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Decentralized Car Hailing Application

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Abstract - *Ride-Hailing has been a great way to travel from one place to another over the traditional ways of traveling. Despite, the great convenience at our hand, the market is captured by a few big companies, which are centralized and store the user data that is further used for various operations. With the advancement and Research in Blockchain Technology, the blockchain can be extended to Car Hailing applications to make a decentralized application to overcome the issues with the current Car Hailing Industry and take a step toward Web 3.0. In this paper, we will discuss a Decentralized Car Hailing System and the benefits it serves over traditional and current Car Hailing Industry.*

Key Words: Blockchain, Decentralized, Peer-to-Peer, Car Hailing, Security

1. INTRODUCTION

Transportation in today's society should be safe and easy for everyone, with a well-functioning public transportation system [9]. The present ride-hailing system, operated by companies like Uber and Ola those are centralized. There is a trust and transparency issue with such a centralized system where servers track every ride and rider's detail. This approach looks to be less open and raises questions about the customer's information and safety. In terms of data integrity and adaptability, centralization causes systems to be untrustworthy.

Blockchain is gaining popularity in the ride-hailing industry by allowing users to connect directly with drivers who are prepared to carry them. Not just the banking sector, but every major business with differentiating qualities is being transformed by blockchain. Researchers are attempting to figure out where blockchain may help solve issues and create excellent services. Blockchain is already making headway in areas such as crowdfunding, insurance, healthcare, governance, and energy. By promoting cooperative management between passengers and drivers, blockchain-based ride-hailing companies might address the need for an hour. Participants distribute transactional data over a vast network of nodes rather than deciding on a single trusted central authority. This eliminates any intermediates who serve as administrators. Transaction information is stored in a distributed ledger that is accessible to all nodes in the blockchain network, making the network more transparent.

In this paper, we discuss a mechanism to develop a ride-hailing service that profits both Riders and Drivers in comparison to traditional or current models. Every ride detail will be recorded as a transaction in the blockchain, which acts as a shared database. In our car-hailing service, blockchain enables decentralization by allowing drivers and riders to interact directly through the app without the participation of a third party, and by automating all operations like ride setup and fair computation. This boosts the system's stability and fairness by making it more transparent.

2. LITERATURE SURVEY

The Blockchain was introduced by Satoshi Nakamoto [12] and has been one of the fastest-growing technology ever, with very high potential and it is still the beginning of the era. The Blockchain came into existence as a technology used by Bitcoin to create a decentralized network for asset exchange, ever since Bitcoin has attained a drastic user base. With more and more research into the field, Blockchain is no more limited to Crypto Currency but is a perfect technology to be used anywhere with the need for transparency, and improved security. Blockchain is the driving force for the new and upcoming Web 3.0.

In this paper, we will be trying to use the very same technology to create a Ride-Hailing System that is transparent, trustful, and privacy-oriented [8]. There has been a great amount of research in the field of Blockchain that discusses the integration of blockchain in various applications. We will also discuss how to decide on pricing to create better affordable rides for the user and at the same time more profitable source of income for drivers.

In a paper by Ruolin Zhang and Neda Masoud [10], they have discussed a model for ride-sharing where based on geographical location the users can be picked based on the owner's route preference. This can be extended to the Ride-Hailing system to show drivers better results based on their current geographical area.

In a paper by Ryan Shivers, Mohammad Ashiqur Rahman, and Hossain Shahriar [1], they discuss a car-hailing system with Autonomous Vehicles where users can enroll their vehicle for Car Hailing Service without the need of a driver.

A Bengaluru-based start-up DRIFE [11] refers to itself as Taxi 3.0 as a reference from Web 3.0, is based on a subscription-based service for drivers rather than taking a share of the Fare every time. Using automated algorithms for price calculations, and providing safety measures, keeping things decentralized along with maintaining the record of the necessary information, such as driver's background check.

The work in the category is endless, keeping the previous work in mind, we will be using the past work, to create an application that meets the need of the user, and also provide a trust-worthy environment, where they can be part of the system, rather than trusting someone blindly.

