

# INTEGRATION OF DECENTRALIZED FINANCE (DEFI) IN THE U.S. SUPPLY CHAIN FINANCE: OPPORTUNITIES, CHALLENGES, AND FUTURE PROSPECTS

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## **ABSTRACT**

*This research examines the integration of decentralized finance (DeFi) in supply chain finance and its potential to revolutionize traditional financial systems. The study aims to provide an understanding of how DeFi can overcome the limitations of traditional supply chain finance methods and create new opportunities for businesses. The research starts by discussing the challenges faced by supply chain finance and introduces DeFi as a solution. Using blockchain technology and smart contracts, DeFi enables a transparent and trustworthy system for real-time tracking of financial transactions and assets, this transparency reduces the risk of fraud and enhances decision-making. The study explores how DeFi can streamline and automate various supply chain finance processes, such as invoice factoring, trade finance, and payments, using smart contracts and decentralized applications. However, there are challenges and limitations that need to be addressed for successful implementation. The implications of DeFi for the US financial system, including risks to traditional institutions and regulatory considerations, are also discussed. The research proposes potential solutions and prospects for DeFi in supply chain finance. Additionally, the research examines the potential impact of DeFi on the US economy and job market, highlighting the emergence of new job roles and skills. The study concludes by providing key findings and recommendations for stakeholders, including companies, policymakers, and researchers. The integration of DeFi in supply chain finance offers an opportunity to transform financial operations and relationships within the supply chain. Collaboration, innovation, and strategic efforts from all stakeholders are crucial for realizing the potential of DeFi. The US should take a proactive approach by developing regulatory frameworks, fostering research and development, promoting partnerships, and investing in education and talent development to position itself as a global leader in supply chain finance innovation.*

## **KEYWORDS**

*Decentralized Finance, Supply Chain Finance, Blockchain, Smart Contracts, Transparency, Automated Processes, Regulatory Frameworks, Integration, Technology.*

## **1. INTRODUCTION**

Supply chain finance (SCF) is a set of financial practices and technologies designed to optimize cash flow and reduce risk within supply chain operations. It involves the collaboration of buyers, suppliers, and financial institutions to ensure the timely and efficient flow of funds across the supply chain [1]. SCF solutions, such as invoice factoring, reverse factoring, and dynamic discounting, help bridge the financing gap between suppliers and buyers, enabling them to manage their working capital more effectively [2].

Despite the benefits of SCF, several challenges hinder its widespread adoption and effectiveness. One of the primary challenges is the lack of transparency and trust among supply chain participants [3]. In traditional SCF arrangements, parties often face information asymmetry, where they have limited visibility into their counterparties' financial health and creditworthiness. This lack of transparency can lead to increased risk, as buyers and financial institutions may be hesitant to extend credit to suppliers without a clear understanding of their financial situation [4]. Another challenge is the complexity and inefficiency of traditional SCF processes. Many SCF solutions rely on manual, paper-based processes, and legacy systems, which can be time-consuming, error-prone, and costly. The involvement of multiple intermediaries, such as banks and logistics providers, further complicates the process, leading to delays in payment settlement and increased transaction costs [5]. Traditional SCF solutions often fail to address the needs of small and medium-sized enterprises (SMEs), which form a significant part of global supply chains. SMEs often face difficulties in accessing affordable financing due to their limited credit history, lack of collateral, and high perceived risk [6]. This financing gap can hinder the growth and sustainability of SMEs, ultimately affecting the overall health of the supply chain [7].

### **1.1. Overview of Decentralized Finance (DeFi) and Its Potential**

Decentralized Finance (DeFi) is an emerging ecosystem of financial applications and protocols built on blockchain technology, aiming to create a more open, transparent, and accessible financial system. DeFi leverages the power of smart contracts and decentralized networks to enable peer-to-peer financial transactions without the need for traditional intermediaries, such as banks and clearinghouses. The potential of DeFi lies in its ability to address many of the challenges associated with traditional financial systems. By enabling direct, peer-to-peer transactions on a decentralized network, DeFi can reduce the need for intermediaries, resulting in lower transaction costs and faster settlement times [8]. The use of smart contracts, which are self-executing contracts with predefined rules and conditions, can automate various financial processes, reducing the risk of errors and disputes.

DeFi also promotes greater transparency and trust among participants. Blockchain transactions are recorded immutable and transparently, allowing all parties to have a shared view of the financial activities taking place [9]. This transparency can help mitigate risks such as fraud, double spending, and counterparty risk, as the blockchain provides a tamper-proof record of all transactions [10]. DeFi has the potential to democratize access to financial services, particularly for unbanked populations. By enabling anyone with an internet connection to participate in financial activities, regardless of their location or financial status, DeFi can foster financial inclusion and provide new opportunities for individuals and businesses to access capital and financial services [11].

## **2. LITERATURE REVIEW**

DeFi is built on blockchain technologies, primarily using Ethereum, which enables decentralized applications (dApps) to be created through smart contracts. These are self-executing contracts with the terms of the agreement directly written into code, distributed across a decentralized blockchain network. DeFi leverages these technologies to recreate and enhance financial services, including lending, borrowing, and trading, without central authorities (Auer et al., 2023). DeFi's core appeal lies in its ability to provide more inclusive financial services. According to Harvey et al. (2021), this aspect of DeFi could significantly equalize access to financial services, ensuring that small and medium-sized enterprises (SMEs), often sidelined by conventional financial systems, can participate more fully in the global economy. However, the technology's newness brings challenges such as high volatility, regulatory uncertainty, and technical barriers to entry,

which are important considerations for its integration into supply chain finance (Makarov & Schoar, 2022).

## **2.1. Supply Chain Finance: Enhancing Transactional Efficiencies**

Supply Chain Finance (SCF) optimizes working capital and reduces supply chain costs by allowing buyers and sellers in a trade transaction to improve their working capital. SCF does this by automating transactions and enabling businesses to manage their invoices and payments more efficiently. Mahmoudi et al. (2023) discuss how blockchain, the underlying technology of DeFi, can provide robust support to SCF systems by increasing the visibility and traceability of transactions, potentially decreasing the risks associated with supplier financing. SCF technologies are pivotal in shortening the order-to-cash cycles and enhancing cash flow predictability, which are critical elements for the stability and growth of businesses within the supply chain. Ning & Yuan (2023) illustrate that blockchain's integration into SCF can lead to significant reconfigurations of business models, particularly through the lens of improved efficiency and security.

## **2.2. Challenges and Opportunities of Integrating DeFi in SCF**

Integrating DeFi into SCF offers opportunities such as increased liquidity, reduced costs, and enhanced efficiency through automated trust mechanisms enabled by smart contracts. However, it also presents considerable challenges. Zhou et al. (2022) highlight security as a paramount concern, noting that the immutable nature of blockchain helps secure transactions but also means that any vulnerability in smart contract code can lead to irreversible losses. Regulatory challenges also loom large, as highlighted by Makarov & Schoar (2022), who discuss the difficulty in applying traditional regulatory frameworks to DeFi projects due to their decentralized nature. This uncertainty can hinder the adoption of DeFi in sectors like SCF, which are heavily regulated. The literature indicates that while DeFi offers transformative potential for SCF, realizing this potential requires navigating significant technical, security, and regulatory challenges. The integration of DeFi into SCF could lead to more democratic financial systems with greater accessibility for SMEs. Still, it must be approached with caution given the nascent state of both the technologies and the regulatory landscapes involved.

