JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Vehicle Registration Using Blockchain Technology

[1]Dr. Preeti Bailke, [2]Arpit Patil, [3]Saloni Khedekar, [4]Rahul Dound, [5]Omkar Vyavahare

[1]Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Department of Information and Technology,
[1]Vishwakarma Institute of Technology, Pune, India

Abstract: The act of registering automobiles is crucial for ensuring the security and legitimacy of the vehicles on the road. However, the existing method of registering vehicles is frequently prone to mistakes, which can cause serious issues. Blockchain technology has recently come to light as a potential answer to these problems, providing a secure and open platform for automobile registration. This study thoroughly examines the possible advantages and difficulties of applying blockchain technology to automobile registration. It examines the technological requirements for implementing a blockchain-based automobile registration system and the infrastructure and regulatory issues that must be resolved. The article also includes case studies of actual blockchain-based car deployments.

I.INTRODUCTION

Vehicle registration is an essential process that enables governments to regulate and monitor the use of vehicles on the road. It helps ensure that vehicles are safe and legally compliant and provides an essential tool for law enforcement and insurance companies. However, the current vehicle registration process is often plagued by inefficiencies, errors, and fraud, which can lead to significant problems for both vehicle owners and governments.

In recent years, blockchain technology has emerged as a potential solution to these challenges, offering a tamper-proof and transparent platform for vehicle registration. Blockchain technology allows for the creation of a decentralized database that can securely and transparently store information related to vehicle registration, ownership, insurance, and service history. By using blockchain technology, vehicle registration can become more secure, efficient, and transparent.

This research paper aims to provide an in-depth analysis of the potential benefits and challenges of using blockchain technology for vehicle registration. The paper will explore the technical aspects of implementing a blockchain-based vehicle registration system, as well as the regulatory and infrastructure challenges that need to be addressed. The paper will also provide case studies of real-world implementations of blockchain-based vehicle registration systems, including the Dubai Smart Vehicle Project and the Estonian government's vehicle registration system.

The paper will begin by providing a brief overview of the current vehicle registration process and the challenges that it faces. It will then introduce blockchain technology and its potential for vehicle registration. The paper will also discuss the key technical features of blockchain technology, including immutability, decentralization, and transparency. The research paper will then provide an in-depth analysis of the potential benefits and challenges of using blockchain technology for vehicle registration. It will explore the benefits of increased security, reduced fraud, improved efficiency, and enhanced transparency, as well as the challenges of regulatory compliance, scalability, and the need for robust IT infrastructure.

This research paper will analyze and present real-world examples of blockchain-based vehicle registration systems, such as the Dubai Smart Vehicle Project and the Estonian government's registration system. By examining these case studies, the paper aims to offer a thorough understanding of the benefits and challenges associated with utilizing blockchain technology for vehicle registration. The findings will serve as a valuable resource for researchers, practitioners, and policymakers interested in this field, providing them with comprehensive insights into the potential of blockchain technology and the key considerations for successful implementation.

II.LITERATURE REVIEW

[1] V. Sanepara, D. Savani, S. Khokhariya, J. Shah, K. Desai, H. Chaudhari, and J. Chaudhary in their proposed paper aims to solve the underlying problems in the vehicle registration system by integrating blockchain technology. By bringing all the different agencies related to vehicles under one portal and connecting them through blockchain technology, the system becomes more reliable and efficient. Moreover, every transaction logs with a timestamp would be available, making it easier to trace back any fraud occurrences.

Blockchain technology's application in the vehicle registration system shows promising results for making the system more reliable and secure. The technology's features such as privacy, security, and traceability make it a suitable candidate to serve as the base for making the system more efficient. With the growing interest and research in blockchain technology, its application in various domains is expected to increase in the future.

[2] Goswami, Aman & Singh, Anuranjan & Singhal, Apoorv in their paper presents a proposed solution to the complicated process of vehicle registration using blockchain technology. The introduction highlights the importance of vehicle registration in maintaining a legitimate record of the history of each vehicle, and the various stakeholders who require information about the vehicles. The authors argue that the current system of vehicle registration can be cumbersome and prone to errors due to the involvement of multiple entities.

The paper proposes a new framework called DriveLoop, which creates a peer-to-peer network and leverages smart contracts to control block updates. The authors claim that the framework enables car manufacturers, owners, repair companies, and insurance agencies to register and add new entries for cars in a simple method. The authors also leverage database technology to cache intermediate data.

