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A Proposed Model for Vehicle Registration Using Blockchain

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Abstract: Systems for registering vehicles are essential for keeping track of ownership changes. However, severe flaws in the current systems permit vehicles that have been stolen or illegally sold to be registered. Inefficient verification techniques, drawn-out administrative processes, and dishonest employees cause these problems. This paper introduces a transparent system to prevent denial, alteration, or unauthorized manipulation. The proposed method employs hybrid blockchain architecture, distinguishing between confidential and non-confidential data. Personal information is stored privately, while vehicle-related data is maintained as public information. The adoption of blockchain technology is driven by its robust security features, transparency, and traceability, as well as its immutability and ability to handle many users effectively.

Index Terms: Vehicle Ownership management, Blockchain, Decentralized, Permissioned blockchain

1. Introduction

Vehicle registration is a crucial process since it enables numerous departments, such as the police, tax authorities, and motor vehicle authority, to use registration information to identify authorized vehicle owners. The registration of motor vehicles has been done through a variety of techniques, including the use of mobile and web technology.

Only the department of motor vehicles has the authority to add or amend vehicle data under the existing centralized system of vehicle registration. Only the users' own records, whether in electronic or physical form, are accessible. Although this approach is intended to safeguard record confidentiality and accuracy, it can potentially limit transparency and allow dishonest people to fraudulently register stolen cars. Finding such incidents might be difficult, especially if the car was stolen in one place and registered in another. Police investigations are started to locate stolen cars, but they can be time-consuming, costly, and occasionally unsuccessful. It is challenging to pinpoint incidents of vehicle theft since multiple agencies, towns, or nations do not coordinate well. 773,139 vehicle theft instances were recorded in the US in 2017, yet the same number of stolen cars were subsequently found[1]. The recovery process can be accelerated by reducing the quantity of unlawfully registered imported automobiles and making sure that theft instances are reported promptly. The existing setup relies on paper proofs. What comes next is a continuation of our explanation of how it works using the US state of New York's automobile registration laws. In order to register a vehicle, you must have the following documents, which are listed in no particular order: A fully completed registration paperwork for the vehicle, verification of ownership, a clearance certificate for certification and sale taxes, a certificate of reliability, identification proof, and an acknowledgment for any fees that have been paid. The department's database system and archives have records for the given documents. The owner receives their vehicle registration certificate once registration is complete. A new matriculation number is also given to the vehicle if it is new or if it was purchased in another state. Noting that The user must submit the necessary evidence when requesting an authenticity upgrade, completing upgrade paper, and paying upgrade expenses in the event that their personal information (name and address) changes. The same is true when the certificate expires, is lost, or is damaged; in those cases, a renewal request is filed along with the required paperwork and a receipt for the fee payment[2].

Systems for registering vehicles differ by country and even by city, and they frequently run independently. Verifying the condition of a vehicle may take longer and adhere to special administrative norms, and registering a car in a new location necessitates repeating administrative procedures. These elements raise the possibility of record forgery. The database is often only accessible by the county's car registration office, which guarantees record confidentiality, safeguards user privacy, and improves security against outside attacks that seek to add false records. The present system, however, is susceptible to internal assaults and can have a single point of failure. The verification of stolen car records is delayed by time-consuming administrative processes, exorbitant registration and renewal costs, and inconsistent county-to-county systems. The anonymity of the system also makes it difficult to spot forgeries at an early stage. The current methods mainly rely on paperwork, evidence, and the reliability of the personnel working in the car registration department.

Due to its greater security, transparency, immutability, and scalability, blockchain technology is being looked at as a potential replacement for conventional car registration systems. This paper suggests a blockchain solution that would keep a safe and precise record of purchasing and registry records for the vehicle history on three permissioned blockchains for the government, the producer, and customs. This would aid in preventing the registration of vehicles that are fake or stolen, as well as unauthorized modifications or false ownership records. Users of the proposed system must present authentication documentation in order to receive certified keys for blockchain registration. Following a successful registration, transaction information pertaining to the sale of the vehicle is entered into the blockchain using certified keys, which is subsequently confirmed and recorded by peers without the need for physical proofs. With the help of this automated procedure, everyone will be able to register vehicles securely and quickly.

The primary objective of our research is to analyze and address various challenges related to capturing vehicle ownership transfer and registration transactions. To accomplish this goal, we aim to identify the difficulties existing vehicle registration models face and develop a tamper-proof blockchain-based system for vehicle ownership transfer and registration.

The remaining portions of this paper are organized as follows: The existing literature in this area is briefly discussed in Section 2, the design concepts guiding our suggested solution and a thorough analysis of our results are described in Section 3. Finally, in Section 4, we conclude the study.

2. Literature Review

2.1 Vehicle Stock and Individual Possession

Currently, there are more than a billion automobiles traveling the world, with the majority of them being in the United States of America. Globally, the number of automobiles is expected to triple over the next 20 years [3]. Africa had 42.5 million registered cars in 2014[4] whereas Kenya had over two million in 2012 and was projected to have over five million in 2030[5].

A 3% increase in the number of cars is anticipated globally, notwithstanding challenges encountered during registration [3]. In the European Union, there were 13.7 million registered cars in 2015, an increase of 1 million from 2014 [6]. A Deloitte's poll from 2016 found that over 1.55 million cars were registered in Africa in 2015, and that in the following 15 years, yearly vehicle sales might reach up to 10 million units[4].