## **3. OPPORTUNITIES OF INTEGRATING DEFI IN SUPPLY CHAIN FINANCE**

The integration of Decentralized Finance (DeFi) into supply chain finance presents a range of compelling opportunities that can transform the way businesses operate and interact within the supply chain ecosystem. By leveraging the power of blockchain technology, smart contracts, and decentralized platforms, DeFi has the potential to address long-standing challenges in traditional supply chain finance, such as lack of transparency, limited access to financing, and inefficient processes. Exploration into three key areas where DeFi can make a significant impact will be made: 1) Transparency and Traceability, 2) Improved Access to Finance, and 3) Automated and Efficient Processes. By examining these opportunities in detail, we can gain a deeper understanding of how DeFi can revolutionize supply chain finance and unlock new possibilities for businesses across industries.

### **3.1. Transparency and Traceability**

#### **3.1.1. Blockchain-based Smart Contracts for Increased Transparency**

The integration of blockchain-based smart contracts in supply chain finance (SCF) introduces an unprecedented level of transparency, addressing a major challenge in traditional financial systems. Smart contracts are self-executing programs that automatically enforce the terms of an agreement once predefined conditions are met without the need for intermediaries [11]. This increases trust among participants and ensures that each step of the financial process is recorded immutably on the blockchain, making it transparent and accessible to all involved parties [12]. By leveraging smart contracts, supply chain participants can track the movement of goods, payments, and other financial transactions in real time, with complete visibility into the entire process. This level of transparency can mitigate risks such as fraud, corruption, and disputes, which are common challenges in supply chain finance. For instance, in traditional trade finance, parties often face issues such as double financing, where the same invoice is used to secure multiple loans or fraudulent documentation. Smart contracts can eliminate these risks by ensuring that each invoice or asset is tokenized and recorded on the blockchain, preventing duplication or manipulation.

The transparency provided by smart contracts can facilitate better auditing and compliance processes. Regulatory authorities and auditors can easily access immutable records on the blockchain, reducing the need for time-consuming and costly manual audits [13]. This can help businesses maintain compliance with various regulations, such as anti-money laundering (AML) and know-your-customer (KYC) requirements, while also enhancing overall trust and credibility in the supply chain finance ecosystem.

#### **3.1.2. Enhanced Supply Chain Visibility and Accountability**

Blockchain technology's inherent traceability features, combined with smart contracts, enhance visibility and accountability across the entire supply chain. Every transaction, including delivery times, payment dates, quantities, and other relevant data, is recorded on the immutable blockchain ledger [15]. This allows all parties involved, from suppliers and manufacturers to logistics providers and buyers, to track the movement of goods and the execution of payments in real time, significantly reducing opportunities for fraud, errors and improving compliance with regulatory requirements. For example, blockchain-based traceability in the food supply chain can provide detailed information about food products' origin, processing, and distribution, enabling better monitoring of food safety and quality. In the event of a food contamination incident, the affected products can be quickly identified and recalled, minimizing the impact on consumers and the overall supply chain.

The increased visibility and accountability facilitated by DeFi can also help build trust and strengthen relationships among supply chain partners. By providing a shared, immutable record of transactions and events, blockchain technology can reduce disputes and improve collaboration among suppliers, manufacturers, and retailers. Additionally, the transparency and accountability enabled by DeFi can enhance overall supply chain performance by identifying bottlenecks, inefficiencies, and areas for improvement, ultimately leading to optimized operations and reduced costs.

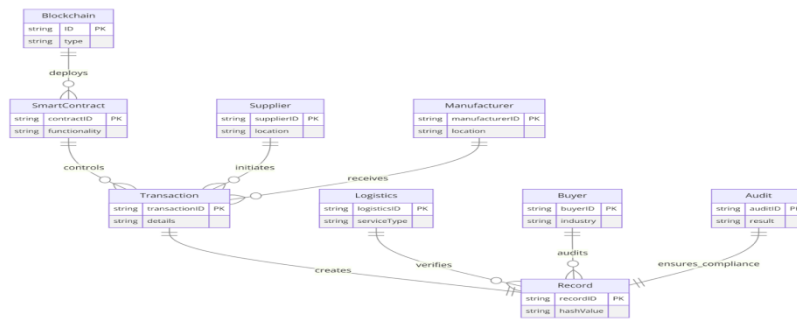


Figure 1. Integrated Entity-relationship Diagram Illustrating both Blockchain-based Smart Contracts for Increased Transparency and Enhanced Supply Chain Visibility and Accountability Figure 1. merges the concepts of smart contract deployment for transparency with the mechanisms that enhance visibility and accountability across the supply chain. It highlights the roles of various supply chain participants—suppliers, manufacturers, logistics providers, and buyers—and shows how each interacts with transactions and records managed by smart contracts on the blockchain. Additionally, it includes an audit process that ensures compliance, further integrating transparency with accountability in the supply chain.

This comprehensive approach helps visualize how blockchain and smart contracts not only increase the transparency of transactions but also improve the overall governance and efficiency of supply chain operations.

### Explanation of Entity-relationship

The integrated entity-relationship diagram illustrating both "Blockchain-based Smart Contracts for Increased Transparency" and "Enhanced Supply Chain Visibility and Accountability" in a supply chain context incorporates multiple entities and relationships that capture the roles and interactions facilitated by blockchain technology and smart contracts. Here's a detailed explanation of each component and their connections:

#### Entities and Their Attributes:

1. *Blockchain Attributes: ID, Type*
  - Represents the underlying blockchain technology that supports all other functions.
2. *Smart Contract Attributes: ContractID, Functionality*
  - Depicts the self-executing contracts that automate and enforce agreements based on predefined conditions.
3. *Transaction Attributes: TransactionID, Details*
  - Each transaction represents a supply chain event (e.g., delivery, payment) controlled by smart contracts.
4. *Record Attributes: RecordID, HashValue*
  - Immutable records created for each transaction, providing a transparent and verifiable history of events.
5. *Supplier, Manufacturer, Logistics, Buyer Attributes: include IDs and specific details like location, service type, or industry.*
  - These are the key participants in the supply chain, each initiating or receiving transactions.
6. *Audit Attributes: AuditID, Result*
  - Represents the compliance checks and verifications to ensure all transactions meet regulatory and operational standards.

## Relationships:

### 1. *Deploys and Controls:*

- The blockchain deploys smart contracts, which in turn control transactions.
- This relationship highlights how smart contracts are used to automate and secure supply chain activities.

### 2. *Initiates and Receives:*

- Suppliers initiate transactions, which are received by manufacturers, showing the flow of goods and services.
- Logistics providers verify the records of these transactions, ensuring that the movement of goods is accurately logged.

