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Peer to Peer Carpooling Using Blockchain

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Abstract : Using blockchain to enable peer-to-peer ridesharing between people eliminates the need for middlemen, which is a revolutionary idea. A decentralized, safe carpooling system is suggested in this paper using the blockchain. The suggested approach eliminates the need for a centralized authority by using smart contracts to fully automate the process, from ride matching to payment settlement. To encourage members to act honourably, the system also includes reputation rating.In order to stop any malicious conduct, the blockchain technology assures the security, transparency, and immutability of data. The system being proposed has the potential to lessen travel expenses,carbon emissions, and traffic congestion. It also improves community building and social interaction.

KeyWords- Carpooling, Blockchain, DApp, Ethereum, Smart contract, Shared Economy.

I. INTRODUCTION

1.1 BACKGROUND:

For past number of decades, Blockchain has transformed all significant industries with unique qualities, not only the financial sectors. Scientists are attempting to examine the issues where blockchain can help and offer first-rate services. The following are some key industries where blockchain is already making progress: energy,governance, insurance, healthcare, and crowdsourcing. The sharing economy has grown exponentially during the last few years. For instance, Ola, Uber, Airbnb, and Lyft will all experience this. It allowed users to lend their resources to people who needed them but lacked them. Sharing resources will cut down on waste and encourage a lot of participation.The majority of sharing economy application transactions, however, take place on a centralised platform with the 3rd party. Payments or the exchange of knowledge are both considered transactions. A centralised system for conducting business is more vulnerable to dangers like password intrusions and the misuse of client data, and its upkeep is more expensive and labor-intensive. Shared transportation services, such as taxi rides, can be one of the topo producers of sharing economy goods and services.. At the moment, ridesharing systems are being led by Uber, Ola, and Lyft. A centralised strategy is employed by almost all ridesharing programmes. However, there are many drawbacks to having a centralised system for ridesharing services, like surge fees, convenience fees, GST, payment gateway fees, etc. Better methods are therefore required. A decentralised, p2p approach to the ride-sharing process is one way to get around the drawbacks of the centralised system.With the help of this article, readers will gain a greater grasp of blockchain technology and learn how to incorporate it into their business plans . The paper modestly assests to contibutions.

1.2 BLOCKCHAIN:

Blockchain is a p2p shared ledger system that evolved from Satoshi Nakamoto's 2008 cryptocurrency Bitcoin. Blockchain's unique qualities, including distributed, decentralised, unchangeable, secured, and shared, are the primary reasonsfor its resounding success. Anybody on the network can see and verify every transaction that has been recorded in the blockchain. Since blockchain operates on a peer-to-peer (P2P) paradigm, middlemen are not required. A smart city that adopts blockchain technology stands to gain a number of advantages, including automation, security, transparency, and trustlessness. A smart city uses information and communication technology to raise living standards and foster a sustainable environment.

1.3 SMART CONTRACT:

A cryptographic bundle called a "smart contract" built on the Ethereum blockchain accepts and processes inputs informationthat both outputs and saves. Only under certain specific circumstances is the output accessible to the general public. In their Secure Smart Contract study, Kevin Delmolino et al. provided a step-by-step breakdown of the implementation process for smart contracts. During compilation time, the smart contracts produce bytecode, which is then recorded in blockchain. These byte codes are executed by the EVM, which is present in each network node.