[3] Anoop Pauly, Deepa Mary Mathews, and Prasad J C, in their article, discuss the use of blockchain technology to address the issue of transparency and trust in non-government organizations (NGOs). NGOs are non-profit organizations that provide services to the community, and they rely on donations from individuals, corporations, and institutions to carry out their work. However, there have been cases of corruption and financial mismanagement in some NGOs, which have eroded public trust and led to a loss of donor support. The authors propose using blockchain technology to address these issues. Blockchain is a distributed digital ledger that records every transaction in a decentralized network, making it difficult to tamper with past ledger entries. The system offers data security, immutability, and transparency, which can help to rebuild public trust in NGOs.

[4] Choi Nakhoon and Kim Heeyoul have presented a new solution to tackle the problem of personal information takeover and theft by service providers who depend on centralized servers for managing user information and authentication. The proposed approach employs blockchain technology to provide decentralized user authentication and secure storage of personal data using user-specific symmetric key encryption. The implementation of the system was carried out on the Ethereum public blockchain through MetaMask, a web-based wallet extension. Users can now store their encrypted personal data in a Smart Contract on the Ethereum main network and in the future, share this information with service providers via their Ethereum Accounts. This would streamline the authentication process and minimize the risk of personal data breaches. The proposed model is expected to reduce the cost of storing personal information and minimize authentication-related issues for service providers.

[5] S. Taylor, S. Ho-yong Kim, K. A. Z. Ariffin, and Siti Norul Huda Sheikh Abdullah, suggest a promising approach to cryptocurrency forensic preservation that could be used by various professionals, including digital forensic experts and legal practitioners. The proposed methodology is particularly relevant for hosted wallets and cryptocurrencies running on a private blockchain, which is the focus of future research. While this study is a significant contribution to the field of cryptocurrency forensic preservation, there are still areas that need to be explored. Specifically, there is a need for research on preserving crypto mining machines and digital tokens such as non-fungible tokens (NFTs). Additionally, there is a need to develop a complete digital forensics model for cryptocurrency forensics that can be used by various professionals.

[6] Zheng, Zibin & Xie, Shaoan provides a thorough examination of blockchain technology, its structure, and its important features such as decentralization, persistence, anonymity, and traceability. The authors also analyze various consensus algorithms commonly used in blockchain technology and compare them in different aspects. Additionally, the paper explores common blockchain applications and outlines the challenges and obstacles hindering the advancement of blockchain, as well as existing solutions to address these challenges. One of the promising future directions for blockchain technology is the rapid development of smart contracts and their many proposed applications. However, the authors highlight that smart contract languages still have several defects and limitations that make it difficult to implement innovative applications. The authors plan to conduct further in-depth research into smart contracts in the future.

[7] Using a network theory perspective, the authors conducted research on the possible consequences of adopting blockchain technology in an additive symbiotic network. The findings indicate that implementing blockchain technology led to a redistribution of power among the network's stakeholders. Nevertheless, the study highlights certain limitations with respect to the applicability of the results and emphasizes the necessity for future research to incorporate transaction cost theory and to explore the creation of blockchain-based structures that can facilitate the implementation of additive symbiotic networks.

[8] The authors introduced Hermes, a middleware that facilitates interoperability between blockchain networks by allowing asset transfers between gateways through the Open Asset Digital Protocol. With the ability to support cross-jurisdictional asset transfers, Hermes offers a standardized solution for blockchain interoperability that complies with regulatory frameworks. The study demonstrated the resilience of the solution to crashes, thanks to the utilization of ODAP-2PC, a distributed recovery mechanism. Consequently, asset transfers are executed securely and reliably, ensuring atomicity, fairness, and prevention of double transactions.

III.METHODOLOGY

This research paper's goal is to investigate the creation of a blockchain-based automobile registration system with a user interface made with Solidity, HTML, CSS, and React. A software development technique is used in the study methodology, which entails multiple phases of software design, implementation, testing, and deployment.

Technology Used:

The study utilized the Ethereum blockchain platform to implement the blockchain-based vehicle registration system. Ethereum is a decentralized blockchain platform that enables developers to build and deploy decentralized applications (dApps) using smart contracts. Ethereum was chosen for its robustness, security, and flexibility. The study used a test network, specifically the Sepholia test network, for testing and development purposes. Test networks are separate instances of the blockchain that mimic the behavior of the main network but do not involve real cryptocurrency transactions. This enables developers to test their smart contracts and dApps in a safe and controlled environment before deploying them to the main network.