### 3. *Audits and Ensures Compliance:*

- Audits are conducted on the records to ensure compliance with supply chain standards and regulations.
- This process is crucial for maintaining accountability and adhering to legal and operational frameworks.

The dynamics behind Figure 1 are:

- The flow of information and control from the blockchain through smart contracts to the transactions and records ensures that all supply chain activities are transparent and verifiable.
- Smart contracts automate processes and ensure that all conditions are met before proceeding, significantly reducing the potential for errors and fraud.
- The record of each transaction being verified by logistics and audited for compliance underscores the enhanced visibility and accountability throughout the supply chain.
- All participants (suppliers, manufacturers, logistics, and buyers) are interconnected, emphasizing the collaborative nature of modern supply chains, which are bolstered by blockchain's capabilities to provide a secure and transparent environment.
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Figure 1. effectively maps out the enhanced capabilities of supply chains enabled by blockchain technology, illustrating the complex interrelations, and streamlined processes that contribute to improved transparency, visibility, and accountability.

## Mathematical Model

To create an integrated mathematical model that combines both increased transparency and enhanced visibility and accountability through blockchain-based smart contracts in supply chain finance, we consider the following elements mathematical model:

### 1. Transaction Validity and Verification

Let  $(T_i)$  represent the  $(i) - th$  transaction in the supply chain, and  $V(T_i)$  denote the verification status of that transaction:

$$V(T_i) = \begin{cases} 1 - & \text{if } (T_i) \text{ meets all smart contract conditions} \\ 0 - & \text{if } (T_i) \text{ did'nt meet all smart contract conditions} \end{cases}$$

## 2. Transparency Index

This defines a transparency index ( $T_i$ ) that quantifies the proportion of verified transactions:

$$V(T_i) = \frac{\sum_{i=1}^n V(T_i)}{N}$$

where ( $N$ ) is the total number of transactions in each period.

## 3. Visibility and Accountability Score

This score integrates visibility and accountability by defining a combined score ( $VA$ ) that measures both aspects through the compliance and activity level of all parties:

$$(VA) = (\alpha)(T_i) + (1 - \alpha)(AC)$$

where:

( $\alpha$ ) is a weighting factor between 0 and 1.

( $AC$ ) is the accountability compliance score derived from the number of actions aligned with regulatory and operational standards.

## 4. Audit and Compliance Verification

Let ( $A_k$ ) represent the audit results of the ( $k$ ) – *th* audit check, which can also be binary:

$$(A_k) = \begin{cases} 1 & \text{if the audit passes} \\ 0 & \text{if the audit fails} \end{cases}$$

The overall compliance score ( $C$ ) could then be defined as:

$$C = \frac{\sum_{k=1}^K (A_k)}{K}$$

where ( $K$ ) is the total number of audits conducted.

## 5. Overall Supply Chain Health

Finally, define the overall supply chain health score ( $S$ ) which incorporates transparency, visibility, accountability, and compliance:

$$(S) = (\beta)(VA) + (1 - \beta)(C)$$

where ( $\beta$ ) is another weighting factor.

This model encapsulates how blockchain technology would potentially enhance the supply chain by improving transparency through ( $T_i$ ), visibility and accountability through ( $VA$ ), and ensuring compliance through regular audits with ( $C$ ). The overall health of the supply chain ( $S$ ) reflects a comprehensive assessment of these factors, providing a robust framework for evaluating the effectiveness of blockchain integrations in supply chain operations.

### **3.2. Improved Access to Finance**

#### **3.2.1. Decentralized Lending and Borrowing Platforms**

DeFi introduces decentralized lending and borrowing platforms that revolutionize how businesses access funding, particularly for small and medium-sized enterprises (SMEs). These platforms utilize blockchain technology to facilitate peer-to-peer lending and borrowing without the traditional barriers that conventional financial institutions impose [15]. SMEs often face challenges in securing financing from banks due to strict credit requirements and lack of collateral, DeFi grants them the opportunity to leverage their invoices, inventory, or other assets as collateral to secure loans directly from lenders worldwide. Decentralized lending and borrowing platforms often operate with lower overhead costs compared to traditional financial institutions, as they eliminate the need for intermediaries and physical branches [6]. This cost-efficiency can translate into more favorable terms for borrowers, making it easier for SMEs and underserved businesses to access the capital they need to grow and sustain their operations.

#### **3.2.2. Leveraging Cryptocurrencies and Tokenization for Liquidity**

DeFi enables the tokenization of real-world assets, allowing businesses to unlock the liquidity tied up in their physical assets. Tokenization involves converting tangible assets, such as invoices, inventory, or equipment, into digital tokens that can be traded on blockchain networks [11]. Tokenization can also facilitate fractional ownership, enabling businesses to raise capital by selling fractions of their assets to multiple investors. This opens new avenues for financing, as businesses can tap into a broader pool of investors who may be interested in owning a share of specific assets rather than investing in the company.

For instance, a manufacturing company can tokenize its inventory of finished goods and sell these tokens to investors, effectively monetizing the value of its inventory without physically selling the goods. This can help businesses improve their cash flow and liquidity position, enabling them to reinvest in growth opportunities or meet short-term financial obligations [6].

In addition to tokenization, DeFi also enables the use of cryptocurrencies and stablecoins for financial transactions within the supply chain. These digital assets can be transferred instantly and securely across borders without the need for traditional intermediaries or foreign exchange processes [12]. This can help businesses streamline cross-border payments, reduce transaction costs, and mitigate foreign exchange risks, ultimately improving the efficiency and cost-effectiveness of supply chain finance operations.

### **3.3. Automated and Efficient Processes**

#### **3.3.1. Smart Contract-based Supply Chain Finance Solutions**

Smart contracts are pivotal in automating and streamlining various supply chain finance (SCF) processes, leading to increased efficiency and cost savings. These self-executing contracts can automatically execute financial transactions and other contractual obligations when predetermined conditions are met, reducing the need for manual processing and human intervention [16]. One of the key applications of smart contracts in SCF is invoice factoring, where businesses sell their outstanding invoices to a third party (factor) at a discount to receive immediate cash flow. Traditional invoice factoring processes can be time-consuming and prone to errors due to manual data entry and verification. However, smart contracts can automate the entire process, from the verification of invoices and approval of financing to the execution of payments [17]. This speeds up the process and reduces the likelihood of errors and disputes, ultimately improving the overall efficiency and reliability of the factoring process.



Smart contracts integrated with liquidity pools in DeFi can enhance the efficiency and accessibility of invoice factoring. This involves users contributing funds for trading, lending, or borrowing. In this scenario, a DeFi platform creates a liquidity pool where investors contribute stablecoins or cryptocurrencies. Businesses submit their invoices, and if approved by smart contracts, funds are automatically drawn from the pool and disbursed. The use of liquidity pools in invoice factoring benefits SMEs by providing financing without traditional institutions, lowers costs by eliminating intermediaries, and enables rapid and automated financing decisions and disbursements.