3. BLOCKCHAIN TECHNOLOGY

3.1 Overview of Blockchain

A blockchain is a digital ledger that contains several blocks which are encrypted and carries out transactions that are circulated across the whole network of a computer system. Transactions are carried out safely which is difficult to hack and each record of the transaction is appended to the participant's ledger.

It is mostly used in payments industries, healthcare, and also in cybersecurity as the data on the blockchain is difficult to alter [5]. It works on distributed ledger technology that follows certain protocols which can either be public or private and also it is permissioned or permissionless. DLT contains nodes that have a database that synchronizes transactions in their corresponding ledgers so that they can be easily accessed by the people and sites.

3.2 Architecture of Blockchain

The blockchain architecture consists of: -

1. Node: Nodes are generally the servers or the laptops/computers which act as a framework in the blockchain. They are mainly used for preserving the information and spreading it and are connected.

2. Transaction: A transaction is any interaction between any nodes of the Blockchain. A transaction is the record of some data. In bitcoin, it stores the amount of bitcoin transferred or received.

3. Block: Block is the basic building block. It contains several data which account for information corresponding to the use case of the Blockchain. Generally, they contain several components like the nonce, root hash, version number, hash of the previous block, and also the time.

4. Miners: They are the special nodes that use the mining hardware and add the transaction to the ledger. They spend their computational power or other resources as per the consensus used, and again the ability to add a transaction, they receive the reward in the native cryptocurrency for adding the block.

5. Chain: Arrangement of blocks in a particular order. They are generally very long in size.

6. Consensus: Consensus is the central part of a blockchain network having distributed systems that contains a set of protocols. All the peers in the blockchain network must reach a common and unified agreement on the distributed ledger for which a consensus algorithm is widely used to develop the trust between the unknown peers.

It accounts for open-source property in the blockchain network. It makes blockchain secure and fault-tolerant and also makes sure in balancing economic incentives.

3.3 Components of Blockchain

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1. Node: It is divided into 2 types, Full Node, and Partial Node.

a. Full Node: They provide the full validation of transactions using full copy. They can validate the accuracy of transactions and can also reject as well as accept it.

b. Partial Node: It contains the lightweight node and doesn't contain the full copy of the ledger. They have low storage as well as low computational power.

2. Ledger: Ledgers are the database that contains the information in the digital form which helps in exchanging currency(cryptocurrency). Generally, it is of 3 types, Public, Distributed, and Decentralized.

a. Public Ledger: - It is a ledger that is completely public which means anyone can perform read and write actions in this.

b. Distributed Ledger: - The database contains the local copy of the node which can be easily attainable through different sites and is also synchronized. In a distributed ledger, various nodes perform a transaction and ensure that there should not be any cyber-attack.

c. Decentralized Ledger: - Each node helps in the completion of the job and also doesn't have central control. They also help in synchronizing transactions in their specific ledgers.

3. Wallet: Wallets are used for storing different cryptocurrencies like bitcoin and Ethereum in digital form to carry out fast transactions. We can access wallets from any device like mobile phones but at the same time, it ensures the privacy of the identity of the user using key pairs. Currency in the wallet is sanctioned and uniform. Generally, it is of 2 types, Hot Wallet and Cold Wallet.

4. Nonce: Nonce which is abbreviated as Number and can be used only once is a 4 byte or the 32-bit number which is used by the miners to create the hash value for the block. It generally changes with time so that each time its pseudo-random value can be used. It uses authentication and a certain set of rules is used to protect the communications.

5. Hash: Hash is a mathematical function that takes input and converts it into bytes of a string having a fixed length and produces the unique output. In the blockchain computation, it ensures to reach encryption. Types of Hash, MD5, SHA-2, SHA-3, RIPEMD, BLAKE2.

3.4 Types of Blockchain

Public Blockchain: It is fully decentralized and can be accessed by every user and is generally used for mining cryptocurrency controlled by consensus algorithms. It is also called a permission-less blockchain.

Private Blockchain: It is also called permissioned blockchain as the name suggests. Now, to validate a transaction for reaching a consensus it offers high speed as permission is granted only to a certain number of users. It is also very scalable.