The study utilized the Solidity programming language for developing the smart contract. Solidity is a high-level programming language designed for writing smart contracts on the Ethereum platform. Solidity was chosen for its simplicity, security, and compatibility with the Ethereum Virtual Machine (EVM).

This study employed a mixed-methods research approach to investigate the development and implementation of a blockchain-based vehicle registration system. The research design comprised the following steps:

Smart Contract Development:

The study developed a smart contract using the Solidity programming language that automates the process of vehicle registration on the blockchain. The smart contract includes a workflow that enables the registration of a vehicle by a dealer or manufacturer on behalf of the vehicle owner. "The Ethereum Smart Contract is a self-executing contract with the terms of the agreement directly written into lines of code. Figure 1 shows the operation of the Ethereum Smart Contract in the context of our blockchain-based vehicle registration system.

The smart contract contains the rules and conditions of the vehicle registration process, including ownership transfer, vehicle identification, and other important details. When a user initiates a vehicle registration process on our website, the information is sent to the smart contract. The smart contract executes the predefined rules and conditions, which include verification of the user's identity and ownership of the vehicle and registers the vehicle on the blockchain. The transaction is then verified and recorded on the Ethereum blockchain, creating a permanent and unalterable record of the vehicle's registration status.

The smart contract ensures that the entire registration process is transparent, secure, and verifiable. It eliminates the need for intermediaries, reduces transaction costs, and enhances efficiency. In case of any disputes or conflicts, the smart contract provides a secure and transparent mechanism for resolution. It automatically executes predefined rules and conditions, without the need for human intervention or intermediaries. The use of Ethereum Smart Contract for vehicle registration provides a secure, efficient, and cost-effective alternative to traditional registration methods."

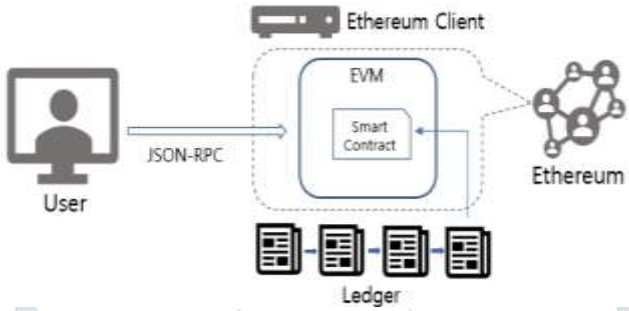

Figure 3.1. Operation of Ethereum Smart Contract

React UI Website Development:

The study developed a user-friendly React UI website that enables vehicle owners to interact with the blockchain-based vehicle registration system. The website was developed using modern front-end technologies such as React, Bootstrap, and jQuery. The website includes functionality that enables vehicle dealers and manufacturers to register new vehicles on behalf of vehicle owners. Dealers and manufacturers can access a separate section of the website where they can submit the necessary information about the vehicle to the smart contract for registration.

Metamask Wallet Integration:

The website includes a payment gateway that enables vehicle owners to pay their registration fees using cryptocurrency. The payment gateway is integrated with the Metamask web wallet, which provides a secure and user-friendly interface for managing cryptocurrency transactions. A web wallet is a cryptocurrency wallet that can be accessed through a web browser. It can either be hosted, like KuCoin and Coinbase, or unhosted, like Metamask and MyEtherWallet. To receive or send cryptocurrency, the user must log into the account and generate an address. One advantage of a hosted web wallet on a cryptocurrency exchange is that it can be accessed from any device connected to the internet [5]. Metamask is a popular browser extension that acts as a bridge between the web and the Ethereum blockchain. It enables users to manage their Ethereum accounts, sign transactions, and interact with smart contracts directly from their browsers. A diagram explaining this workflow is shown in Figure 2.