This concept holds the potential to revolutionize trade finance by automating processes and reducing delays and inefficiencies. They can streamline tasks such as document verification, letter of credit issuance, and payment processing by automatically executing payments and releasing funds. This automation significantly improves the efficiency of trade finance operations and reduces associated costs. Beyond trade finance, smart contracts can also automate processes like inventory financing, purchase order financing, and supply chain risk management. This integration with liquidity pools optimizes financial operations, reduces errors, and improves operational efficiency throughout the supply chain.

### **3.3.2. Enhancing the Competitiveness of U.S. Supply Chains**

The integration of DeFi in supply chain finance can significantly enhance the competitiveness of U.S. supply chains by enabling more efficient and cost-effective operations. By leveraging blockchain technology and smart contracts, U.S. businesses can streamline their financial processes, reduce transaction costs, and improve overall operational efficiency. One of the key benefits of DeFi for U.S. supply chains is the potential for cost savings. Traditional supply chain finance processes often involve multiple intermediaries, such as banks and logistics providers, which can add significant costs and delays to transactions [5]. By eliminating the need for intermediaries and enabling direct, peer-to-peer transactions through decentralized platforms, DeFi can help U.S. businesses reduce their financing and transaction costs.

Smart contracts automate supply chain operations, reducing errors, disputes, and costs. This enhances efficiency and competitiveness. DeFi allows US businesses to access financing and unlock liquidity, addressing the financing gap faced by industries with long payment cycles or seasonal fluctuations.

## **3.4. Software Implementation and Architecture for DeFi Integration**

### **3.4.1. System Architecture**

The engineered system architecture for integrating DeFi in supply chain finance is designed to enable seamless interaction between the DeFi ecosystem, supply chain finance platforms, and existing enterprise systems, as illustrated in Figure 2.

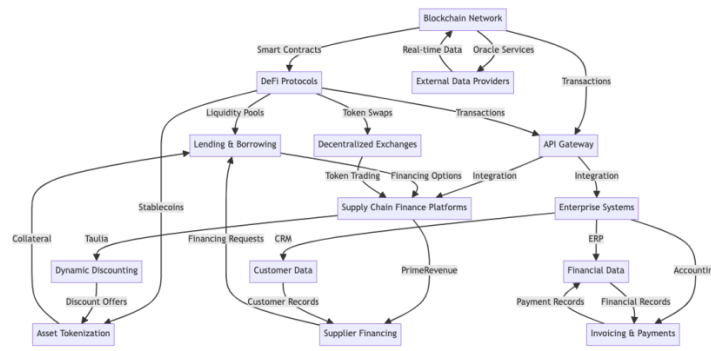


Figure 2: System Architecture Diagram

The main components of the system architecture in Figure 2 include:

- **Blockchain Network:** A permissioned blockchain network serves as the foundation for the DeFi integration. It provides a secure, transparent, and immutable ledger for recording financial transactions and smart contract execution.
- **Smart Contracts:** Self-executing programs deployed on the blockchain network, encapsulating the business logic and rules for automating supply chain finance processes.
- **DeFi Protocols:** Integration of various DeFi protocols, such as lending and borrowing platforms, decentralized exchanges, and stablecoins, enabling asset tokenization, liquidity provision, and seamless fund transfers.
- **Oracle Services:** Secure real-world data feeds into the blockchain network, providing reliable inputs for smart contract automation based on external events or conditions.
- **API Gateway:** The interface between the blockchain network, DeFi protocols, and external systems, enabling seamless integration and communication.
- **Supply Chain Finance Platforms:** Existing platforms, such as PrimeRevenue or Taulia, can integrate with the DeFi ecosystem through the API gateway, leveraging the benefits of blockchain and DeFi.
- **Enterprise Systems:** Integration with existing ERP, CRM, and accounting software, enabling seamless data flow between the DeFi ecosystem and the organization's internal systems.

### 3.4.2. Mathematical Model Application

There are various mathematical models that can be applied to this integration of decentralized finance (DeFi). These models can help quantify and analyze the benefits, risks, and performance of DeFi solutions in different supply chain finance scenarios. Linear programming or convex optimization techniques can allocate funds across lending pools, considering factors like interest rates, loan durations, and market demands. Game theory models can be used to design incentive mechanisms, considering participants' strategic interactions. Nash equilibrium and mechanism design can be used to create structures that encourage desired behaviors. Network models can analyze risk propagation, identifying concentrations and designing mitigation strategies based on network analysis techniques. These mathematical models provide a foundation for quantitative analysis and decision-making in integrating DeFi into supply chain finance, evaluating performance and risks comprehensively, but for this study, we will focus on a model with the capability of mitigating risks.

### *Stochastic Models for Risk Assessment:*

Stochastic models can be used to assess the risks associated with DeFi in supply chain finance. These models consider the randomness and uncertainty involved in financial transactions and market conditions. For instance, a stochastic model can be used to estimate the probability of default for a given supplier based on historical data and market trends. The model can help determine the optimal lending rates and collateral requirements for DeFi lending platforms.

Let  $X$  be a random variable representing the default rate of a supplier, following a normal distribution with mean  $\mu$  and standard deviation  $\sigma$ . The probability of default ( $PD$ ) can be calculated as:

$$PD = P(X > threshold)$$

Where: The threshold is a predefined value based on the acceptable risk level.

### **3.4.3. Case Study: Integrating DeFi with PrimeRevenue**

To demonstrate the practical application of the proposed DeFi integration, consideration is made on a case study involving a leading supply chain finance platform, PrimeRevenue.

PrimeRevenue decides to integrate DeFi capabilities into its platform to offer clients access to alternative financing options and improve the efficiency of its processes. The integration follows these steps:

1. PrimeRevenue collaborates with a blockchain development firm to design and implement a permissioned Ethereum Enterprise network.
2. Smart contracts for invoice factoring, reverse factoring, and dynamic discounting are developed and deployed on the blockchain network.
3. The PrimeRevenue platform integrates with popular DeFi protocols, such as Compound and Uniswap, through an API gateway. This integration allows suppliers to access liquidity pools and trade tokenized invoices.
4. Oracle services are set up to feed real-time data, such as interest rates and currency exchange rates, into the smart contracts, enabling automated execution of financial transactions.
5. PrimeRevenue's internal systems, including its ERP and accounting software, are connected to the DeFi ecosystem through the API gateway, allowing seamless data flow and reconciliation.
6. Suppliers and buyers on the PrimeRevenue platform can now leverage DeFi capabilities, such as instant access to liquidity, transparent transaction history, and automated settlement of invoices.

The integration of DeFi with PrimeRevenue's supply chain finance platform results in increased efficiency, reduced costs, and improved access to financing for its clients. The case study demonstrates the potential of DeFi to transform traditional supply chain finance processes and create value for all stakeholders involved.

## **4. CHALLENGES AND LIMITATIONS**

While the integration of decentralized finance (DeFi) in supply chain finance presents numerous opportunities, it is crucial to acknowledge and address the challenges and limitations that may hinder its widespread adoption. These challenges span across various domains, including regulatory uncertainties, scalability and interoperability concerns, adoption and trust barriers, and implications for the U.S. financial system. By carefully examining these challenges and developing strategies to overcome them, we can pave the way for a more robust and sustainable integration of DeFi in supply chain finance. Four key areas of concern will be delved into: 1)

Regulatory Uncertainties and Compliance, 2) Scalability and Interoperability Concerns, 3) Adoption and Trust Barriers, and 4) Implications for the U.S. Financial Systems. By understanding these challenges, stakeholders can work together to create solutions that unlock the full potential of DeFi in transforming supply chain finance.