2.2 Vehicle Registration

Vehicle registration is the process of adding a vehicle to the Motor Vehicle Register (MVR) by recording information about the vehicle, such as its type, make, and owner's contact information[7]. The Motor Vehicle Administration (MVA) is responsible for carrying out this task. The MVA has jurisdiction over a number of actions relating to the ownership and use of motor vehicles, including vehicle registration and title issuance[8]. The National Transport and Safety Authority was the official repository for car registration data in Kenya, however the Registrar of Motor Vehicles was a KRA department[9].

In general, registering a vehicle comprises filling out an application form, supplying ownership papers, paying a registration fee, and receiving a registration plate and sticker to display on the vehicle. Different nations may have different rules and processes for registering an automobile. To maintain the vehicle's legality and roadworthiness, the registration must be renewed periodically, typically once every year or twice every two years. According to the Virginia Department of Motor Vehicles, "Registrations must be renewed annually."

2.3 Importance of Vehicle Registration System

A system of car registration is a crucial component of a transportation system that helps manage and regulate the use of automobiles. Maintaining road safety and efficient transportation is the importance of a car registration system.

Road Safety: Vehicle registration systems are crucial for ensuring road safety since they enable effective traffic law enforcement and the identification of potentially unsafe cars. Systems for registering vehicles are essential for raising traffic safety and reducing fatalities. Accurate registration data can be utilized to identify risky vehicles, enforce regulations governing vehicle inspection, and facilitate effective traffic law enforcement.

Transportation Management: Information on vehicle ownership, registration fees, and specifications are all available via vehicle registration systems, which is essential for controlling transportation. Systems for registering vehicles are crucial for effective transportation management, which includes the construction and upkeep of road infrastructure. Using information from vehicle registration, transportation authorities may manage traffic, plan upgrades to the infrastructure, and monitor vehicle movement.

Governments can generate a significant amount of revenue from automobile registration systems through taxes and registration fees. A World Bank investigation found that taxes and fees related to vehicle registration can be a significant source of revenue for governments[11]. The money collected from car registration fees can be used to fund crucial transportation-related services like road maintenance and infrastructure improvements.

Data for Policymaking: Vehicle registration systems, which are essential sources of information for policymakers, include data on car ownership, traffic patterns, and vehicle characteristics. For the purpose of formulating road safety policies and planning infrastructure projects, registration information on vehicles is essential. In order to improve traffic safety and transportation planning, decision-makers can identify trends and develop laws based on the available data.

Environmental Impact: Systems for registering automobiles can be crucial in reducing the impact of transportation on the environment. Registration systems can provide information on vehicle emissions and fuel efficiency, this might then be utilized to support legislation aimed at decreasing greenhouse gas emissions and encouraging environmentally friendly transportation. Accurate registration information can help with the development and application of rules that favour more sustainable and environmentally friendly forms of transportation.

Combating Vehicle Theft: Vehicle registration systems, which offer a precise record of ownership and enable the identification of stolen vehicles, can also help. For the purpose of identifying stolen automobiles and reducing the incidence of vehicle theft, vehicle registration information is essential. Vehicle registration systems can help by ensuring accurate and up-to-date registration data, which can help reduce the frequency of auto theft and promote effective law enforcement.

Public Safety: Vehicle registration systems also significantly contribute to preserving public safety by enabling the tracking of automobiles used in criminal activity. Systems for registering vehicles can be used to track down vehicles used in crimes and support effective law enforcement. By providing correct registration data, vehicle registration systems can help law enforcement find and track vehicles involved in illegal activities, thereby enhancing public safety.

Regulation Adherence: Car registration systems help ensure compliance with environmental and vehicle safety regulations by permitting effective enforcement. Systems for registering vehicles are crucial for ensuring that safety regulations are followed and for facilitating effective enforcement. By helping to identify hazardous vehicles, accurate registration information can improve efforts to enforce compliance with safety and environmental regulations.

Vehicle registration systems significantly aid in promoting international trade by enabling the tracking of automobiles that are traveling between different countries. Systems for registering vehicles are essential for facilitating international trade and fostering cross-border travel. By ensuring interoperability and accurate data sharing across many nations, vehicle registration systems can help with international trade and transit.

These studies highlight the crucial role vehicle registration systems play in promoting traffic safety, assisting effective transportation management, generating revenue, offering data for policymaking, reducing environmental impact, preventing vehicle theft, assuring public safety, ensuring compliance with regulations, and promoting international trade.

2.4 Existing Motor Vehicle Registration Systems

The architecture of various car registration systems in various nations is the main topic, and similarities and differences are observed. The drawbacks of these methods are also highlighted.

2.4.1 Motor Vehicle Registration System in India

This method was created in India to take pictures of license plates and record information about the vehicle for registration. Character segmentation is a feature of the optical character recognition (OCR) technique that is used to extract information about automobiles from the acquired image. Using the data they have on a car that has infringed any traffic laws, the police may impose a fine.

It is run using a mobile web application. This system's primary shortcoming is that it doesn't keep track of when automobiles have undergone prohibited modifications. Without the owner's knowledge or consent, anyone with the required access rights might access the system and change the data on a car [12]. A diagram of this system's layout may be seen in Figure 2.

