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CarBook : Decentralized Ride-Sharing System using Blockchain

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Abstract – *A decentralized, distributed ledger system called blockchain technology makes it possible to securely and openly record transactions over a network of computers. A ride-sharing system is a transportation service that connects passengers with drivers willing to offer rides using their own vehicles. By incorporating blockchain technology into its architecture, the ride-sharing sector can undergo a revolutionary transformation. Traditional ride-sharing systems face challenges related to security and centralized control. The purpose of our paper is leveraging the decentralized nature of blockchain for drivers and passengers, that ensures enhanced privacy and trust which are the major concerns in these ride-sharing systems. In this paper, we have used blockchain to store ride details and user information to maintain security, wherein sensitive user data is encrypted, to prevent unwanted access. The ride-sharing agreements between drivers and passengers are automated and carried out by the system architecture through the use of smart contracts. Our proposed system eliminates the need for intermediaries, leading to lower charges and increased transparency. It also provides enhanced security and privacy for all parties involved, as all transactions are recorded on an immutable ledger.*

Key Words: **Blockchain, Security, Ridesharing, Smart Contract, Solidity**

1. INTRODUCTION

Through "ride-sharing" service, drivers can share the cost of their travel with other passengers. Ride-sharing has become increasingly common in today's society, expanding outside of urban areas and into suburban and rural places. Ride-sharing or ride-hailing services like OLA, Uber have become an integral part of urban transportation, offering convenient and cost- effective mobility solutions. These platforms do, however, confront a number of difficulties, such as problems with security, transparency, and trust. They rely on centralized intermediaries, which can lead to problems such as unfair pricing, data manipulation, and disputes between drivers and passengers. To address the issues with centralized traditional ride-sharing services, we use blockchain. The implementation of blockchain in ride-sharing could result in significant shifts in terms of trust and privacy. The user's data can be secured securely and will be unchangeable with the aid of blockchain. Additionally, a centralized system cannot be regarded as trustworthy because every user is impacted if the server goes down, whereas there are no such problems in a distributed system, making it robust and reliable. To ensure that the ride-sharing system functions more smoothly, a decentralized system in the public domain is required, as the majority of the present ride-sharing techniques are governed by large firms and central agencies. One of the cutting-edge technologies with the power to totally change the market is blockchain. Decentralization, openness, consistency, immutability, and data security are some of the key features that make blockchain so powerful. Blockchain technology is an advanced technology that has the potential to power decentralized systems.

Also, Pollution reduction is a crucial objective that humanity must achieve. The majority of air and noise pollution is caused by vehicles. By reducing the number of cars on the road, a ride-sharing service will help to protect the environment. Our proposed method strives to be decentralized by recording the rider's journey and user data on the blockchain.

Elements in Proposed System :

Blockchain : A distributed database that is shared by every computer network node is called a blockchain. It uses cryptography to link the pieces of information it keeps together. This creates a secure, uncrackable record of each and every transaction made on the blockchain.

Smart Contract : The primary purpose of these systems is to programmatically carry out business logic, which is designed to carry out certain operations, procedures, or transactions in response to predetermined criteria. To put it simply, smart contracts are blockchain-based programs that execute in response to predefined conditions.

Ride-Sharing : To facilitate peer-to-peer sharing, the vehicle can accommodate three passengers and pick them up from various locations, ultimately reaching the final destination.

2. RELATED WORK

Carpooling is a revolutionary way to commute. This carpooling application is designed to be scalable, extensible and highly available. [1]. Centralized systems rely heavily on