## **4.1. Regulatory Uncertainties and Compliance**

### **4.1.1. Lack of Clear Regulatory Frameworks for DeFi and Cryptocurrencies**

One of the most significant challenges facing the integration of DeFi in supply chain finance is the lack of clear regulatory frameworks for DeFi and cryptocurrencies. As DeFi is a relatively new and rapidly evolving ecosystem, regulatory bodies have struggled to keep pace with technological advancements and develop comprehensive guidelines for its governance. The absence of clear regulations creates uncertainty for businesses looking to adopt DeFi solutions, as they may face potential legal and compliance risks. For example, the use of cryptocurrencies in supply chain finance may raise concerns about money laundering, terrorist financing, and other illicit activities, as these digital assets can be used to facilitate anonymous transactions [10].

The unique nature of DeFi platforms presents regulatory challenges, including the difficulty of enforcing traditional financial regulations like KYC and AML requirements. The lack of guidance and clarity may deter businesses from adopting DeFi solutions, hindering the growth of the ecosystem. Without a clear legal framework, DeFi projects may struggle to attract institutional investors and form partnerships with traditional financial institutions. This uncertainty limits the potential of DeFi to revolutionize supply chain finance.

### **4.1.2. Potential Legal and Compliance Issues**

The integration of DeFi in supply chain finance may give rise to various legal and compliance issues, particularly in the absence of clear regulatory frameworks. One of the primary concerns is the potential for DeFi platforms to be used for illegal activities, such as money laundering, tax evasion, and terrorist financing [14]. The pseudonymous nature of blockchain transactions and the lack of centralized oversight make detecting and preventing these illicit activities challenging. Compliance with existing financial regulations is another significant challenge for businesses adopting DeFi solutions. For example, the use of cryptocurrencies in supply chain finance may require businesses to comply with KYC and AML regulations, which are designed to prevent financial crimes and protect consumers. However, the decentralized nature of DeFi platforms makes it difficult to implement these regulations, as there is no central authority responsible for collecting and verifying customer information [18].

Cross-border DeFi transactions face legal and compliance complexities due to varying regulations and requirements. Smart contract vulnerabilities and coding errors also pose risks. If not audited properly, bugs in smart contracts can lead to unintended consequences and financial losses. Resolving disputes and determining liability in decentralized networks without a legal framework is challenging.

## **4.2. Scalability and Interoperability Concerns**

### **4.2.1. Scalability Challenges of Blockchain Networks**

Scalability is a major challenge for the widespread adoption of DeFi in supply chain finance. Blockchain networks, which form the foundation of DeFi platforms, often face limitations in terms of transaction throughput and processing speed [16]. As the number of users and

transactions on a blockchain network increases, the network may become congested, leading to slower transaction times and higher fees. For example, the Ethereum blockchain, which hosts a significant portion of DeFi applications, has faced scalability issues due to its limited transaction capacity. During periods of high network activity, users may experience long waiting times for their transactions to be confirmed, and the associated gas fees can become prohibitively expensive [12].

Scalability issues in DeFi can hinder its adoption in supply chain finance as businesses need fast and cost-effective transaction processing. Slow transaction times and high fees can disrupt cash flow management and increase operational costs. If DeFi platforms cannot efficiently handle the volume and complexity of supply chain transactions, they may not be a viable alternative to traditional trade finance methods.

#### **4.2.2. Interoperability Between DeFi Protocols and Legacy Systems**

Interoperability is another significant challenge for the integration of DeFi in supply chain finance. DeFi protocols and platforms are built on various blockchain networks, each with its own unique features, consensus mechanisms, and token standards [118]. This fragmentation makes it difficult for different DeFi protocols to communicate and interact with each other seamlessly, limiting their potential for integration and collaboration.

The lack of interoperability between DeFi protocols and traditional financial systems hampers adoption. Legacy systems and ERP systems used by businesses for supply chain operations may not be compatible with DeFi, making integration difficult. Additionally, the lack of standardization in the DeFi ecosystem further complicates interoperability. Different platforms have varying data formats, API specifications, and smart contract standards. Interoperable frameworks like the Interledger Protocol and Polkadot network aim to address these challenges, but more work is required to establish robust standards for the DeFi ecosystem.

### **4.3. Adoption and Trust Barriers**

#### **4.3.1. Resistance to Change and Lack of Understanding**

The adoption of DeFi in supply chain finance faces significant barriers related to resistance to change and a lack of understanding among stakeholders. Many businesses, particularly small and medium-sized enterprises (SMEs), may be hesitant to embrace DeFi solutions due to their unfamiliarity with blockchain technology and its potential benefits.

The complexity of DeFi platforms and blockchain terminology can be intimidating for non-technical users, leading to a preference for traditional supply chain finance methods. The decentralized nature of DeFi may contradict established trust relationships in supply chain finance. To promote adoption, education and awareness initiatives are needed. Collaboration between DeFi developers, industry associations, and academic institutions can bridge the knowledge gap. User-friendly interfaces that simplify blockchain technology can make DeFi more accessible. By providing intuitive platforms, DeFi developers can encourage wider adoption in supply chain finance.

#### **4.3.2. Security and Privacy Concerns Related to DeFi**

Security and privacy concerns are significant barriers to the adoption of DeFi in supply chain finance. While blockchain technology is designed to be secure and tamper-proof, DeFi platforms are not immune to security vulnerabilities and attacks. Smart contract vulnerabilities are a

particular concern in the DeFi ecosystem. Smart contracts are self-executing programs that automatically enforce the terms of an agreement based on predefined conditions. However, if these contracts contain bugs or are not properly audited, they may be exploited by malicious actors, leading to financial losses and erosion of trust in DeFi platforms [8].

The irreversible nature of blockchain transactions may make it difficult or impossible to recover stolen or lost funds, deterring businesses from adopting DeFi solutions due to security risks. Additionally, privacy concerns hinder the adoption of DeFi in supply chain finance since blockchain transactions are not completely anonymous. To address these concerns, DeFi platforms should prioritize robust security measures and privacy-preserving technologies. Regular security audits, bug bounties, and verification of smart contracts can mitigate vulnerabilities, while privacy-enhancing technologies protect confidential information while maintaining transaction transparency. Prioritizing security and privacy can establish trust and encourage wider DeFi adoption in supply chain finance.

#### **4.4. Implications for the U.S Financial Systems**

##### **4.4.1. Potential Risks and Challenges Posed by DeFi to Traditional Financial Institutions**

The rise of DeFi poses significant risks and challenges to traditional financial institutions in the U.S., particularly in the context of supply chain finance. As DeFi platforms gain traction and offer alternative financing solutions, they may disrupt the established business models and revenue streams of banks and other financial service providers. One of the primary risks is the potential for disintermediation, as DeFi platforms enable peer-to-peer transactions and bypass traditional intermediaries [18]. If businesses and individuals increasingly adopt DeFi solutions for their supply chain finance needs, they may reduce their reliance on traditional banking services, such as trade finance, factoring, and lending [12]. This shift could lead to financial institutions losing market share and revenue, forcing them to adapt their business models and compete with DeFi platforms.