1.4 DECENTRALIZED APPLICATION:

DApps have a two-tier design, with the front-end client-side application making up one tier and the back-end server-side tier, where the smart contract for the blockchain network is installed, making up the other. The interaction between a client-side application and a server-side application is shown in Figure 1. below, along with the overall architecture of the decentralised application. The following portions of this article detail the technologies that were utilised to create the ridesharing Dapp. Any DApp has a backend and a frontend application, as was already established. The backend code of a

DApp is distributed across a decentralised peer-to-peer network, in contrast to centralised apps, which operate on centralised servers. Any language may be used to create a DApp's front-end code, and API calls may be made to the back end.UsingEthereum blockchain-based platform to establish a DApp development platform and a Turing complete language for authoring smart contracts. Solidity is the official programming language for creating DApps on the Ethereum network. The Ethereum Truffle suite was utilised in this project to create and implement smart contracts. Tulpa suite The Truffle suite includes a number of essential building blocks for creating Dapps. It makes it easier to create, compile, deploy, and test smart contracts. Additionally, it enables front-end user interface development for Dapps. The Truffle framework is the main building block of the Truffle suite and is where smart contracts are developed, deployed, and tested. 2. Ganache, a simulator used to test and develop the Dapp's Graphical User Interface (GUI).

II. EXISTING SYSTEMS

A. Pricing Let's look at Uber and Ola, which provide services for user-driver transactions. They assist the clients in making a secure payment and giving them freedom when it comes to selecting taxis and other services while travelling. This makes the consumer and the driver dependent on one another and helps the middlemen raise their fees. According to [12], these intermediaries charge clients 10–20% more than what is really charged.

B. Security and Privacy Uber even makes use of algorithmic predictions to determine how much users are ready to pay for additional services, which is a serious security risk. Additionally, storing all consumer information on centralised systems opens the door to multiple cyber assaults.

C. Transparency Issues Most of these ride-sharing businesses use escalating pricing models, where they may charge clients more, particularly in major cities, depending on demand. Most clients are unaware of how these activities are conducted. Between clients and organisations, there is no transparency.

D. Safety requirements is now the biggest problem that users of Uber, Ola, or any other riding platform encounter. Both the driver's and the passengers' safety are in jeopardy. Despite investing a sizable sum in background check procedures, this issue still exists.

