Ride Sharing for Maximizing Passenger Utility Using Blockchain

B. Narsingam[1], M. Lavanya[2], M.Varshith Sai[3], N. Saiteja[3]
[1]*Assistant Professor, Teegala Krishna Reddy Engineering College,Hyderabad*
[2,3,4] *Undergraduate Student, Teegala Krishna Reddy Engineering College,Hyderabad*

***Abstract*—This project presents a Decentralized Carpooling Platform designed to facilitate secure, transparent, and trustless ride-sharing using blockchain technology. The system leverages Ethereum smart contracts to manage ride listings, bookings, payments, and reputation tracking between drivers and passengers without the need for intermediaries.The core functionalities are implemented through robust smart contracts that allow drivers to create ride offers and passengers to book seats by transferring Ether. The system ensures transactional integrity by validating availability, automating payments, and recording bookings on the blockchain. Additionally, a reputation mechanism enables passengers to rate drivers, promoting accountability and service quality.An auxiliary contract (DataBank) is integrated to handle user-related metadata, providing modularity and potential support for off-chain enhancements such as identity verification or profile management.This decentralized approach not only enhances transparency and security, but also reduces operational costs and fosters a peer-to-peer ecosystem for urban mobility. The platform is scalable and can be extended to support advanced features such as dynamic pricing, route optimization, and integration with decentralized identity systems.**

***Index Terms*—Carpooling System, Data Acquisition, Smart contract, Web3 Integration.**

I. INTRODUCTION

The traditional carpooling system is usually dependent on centralized services, which unfortunately are known for some disadvantages. These may include high fees for services,data breaches, and less transparence between the users. Such issues foster mistrust and inefficiencies in the platform, thereby discouraging participation in ride-sharing solutions.The on-set of blockchain technology grants decentralized solutions a clear and secure alternative to current technology. Blockchain's attributes include decentralization, immutability, and smart contracts as a means to create a peer-to-peer carpooling platform that removes intermediaries and shows trust among users directly.This one utilizes smart contracts based on Ethereum to automate booking rides and paying securely. Smart contracts make sure all transactions are self-executing, tamper-proof, and
transparent; thus, the chances of fraud and disputes are reduced. The platform implements Web3.js connectivity to blockchain and thereby provides an easy and accessible interface through which the user can interface with the system seamlessly.Unlike most other systems, this platform allows users to retain full ownership of their data and transactions but at a decreased cost from eliminating the platform fee. Drivers and riders can monitor payments and ride activities in real-time to enhance trust and accountability.The platform also responds to other pressing issues like data security and sustainability.
Blockchain ensures that all information is safely stored and cannot change, ensuring peace of mind for users who dread a breach of data. Again, the decentralized nature of the platform promotes wider participation by removing barriers imposed by centralized systems.This project creates a fair, efficient, and secure solution for urban mobility by leveraging the power of blockchain technology. In addition to ensuring an enhanced carpooling experience,the scheme is in line with modern needs for privacy, transparency, and cost-effectiveness as it sets the theme for the future of ride-sharing.

II. BACKGROUND STUDY

The rapid growth of urban populations and increasing vehicle ownership have contributed to severe traffic

congestion, environmental pollution, and inefficient transportation systems in many cities worldwide. In response, carpooling has emerged as a sustainable mobility solution that allows individuals to share rides, thereby reducing the number of vehicles on the road, lowering fuel consumption, and promoting eco-friendly travel.Traditional carpooling platforms, however, are predominantly centralized and rely on third-party service providers to manage ride listings, user verification, payment processing, and dispute resolution. This centralized architecture often results in data privacy concerns, high service fees, and **a** lack of transparency, which can diminish user trust and system efficiency.With the advent of blockchain technology, particularly Ethereum's smart contract platform, new opportunities have arisen to decentralize such services. By shifting core functionalities onto the blockchain, it is possible to create trustless, secure, and self-governing systems that eliminate intermediaries while ensuring data integrity and transparency.This project builds upon these advancements by developing a decentralized carpooling application using Solidity-based smart contracts. It enables drivers to publish ride offers and passengers to book them in a peer-to-peer manner, with all interactions recorded immutably on the blockchain. The inclusion of a reputation mechanism further ensures user accountability and service reliability. Additionally, a modular storage layer (DataBank.sol) is implemented to manage user-specific metadata, paving the way for integration with decentralized identity frameworks or future scalability. This approach aligns with the broader vision of Web3—a decentralized, user-centric internet—and offers a transformative step toward more equitable and efficient transportation ecosystems.