DeFi's automated transactions can eliminate manual processes and improve efficiency, pressuring traditional financial institutions to lower fees. However, the decentralized nature of DeFi presents challenges for risk management and compliance, as it bypasses KYC and AML checks. To address these issues, financial institutions must collaborate with DeFi platforms to create hybrid solutions that combine centralized and decentralized finance. By integrating DeFi technologies, they can enhance efficiency, cut costs, and provide innovative offerings to customers.

##### **4.4.2. Regulatory Considerations for Maintaining Financial Stability and Consumer Protection**

The emergence of DeFi in supply chain finance raises important regulatory considerations for maintaining financial stability and consumer protection in the U.S. As DeFi platforms operate outside the traditional regulatory perimeter, they may pose risks to the broader financial system if left unchecked [12]. One of the primary concerns is the potential for systemic risk, as DeFi platforms' interconnectedness and reliance on smart contracts may create new channels for financial contagion [18]. If a major DeFi platform experiences a security breach or smart contract failure, it could trigger a cascade of liquidity and credit events that spill over into the traditional financial system.

Regulators face challenges in monitoring and mitigating risks associated with money laundering and illicit activities in decentralized finance (DeFi) due to its pseudonymous nature and lack of oversight. This can undermine the financial system and expose consumers to fraud. To address

these risks, US regulators may need to develop new approaches, such as sandboxes and innovation hubs, to oversee DeFi activities in supply chain finance. Collaboration with industry stakeholders and international bodies is necessary to establish global standards for DeFi governance, risk management, and consumer protection. Additionally, consumer education initiatives are needed to enhance understanding of DeFi risks and benefits.

## **5. FUTURE PROSPECTS AND POTENTIAL SOLUTIONS**

The integration of decentralized finance (DeFi) in supply chain finance is evolving, and exploring prospects and solutions is crucial. By addressing regulatory uncertainties, fostering technological advancements, developing adoption strategies, promoting innovation and collaboration, stakeholders can create a robust and sustainable DeFi ecosystem. Five key areas will shape the future of DeFi: regulatory developments, technological advancements, adoption strategies, fostering innovation and collaboration, and the potential impact on the economy. Exploring these areas will help drive successful implementation and position the U.S. as a global leader.

### **5.1. Regulatory Developments and Standardization Efforts**

#### **5.1.1. Potential Regulatory Frameworks for DeFi and Cryptocurrencies**

As DeFi and cryptocurrencies continue to gain traction in supply chain finance, there is a growing need for regulatory frameworks that can provide clarity, protect consumers, and promote innovation. Regulators in the U.S. and around the world are exploring various approaches to address the unique challenges posed by DeFi and create an enabling environment for its growth [13][14]. One potential regulatory framework is the development of a comprehensive legal classification for cryptocurrencies and tokens used in DeFi platforms. By clearly defining the legal status of these assets, regulators can provide certainty to market participants and establish rules for their issuance, trading, and use in supply chain finance [19].

Another approach is the creation of regulatory sandboxes and innovation hubs that allow DeFi platforms to test their solutions in a controlled environment under the supervision of regulators [18]. These initiatives can help regulators understand the risks and benefits of DeFi while providing a space for experimentation and collaboration between innovators and policymakers. International cooperation and coordination will be crucial in developing consistent and harmonized regulatory frameworks for DeFi. As DeFi platforms operate across borders and jurisdictions, regulators will need to work together to address common challenges, share best practices, and prevent regulatory arbitrage [19].

#### **5.1.2. Industry-led Standardization Initiatives**

In addition to regulatory efforts, industry-led standardization initiatives can play a crucial role in shaping the future of DeFi in supply chain finance. Standardization can help address issues related to interoperability, security, and user experience, making it easier for businesses to adopt and integrate DeFi solutions. One key area for standardization is the development of common protocols and APIs that enable seamless communication and data exchange between different DeFi platforms and legacy systems. By establishing open standards for interoperability, the industry can foster a more connected and efficient DeFi ecosystem that can support the complex needs of supply chain finance [12]. Another important aspect of standardization is the creation of best practices and guidelines for smart contract development, security auditing, and risk management. By promoting the adoption of secure coding practices, regular audits, and robust

risk management frameworks, the industry can help mitigate the risks associated with DeFi and build trust among stakeholders [8].

## 5.2. Technological Advancements

Scalability is a critical challenge that must be addressed to enable the widespread adoption of DeFi in supply chain finance. As the number of transactions and users on DeFi platforms grows, the underlying blockchain networks must be able to handle increased throughput and maintain fast settlement times. Layer-2 solutions are one promising approach to scaling DeFi platforms. These solutions involve building additional layers on top of existing blockchain networks to process transactions off-chain while still leveraging the security and immutability of the underlying blockchain [12]. Examples of layer-2 solutions include state channels, sidechains, and rollups. State channels allow participants to transact directly with each other off-chain without recording every transaction on the blockchain [8]. This can significantly reduce the load on the main blockchain and enable faster, cheaper transactions. Sidechains are separate blockchain networks that are interoperable with the main blockchain, allowing assets and data to be transferred between them. Rollups involve bundling multiple transactions together and processing them off-chain, with only the final state being recorded on the main blockchain.

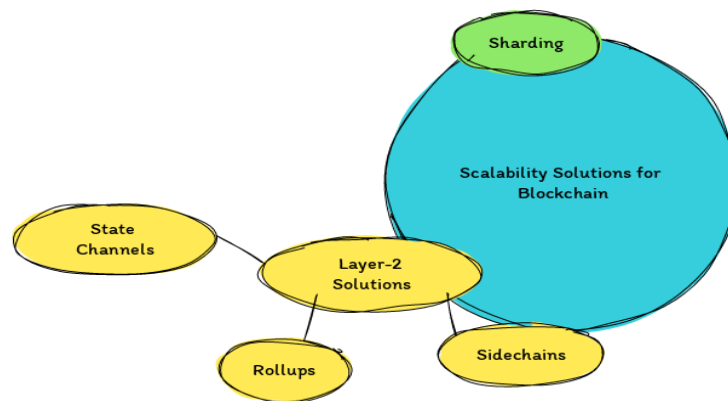


Figure 3. Mindmap for scalability solutions for blockchain technology, including Layer-2 solutions, sharding, and their sub-components like state channels, sidechains, and rollups.

Sharding is another scalability solution that involves dividing the blockchain network into smaller, more manageable parts called shards [6]. Each shard processes a subset of transactions in parallel, allowing the network to handle a higher overall throughput. Sharding can be implemented at the protocol level, requiring changes to the underlying blockchain architecture, or at the application level, using techniques like horizontal scaling and database partitioning. The adoption of these scalability solutions can help DeFi platforms process a larger volume of transactions and support more users in supply chain finance. However, implementing these solutions also comes with trade-offs in terms of complexity, security, and decentralization. DeFi developers and stakeholders will need to carefully evaluate the costs and benefits of different scalability approaches and choose the most appropriate solutions for their specific use cases.