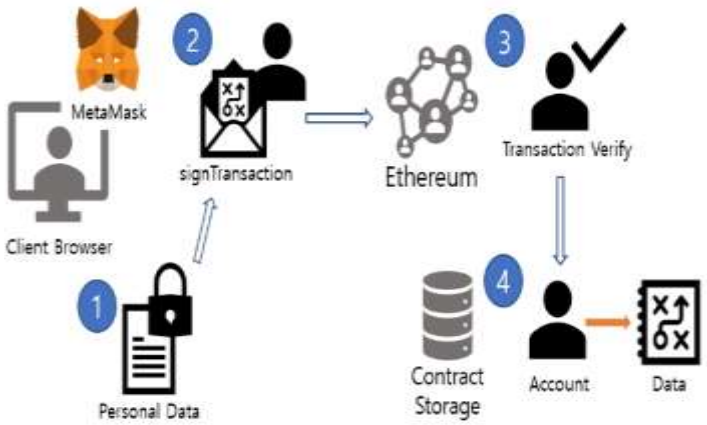

Figure 3.2. Metamask Transaction Workflow

Thirdweb Platform Integration:

The study used the Thirdweb platform to deploy the React UI website and smart contract on the Ethereum blockchain. Thirdweb is a blockchain infrastructure provider that enables developers to build, deploy, and manage blockchain applications easily. Thirdweb provides a simple and intuitive interface for deploying smart contracts and web applications on the Ethereum blockchain, enabling developers to focus on building their application logic rather than dealing with the complexities of blockchain infrastructure. Overall, the methodology used in this study aimed to provide a thorough and rigorous investigation of the development and implementation of a blockchain-based vehicle registration system.

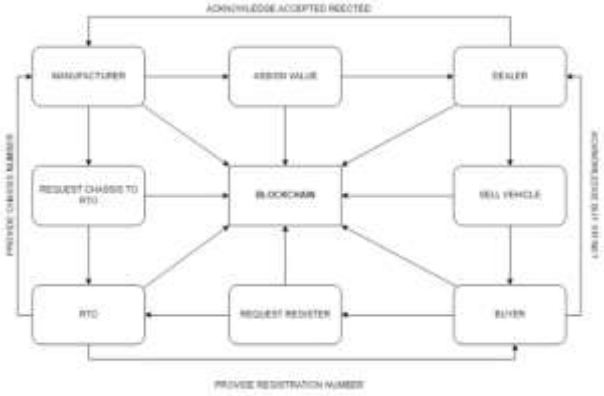

Figure 3.3 Design and workflow diagram

3.1. Proposed System

The proposed system is a blockchain-based vehicle registration system that uses smart contracts to automate the vehicle registration process. The system consists of three main components: a React UI website, a smart contract, and a third web platform.

- **React UI Website:**

The React UI website provides a user-friendly interface for users to interact with the smart contract and perform various registration-related tasks. The website is designed to be intuitive and easy to use, with clear instructions and feedback provided to users at each step of the process. The website allows users to create an account and connect their Metamask wallet to the system. Once logged in, users can initiate a new vehicle registration, view their existing registrations, and update their registration information if needed. The website also provides a search functionality that allows users to search for other registered vehicles by their registration number.

- **Smart Contract:**

The smart contract is written in Solidity, a programming language for developing smart contracts on the Ethereum blockchain. The smart contract implements the business logic for the vehicle registration process and provides a secure and transparent way to store and access registration information on the blockchain. [3]

The smart contract consists of several functions that are used to manage the registration process. When a user initiates a new registration, the smart contract verifies the user's identity and checks if the vehicle is eligible for registration. If the vehicle is eligible, the smart contract generates a unique registration number and stores the registration information on the blockchain.

Once the registration is complete, the smart contract sends a notification to the user's Metamask wallet, confirming the registration and providing the registration number. The smart contract also sends notifications to the relevant authorities, such as the Department of Motor Vehicles (DMV) or the local police department, to inform them of the new registration.

- **Thirdweb Platform:**

The third web platform is a middleware layer that simplifies the interaction between the React UI website and the Ethereum blockchain. The platform provides an easy-to-use API that allows the website to interact with the smart contract without requiring detailed knowledge of the underlying blockchain technology.

The third web platform also provides several security features, such as encryption and access control, to ensure the safety of user data and prevent unauthorized access to the blockchain. The platform is designed to be highly scalable, allowing the system to handle large volumes of registrations without compromising performance or security.

