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SUSTAINABLE TRAFFIC MANAGEMENT APPROACH: EVALUATING THE EFFECTIVENESS OF PADAAV FOR PARKING PRICE PREDICTION

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Abstract:
The objective of this study is to assess the effectiveness of the Parking Price Prediction based on the PADaaV framework for sustainable traffic management. This will involve evaluating the model's accuracy and its potential to optimize parking pricing strategies in urban areas. The title "A Sustainable Traffic Management Approach: Evaluating the Effectiveness of PADaaV for Parking Price Prediction" suggests a focus on developing environmentally friendly and efficient traffic management solutions. The PADaaV framework refers to a method or algorithm designed for predicting parking prices, which is vital for improving urban traffic flow and reducing congestion. Historically, parking management relied on static pricing models and manual monitoring to gauge demand, leading to inefficient use of resources. Traditional systems often involved physical signage for price changes and limited data collection, resulting in suboptimal pricing strategies Before the integration of machine learning and AI, traditional traffic management systems relied on manual data collection and analysis, often using paper-based methods for monitoring parking demand. Parking prices were typically set based on fixed schedules and did not account for real-time demand fluctuations.

Keywords: Traffic Congestion, PADaaV, Block Chian, Smart Contracts.

1.INTRODUCTION

India is experiencing rapid urbanization, leading to a surge in vehicle ownership. With over 295 million registered vehicles in 2019 and an annual growth rate of 9-10%, major metropolitan cities face severe parking shortages. Studies indicate that 30% of urban congestion is caused by vehicles searching for parking spaces. Traditional parking systems are centralized, inefficient, and prone to price manipulation and lack of transparency. The PADaaV model integrates Blockchain technology to create a decentralized, fair, and secure parking price prediction system using a second-highest bid auction mechanism. Before the adoption of AI and Blockchain, parking management relied on manual and centralized systems, which had significant drawbacks. Traditionally, parking slots were allocated through manual attendants, fixed pricing models, or centralized online booking systems, each with its own inefficiencies.

Parking management is crucial for traffic regulation and urban planning. Traditional centralized models lead to high costs, inefficient allocation, and security issues. The PADaaV system introduces Blockchain-based decentralized pricing, ensuring fair, tamper-proof, and secure parking transactions. This solution is beneficial for smart cities, commercial parking lots, and urban traffic management. Traditional parking systems are prone to high costs, inefficiency, and manipulation. Centralized models allow favoritism, where parking spaces are allocated to the highest bidder, leading to overpriced parking for users. Data tampering risks exist as administrators can manipulate parking records. Lack of dynamic pricing results in inefficient space utilization, causing congestion. Traffic and environmental pollution increase due to vehicles searching for parking slots for extended periods.

2.LITERATURE SURVEY

Traffic management is one of the challenging tasks that need to be controlled efficiently. It is necessary to regulate the flow of traffic for sustainable traffic management. Traffic congestion is the main reason that it is getting difficult day by day for the drivers to find an empty parking slot, especially during peak hours (1). There are many research studies conducted (2) (3), which state that vehicles looking for free parking slots include approximately 8% of traffic. The survey data of 2013 and 2015 states that on-street parking price on weekdays has increased from 2.00 USD to 4.40 USD per hour (10). Many researchers worldwide discussed the various parking price prediction schemes. Still, with the help of a centralized authority, which is vulnerable to various security issues such as data modification, spoofing, Man-inthe-middle (MitM) attack, etc. (11). Centralized authority can charge high parking prices to allocate a parking slot for users for their benefit (12). These issues can deviate users from utilizing the parking slots leading to the loss of parking slot owners. It is necessary to ensure security, privacy, and transparency users can book the parking slot at the optimum price.

The PADaaV model introduces a Blockchain-based decentralized system for parking price prediction, ensuring fair, tamper-proof, and efficient allocation.

Many researchers discussed the blockchain-based system to mitigate the security and privacy issues of the centralized authority. Some of the works are: Chai et al. (16) proposed a consortium-based blockchain model for resource sharing on the internet of vehicles using a consensus mechanism to ensure security in the system. Later, Syed et(17) presented a blockchain-based framework for vehicle tracking integrated with IoT devices. Authors in (15) presented a blockchain-based layered architecture for a smart parking system to establish trust between users. Then, Hassija et al.