## 5.3. Adoption Strategies and Use Cases

Pilot projects and proof-of-concepts (PoCs) are essential for demonstrating the feasibility and value of DeFi solutions in supply chain finance. These initiatives allow businesses to test and refine DeFi applications in a controlled environment, gather real-world data, and build the



necessary infrastructure and partnerships for larger-scale adoption. One example of a DeFi pilot project in supply chain finance is the Marco Polo Network, a consortium of banks and technology providers that are exploring the use of blockchain and smart contracts for trade finance. The network has conducted several successful PoCs, including a test of a blockchain-based system for managing receivables finance between two European companies [12]. Another example is the we.trade platform, a joint venture of major European banks that uses blockchain technology to facilitate trade finance for small and medium-sized enterprises (SMEs) [16]. The platform has conducted PoCs with various companies across different industries, demonstrating the potential of DeFi to streamline and automate trade finance processes [8].

DeFi can also be applied to specific industries and supply chains, such as agriculture, pharmaceuticals, and automotive [6]. For example, in the agriculture industry, DeFi solutions can be used to provide financing to smallholder farmers, track the provenance and quality of agricultural products, and enable more sustainable and ethical supply chain practices. DeFi can help ensure the integrity and traceability of drug supply chains in the pharmaceutical industry, prevent counterfeiting and diversion, and enable more efficient and secure payment processes. In the automotive industry, DeFi can be used to finance vehicle inventories, manage supplier payments, and enable usage-based financing and leasing models.

## **5.4. Fostering Innovation and Collaboration in the U.S. DeFi Ecosystem**

### **5.4.1. Public-Private Partnerships and Industry Collaborations**

Public-private partnerships (PPPs) and industry collaborations will play a crucial role in fostering innovation and adoption of DeFi in supply chain finance in the U.S. These initiatives bring together stakeholders from government, industry, academia, and the nonprofit sector to share knowledge, resources, and best practices, and to develop common standards and frameworks for DeFi implementation. One example of a PPP in the U.S. DeFi ecosystem is the Blockchain Research Institute. This global think tank brings together leaders from the public and private sectors to explore the strategic implications of blockchain technology. The institute has conducted research on various aspects of DeFi, including its potential impact on supply chain finance, and has worked with government agencies and industry partners to develop policy recommendations and pilot projects [12]. Another example is the Hyperledger project, an open-source collaborative effort hosted by the Linux Foundation that aims to advance cross-industry blockchain technologies [19]. The project includes several DeFi-related initiatives, such as the Hyperledger Fabric framework for building enterprise-grade blockchain applications and the Hyperledger Indy platform for self-sovereign identity and decentralized key management.

### **5.4.2. Establishing the U.S. as a Global Leader in DeFi and Supply Chain Finance Innovation**

Given its strengths in technology, finance, and logistics, the U.S. has a significant opportunity to establish itself as a global leader in DeFi and supply chain finance innovation. To realize this potential, the U.S. will need to create a supportive policy and regulatory environment, invest in research and development, and foster a culture of innovation and collaboration across the DeFi ecosystem. One key aspect of establishing US leadership in DeFi is to develop a clear and consistent regulatory framework that balances the need for innovation with the need for consumer protection and financial stability. This may involve creating new laws and regulations that are specifically tailored to DeFi and blockchain technology, as well as adapting existing regulations to accommodate the unique characteristics of DeFi [12]. Another important factor is investing in DeFi technologies and applications. This may involve providing funding and incentives for

academic institutions, startups, and established companies to explore new use cases and develop cutting-edge DeFi solutions.

The US should support the development of open-source software, standards, and protocols for DeFi to foster innovation and collaboration. To lead in DeFi, it is crucial to cultivate a diverse and skilled workforce through investment in education, training programs, and promoting diversity and inclusion. Additionally, building public awareness and trust in DeFi's benefits for supply chain finance can be achieved through outreach campaigns, educational efforts, and showcasing successful use cases.

## **5.5. Potential Impact on the US Economy and Job Market**

### **5.5.1. Emerging Job Roles and Skills Required in the DeFi and Supply Chain Finance Space**

The growth of DeFi and its potential applications in supply chain finance is likely to create new job roles and demand for specific skills in the U.S. labor market. As businesses adopt DeFi solutions and integrate them into their operations, they will need professionals who can design, develop, implement, and manage these systems.

Some of the emerging job roles in the DeFi and supply chain finance space may include:

- **Blockchain developers and engineers:** Professionals who can design, build, and maintain the underlying blockchain infrastructure and protocols for DeFi applications.
- **Smart contract developers:** Experts who can write and audit self-executing contracts that automate various aspects of supply chain finance, such as payments, financing, and risk management.
- **DeFi product managers:** Professionals who can identify market opportunities, define product requirements, and coordinate the development and launch of DeFi solutions for supply chain finance.
- **DeFi risk and compliance officers:** Specialists who can assess and mitigate the risks associated with DeFi, ensure compliance with relevant regulations, and develop governance frameworks for DeFi projects.
- **DeFi business analysts:** Professionals who can analyze the business processes and data flows in supply chain finance, identify areas for improvement, and design DeFi solutions that deliver value to stakeholders.

To fill these emerging roles, professionals will need to develop a range of skills and competencies, such as:

- **Blockchain and distributed ledger technology:** Understanding the fundamentals of blockchain architecture, consensus mechanisms, and cryptography.
- **Smart contract development:** Proficiency in programming languages such as Solidity, Vyper, and Rust, as well as familiarity with smart contract design patterns and security best practices.
- **Supply chain finance:** Knowledge of the key concepts, processes, and challenges in supply chain finance, such as trade finance, working capital management, and risk mitigation.
- **Data analysis and visualization:** Ability to collect, process, and interpret large volumes of data from various sources and to communicate insights and recommendations to stakeholders.
- **Project management and collaboration:** Skills in agile development methodologies, stakeholder management, and cross-functional teamwork.

To prepare for the future of DeFi and supply chain finance, the U.S. needs to invest in education and training programs that combine technical expertise with business knowledge. This may involve developing new degree programs and certifications in blockchain and DeFi and integrating these subjects into existing curricula in fields like computer science, finance, and supply chain management. Universities, community colleges, and online learning platforms can collaborate with industry and government stakeholders to provide education and training. Apprenticeships, internships, and hands-on learning experiences can also help students gain practical knowledge in DeFi and supply chain finance.

### **5.5.2. Economic Implications of More Efficient and Competitive Supply Chains**

One of the key economic benefits of DeFi in supply chain finance is the potential to reduce the trade finance gap, which is estimated to be around \$1.5 trillion globally[12]. By providing alternative financing options and improving access to credit for small and medium-sized enterprises (SMEs), DeFi can help bridge this gap and enable more businesses to participate in global trade.