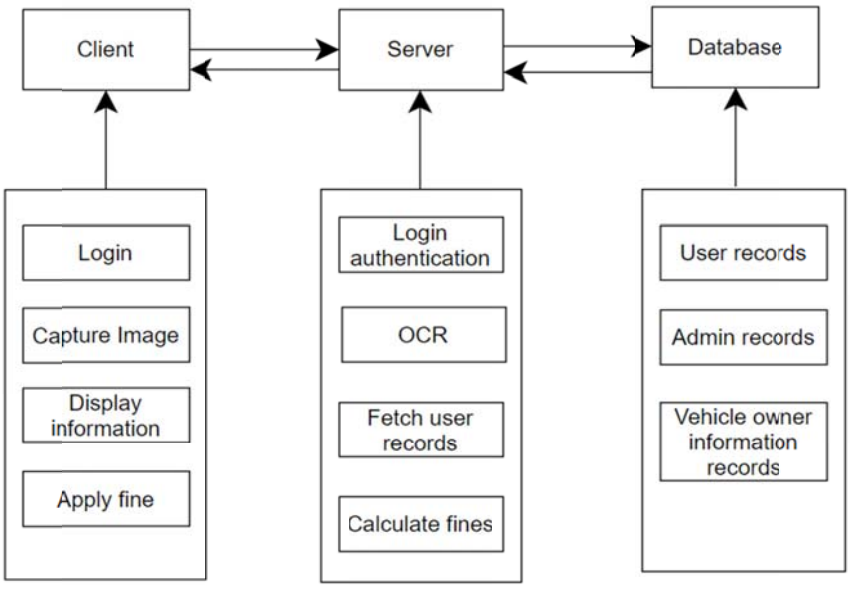

Fig.1. System Architecture

2.4.2 Vehicle Registration System in Nigeria

This procedure was established in Nigeria to help with vehicle registration. The system has a mobile-based interface that enables users to register using a mobile device. The registration information is instantly recorded in the State Board of Internal Revenue's (SBIR) database. The web server serves as the entry point for the web page and any internal systems it may interface with. If they have access to the Internet, vehicle owners and customers can easily supply their personal data and registration details. Following completion of the registration process, a random PIN will be generated. Apart from the designated account administrator, it will be the only entity with the power to provide a client basic account access.

This will make it easier to register in one place. The main drawback of this system is that it can only be used to register vehicles; it cannot be used to validate transfers of ownership or transfer ownership itself[7].

2.4.3 Vehicle Registration System in Kenya

Vehicle registration is handled by the National Transport and Safety Authority (NTSA). It is possible to register as an individual, dealer, agency, financial institution, or corporation. Among the services offered are car registration, ownership transfers, information changes, duplicate logbook applications, reflective number plate applications, vehicle inspections, and online car searches[13]. Unauthorized users have the potential to seriously damage the system, allowing them to distribute vehicle ownership information to unauthorized owners for damaging purposes without the program being able to record the illicit acts. A legal car owner has recently encountered someone claiming to be the owner of the identical vehicle on a number of occasions. This is made possible by the fact that a small number of unapproved users have access to the system and have the ability to secretly change the system's initial vehicle ownership details[14].

2.5 Challenges Faced by Existing Vehicle Registration Systems

From the discussion above, it is clear that the effectiveness and efficiency of the current vehicle registration systems can be impacted by a number of issues. An analysis of the literature on car registration systems reveals some common issues that are addressed in research publications. Here are some of the major challenges:

Fraud and Forgery: Fraud and counterfeiting pose significant challenges for car registration models. A World Bank study claims that fraudulent activities including manufacturing bogus documents or cloning cars can make vehicle registration systems less effective. To solve this problem, some countries have implemented biometric verification systems or tamper-proof license plates.

Lack of Standardization: If there is a lack of consistency between regions or countries, vehicle registration models may encounter problems. It can be difficult to trace automobiles that move across regions or countries because of the uncertainty brought on by a lack of standards. In attempt to overcome this issue, some countries have developed regional or international agreements to standardize car registration regulations.

Vehicle registration systems collect sensitive data that is vulnerable to cybercrime, such as the owner's name, address, and vehicle specifications. For the purpose of preventing identity theft and other forms of cybercrime, data security and privacy are essential. In order to address this issue, some countries have implemented security measures including encryption, firewalls, and secure servers to protect personal data.

Resource Limitations: In countries with limited resources, setting up and maintaining a vehicle registration system can be very expensive. Due to resource constraints, registration processes may take longer than expected or be erroneous. To address this issue, some countries have implemented programs like mobile registration units or online registration systems in an effort to boost efficiency and reduce expenses.

Resistance to Change: Because some vehicle owners can be opposed to changing their current registration system, it might be challenging to establish new systems or make modifications to existing ones. Because individuals are resistive to change, implementing transportation-related policies can be challenging. In order to address this issue, some countries have implemented tactics like public education campaigns or financial incentives to urge vehicle owners to migrate to new registration systems.

Insufficient automation Many car registration models still employ manual processes, which can lead to delays and inefficiencies. These manual processes can include filling out paper forms or visiting registration offices in person. In an effort to boost productivity and cut down on wait times, some countries have introduced solutions to solve this problem, such as automated kiosks or online registration procedures.

Inaccurate Vehicle Ownership monitoring: Inaccurate vehicle ownership monitoring can cause issues for enforcement and regulation. This is made feasible by automobile registration systems' use of outdated or partial data. Inaccurate or missing data can worsen safety risks and make it more challenging to find and recall automobiles. To solve this issue, some countries have launched measures including data cleaning and standardization processes to increase data accuracy.

Lack of Interoperability: If there isn't interoperability between the various vehicle registration systems, tracking cars that travel between many jurisdictions or countries may be challenging. Inefficient interoperability is a significant issue with car registration systems. By boosting data exchange through regional or international agreements and standardizing car registration procedures, some countries have taken action to address this issue.