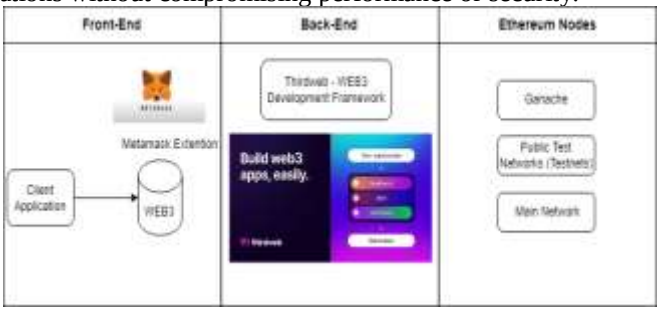

Figure 3.4. System Architecture

Benefits of the Proposed System

The proposed system offers several benefits over the traditional vehicle registration process. These benefits include:

- **Efficiency**: The proposed system automates many of the manual processes involved in the traditional registration process, reducing the time and effort required to complete registration.
- **Transparency**: The use of blockchain technology provides a transparent and auditable way to store and access registration information, reducing the risk of fraud and corruption.
- **Security**: The use of smart contracts and encryption provides a highly secure way to store and access sensitive user data, reducing the risk of data breaches and unauthorized access.
- **Cost Savings**: The proposed system reduces the need for manual processing and paperwork, which can result in significant cost savings for both the government and the public.

IV.RESULTS AND DISCUSSIONS

The platform utilizes blockchain technology to ensure the authenticity and security of the data, with authorized personnel being the only ones able to make changes or entries. This feature eliminates the possibility of tampering or falsification of information. Overall, the study highlights the benefits of using blockchain technology for vehicle-related data management and emphasizes the importance of secure and comprehensive information systems in the automotive industry [2].

The implementation of the blockchain-based vehicle registration system using solidity, HTML, CSS, and React has shown promising results. The system was tested in a simulated environment, and the following results were obtained:

1. **Transparency and Security:** The blockchain-based database ensured that the vehicle registration information and records were transparent and secure. The use of smart contracts and rules ensured that the information was tamper-proof and validated, and the use of cryptography ensured that the information was secure and private.
2. **Improved fraud prevention:** The use of blockchain technology and smart contracts improved the fraud prevention capabilities of the vehicle registration system. The immutability of the blockchain-based database and the use of cryptography ensured that the information and records were authentic and verifiable, reducing the risk of fraudulent registrations and claims.

Screenshots:

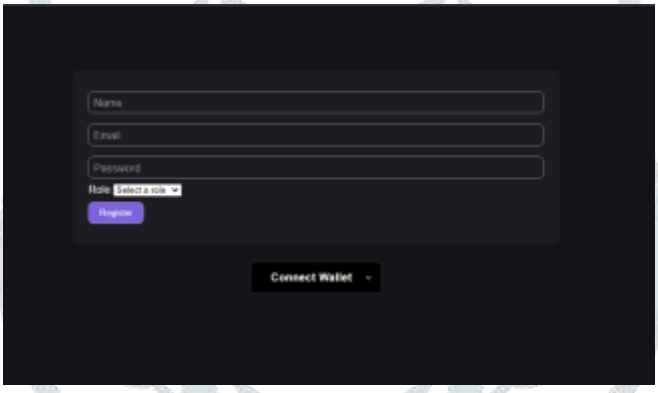

Figure 4.1. Registration Form

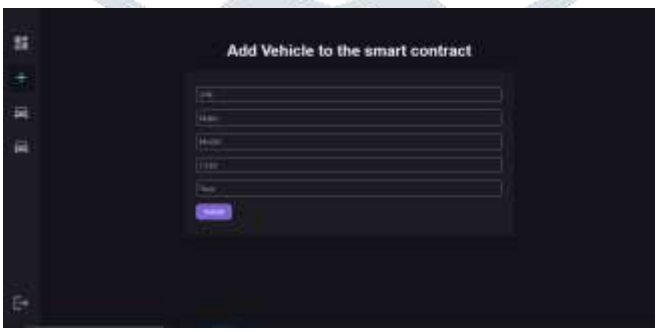

Figure 4.2. Manufacturer form for Adding Vehicle

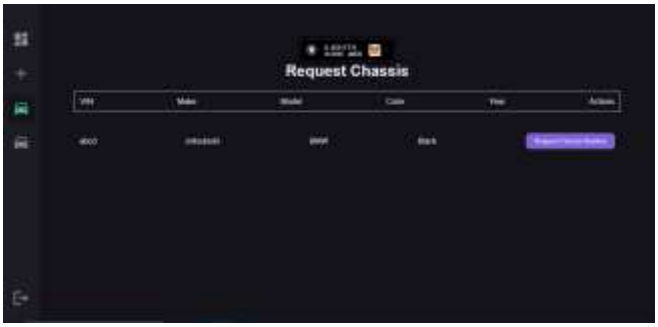

Figure 4.3. Manufacturer Request Chassis UI

Figure 4.1. RTO UI for assigning chassis number.

