# II. Literature Review

This section provides an overview of the current research status on blockchain scalability, Ethereum gas fees, Uniswap and related fields.

## 2.1 Blockchain scalability Research Status

## 2.1.1 Challenges of Blockchain Scalability

There are many benefits of using blockchain in the areas of finance and economy, but there also many problems along with. Among them, the problem of scalability has become one of the main challenges. This section discusses the challenges of blockchain scalability: The performance-related problems in blockchain are expressed mainly in three characteristics: a small number of transactions per second, high time delay for confirmation, and limited opportunities for addition of new functions. For instance, Bitcoin has a capacity to process about 7 TPS while Ethereum only has approximately 30 TPS and none can meet the real-life payment processing situation. For example in Alibaba’s “Double 11” shopping festival at the same day, the number of transactions per second achieved 540,000 tps [1].

## 2.1.2 Main Solutions to Enhance Blockchain Scalability

Currently, there are several mainstream methods to address the scalability problems of blockchain: [1]

* Sharding: Sharding enhances the performance of the blockchain network through partitioning to deal with large transactions. For instance, the Zilliqa project asserts that it increases the blockchain throughput by more than hundred folds.
* DAG-based solutions (Directed Acyclic Graph): To avoid clogging of the network, DAG structures transactions in terms of a directed acyclic graph thus enhances parallelism of the network and scalability.
* Off-chain Payment Networks: On the features of payment networks, the off-chain payment networks process a part of the payment volumes off-chain so as to empty the on-chain transactions enhancing scalability. Such systems include Bitcoin’s Lightning Network and Ethereum’s Raiden Network.
* Cross-chain Technology: Through side chains or relay chains cross chain enables the transfer of assets and information between various blockchains.

## 2.1.3 Future Research Directions

Some common approaches have emerged, however, they only partially satisfy the problem of blockchain scalability and many more aspects need investigation. According to the literature by Di Yang et al. [1], the future research directions mainly include:

* High-performance P2P Networks: Due to the fact that blockchain fundamentally utilizes P2P networks for exchanging information in the future, further developments of the network must be made to improve performance.
* Modular Cryptographic Protocols: Based on demands from a set of applications, it is obligatory to create effective cryptographic modules and programmable environments.
* Efficient Smart Contract Execution: Another direction of development that requires attention in the future is related to the fine-tuning of the environment in which smart contracts operate in order to enhance the performance of those algorithms, which require considerable computation when assessing complex results.

## 2.2 Defi Research Status

## 2.2.1 Overview of the DeFi Ecosystem

Due to the advanced blockchain technology, Decentralized Finance (DeFi) has developed which provided financial service that are not available in the central financial systems like lending or trading of assets. According to Jiahua Xu [2], there are two core components in the DeFi ecosystem: Automated Market Makers (AMMs) and Peer-to-Peer Lending Facilities (PLFs). Some users submit liquidity or contribute assets to the platforms to earn revenues that will be described below.

## 2.2.2 Yield Farming

Yield farming is a key element in DeFi; users deposit liquid tokens in decentralized exchanges or lending platforms for fees, and interest, as well as token incentives. This Compound was the first time to issue what is called governance tokens (COMP), this was followed by other protocols such as Uniswap and Yearn Finance [2]. Uniswap’s AMM enables the liquidity providers (LPs) to earn a cut from the fees that accrue from a particular transaction since they offer their assets in these liquidity pools hence encouraging more users’ participation in DeFi.

## 2.2.3 Major Risks and Challenges

Yield farming provides substantial profits, but at the same time it has numerous unsafe strategies and threats to security and economy. For instance, flash loan attack and reentrancy attacks are some of the smart contract vulnerabilities whose impacts have affected several decentralized finance platforms [2]. Also, there are economic risks in form of impermanent loss and liquidation risks. In very volatile markets, u may not have adequate collateral to meet the loans and leads to people getting liquidated and loss of property.