a central authority to manage and coordinate rides, which can lead to bottlenecks, delays, and potential points of failure. Centralized platforms usually collect transaction fees for each journey, which can diminish revenues for drivers while increasing expenses for customers. Existing ride-hailing services, while useful and popular, still have some scope for improvement in terms of pricing models, user safety, transaction transparency, and data security [2]. Blockchain is gaining popularity in the ride-hailing industry by allowing users to connect directly with drivers who are prepared to carry them [2]. The exclusion of a third party would mean that user's data won't be exposed to anyone outside the system or some unnecessary entity within the system [5]. A rider can request a car by providing his/her preferred start location and the destination of the trip [1]. With the help of Google Maps integrated in the application, the driver and rider would know each other's whereabouts, so as to catch up before the ride [5]. After the completion of the ride the fare is calculated using two factors i.e. base price and a multiplying factor associated with the distance travelled [5]. First, a user chooses his Pickup and Destination, after that the system makes calculations to calculate Distance, Estimated Travel Time, and Total Fare which are added to the information along with Pickup and Destination, which are then sent to the main Blockchain which contains all the data [2]. An important aspect of a ride sharing platform is to provide a robust and efficient ride matching system. A ride matching system allocates the rider with a set of some potential drivers. This set of drivers would only be chosen from the rider's vicinity[5].

3. METHODOLOGY

A. Existing Ride-Sharing System

Centralized Ride-sharing applications like OLA, Uber are an installation that arrange two-way transportation on short notice through mobile apps and websites.

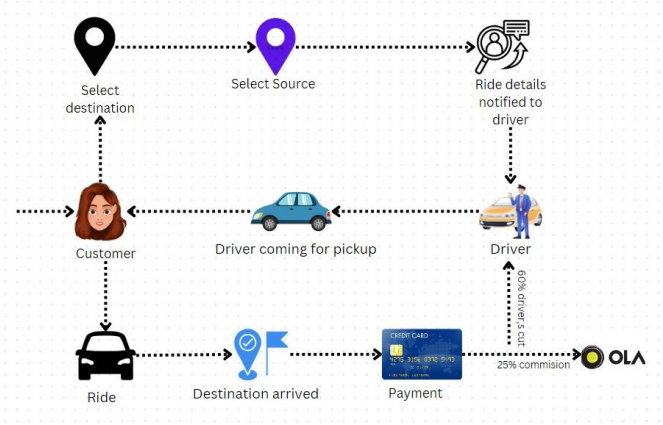

Fig -1: Block Diagram of Existing Ride-Sharing System

Challenges in the Existing Ride-Sharing Industry

1) **Expense issues brought on by intermediaries:** In order to book cabs, third-party companies must handle the payment process, vehicle monitoring, etc. Each of these mediators will charge a significant fee for each deal. In addition to raising the cost for the passengers and resulting in lower pay for the drivers.

2) **Absence of Data Security and Privacy Mechanisms:** The company's database contains a wealth of sensitive information, including each user's home address, phone number and current location. Even though businesses spend a lot of money on data protection and user authentication, incidences of fraudulent identities and database hacking by data pirates are prevalent.

3) **Trust-based Centralization:** The users' trust in the system gives credibility and accountability. A centralized organization also means that there is a single point of failure. Thus, a single unfriendly behavior or dishonest employee has the power to bring down a whole institution.

B. Proposed System

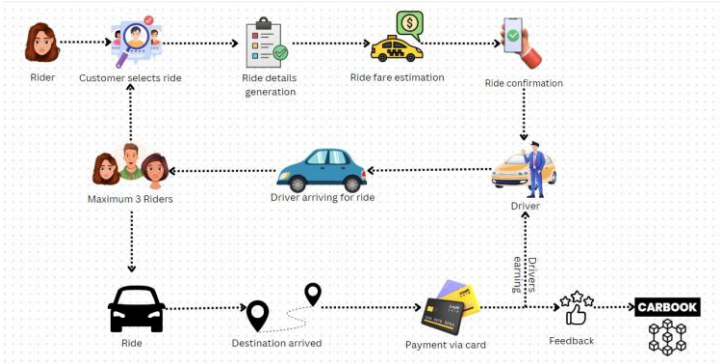

Fig -2: Block Diagram of CarBook

The objective of CarBook is to design and implement a user-friendly and decentralized ride-sharing system powered by blockchain that benefits both drivers and riders. It maintains openness on pertinent transaction details while guaranteeing the privacy and confidentiality of user data. Our proposed system eliminates the need for intermediaries, leading users to pay lower fare price. The proposed system includes following sections:

1) User Platform: The user interface of CarBook is built using front-end frameworks, such as HTML, CSS, Web 3.0 technology and is the part where riders and drivers interact with. Users can create accounts, login, input their travel preferences, and request rides using the CarBook's user-friendly interface. The drivers can register themselves and upload documents as the proof, upload car details and ride details. It also includes "Google Map directions API" which is

used for traversing the route from the source towards the destination.