DeFi has the potential to reduce supply chain disruptions and associated costs by providing transparency and traceability. This helps businesses identify and mitigate risks like supplier defaults and fraud. Furthermore, DeFi enables more efficient working capital management by offering real-time visibility into fund and asset flow across the supply chain. This optimization reduces inventory carrying costs and improves overall financial health. The success of DeFi in supply chain finance depends on effectively managing its risks and challenges. By taking a proactive and strategic approach, the U.S. can lead the way and shape the future of supply chain finance in the digital age.

## **6. CONCLUSIONS**

Decentralized finance (DeFi) integrated into supply chain finance can revolutionize financial operations and relationships in the supply chain. Blockchain technology and smart contracts can address limitations like lack of transparency and limited access to financing. DeFi enhances transparency and traceability in supply chain finance, enabling real-time tracking of funds and goods. It expands financing for SMEs through decentralized lending and borrowing platforms. Automation and streamlining through smart contracts reduce errors, speed up transactions, and lower costs. Challenges need to be addressed for successful DeFi adoption, and the US has the potential to be a leader in this field by investing in research and fostering partnerships. DeFi adoption can have significant economic benefits but requires proactive efforts from stakeholders.

### **6.1. Recommendations for Stakeholders (Companies, Policymakers, Researchers)**

Based on the findings of this research, the following recommendations are proposed for key stakeholders in the DeFi and supply chain finance ecosystem:

- Companies should align their DeFi strategy with supply chain finance objectives, conduct pilot projects, and collaborate with technology providers to establish secure and scalable solutions. They should also invest in education and training programs and engage with regulators for compliance.
- Policymakers should develop a regulatory framework that balances innovation and consumer protection. They should invest in research and development, promote knowledge sharing, and create education and workforce development programs.

- Researchers should conduct further research on DeFi's applications and impacts, collaborate with industry partners and policymakers, and develop new methodologies and tools for analysis. They should also contribute to the development of open-source software and actively participate in community initiatives. By embedding AI models and algorithms in the integration of DeFi and supply chain finance, researchers can explore new opportunities for enhancing the efficiency, accuracy, and robustness of DeFi platforms. The combination of AI and blockchain technologies can unlock new insights, automate complex decision-making processes, and enable more intelligent and adaptive DeFi solutions.

This research highlights the significant potential of DeFi to transform supply chain finance and create new opportunities for businesses, investors, and society. However, realizing this potential will require ongoing collaboration, innovation, and education across the DeFi ecosystem, as well as a supportive policy and regulatory environment. As the U.S. seeks to establish itself as a leader in this rapidly evolving field, it will be critical to balance the need for innovation with the need for stability, security, and inclusivity. By working together and leveraging all stakeholders' unique strengths and capabilities, we can help shape the future of supply chain finance in the digital age and create a more efficient, resilient, and equitable financial system for all.

## 6.2. Policy Recommendations for the US Government

To support the responsible development of DeFi in supply chain finance, clear regulatory frameworks and guidelines are needed for businesses, investors, and consumers. This includes clarifying the legal status of digital assets used in DeFi, developing specific regulations for DeFi applications in supply chain finance, harmonizing regulations across agencies and jurisdictions, and establishing regulatory sandboxes for testing. These measures aim to foster innovation while protecting consumers and the financial system.

In addition to regulatory frameworks and guidelines, the U.S. government should also launch and support initiatives that promote research, innovation, and talent development in the field of DeFi and supply chain finance. This entails funding academic institutions, research centers, and industry consortia to conduct interdisciplinary research on DeFi technologies. It also involves establishing national programs and centers of excellence to tackle challenges like scalability and security. Education and workforce development programs should be created to train professionals in blockchain engineering and digital asset management. Public-private partnerships and industry collaborations should be fostered to promote adoption and innovation. These efforts will establish the US as a global leader in this field but require sustained commitment and cooperation from all stakeholders. By implementing these policy recommendations, the US government can create a more supportive and enabling environment for DeFi and supply chain finance and help position the country as a global leader in this rapidly evolving field.

## REFERENCES

- [1] Hofmann, E., Strewe, U. M., & Borgia, N. (2018). *Supply chain finance and blockchain technology: The case of reverse securitization*. Springer.
- [2] Gelsomino, L. M., Mangiaracina, R., Perego, A., & Tumino, A. (2016). Supply chain finance: A literature review. *International Journal of Physical Distribution & Logistics Management*, 46(4), 348-366.
- [3] Bals, C. (2019). Toward a supply chain finance (SCF) ecosystem – Proposing a framework and agenda for future research. *Journal of Purchasing and Supply Management*, 25(2), 105-117.
- [4] Camerinelli, E. (2009). Supply chain finance. *Journal of Payments Strategy & Systems*, 3(2), 114-128.

- [5] Pfohl, H. C., & Gomm, M. (2009). Supply chain finance: Optimizing financial flows in supply chains. *Logistics Research*, 1(3-4), 149-161.
- [6] Beck, T., & Demircug-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, 30(11), 2931-2943.
- [7] Yan, J., Yu, W., & Zhao, J. L. (2016). How signaling and search costs affect information asymmetry in P2P lending: The economics of big data. *Financial Innovation*, 1(1), 1-11.
- [8] Harvey, C. R., Ramachandran, A., & Santoro, J. (2021). *DeFi and the future of finance*. John Wiley & Sons.
- [9] Chen, Y., & Bellavitis, C. (2020). Blockchain disruption and decentralized finance: The rise of decentralized business models. *Journal of Business Venturing Insights*, 13, e00151.
- [10] Bech, M., & Garratt, R. (2017). Central bank cryptocurrencies. *BIS Quarterly Review*, September.
- [11] Kshetri, N. (2021). Blockchain and sustainable supply chain management in developing countries. *International Journal of Information Management*, 60, 102376.
- [12] Auer, R., Cornelli, G., & Frost, J. (2021). Rise of the central bank digital currencies: Drivers, approaches, and technologies. *Bank for International Settlements*.
- [13] Makarov, I., & Schoar, A. (2022). Cryptocurrencies and decentralized finance (DeFi). *Brookings Papers on Economic Activity*.
- [14] Mahmoudi, A., Sadeghi, M., & Naeni, L. M. (2023). Blockchain and supply chain finance for sustainable construction industry: Ensemble ranking using Ordinal Priority Approach. *Operations Management Research*.
- [15] Ning, L., & Yuan, Y. (2023). How blockchain impacts the supply chain finance platform business model reconfiguration. *International Journal of Logistics Research and Applications*.
- [16] Zhou, L., Xiong, X., Ernstberger, J., Chaliasos, S., Wang, Z., Wang, Y., Qin, K., Wattenhofer, R., Song, D., & Gervais, A. (2022). SoK: Decentralized Finance (DeFi) Attacks. *IEEE Symposium on Security and Privacy*.
- [17] Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, 57(7), 2117-2135.
- [18] Schar, F. (2021). Decentralized finance: On blockchain- and smart contract-based financial markets. *Federal Reserve Bank of St. Louis Review*, 103(2), 153-174.
- [19] Zetsche, D. A., Arner, D. W., & Buckley, R. P. (2020). Decentralized finance. *Journal of Financial Regulation*, 6(2), 172-203.