Building capacity: To implement and maintain a trustworthy automobile registration system, qualified personnel and adequate resources are needed. A key component of efficient car registration systems is capacity-building. Some countries have implemented initiatives including employee training programs and collaborations with private sector companies to increase efficacy and efficiency in addressing this issue.

2.6 Blockchain Technology

Blockchain technology is a game-changing innovation that enables secure, decentralized digital transactions. Data integrity, transparency, and immutability across numerous users are ensured by this distributed ledger technology.

Blockchain technology is defined as a decentralized and distributed digital ledger that records transactions across many computers or nodes. Without a centralized authority, transactions are confirmed by network users through a consensus process[15].

Blockchain technology's key characteristics are as follows:

1. Distributed Ledger: The blockchain is a shared digital record that has been duplicated and synchronized by numerous members. Because each participant has a copy of the full blockchain, transparency is guaranteed and there is no need for a central database.
2. Security and immutability: The blockchain's transactions are safeguarded using cryptographic methods. The immutability of a transaction on the blockchain means that once it has been recorded, it cannot be changed or amended.
3. Consensus process: Blockchain technology employs a consensus mechanism to confirm and concur on the current state of the ledger. To reach consensus among network users, a number of consensus procedures, including Proof of Work (PoW) and Proof of Stake (PoS), are utilized.

2.6.1 How Blockchain Works

Much attention has been paid to the potential of blockchain technology to disrupt a variety of businesses. Understanding the sequential process that drives the decentralized and secure characteristics of blockchain technology is essential for understanding how the technology operates. This document provides a comprehensive explanation of how blockchain technology operates, outlining each step of the procedure.

Explanation of Blockchain Technology in Steps

1. Begin the transaction: The initiation of a transaction marks the start of the procedure. Through transactions, which contain important information such the sender, recipient, and transaction amount, digital assets or information are transferred.
2. Validating the transaction: After a transaction has been initiated, it must be verified by the network's users. The verification process frequently comprises confirming the authenticity of the transaction, ensuring the sender has sufficient funds, and ensuring the transaction complies with existing rules and laws.
3. Block formation: Blocks are groups of transactions that have been confirmed. A specific amount of transactions are included in each block, which also contains a unique identifying number called a block header. The block header contains crucial information such as a date, a reference to the block preceding it, and a cryptographic hash.
4. Consensus mechanism: To review the block and decide whether to add it to the blockchain, the blockchain network uses a consensus method. To achieve consensus among network users, a number of consensus procedures, such as Proof-of-Work (PoW) or Proof-of-Stake (PoS), are utilized. Consensus methods guard the integrity of the blockchain and eliminate double spending.
5. Block validation: A block is added to the blockchain once it has been approved by consensus. This entails adding the block in a time-stamped and sequential manner to the existing chain of blocks. The hash of the most recent block is connected to the hash of the oldest block, forming a chain that guarantees the immutability and integrity of the data.
6. Mining and incentives (optional): In some blockchain networks, mining may be utilized to reward users and uphold the network's security. Miners use processing power to solve difficult mathematical puzzles in order to verify and add new blocks to the blockchain. Successful miners are compensated with transaction fees or newly created bitcoin coins.
7. Update the distributed ledger: Each participating node keeps an exact duplicate of the whole blockchain as it expands. Each node independently checks and updates the blockchain's state, ensuring redundancy and improving transparency.

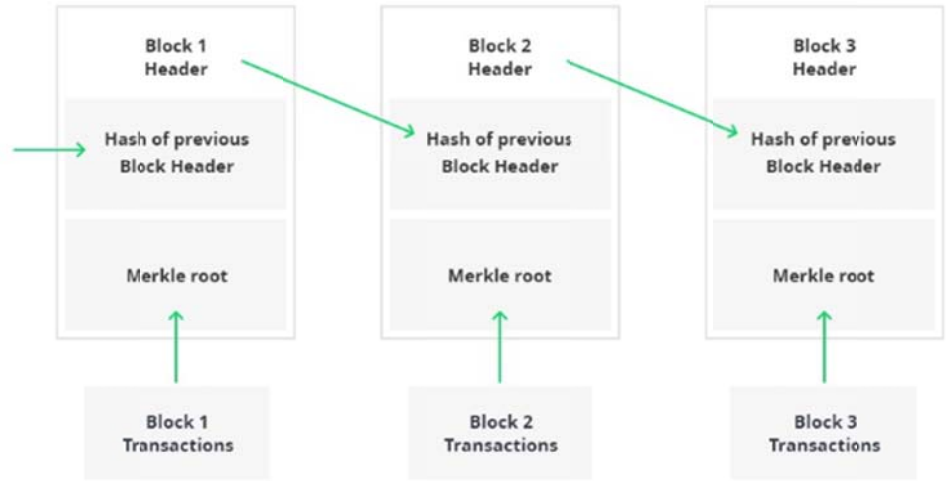

Fig. 2. Blockchain illustration

2.6.2 Smart Contract

Smart contracts are self-executing agreements that have the contract's terms and conditions encoded directly into its source code. These agreements automatically uphold the terms that were agreed to and authorize transactions based on accepted standards and conditions[16]. Smart contracts built on blockchain technology provide decentralization, transparency, and security.

2.6.3 Smart contract's characteristics

Smart contracts don't involve middlemen or manual execution, therefore they are automated and autonomous. When the contract's coding requirements are met, it can be executed automatically without any input from the user.