2) Backend: Flask will serve as the backend. It will expose APIs for frontend interaction. The fare estimations, the condition to limit maximum 3 passengers, Driver Waiting Algorithm are implemented using Javascript and python. MySQL is used to store the database of the payments done by the rider.

3) Blockchain: Flask is used to build the backend server that manages and serves this data to a frontend application. Flask is used to connect the web-app to the blockchain using smart contracts in Ganache. CarBook has mechanism for storing the details of both drivers and passengers in an encrypted form using Keccak256 algorithm to ensure safety and security. The smart contracts for the blockchain-based ride-sharing system is written in Solidity. The smart contracts are intended to make sure that the data being entered is traceable, transparent and irreversible. The details of the rides to be shared are stored on the blockchain with the help of the smart contract and cannot be changed at any cost. This ensures that the network is safe and secured. The rider/driver who wants to share the ride can enter the required details and can post it on the blockchain.

4) Ride-Sharing: To facilitate peer-to-peer sharing, the vehicle can accommodate three passengers and pick them up from a particular location, ultimately reaching the final destination. At the time of uploading ride details, the driver inputs the time when the ride would start. An algorithm has been incorporated wherein after 15 minutes from the input time, the driver's vehicle option will be unavailable for ride booking. Also, once the driver accepts three ride requests, then too, that particular driver's option would freeze.

5) Payment and Pricing: Payment for rides is typically handled through the CarBook platform, and prices can be variable based on factors like distance and cost of fuel. Once the ride is completed the rider gets an option to pay to the driver. He/she can pay via card.

C. Data Flow

A user has to sign up first to get registered on the CarBook. Thereafter, he/she can log into the web-app for daily use. They can even register themselves as drivers using the same account. On uploading the required documents, the user will become a driver on the CarBook. Once the user becomes a driver, he can fill the ride details in the 'Start Ride' section anytime he wants to start a ride. The fare for the ride is estimated automatically which depends on the distance between the source and destination and cost of the fuel. The driver has to input the time he wants to start the ride. The default waiting time in that particular area has been set to 15 minutes. The user can request only the cars that are available at that moment and have been displayed in the 'Book ride' section. The acceptance of the request depends solely on the driver. The driver has a choice to accept riders upto a limit of 3. Once there are 3 passengers, that particular driver's car selection option freezes. Also, after 15 minutes from the time that driver had set, that driver's car option from the 'Book ride' section of the user freezes. With the help of Google Maps integrated in the web-app, the driver and rider would know the route of the ride (source to destination). Once the ride is completed, the user can pay the driver via card.

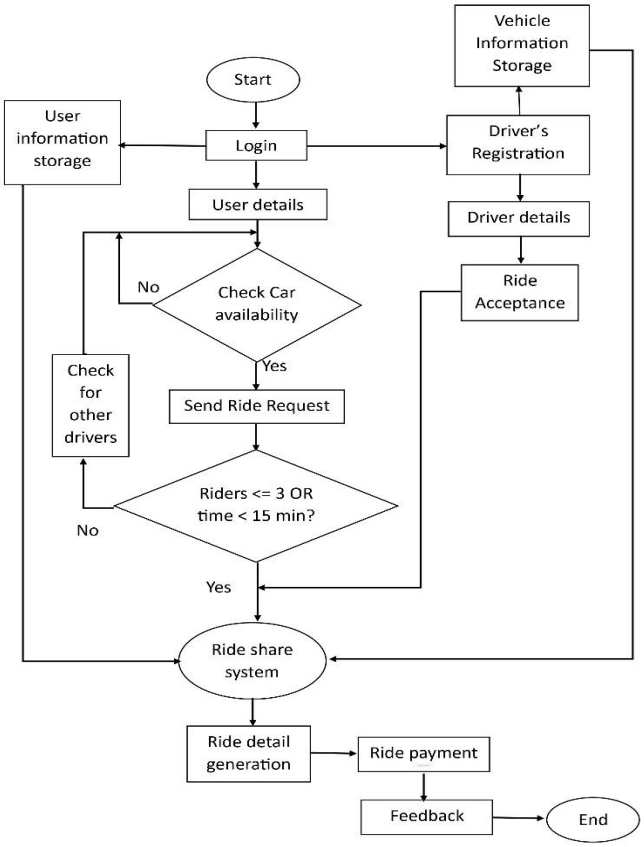

Fig -3: Flowchart of CarBook

D. Algorithms

Algorithm 1: Fare Estimation

Algorithm calculate fare(distance, rate per kilometer):
1. fare = distance * rate per kilometer
2. return fare