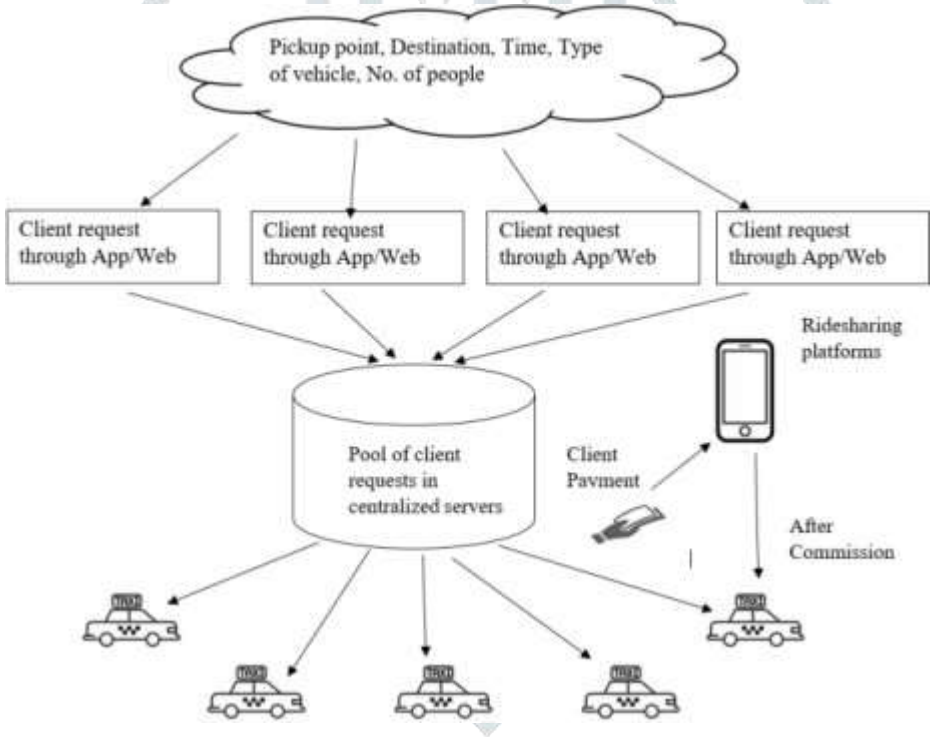

Fig. 1 Existing System of P2P Carpooling

2.1 DECENTRALIZED BLOCKCHAIN

To fix the centralised model's aforementioned problems. It is advised to take a decentralised strategy. As far as we are aware, blockchain is a peer-to-peer decentralised public ledger that enables transactions to take place without the use of middlemen. Additionally, every transaction on a blockchain network is safe, transparent, and immutable. Therefore, implementing blockchain in ridesharing services eliminates the middleman and reduces the cost of transactions between consumers and drivers. As a result, more users sign up and gain financial gain. Applying blockchain technology to ridesharing services would get us closer to the idea of a smart city, according to S. E. Chang et al. in their paper "Application of Blockchain Technology to Smart City Service." This is because it integrates the technology into the city and adds many social elements for clients.for the effective use of resources, the delivery of high-quality services, and the enhancement of public quality of life. Following is a summary of some advantages that blockchain technology offers over a centralised model:

A. Less Cost: According to reports, blockchain eliminates the middleman in the information flow, significantly reducing

transaction costs. Additionally, it gives users the ability to trust blockchain data over that of an unidentified third party.

B. Transparency: Even though Blockchain allows for anonymity, it also makes transactions transparent. As a result, in the event that something goes wrong, it is always feasible to go back to the information.

C. Safety: All data on the blockchain are cryptographically safeguarded, ensuring data authenticity. Any false data transmitted via the network is not feasible.

D. Transparent network: The blockchain makes the data visible across the network so that the parties conducting the raid can see each other clearly.

E. Safe Payments: Using smart contracts, another distinctive aspect of blockchain, users will be able to send a secure payment straight to the drivers.

III. PROPOSED SYSTEM

Based on an existing architecture, a decentralised P2P system employing blockchain is presented. A decentralised Ethereum blockchain is used as the foundation of a decentralised application (DApp), which will serve as the front-end interface. According to this structure, the user and the driver are both properly identified and registered in the blockchain network. Each of their profiles has this meta-data information connected to it, which any node in the network may see. As a part of this framework, three user roles were created: the driver, the user, and various legal authorities for verification. The workflow is described below.

1. The driver registers with the network and uploads his driver's licence and other required papers. The hashed value is kept in the MongoDB database, which is employed as a storage method in blockchain.Once the motorist provides the information, the legal authorities, who are also a part of the network, will be contacted. The notes will be posted to the driver's profile when the background check is completed. The review or ratings of the driver are produced by a smart contract, on the basis of which the passenger chooses whether to travel with the driver.
2. Users who wish to ride should register with the network similarly by providing certain necessary details like name, phone, etc., and background checks. This assures the safety of drivers.
3. Once the user's identity has been verified, the user can order cabs by entering his or her location and other trip information. In these situations, the driver estimates the cost of the trip based on the users' request and a number of factors, including the distance to be travelled, the kind of vehicle, and a set fee per kilometre.
4. The rider may now select the vehicle that best suits their needs.
5. Payment may be sent automatically as cryptocurrency payments from one wallet to another when the journey is over data flow diagram