(12) proposed a distributed parking slot allocation framework based on virtual voting and an adaptive pricing algorithm to allocate the parking slot for users in an optimal way. Later, Jog et al. (23) discussed a smart parking technology and automated parking to allocate parking space for users using different technologies such as wireless sensors networks, RFID technology, etc. Then, Simhon et al. (14) proposed a smart parking pricing system to predict the occupancy rate of a parking area using a machine learning approach. Peyal et al. in (19) proposed a smart car parking system in urban areas with the help of IoT. The main focus is to reduce traffic congestion and make parking easy for users. Table 1 shows the comparative analysis of various state-ofthe-art parking price prediction schemes with the PADaaV PADaaV with or without blockchain. Some of the solutions in (15) (16) (17) (19) given by the researchers are only focusing on enhancing the security of the system.Huang et al. (2020) [5] Huang et al. introduced Clinical BERT, a transformer-based model designed to analyse clinical notes and predict hospital readmissions. By incorporating natural language processing (NLP) with deep learning, Clinical BERT improved the interpretation of unstructured clinical data. This study highlights the potential of combining NLP techniques with predictive modelling to enhance the accuracy and effectiveness of readmission predictions.

Emphasize optimizing the parking price for users, they are not focus motivated by this, we propose a secure blockchain-based parking price prediction scheme using a second price auction model for sustainable traffic management. The second price auction model optimizes the price for users so that users who booked parking slots with the highest price. The integrated IPFS with the proposed scheme mitigates and prevents the issues of the block chain, which further enhances the scalability and reduce The computation time and data storage cost of the system. So, users can book the parking slot at the optimized price. Reducing traffic congestion, and parking slot owners can also benefit from it.

Drivers spend approximately3.5 to 14 minutes to find an empty slot (4) (5). Even in developing countries, many types of fatal accidents are caused due to traffic congestion (6) (7). There are various studies on vehicle parking prices, and they have shown that the vehicle pays approximately 5 dollars or more, which is a huge amount of total travel cost (8) (9).

The main focus is to reduce traffic congestion and make parking easy for users. Table shows the comparative analysis of various state-of the-

Blockchain-based decentralization eliminates the risks of single-point failure and data tampering. The second-highest bid auction system ensures fair pricing, reducing parking costs for users while increasing revenue for owners. Secure, tamper-proof storage using IPFS and Blockchain enhances data integrity and transparency. The implementation of smart contracts automates transactions, reducing manual errors and favoritism. This approach supports sustainable traffic management by optimizing parking slot allocation.

Tonelli et al. (2015) [11] Tonelli et al. outlined methods for identifying chronic conditions using administrative data, which is vital for accurate predictive analytics. Their studyemphasized the importance of accurate chronic condition identification for risk assessment and management. By improving the methodologies for chronic condition detection, their work contributes to more effective predictive models and enhanced patient care that is to be provided for the customer for it's parking slot.

3. PROPOSED METHODOLOGY

To begin blockchain development, first, understand its fundamentals, including decentralization, consensus mechanisms (Proof of Work, Proof of Stake), and smart contracts. Choose a blockchain platform like Ethereum, Hyperledger, or Binance Smart Chain based on your use case. Set up a development environment with tools like Solidity (for Ethereum smart contracts), Web3.js, and Truffle. Learn how to create and deploy smart contracts, set up a blockchain node, and interact with decentralized applications (DApps). Finally, practice by developing a simple blockchain-based project to gain hands-on experience. Traditionally, systems rely on centralized servers where a single entity manages and controls data, leading to potential security risks, single points of failure, and lack of transparency. Centralized systems are efficient but pose risks such as data manipulation, privacy concerns, and vulnerability to cyberattacks.

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The proposed methodology typically includes the following key components: Like RFC, ETC uses the entire dataset without bootstrapping (i.e., without resampling the data). Instead, each tree uses the full dataset or a random subset.

In this research, blockchain is used to provide a **secure, transparent, And efficient** framework for data change, making it ideal for applications such as cost storage, for financial transactions, and **Identify verification or supply chain management.** The proposed system enhances performance by integrating optimizing census mechanism and smart contracts for automation, ensuring real-time execution with minimum computational overhead. Decentralized, secure, and transparent network.

By utilizing a distributed ledger, all transactions are recorded immutably, ensuring data integrity trust. Smart contracts automate processes, eliminating intermediaries and reducing costs. The proposed system enhances security through crypto graphic techniques and consensus algorithms, preventing fraud and unauthorized access and reducing reliance on a central authority. Conduct initial testing for performance and security vulnerabilities. Test with a private test to identify the vulnerabilities and optimize the scalability before deployment on a main net or enterprise the block chain development for the need of customer.