III. PROPOSED METHODOLOGY

The proposed methodology for developing the decentralized carpooling platform is centered around leveraging blockchain technology, particularly the Ethereum network, to create a secure, transparent, and peer-to-peer ride-sharing ecosystem. The system architecture is divided into three main components: smart contracts**,** Web3-enabled frontend**,** and auxiliary data management. The core functionality is implemented through Solidity-based smart contracts that handle ride creation, booking, payment processing, and reputation tracking. These contracts are deployed to the Ethereum blockchain, ensuring immutability and trustless execution of all transactions. A modular smart contract, DataBank.sol, is introduced to store user-specific metadata and support extensibility. The frontend interface is developed using standard web technologies and integrated with blockchain through Web3.js or Ethers.js, allowing users to interact with smart contracts via wallets such as MetaMask. All user actions—including creating rides, booking seats, and submitting ratings—are processed as blockchain transactions to eliminate the need for centralized servers or administrators. The development process follows a structured lifecycle, beginning with requirement analysis, followed by smart contract development, frontend integration, testing on Ethereum testnets, and finally user validation. This methodology ensures a decentralized, tamper-resistant platform with a focus on user autonomy, operational transparency, and scalability for future enhancements.

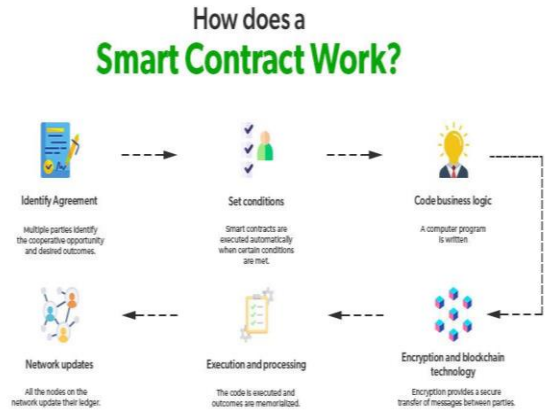
A.DATA ACQUISITION

The data storage architecture of this decentralized carpooling system is designed to ensure security, transparency, and modularity by leveraging the inherent properties of blockchain technology. Core transactional data—such as ride details, bookings, payments, and user interactions—is stored directly on the Ethereum blockchain through structured smart contracts. This ensures immutability, auditability, and resistance to tampering. To optimize contract performance and gas efficiency, the system employs mappings and structured data types within the primary smart contract (CarpoolingContract.sol) to manage ride information and passenger records. Additionally, a dedicated auxiliary contract (DataBank.sol) is introduced to handle user-specific metadata and extend data management capabilities without bloating the core contract. This separation of concerns enhances scalability and allows for seamless integration with off-chain components or decentralized identity systems. By maintaining a minimal and efficient on-chain data footprint, the project achieves a balanced approach between blockchain benefits and resource constraints.