Transparency: Smart contracts are transparent because everyone using the blockchain network can see and access their code. This transparency allows all parties to examine and audit the conduct and performance of the contract.

Trust and security: Smart contracts use cryptographic methods to assure tamper-resistance and security. By utilizing cryptographic hash functions and digital signatures, the integrity of the contract is ensured and the possibility of fraud or unauthorized modifications is decreased.

Efficiency and Cost Reduction: By eliminating middlemen and automating contract execution, smart contracts can increase efficiency and reduce transaction costs. Smart contracts eliminate the need for middlemen like brokers, attorneys, or escrow services, which speeds up and lowers the cost of transactions.

Immutable and Irrevocable: After being put into use on a blockchain, a smart contract becomes both immutable and irrevocable. The terms and conditions of the Contract may not be modified unless as expressly provided in any updates or modifications.

Programmability offered by smart contracts makes it possible to carry out conditional actions and business logic that is complex. Smart contracts also provide flexibility. You have flexibility when deciding how to implement specific contractual conditions because they can be changed to fit various use scenarios.

2.7 Types of Blockchain

The three fundamental kinds of blockchain technology are public, private, and consortium blockchains[17].

Blockchains that are accessible to the general public include many of the open, decentralized networks like Bitcoin and Ethereum that permit anybody to view the ledger and interact with the network. They are designed to be resistant to censorship and government regulation by any one entity. Public blockchains utilize proof-of-work or proof-of-stake consensus processes to certify transactions and safeguard the network.

Private blockchains are closed, permissioned networks that are only accessible to predetermined groups of authorized users. Private blockchains, which are frequently used within businesses or consortiums for internal processes due to their smaller size and controlled access, can be more efficient than public blockchains. Private blockchains can use a variety of consensus procedures, including proof-of-authority and Byzantine fault tolerance.

Blockchains used by consortiums of businesses to participate in a blockchain network combine the features of public and private blockchains. Blockchains for consortiums enable businesses to collaborate more successfully while maintaining network privacy and security. Only a few of the consensus methods that consortium blockchains can use include proof-of-authority and Byzantine fault tolerance.

Blockchain technology is available in variations and subtypes in addition to these three main categories, enabling interoperability across different blockchain platforms through sidechains and hybrid blockchains [26].

Which blockchain type should be utilized generally depends on the specific requirements and application use case. Public blockchains are appropriate for uses that ask for transparency, security, and censorship resistance, whereas private and consortium blockchains are better suited for uses that demand for control, privacy, and efficiency.

2.8 Blockchain Based Platforms

2.8.1 Hyperledger Fabric

The Linux Foundation created the open-source, permissioned blockchain technology known as Hyperledger Fabric. It is intended for usage in corporate settings where security, scalability, and productivity are essential. A flexible design offered by Hyperledger Fabric enables customisation to cater to particular business demands[18]. It makes use of distributed ledger technology, which enables users to trade data and assets in a secure, open, and efficient manner.

With the help of Hyperledger Fabric, private, permissioned networks may be built, allowing network administrators to govern who has access to the network and what data is stored on the blockchain. This provides the participants with a high level of privacy and security while still providing transparency and accountability. Smart contracts, which are self-executing agreements that autonomously enforce an agreement's terms, are also supported by Hyperledger Fabric.

Several characteristics of Hyperledger Fabric make it appropriate for application in businesses, including:

- Modular architecture that enables flexibility and personalization
- Permissioned, private networks that offer security and confidentiality
- Scalability and high transaction throughput
- Support for smart contracts.
- Identity management and access management
- Assistance with various consensus algorithms

2.8.2 Ethereum

Decentralized apps (dApps) can be created and deployed using smart contracts on the decentralized, open-source Ethereum blockchain platform[19]. Like Bitcoin, Ethereum keeps a tamper-proof record of all transactions on the network using distributed ledger technology. Ethereum, in contrast to Bitcoin, was intended to be a more adaptable and programmable platform, allowing developers to create unique dApps for a variety of use cases.

The native coin of Ethereum, called Ether (ETH), which is used to carry out smart contracts on the network and pay transaction fees, is one of its main characteristics. Ethereum can handle sophisticated financial instruments like loans and derivatives in addition to allowing simple transactions by utilizing smart contracts.

One of the most well-liked blockchain platforms worldwide, Ethereum has been warmly embraced by the blockchain community. As of May 20th, 2023, Ethereum had a market valuation of more than $500 billion USD, according to CoinMarketCap. Ethereum is a popular choice for developers wishing to construct cutting-edge new applications on a decentralized platform since it can be tweaked and programmed.

2.8.3 Neo Blockchain

It represents a permissioned open source blockchain platform that enables the use of smart contracts and decentralized applications (Dapps). In order to build a smart economy—that is, an economy where individuals can agree on a contract without the requirement for mutual trust—it intends to digitize assets and automate the administration of these digital assets. For individuals who own some kind of digital asset within the network, GAS, the native currency of NEO, is automatically created for them[20]. GAS is a price paid so that one can be able to use NEO's network.

2.9 Current Blockchain-Based Technologies for the Vehicle Industry

All parties involved in the automotive industry may benefit from the myriad complex services that networked cars offer. As a result, smart vehicles are subject to a range of security and privacy issues, including remote vehicle tracking and vehicle position tracking.

A blockchain-based architecture is advised to protect vehicle owners' privacy and enhance the security of the automotive ecosystem. To accomplish this, secure data storage is built in every car. The car's owner then decides what data is stored in the vehicle and what data is disclosed to outside parties.