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Evaluating blockchain performance involves measuring key metrics like transaction speed, scalability, security, and energy efficiency. Factors such as consensus mechanisms (e.g., PoW vs. PoS), network latency, and block size affect performance. Layer-2 solutions like sidechains and sharding help enhance scalability. Benchmarking tools like Hyperledger Caliper assess throughput and latency. Optimizing smart contracts and network infrastructure further improves blockchain efficiency. A well- designed blockchain system balances decentralization, security, and performance to ensure practical adoption in real-world applications.

Advantages:

The ETC (Extra Tree Classifier) algorithm is commonly used in multi- armed bandit problems and online learning settings. Here are some advantages of the ETC algorithm:

Security& Integrity – Cryptographic encryption ensures data security.

Decentralization – Eliminates intermediaries, reducing costs.

Transparency – Transactions are visible to authorized participants.

Immutability – Prevents unauthorized alterations.

Efficiency – Reduces processing time using automated smart contracts.

Robustness: The added randomness often leads to better generalization on unseen data, making ETC robust in various scenarios.

Faster Predictions: ETC can be faster in both training and prediction phases compared to RFC due to its simplified split selection process.

Blockchain is a **decentralized, distributed ledger** technology that records transactions across multiple nodes in a secure, tamper-proof manner. It eliminates the need for a central authority, ensuring **transparency, security, and immutability**. Transactions are stored in blocks, cryptographically linked to form a chain, making it resistant to data manipulation.

Proposed Algorithm and Architecture

The proposed blockchain system follows a structured algorithm for transaction processing:

Transaction Initiation – A user generates a transaction request containing necessary data (e.g., sender, receiver, amount, timestamp).

Transaction Verification – Network nodes validate the transaction using cryptographic consensus mechanisms like **Proof of Work (PoW)** or **Proof of Stake (PoS)**.

Consensus Mechanism – The network reaches an agreement on the validity of the new block.

Block creation- Verified transactions are grouped into block.

Block Addition to the Chain – The new block is cryptographically linked to the previous block.

Distributed Ledger Update – All nodes update their copies of the blockchain.

Centralized Online Parking System- Digital booking platforms for automation but the centralized storage.

Corruption & Favouritism in Manual Parking - Parking attendants often reserved spaces for specific customers, causing bias in allocation.

Finalization and Immutability – Once confirmed, transactions cannot be altered.

4. EXPERIMENTAL ANALYSIS

The core of the system is a **smart contract** deployed on an Ethereum-based blockchain (Ganache, Truffle, or Ropsten). The contract automates the auction process. The core of the system is a smart contract deployed on a Ethereum based block chain. The contract automates the auction process.

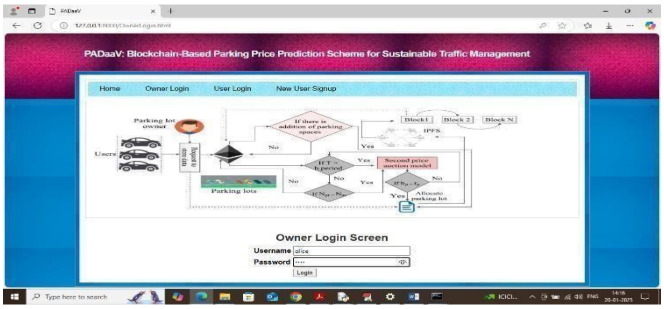

Figure 1: Uploaded the Dataset

In above screen sign up details saved in Blockchain and then I am displaying entire log obtained from Blockchain which contains details

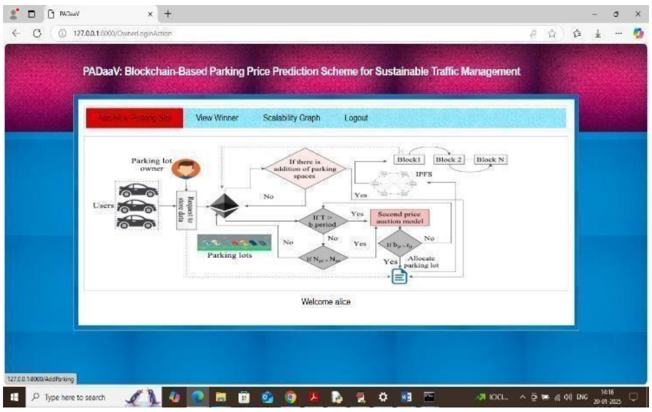

Figure 2: Home Page

Price prediction will get won. Now click on 'Owner Login' link to get below page. In above screen auction details saved in IPFS and its hash code saved in Blockchain and similarly you can add as many auction as you want. Now click on 'Scalability Graph' link to get below storage comparison of the required storage of the blockchain usage.