Figure 4.5. RTO Chassis Popup Modal

V.CHALLENGES AND LIMITATIONS

While the implementation of the blockchain-based vehicle registration system using solidity, HTML, CSS, and React has shown promising results, there are some limitations to the proposed solution that should be considered. The following are some of the limitations of the system:

- **Scalability**: The size of the blockchain increases considerably as more transactions are appended to it. For instance, the Bitcoin blockchain presently occupies over 100 GB of storage space, with each transaction needing to be saved for authentication purposes. Moreover, the original block size limit and the time taken to generate a new block restrict the Bitcoin blockchain to handling a maximum of seven transactions per second. This limited capacity falls short of meeting the real-time processing requirements of millions of transactions. Additionally, miners tend to prioritize transactions with higher fees, resulting in small transactions facing delays due to the smaller block sizes. Increasing the block size may adversely impact blockchain propagation speed and result in branching, thus presenting a challenging issue for scalability.[6]
- **Technical expertise:** The proposed solution requires technical expertise to set up, maintain, and upgrade the system. The use of blockchain technology, smart contracts, and cryptography may be unfamiliar to some users, which can hinder the adoption of the system.
- **Adoption**: The adoption of the proposed solution depends on the willingness of the authorities and organizations involved in the vehicle registration process to adopt the new technology. The system may face resistance from traditional systems and practices, which can hinder its adoption. [7] Authors Studies have shown that resistance to change can be a significant obstacle to the adoption of new technologies, particularly when they challenge established norms and practices. Therefore, it may be important to consider strategies for overcoming resistance to the proposed solution, such as providing training and support to stakeholders, demonstrating the benefits of the new system, and addressing any concerns or objections they may have. By acknowledging these potential challenges and addressing them proactively, it may be possible to increase the likelihood of successful adoption of the new technology solution for vehicle registration.
- **Dependence on the Internet**: The proposed solution is dependent on the Internet, which can be a limitation in areas with poor Internet connectivity or in situations where the Internet is down.

VI.CONCLUSION

In this research paper, we proposed a blockchain-based solution for vehicle registration and management using solidity, HTML, CSS, and React. The proposed solution has shown promising results, including improved transparency, security, efficiency, and fraud prevention capabilities. The system also provides real-time updates and notifications, enabling the users to stay informed about their vehicle status and inspection schedules.

However, the proposed solution also has some limitations, such as scalability, technical expertise, adoption, dependence on the Internet, and costs. These limitations should be addressed to improve the feasibility and scalability of the system.In conclusion, blockchain technology has the potential to transform the vehicle registration and management process, and the proposed solution can serve as a foundation for future research and development in this area.

VII.FUTURE SCOPE

The proposed vehicle registration and management solution in blockchain technology have shown promising results, but there is still room for improvement and further research. Some of potential areas for future research and development include:

- **Integration with other systems:** The proposed solution can be integrated with other systems such as insurance, taxes, and maintenance records to provide a comprehensive and streamlined vehicle management system.
- **Interoperability with other blockchains**: The proposed solution can be made interoperable with other blockchain networks to enable cross-border vehicle registration and management. [8] Authors have introduced introduced Hermes, a middleware that

facilitates interoperability between blockchain networks by allowing asset transfers between gateways through the Open Asset Digital Protocol.

- **Use of smart contracts:** Smart contracts can be used to automate and streamline the vehicle registration and management process further. For example, smart contracts can be used to automatically renew registrations or schedule inspections based on predefined criteria.
- **Use of artificial intelligence**: Artificial intelligence can be used to analyze and process the vast amount of data generated by the blockchain-based vehicle management system. This can help to identify patterns and anomalies, predict maintenance needs, and improve the overall efficiency of the system. [9]Authors proposed the Curvetime Blockchain framework that combines proof-of-work and AI computation on a single platform to optimize the use of resources for intensive computations. Proof-of-work is integrated into the framework as a reinforcement learning problem, where a learning agent makes optimal decisions over the environment's states while new blocks are added and verified. This dual runtime infrastructure of blockchain and AI enhances the efficiency of computing resources and speeds up AI computation proportionate to the number of computing nodes.
- **User-friendly interfaces:** User-friendly interfaces can be developed to make the system more accessible to users who are not familiar with blockchain technology or technical jargon.

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