A live-updated copy of a physical object called a "digital twin" allows for historical performance tracking and predictions. In a prototype created by Groupe Renault in partnership with Microsoft and VISEO, the maintenance records of new vehicles are connected to their digital counterpart via blockchain. This makes sure that the data is only accessible to people who are authorized, like car owners. The blockchain-based solution ensures that even if an automobile's owner changes, its maintenance history will follow it. Vehicle registration projects based on various blockchains are numerous. As follows:

Hossain et al. [21] have suggested a BCT-based hybrid vehicle registration system for the year 2020. The road transport authority validates the information given when a user submits an online registration form to request registration. The data will then be stored on the blockchain network and promptly shared with other RTAs. Data validation and dealing with those who give fraudulent data require time.

BCvehis, a commercial blockchain infrastructure-based solution that gathers the prior records of a vehicle from numerous data sources throughout its life cycle, was suggested by JINGJING CHEN et al. [22] in 2020. The historical vehicle records can be entered into BCVehis by vehicle owners, vehicle authorities, registration information, repair facilities, and insurance brokers. The limited storage capacity of mobile review devices and the restriction to used cars make this technique ineffective.

A cost-effective distributed vehicle registration system based on the creation of their own blockchain was proposed by Leila Benarous et al. [23] in 2020. The suggested system saves details about the owner and the cars as transactions. They connected end users to the blockchain and introduced CA-generated certified keys. The phrase "blockchain of blockchains" was used to describe their system. It confirms each field while holding a collection of coordinators (state, custom, and manufacturer). They created an attack probability tree and reduced the possibility of registering fake cars to 10%.

S. V. Aswathy et al.'s system for car registration and the detection of traffic offenses was proposed in 2019 [24]. For this system, Ethereum was used. They suggested a system to prevent auto theft and monitor traffic infractions. Vehicle tracking is made possible through toll booths, and records containing the position and registration details of the vehicle are uploaded to a blockchain.

A blockchain-based car registration system was proposed by Abhishek Pandey et al. [25] in 2021 to counteract data manipulation and fraud detection. This system made use of Hyperledger. The manufacturer module, dealer module, buyer module, and RTO module are only a few of the parts that make up this system. They followed a process to transfer ownership even for used items.

In 2020, Georges Bell Bitjoka et al. [26] proposed using a consortium blockchain (corda) for the system, which uses algorithms like Raft on Byzantine fault tolerance and allows the management of network scalability and data storage. The system would secure the data of driver's licenses and vehicle registrations.

An intelligent vehicle registration certificate that automatically updates itself (RC, pollution, insurance) was presented by Jatin Sharma et al. in 2019 [27] includes on a single smart card a certificate of vehicle registration, insurance, pollution, etc. A smartphone application was also created to communicate with the smart card and manage the documents. This clever system will operate very effectively when all vehicles are kept up to date because it will increase revenue and reduce pollution.

From this above discussion, all car owners were not provided with a tracking feature in the Tejas et al. [12] system. The car ownership transfer capability was absent from the system that James, Ansa, and Udaeka [7] created; it simply

allowed for vehicle registration. The Rosado Tiago et al. [28] suggested a technique that administers processes connected to car registration administration, including registering vehicles, changing ownership statuses, and registering lease agreements between lessors and lessees. This method is implemented on the Hyper-Ledger Fabric blockchain network. The system was not entirely automated, though. Hossain et al. [21] developed a BC approach that manages vehicle registration administration, including registering a car and changing the ownership state, however it is missing data on the vehicle's fitness certificate and license plate after registration. The idea of BCvehis was first suggested by JINGJING CHEN et al. [22]. This research will result in the creation of a system enabling future car registration, ownership transfer, and certification of ownership transfer. Furthermore, we are developing a tool that will empower new car owners to access information about previous owners. This forthcoming system and tool will completely transform the way car ownership is handled, introducing streamlined processes and enhanced transparency for managing and validating ownership details.

3. Proposed Model & Discussion

The proposed concept based on consortium blockchain car registration architecture is described in this section. We must first describe the potential scenarios of a car purchase and how such scenarios might effect the registration of the vehicle in order to help the readers comprehend the technique used. The extraction of our system players is then continued. The broad description of the system is then given, followed by a specification and justification of the blockchain type we choose.

3.1 Cases of vehicle purchases and the expulsion of actors

Purchasing vehicles from sellers:

- Brand-new vehicles can be purchased directly from the manufacturer or via a new car dealer.
- Pre-owned or used vehicles can be purchased from individual sellers or through used car dealerships

So, this indicates that two organizations are responsible for keeping track of vehicle purchases:

- If the vehicle is new, it will already be in the databases of the manufacturer and the dealer.
- If the vehicle is pre-owned, it has already been registered in the State’s RTA’s system.

Therefore, the RTA is a key component in our model alongside vehicle buyers, manufactures, and dealerships. The certifying authority (CA) is another critical component since it generates the certified keys that actors need to join the blockchain.

3.2 Roles of actors:

Manufacturers: Adds authorized dealers and vehicle information to the blockchain.

State’s RTA: Adds already registered vehicle information to the blockchain.

Certifying authority: It connects the other actors and the blockchain's public key. The certificate confirms that the public key is in the rightful owner's hands and links it to the actual actors by providing accurate and up-to-date information, such as the user's name, birthdate, and address (identification verification is necessary for the generation of the public key). Additional identifying information would be included in the certificate if the network node represents an organization rather than an individual user.

Observers: These are actors such as insurance companies who can explore public information.