Consortium Blockchain: Here the miner rights are given to some specific nodes only. Though the blockchain can be read and viewed by anyone the block addition is limited to a selected set of nodes.

3.5 Consensus Algorithm

The consensus algorithm aims to find a unique agreement in the entire blockchain network and involves the essential participation of all the nodes. Discussing the most used Consensus Algorithms [7].

Proof of Work: - It is a decentralized mechanism that is mostly used in mining cryptocurrency to generate the next block. It decodes complex mathematical puzzles by using long strings and lots of computational power. The arbitrary hash function used in the proof of work algorithm generates an output that has a minimum number of leading zeroes.

Proof of Stake: - Instead of solving the complex mathematical puzzles users invest in the coins to become a validator. Hardware requirements are less in proof of stake and require fewer energy mining blocks. It motivates the validators through an incentive mechanism to reach an agreement.

4. DECENTRALIZED CAR HAILING

4.1 Understanding & Idea

Car Hailing Industry is a billion-dollar market and is captured by few companies in today's world. Towards an Approach to Web 3.0, i.e., creating a network where no one else has control over your data. Only you own your data. These companies use your travel data, address, and other information to earn money. Apart from user data, these companies act as a mediator between driver and rider and take a big chuck out of the total fare, as per studies, the mediator may charge as much as 25% of the total share, which is a big percentage. This results in Drivers having less income and at the same time, riders have to spend an extra amount which goes to the mediator. This Mediator can be removed by making the system decentralized. Though there are a few aspects that need monitoring such as safety issues, due to which taking such a system completely decentralized can be challenging. We can create a system that is trustworthy, open-sourced, transparent, and uses automated algorithms for price calculation.

We purpose to create a model on Consortium Blockchain, as discussed earlier it is a blockchain where the process of mining or in simple terms the addition of blocks is limited to a few individuals. The mediator or the application owner can use a subscription-based package from drivers to become a part of the blockchain. Once a driver is a part of the blockchain after verification by the app owner, the driver can have access to the Dashboard where they can access all the available rides, can select from the pool of Rides, and the driver can act as a miner.

Rather than charging a great percentage out of every ride, very affordable monthly subscription fees can be used. No database has to be used, rather a Blockchain-based network can be used which is transparent and trustworthy. Temporary Chat Rooms can be created between Rider and Driver for communication without the need for database. All of these topics are discussed in detail in further sections.

4.2 Architecture

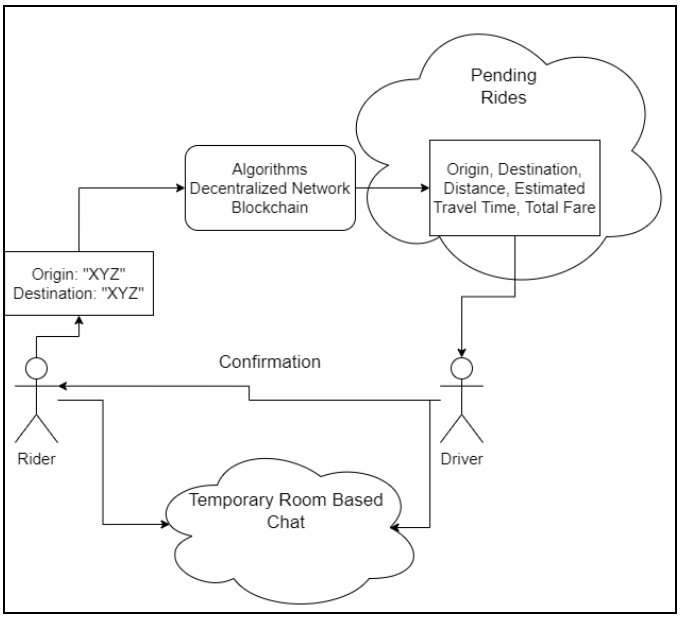

Fig -1: Rider-User Connection

The system contains algorithms that are optimized to calculate prices based on daily fuel prices and other factors which are discussed in depth in the Fare Calculation Section of this paper. 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. Once a driver accepts the request, the block is also appended to the Final Blockchain as a confirmation. The use of 2 Blockchain is discussed in the next section. A confirmation is sent to the Rider that his request has been approved and the driver and rider are sent to a Chat Application where they can share further required details.