Algorithm 2: Driver Waiting Algorithm

1) Get the current time using the 'Date' object.
2) Extract a specified time from the 'recordResults' array, adjusting it by adding 15 minutes.
3) Calculate the time difference in minutes between the time specified by driver and the current time.
4) Log the difference in minutes to the console.
5) If the count of riders equal to '0' OR atmost '3', OR, if the calculated time difference in minutes is less than 0:

- Driver selection option freezes

4. RESULT AND DISCUSSION

A. Implementation

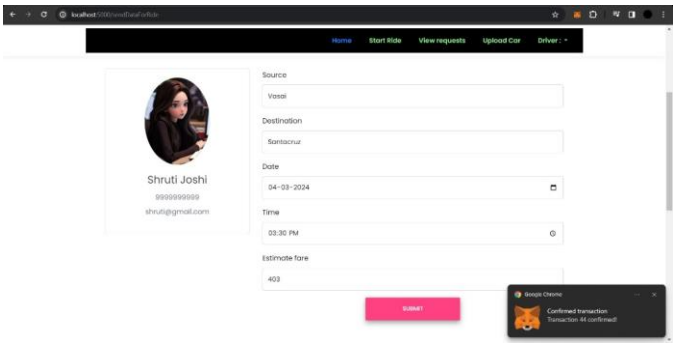

Fig -4: Ride Details

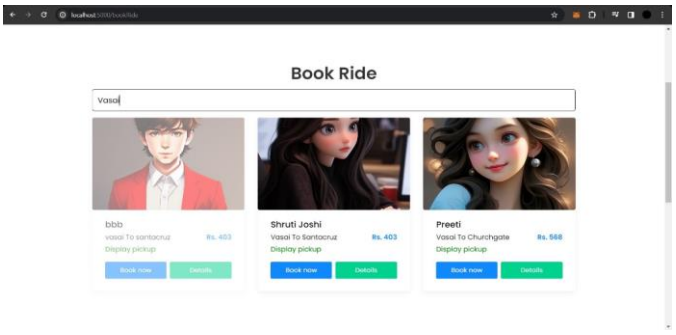

Fig -5: Book Ride Section for User

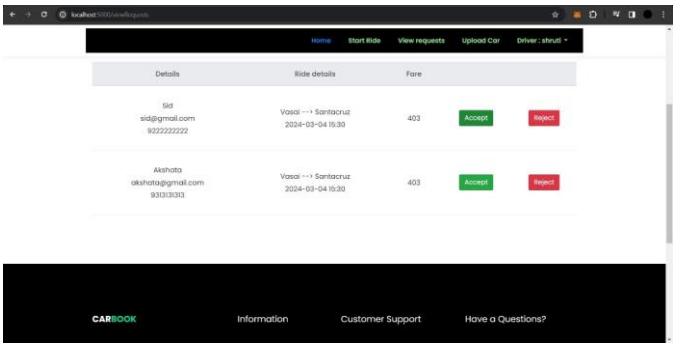

Fig -6: View Requests section of Driver

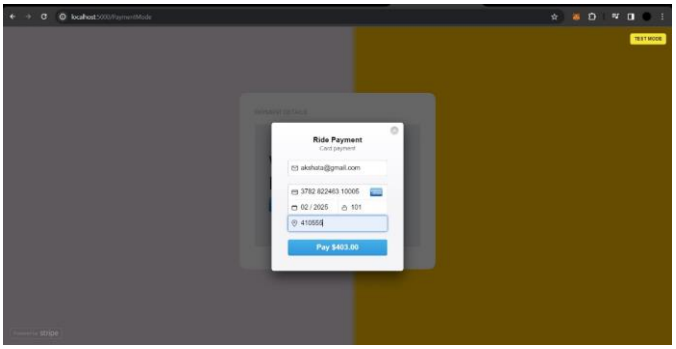

Fig -7: Payment via card

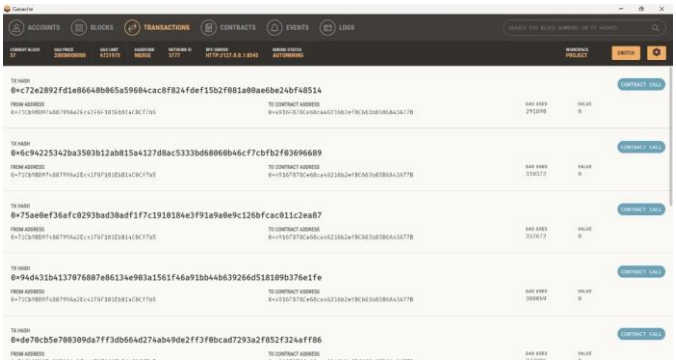

Fig -8: Encrypted User/Ride Details

B. Comparison between Centralized Ride-Sharing systems and CarBook

Table -1 shows some of the improvements of CarBook over Centralized Ride-Sharing systems.

Table -1: Comparison between Centralized Ride-Sharing systems and CarBook

Parameters	Centralized Ride-sharing Systems	CarBook : A Decentralized Ride-sharing System
Security	The large corporations control a central server where all the data is kept, hence the security of the data might be compromised.	The data is kept on Blockchain, which is unchangeable and cannot be altered under any circumstances.
Privacy	The rider's personal information is shared with the central authority and may be abused.	Despite the fact that the blockchain may be independently verified by the public, user privacy is maintained since sensitive information is encrypted and kept secure.
Fare	Centralized systems involve third parties where passenger costs tend to increase, while drivers receive a comparatively lower payment.	In CarBook, there is no involvement of third parties and hence, passengers pay only the fare for ride distance and fuel used.

5. CONCLUSION

Existing ride-sharing platforms, while efficient and popular, would not be better in terms of pricing models, user safety, transaction transparency, and data security. A centralized ride-sharing application is prone to violation of privacy of the personal data. In conclusion, CarBook is an innovative concept that offers several benefits over the traditional ride-sharing system. The system eliminates the