End-users: These are the people who buy and sell vehicles.

Anyone who has permission can add information to the blockchain, but only after a consensus mechanism confirms that the information provided matches the previous hash., preventing the inclusion of erroneous data. People with limited access to the blockchain can make observatory entries, such as a customer who wants to view the intricacies of their information in a government repository or an individual purchasing a vehicle who wishes to see the ownership and service record of a used vehicle. The vehicle's history and data are protected by this mechanism.

A user with permissions can add, modify, or remove data in a decentralized database and has full access to the system database. An insurance provider or a buyer of a car, for example, who can thereafter log in and check the vehicle's information, can register as an observer and input or amend certain details. Figure x depicts the various user roles.

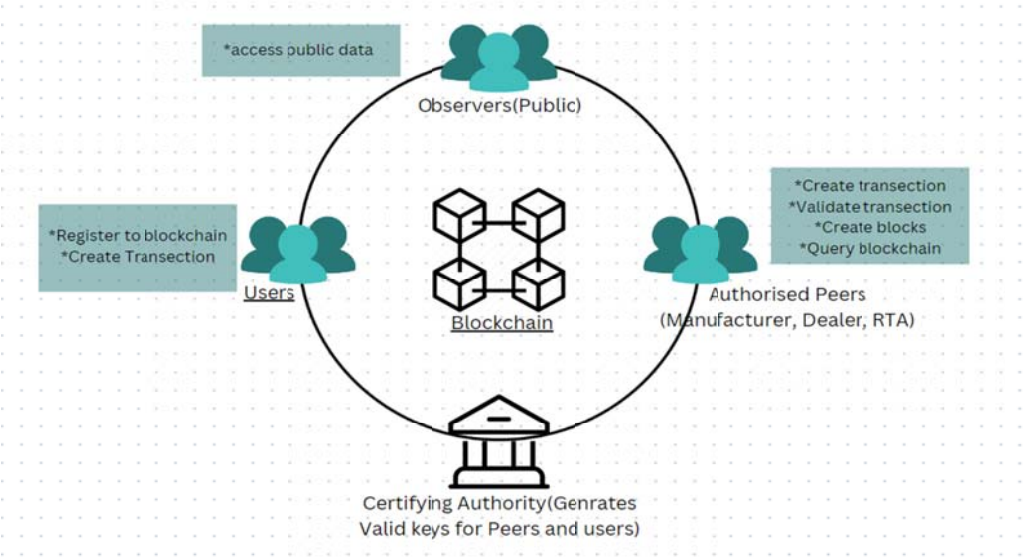

Fig 3. Operations carried out by each node in the distributed ledger car registration system

Because of its permissioned structure, the blockchain restricts activity to just those nodes that are authorized to validate transactions, build and validate blocks, and chain them. The State RTA, the retailers, and the manufacturers are all represented by these hubs. Vehicle owners have the option of kicking off the buying and selling processes themselves. Until the authorized peers have approved the transactions, however, they remain in a pending status. A block can only contain valid transactions if it has been signed by all three of the involved blockchains. In order to sign in to the blockchain system, the user must have to be first registered with the CA and receive a set of certified credentials. The user creates a transaction to record the purchase of a vehicle, which is subsequently verified by the state-authorized RTA peer and appended to a particular block. Each of the three authorized peers (State RTA, Dealer, and Manufacturer) signs the block. Copies of the verified blocks are also shared with the other nodes in the network.

The following diagram depicts the basic format of a transaction to transfer car ownership.

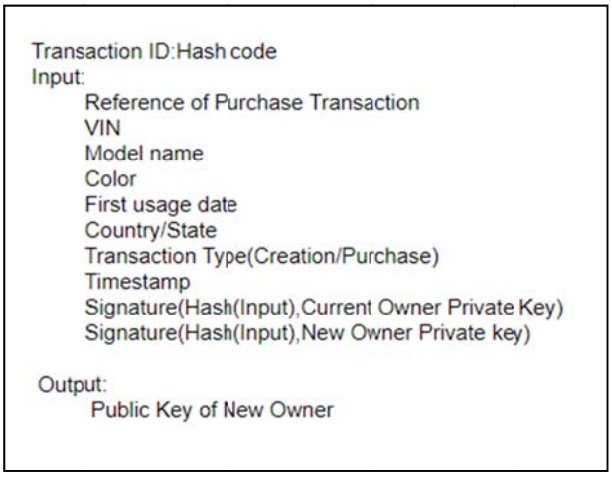

Fig.4. Transection of ownership transfer

Below is the comprehensive diagram of our proposed model, showcasing its intricate components and their interconnections, designed to ensure a highly efficient and robust system.

