
- [29] M. Saleem and C. Chawla, "Blockchain-Powered Decentralized Finance (DeFi): Transforming Financial Inclusion & Investment Landscapes," in *Proc. 12th Int. Conf. System Modeling & Advancement in Research Trends (SMART)*, 2023, pp. 342–346. Available from: <https://doi.org/10.1109/SMART59791.2023.10428666>
- [30] S. A. Abdulhakeem and Q. Hu, "Powered by Blockchain Technology, DeFi (Decentralized Finance) Strives to Increase Financial Inclusion of the Unbanked by Reshaping the World Financial System," *Mod. Econ.*, vol. 12, no. 1, pp. 1–17, 2021. Available from: <https://www.scirp.org/journal/paperinformation?paperid=106789>
- [31] D. Yermack and A. Fingerhut, "Blockchain Technology's Potential in the Financial System," in *Proc. 2019 Financial Markets Conference*, 2019. Available from: https://www.atlantafed.org/-/media/documents/news/conferences/2019/0519-financial-markets-conference/papers/yermack_policy-session-one_blockchain-technology-potential-in-the-financial-system.pdf
- [32] J. C. Crisanto and J. Prenio, *Regulatory Approaches to Enhance Banks' Cyber-Security Frameworks*. Basel, Switzerland: Bank for International Settlements, Financial Stability Institute, 2017. Available from: <http://www.asbaweb.org/E-News/enews-50/JBS50.pdf>
- [33] P. K. Ozili, "Decentralized Finance Research and Developments Around the World," *J. Bank. Financ. Technol.*, vol. 6, no. 2, pp. 117–133, Oct. 2022. Available from: <https://doi.org/10.1007/s42786-022-00044-x>