need for intermediaries, resulting in reduced costs for passengers and drivers. The blockchain technology provides transparency and security, ensuring that the system is reliable and trustworthy. Blockchain ensures security and privacy of data by using public and private keys. It uses public-key cryptography to handle transactions between users. It does not permit users to tamper data once the data is added to the chain. Decentralized approach towards ride-sharing will store all transactions, fare calculation, ride-matching and user information on a distributed ledger. The smart contract automates the process, reducing the time and effort required for manual processing, making the system efficient and fast. As ride-sharing services grow in popularity and demand increases, scalability becomes a critical issue. However, the system also, faces several challenges that need to be addressed for successful implementation, including lack of awareness about blockchain, technical challenges like connectivity, system reliability and scalability challenges. To overcome these challenges, collaboration among stakeholders, including governments, vehicle associations and blockchain developers, is necessary.

6. FUTURE SCOPE

Here are some potential areas of growth for the CarBook:

1) **Expansion to More Regions:** Currently, CarBook is only available in a few regions. However, with its numerous benefits, it is expected to expand to more regions, offering passengers and drivers a secure and reliable platform to share vehicles.

2) **Integration with Other Blockchain Applications:** CarBook can be integrated with other blockchain applications like verification mechanisms, for drivers and digital identities to offer a more comprehensive solution. This integration will make the system more efficient and secure.

3) **Improve User Experience:** It is anticipated that the blockchain-based decentralized ride-sharing system would keep enhancing both drivers' and passengers' user experiences. This will include faster and more accurate booking and payment processing, improved safety features and more personalized services.

Overall, the future scope of CarBook is vast and promising. As the technology continues to evolve, the system is expected to offer more benefits to passengers and drivers, making it the widely preferred platform for ride-sharing.

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