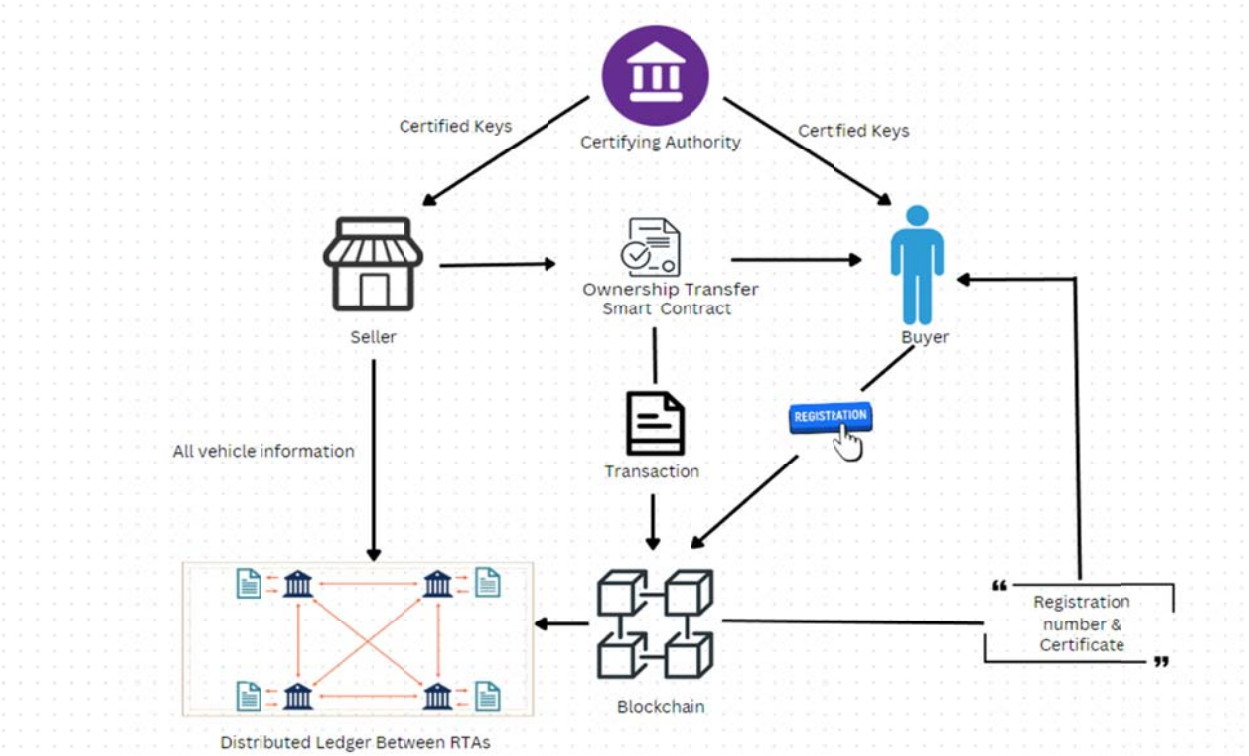

Fig.5. Blockchain based vehicle ownership transfer and registration system

3.3 Discussion:

In addition to examining current vehicle registration models and the difficulties they encountered, this study attempts to identify difficulties in recording vehicle registration and ownership transfer transactions.

The objective is to identify a technique that might be used to track vehicle ownership and transfer transactions and to address problems with the present car registration models. It was evident from the study's findings that a blockchain-based application was the optimal course of action.

The first objective was achieved by conducting a review of the literature on existing vehicle registration models. As we can see from the discussion above, other models did not offer a tracking feature to all automobile owners. Additionally lacking was the ability to transfer car ownership; just vehicle registration was supported. The administration of processes related to vehicle registration administration, such as registering vehicles, altering ownership statuses, and registering lease agreements between lessors and lessees, is handled by another model provided technique. On the Hyper-Ledger Fabric blockchain network, this technique is used. However, the system wasn't totally automated. However, it lacks information on the vehicle's fitness certificate and license plate after registration. There was also a model that established a BC strategy that controls vehicle registration administration, including registering a car and changing the ownership status. Our groundbreaking work has inspired the development of a ground-breaking system that uses blockchain technology to alter the certification, ownership transfer, and registration processes for automobiles. Our system provides a complete solution by utilizing the immutable and transparent records of blockchain, improved security, faster processes, eradication of fake documents, access to prior owner information, interoperability, and standardization. This system has the potential to revolutionize the automotive sector by offering a smooth and reliable platform for automobile transactions and ownership verification at reduced prices, better time efficiency, and higher levels of confidence.

The second objective was achieved by conducting a study of relevant literature. The owner(s) of a certain automobile could not be found using the first technique that was thought of. Because of this, it was difficult for a new car owner to determine how many, if any, prior owners the vehicle had. Only car registrations could be handled by the second system. Elements that would have allowed for the confirmation of transfers and vehicle transfers were missing. The third system was unable to record all transactions connected to registration and transfer. Any potentially fraudulent transactions could not be monitored by the system. Our research led to the development of a blockchain-based solution that can register cars, transfer them, and confirm ownership transfer. Every transaction concerning the car was recorded in a ledger in order to keep track of everything.

4. Conclusion

In this research paper, we have presented a prototype for vehicle registration using blockchain technology. While we have not implemented the system in its entirety due to lack of time and resources, our study highlights the potential benefits and challenges associated with adopting blockchain for vehicle registration. Our prototype demonstrates the feasibility of using blockchain as a secure and decentralized platform for recording and verifying vehicle registration information. By leveraging the immutability and transparency of blockchain, we can mitigate issues such as fraudulent registrations, tampering with records, and inefficient paper-based processes.

Due to the wide variations in the data supplied for vehicle registration issued by Motor Vehicle Administrations, identifying the owner of a vehicle has long been a significant challenge. The old systems lacked a tracking system for auto registration transactions. Identification of actual car owners proved challenging for relevant parties. Because the new owners were unable to identify the former owner, this was the main problem when it came to vehicle transfers.

It is important to acknowledge that implementing blockchain-based vehicle registration on a large scale requires overcoming several challenges. First, there is a need for collaboration and coordination among various stakeholders, including government authorities, vehicle manufacturers, insurance companies, and regulatory bodies. Establishing a standardized framework and consensus on data sharing and access control is crucial for the success of such a system.

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