Figure 3 shows that the dataset has been split into training and testing sets, with 142,656 samples for training and 35,664 samples for testing, maintaining an 80:20 split. Each sample contains 49 features, meaning model will learn from 49 input variables. The corresponding target labels (Y-train and Y-test) are single-column vectors, a single-output prediction task.

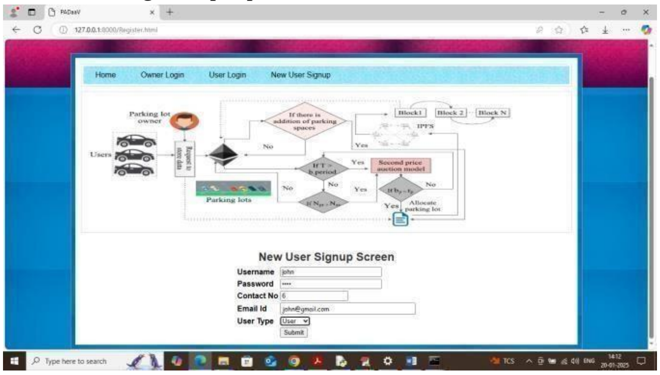

Figure 3: Classification report of RFC

In above screen user sign up completed and similarly add multiple users so bidding can be done for various prices and then second highest price prediction will get won. Now click on 'Owner Login' link to get below page

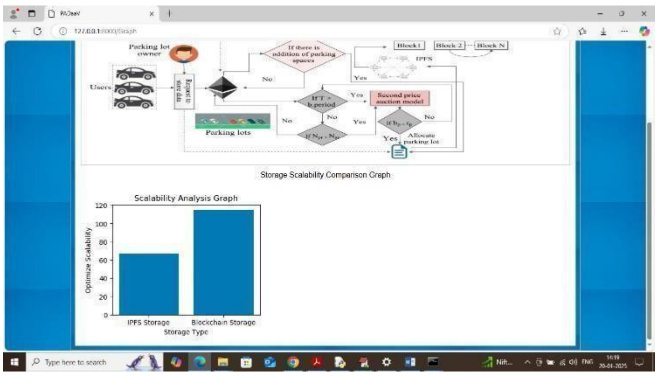

Figure 4: Classification report of ETC

Figure 4 displays a image showing a confusion matrix for an Extra Trees Classifier model. The matrix displays the performance of the model in predicting three classes: "admitted after 30 days," "admitted within 30 days," and "not admitted."

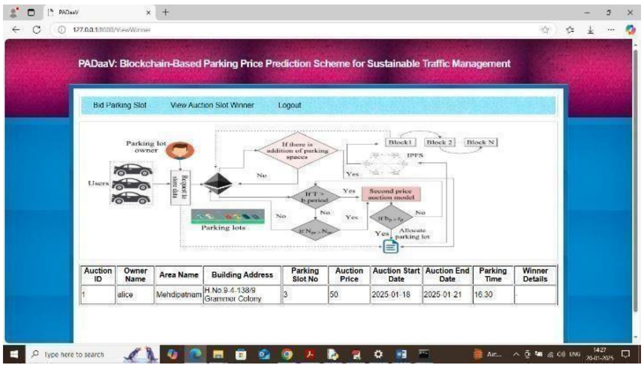

Figure 6: Predicted Output

5. CONCLUSION

The Blockchain-Based Parking Slot Auction System presents an innovative, decentralized approach to managing urban parking spaces efficiently. By leveraging Ethereum smart contracts, the system ensures transparency, security, and fairness in parking slot allocation through an auction mechanism. The integration of IPFS for decentralized metadata storage and PostgreSQL for auxiliary data makes the system scalable and efficient. One of the primary advantages of this system is its tamper-proof nature, ensuring that all transactions, including bids and payments, are securely recorded on the blockchain.

This prevents fraudulent activities and unauthorized modifications. Smart contracts automate the bidding and payment process, eliminating the need for intermediaries and reducing operational costs. The system enhances the user experience by allowing real-time bidding, secure payments, and instant booking confirmations. The decentralized nature of the system ensures that parking slot owners get the best price through fair competition, while drivers gain access to available slots without manual searching.

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In above screen auction details saved in IPFS and its hash code in similarly you can add as many auction as you want. Now hover the and decision click on 'Scalability Graph' link to get below it's storage.

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