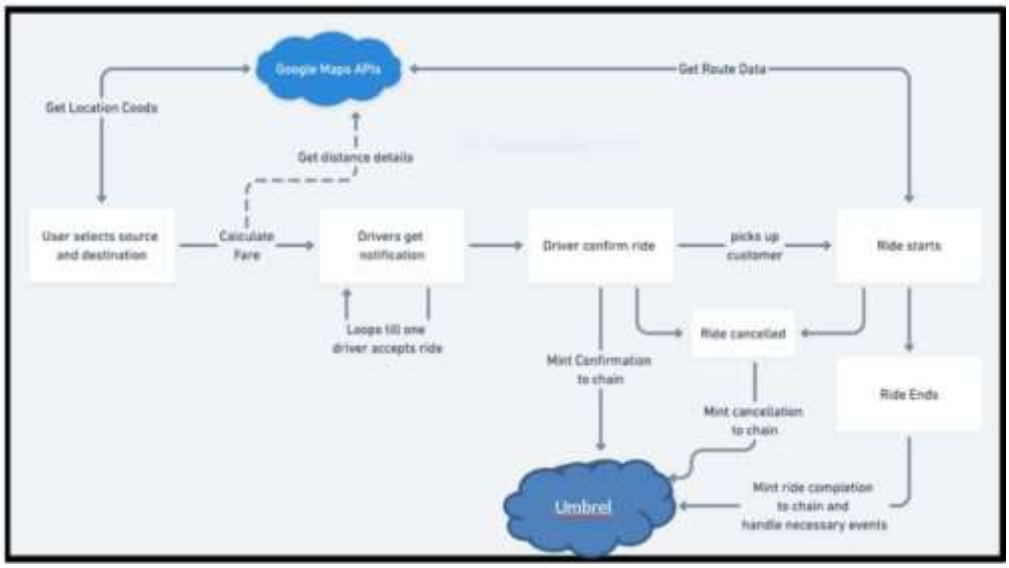

Fig.2 DATAFLOW DIAGRAM OF P2P CARPOOLING USING BLOCKCHAIN

IV. IMPLEMENTATION

4.1 ENVIRONMENTAL SETUP

Umbrel:

Umbrel is a operating system as well as a services dashboard that is a good start for someone interested in self-hosting. It has a nice web GUI and enables easy installation of containerized web services with a one-click install. Umbrel is a commonly used software for running a bitcoin lightning node on a Raspberry Pi. It means users can run their own node without using up space on their main computer while leaving the Pi on permanently if they so wish. Until the latest upgrade it offered a few bitcoin-related apps, including support for running a block explorer using data from the node and lightning-dedicated apps.

Lightning node:

A Lightning Network node has two responsibilities.Monitor the underlying blockchain (bitcoin) Interact with other Lightning Network nodes to transactmoney. Every Lightning Network node must monitor the blockchain(s)that it holds tokens on. When talking about the Lightning Network, most people implicitly mean “The Lightning Networkrunning on top of the bitcoin blockchain.” What they leave outis the fact that the Lightning network can run on top of multiple blockchains. We will leave the details of how this canbe done for a future blog post.

Bitcoin Node:

In the Bitcoin network, nodes fulfill a very important role. A node is a computer connected to other computers which follows rules and shares information. A 'full node' is a computer in Bitcoin's peer-to-peer network which hosts and synchronises a copy of the entire Bitcoin blockchain Nodes are essential for keeping a cryptocurrency networkrunning.

CryptoWallet:

Cryptocurrency wallets store users' public and private keys, while providing an easy-to-use interface to manage crypto balances. They also support cryptocurrency transfers through the blockchain. Some wallets even allow users to perform certainactions with their crypto assets, such as buying and selling or interacting with decentralized applications (dapps). It is important to remember that cryptocurrency transactions do not represent a 'sending' of crypto tokens from a person's mobile phone to someone else's mobile phone. When sending tokens, a user's private key signs the transaction and broadcasts it to the blockchain network. The network then includes the transaction to reflect the updated balance in both the sender's and recipient's address. So, the term 'wallet' is somewhat of a misnomer, as crypto wallets don't actually store cryptocurrency in the same way physical wallets hold cash. Instead, they read the public ledger to show the balances in a user's addresses, as well as hold the private keys that enable the user to make transactions.