4.3 Blockchain Integration

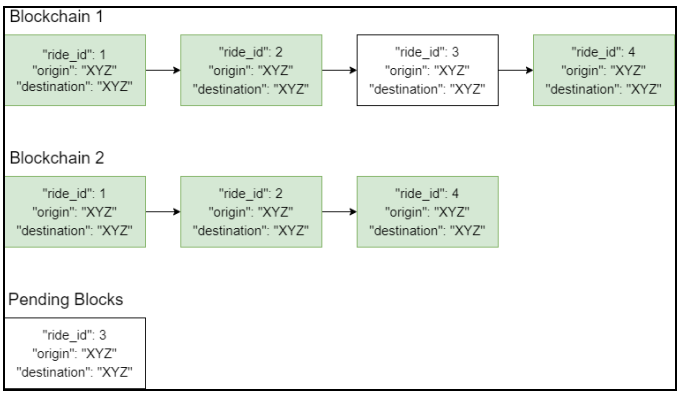

Fig -2: Two Blockchain Approach

We will be using a 2 Blockchain-based approach for our model. First Blockchain will be used to record all the transactions and transactions that are completed, i.e., accepted by the driver are added to the Second Blockchain. When a driver wants to look up available rides, we will be traveling the first Blockchain in reverse order, we will also be making sure that we only check blocks that are not older than 3 minutes. All the blocks from the First Blockchain which are not older than 3 minutes are added to a variable that acts as temporary storage. Now, we will traverse the Second Blockchain, again in reverse order. We will only check blocks that are not older than 3 minutes. All such blocks are removed from the variable created during the previous iteration. After this, we will only have unaccepted, or pending requests left in the variable. All such rides are shown to the driver and sorted in the Estimated Time to reach the location for the driver and are shown to the driver. Once the Ride is Accepted by the driver, the request will be added to the second blockchain, and both rider and driver will be redirected to 1 on 1 chat window. Where they can share their details such as Phone Numbers, or other information. About the Communication between Rider and Driver is further discussed in the Communication section of this paper.

4.4 Fare Price Calculation

For a Decentralized Car Hailing System [2], it is important to have an Algorithm that takes into consideration various factors for Fare Calculation. As most of the drivers use CNG as a preferred Gas Medium due to the less cost compared to Diesel and Petrol. The Pricing will be calculated based on the Current Price of CNG. An API call will be used to fetch daily CNG Prices in respective Cities and States and further will be used for Fare Calculation. A CNG vehicle has an average Milage of 25-30 Km per Kg. Therefore, the algorithm will consider the lower limit i.e., 25 Km per Kg for Fare Calculation.

As per online articles from Hindustan Time, Financial Express, and Factory Daily Existing Market Leaders like OLA and Uber used to have a good share for drivers, where drivers can earn a gross income of 88,000 to 100,000 per month but eventually, this has reduced to 25,000 to 35,000 in recent days. From an article by Entrackr, driver claims to earn Rs 7 per Km which is lower the traditional taxi services.

Considering the facts based on Articles and Research [4], Algorithm will charge a base fare of 100 Rs for Rides less than or equal to 5 Km and above which the Driver can earn a fee of Rs 11 per Km excluding the Gas Price which will be added to the fare. The fare is calculated to provide a better experience to both the Drivers and Users. Make sure the Driver is earning a good amount for living, as well as making it affordable for a user. The Base Fare is kept at 100 Rs considering the distance driver would have to travel to reach the Pick-up Location.

An extra fare will be added in the case of Toll-Tax.

Suppose a ride of 20Km is assigned to a driver, the fare will be Rs 100 (Base Fare of 5 Km) + Rs 165 (Drivers Profit for other 15 Km @ Rs 11 per Km) + CNG Price Rs 56 (Calculated @CNG Price of Rs 70 Per Kg and Car Mileage @25 Km Per Kg) which results in Total of Rs 321 which is comparatively better than current Market Price for a similar distance as well as gives a much better return to Driver.