B. SMART CONTRACT

At the core of the decentralized carpooling system lies a suite of carefully designed Ethereum smart contracts that govern all critical operations such as ride creation, booking, payments, and user interaction. The primary contract, CarpoolingContract.sol, encapsulates the business logic of the platform by allowing drivers to register rides with defined parameters including origin, destination, departure time, price, and available seats. Passengers can then book rides by sending the required amount of Ether to the contract, which automatically updates seat availability and maps the passenger to the ride. These interactions are handled in a trustless and autonomous manner, ensuring that no third party is required to verify or mediate transactions.The contract enforces strict validation checks to prevent overbooking and unauthorized access, while also managing state transitions such as ride cancellation and completion. Once a ride concludes, passengers are encouraged to rate the driver, and these ratings contribute to a decentralized reputation system that helps maintain accountability and service quality. Furthermore, to support separation of concerns and improve maintainability, the system includes an auxiliary contract, DataBank.sol, which serves as a lightweight storage layer for user-specific metadata.

This modular design not only ensures efficient on-chain operations but also supports future expansion, such as integration with decentralized identity (DID) systems or off-chain data storage mechanisms. By employing Solidity programming and conforming to Ethereum's execution model, these smart contracts are executed on the Ethereum Virtual Machine (EVM)**,** providing deterministic and verifiable outcomes. The architecture is crafted with scalability and upgradability in mind, positioning the platform for broader adoption and extended feature sets, such as dynamic pricing models, ride matching algorithms, and advanced governance protocols in future iterations.



C.WEB3 INTEGRATION

The decentralized carpooling platform is seamlessly integrated with Web3 technologies, enabling direct interaction between users and the Ethereum blockchain through a web-based interface. Utilizing libraries such as Web3.js or Ethers.js, the frontend application connects to the user's blockchain wallet—typically MetaMask—to authenticate identities, send transactions, and retrieve data from smart contracts in real time. This integration eliminates the need for centralized servers or intermediaries, giving users full control over their data and digital assets. Through the Web3 layer, drivers can publish rides, and passengers can view available rides and book them by signing blockchain transactions directly within their browser. The interface interacts with deployed smart contracts to reflect live updates, such as seat availability, ride statuses, and user ratings, creating a transparent and responsive user experience. Additionally, Web3 integration facilitates secure Ether payments and provides a foundation for incorporating decentralized identity (DID) or token-based reward systems in the future. This approach not only decentralizes the backend but also aligns the platform with the principles of Web3: user sovereignty, transparency, and decentralization, thereby empowering participants to engage in peer-to-peer mobility services without relying on centralized authorities.

IV.RESULT ANALYSIS AND DISCUSSION

The development and deployment of the decentralized carpooling system yielded promising results in terms of functionality, transparency, and user autonomy. The system successfully demonstrated the core features expected of a

blockchain-based ride-sharing platform, including ride creation**,** seat booking**,** secure payments using Ether**,** and real-time updates via Web3 integration**.** During testing on the Ethereum testnet (e.g., Ropsten or Goerli), all smart contract functions performed deterministically, validating the correctness of ride registration, transaction processing, and user interaction. Gas consumption was within acceptable limits, particularly for ride creation and booking, indicating that the contract logic is optimized for real-world deployment.

`The implementation of a reputation mechanism provided a foundational level of accountability, with passengers able to rate drivers upon completion of a ride. This feature enhances trust within a decentralized environment where no centralized authority exists to mediate disputes. Furthermore, the integration of the DataBank.sol contract helped in decoupling user metadata from operational logic, paving the way for modular enhancements, such as off-chain storage or identity verification layers in future versions.

From a user experience perspective, the Web3-based frontend effectively facilitated direct blockchain interactions. Wallet integration via MetaMask allowed for secure login and transaction signing without exposing private keys. The use of event listeners and asynchronous JavaScript provided responsive feedback to users, ensuring a smooth and intuitive interface.

In conclusion, the project demonstrates a viable proof of concept for a decentralized ride-sharing platform. It addresses key limitations of centralized systems—such as lack of transparency and user control—by offering a peer-to-peer model underpinned by blockchain. The results affirm the feasibility of using smart contracts for real-world applications and highlight opportunities for further development in pursuit of a fully autonomous and scalable decentralized transportation network.

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