WEB FRONT END

HTML/CSS/JAVASCRIPT

4.2 PROCESS FLOW OF CARPOOLING

DApp We utilise the local Ethereum framework, MetaMask, Web3js, Nodejs, and MongoDB to create the prototype of the proposed framework. The rider and the driver are the two different types of stakeholders for this DApp. Each user has a unique set of roles and responsibilities, which are provided through several DApp dashboards. When a user detail is input, the information is stored in MongoDB and the credential's metadata is published into the blockchain. The Driver Dashboard displays the user's pick-up and drop details, the ride fare, and the payment status. The Rider Dashboard displays the same information. The DApp has a front end and a decentralised platform at its core.

4.3 RIDE MATCHING PROBLEMS

The ride-matching issue is one of the P2P ridesharing system's main issues. A defining feature of every ridesharing system is its capacity to match drivers with customers in the most effective way. Any adaptable ridesharing system must be ready to offer the best answer to ride-matching issues. Several techniques, including dynamic programming, greedy heuristic optimisation, meta-heuristic optimisation, exact formulation and heuristic solution, and exact formulation and heuristic solution, provide the best answer for ride-matching. In order to reduce overall journey distance, the DApp matches riders who seek ridesharing using a minimum matching algorithm.

4.4 MATCHING ALGORITHM

In mathematics, specifically in graph theory, the idea of matching is present. In an undirected graph, matching is a collection of edges without any shared vertices. An undirected network with the nodes representing the passengers and the edges representing their shared plan is created for this ride-sharing challenge. Finding the optimal sharing plan with the least amount of total distance is attainable using a maximum matching with minimum weight method. Different situations are used to create the algorithm that determines the distance between every two passengers.

4.5 MINIMUM MATCHING

Once the weights of the edges are established, a full graph is created to represent passengers and the best manner for them to be pooled together. contains the minimal matching algorithm's pseudocode. Below is a diagram that illustrates how passengers are matched for ridesharing using one of the situations stated . The four passengers, A, B, C, and D, each have a weight allocated to them. The approach of pooling is used to identify the edges. The best matches for all passengers with the lowest combined weight are pairs A and D

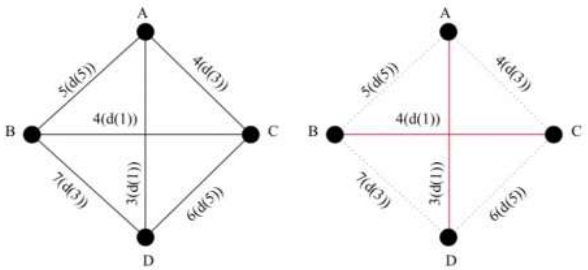

Fig.3 MATCHING ALGORITHM

V. CONCLUSION

This is to examine the cutting-edge shared economy technology Blockchain and how it fits within the concept of a smart city. The existing foundation for decentralised, peer-to-peer, blockchain-based ridesharing services is presented in this article, along with a suggestion for an enhanced version of the same. Further, a decentralised application (DApp) is created to enable this ridesharing architecture. It will serve as a front-end user interface with blockchain assistance. In this DApp, transactions and data exchange throughout the network are automated using smart contracts on Ethereum, a permissionless public blockchain. In conclusion, smart contracts embedded in digital code may be maintained in decentralised and transparent databases using blockchain technology. These databases' data are thought to be changeable. It is envisioned that every procedure and job would have a digital record that can be recognised and verified using a digital signature. There won't be a need for middlemen in our ecosystem. In fact, blockchain transforms governance and business paradigms, but this won't happen for many years. Blockchain is not a disruptive technology that aims to replace existing business models with less expensive ones. Instead, it might be viewed as a pillar of technology that can build new

structures for dealing with economic and social problems. Blockchain is not a quick fix for an everyday technology issue. Although it might ease the transition, a detailed strategy based on possibilities that have been proven to exist to be published. It will take decades for blockchain to permeate our socioeconomic infrastructure, despite the fact that it will have a significant impact. Acceptance will be gradual and steady rather than dramatic as waves of technical and structural change advance.

VI. ACKNOWLEDGEMENT

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