Algorithm 1: Fare Calculation Algorithm

Input: Pick-up Location, Destination Location

Output: Origin, Destination, Total Distance, Est. Travel Time, Total Fare

1. variable CNG Price = CNG Price API (Pass = Pick-up Location)

2. variable Travel Time, Total Distance = Google Distance Matrix API (Pass = Pick-up Location, Destination Location)

3. variable Base Fare = 100

4. variable CNG Cost = (Total Distance / Car Milage assumed = 25) * CNG Price

5. variable Driver Profit = Total Distance * Profit Per Kilo assumed = 11

6. variable Total Fare = Base Fare + CNG Cost + Driver Profit

4.5 Communication

As we see in the existing Cab Hailing Application there is a mechanism like sharing phone numbers and creating a private chat room. This functionality can be easily achieved using a Database over a secured channel. But for the decentralized application, we can't have a database to store user details. Therefore, we have to come up with a new innovative model that can be used to create a communication between Rider and Driver once the ride is confirmed.

When a ride is confirmed, it is a necessary step to establish communication between driver and rider. This can be a challenging step when it comes to Decentralized Applications. This application will be using a temporary room-based chat. No database will be kept to store the chat, rather it will be saved in the browser itself and will be cleared when the ride is completed.

We can use a chat application using socket.io which is used to establish a connection between driver and user over a private room. The private chat room can be created using a common feature or ID which can be accessed by both Rider and Driver, both can use the private chat to share communication details, share live location, or other necessary information.

5. FUTURE SCOPE

There is always a scope for Improvement, there are still a few things that should be taken care of to make the application more secure, reliable and user friendly. Below are few of the topics which can be integrated and worked upon in the existing model to make it more reliable.

1. OTP System: A “One time password” is a unique passcode that the rider will receive after booking the ride. The rider will have to share the OTP with the driver and the driver will have to enter the OTP accurately before starting the ride. This will make sure that the right customer is with the right driver. This is good for safety and a big convenience for any further mix-ups. Frequently, a traveler may hire a cab and board the incorrect cab, particularly at congested locations like airports, railway stations, etc. where such mix-ups could happen and cause major issues. The OTP system guarantees that the correct person is transported to the correct location [6].

2. Tolls and Tax: There are many additional charges on a ride like tolls, MCD Tax,

Airport Surcharge, and other minor charges. All these charges will be included in the trip automatically with the total fare which will ease the trip. It will prevent any sort of misunderstanding or last-minute mix-ups. The additional charges vary by location.

3. Sorting nearby drivers: From the passenger's location point of view, the driver's location should be nearer [3]. So, there is an opportunity to build a location sorting function that can sort the nearest driver location and connect that driver with the passenger. This can effectively save the cost of the driver for picking up a passenger and the waiting time of the passenger is also reduced.

4. Live Location Sharing: The Live Location function enables users to share their current location with someone. We can use this to track the driver's location and then show it to the passenger. We can also use this as a safety measurement and share passengers' locations with their trusted ones.

5. Accuracy in Pricing: By Identifying the model, year, condition, and the things which affect the mileage of a car and adding the data for the calculation. We can have more accurate pricing by this method and due to the transparency in pricing, the driver gets the fair compensation in price value and the passenger gets the fair price for the ride.

6. CONCLUSIONS

This paper provides a framework for developing a decentralized ride-hailing system that acts as an intermediary between drivers and passengers.

Excessive transaction costs will be eliminated, censorship will be reduced, and value will be redistributed to the community while transparency is improved. A zero-commission arrangement results in higher earnings for drivers, who can then pass on part of these savings to customers who save money on commuting. As a result, the platform evolves into one that pays drivers well and offers good fare rides to passengers.

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. All of these problems can be solved with blockchain-based solutions, which provide more innovative functionality with greater simplicity of use and control. Riders may communicate directly with drivers via the blockchain's decentralized network, minimizing the cost of extra services. As a consequence, the system acquires trust and transparency by consistently providing appropriate prices.

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