## 2.3 Ethereum Gas Price Research Status

## 2.3.1 What is Gas Fee?

Gas fees are the costs Ethereum users need to pay when executing transactions, typically measured in Gwei (1 Gwei = 10^-9 ETH). It is therefore proportional to the computational power required by the employed network and the strategies adopted by the miners in processing the transaction. For example, miners generally prioritize transactions with higher gas fees, so users are often willing to pay more to expedite transaction confirmation [3][4].

## 2.3.2 Impact of Gas Fee Volatility

According to the research by Youssef et al. [4], gas fees fluctuate significantly with transaction demand and network congestion on the Ethereum network. During the DeFi boom in 2020, gas fees surged from 0.0225 ETH to 0.193 ETH, an increase of 8500%. Network congestion caused delays or cancellations for ordinary users’ transactions, creating a barrier for those unwilling to pay high gas fees. Moreover, the volatility of gas prices requires users to account for dynamic rate changes when executing transactions, which affects the overall user experience on the network.

They also have an effect on how active users are in Decentralized Autonomous Organizations (DAOs); Especially regarding gas fees. Some studies point out that where gas fees are transitory, its users will rush to make their decisions to avoid exponentially higher fees in future [4]. However, most of the DAO users still remain an active participant on the platform due to the high gas fees and the average activity level is low. In the long run, the increase in the gas fees could mean less utilization of blockchain [4].

## 2.3.3 Economic Analysis of Gas Fees

The gas fees are directly proportional to the rate at which Ethereum network is being used from an economical point of view. The literature [5] shows that when the block occupancy is above 90%, the gas fees rise steeply, especially during DeFi mania when the fluctuation of gas fees was more significant. Moreover, miners prefer the transactions that are priced higher in fees, which adds to the expense. This high volatility of the gaseous fees ends up raising the expenses of regular consumers even for basic activities such as smart contract executions.

## 2.4 Uniswap Research Status

In the previous sections, we mentioned Uniswap. This section will provide a detailed introduction to it.

## 2.4.1 What is Uniswap?

Uniswap is a decentralized exchange(DEX) built from an Automated Market Maker or AMM model for people to trade their tokens directly through smart contracts from sellers without getting into contact with the middleman or developer. As for the selection of the CPMM model, it is used for determining the asset prices amongst supported platforms. This mechanism preserves and holds assets in liquidity pools with the exchange rate calculated in relation to the available number of assets in the pool [6]. Uniswap saw exponential growth during the summer of 2020 during the DeFi craze with trading volume increasing within months of its operation making it a key player in DeFi [7].

## 2.4.2 Market Efficiency and Arbitrage Opportunities

According to the research by Jan Arvid Berg et al. [7], despite providing a decentralized trading environment, Uniswap still exhibits market inefficiencies due to market volatility and inaccurate pricing. For instance, around 30% of trades are executed at unfavorable exchange rates, especially during the 2020 DeFi boom when arbitrage opportunities frequently occurred. Although Uniswap and other DEXs have gradually improved market efficiency with increasing trading volumes, during periods of high cryptocurrency price volatility, market efficiency declines, leading to more circular arbitrage opportunities [7].

## 2.4.3 Impermanent Loss

Liquidity providers are invariably exposed to impermanent loss in AMM systems, especially when price variations cause considerable effects on the profits [8]. In the context of the design of concentrated liquidity, Uniswap V3 enhanced capital efficiency while at the same time amplifying the degree of impermanent loss for providers of liquidity. As it is pointed out by Andreas A. Aigner and Michael Neuder [9][10] the losses are more prominent when the market prices move away from these range prices offered by the liquidity providers. This puts more potential risks on the liquidity providers especially in markets that are highly unstable.

## 2.4.4 The Rise of Uniswap and Decentralized Exchanges

Uniswap, as a paradigm of decentralized exchanges (DEXs), has revolutionized the decentralized finance (DeFi) sector. Its AMM model eliminates intermediaries present in traditional trading systems, lowering the barriers to entry in financial markets and offering a broad range of investors opportunities to participate in DeFi [11][12]. Uniswap’s success has also driven the development of other DEXs, such as SushiSwap and Balancer, further consolidating DeFi's position in the global financial system [6].

# References

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