

# A Proposed Framework for the Automobile Registration System Using Blockchain

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## Abstract:

The Automobile Registration System on Blockchain is a groundbreaking solution that utilizes blockchain technology to secure the process of automobile registration. Traditional systems often face challenges such as data manipulation, fraud, and inefficiency. In contrast, this proposed system leverages blockchain's transparency, immutability, and decentralized consensus to overcome these issues. The central idea of this system is to establish a trustworthy, reliable, and impenetrable registration system for vehicles. The framework uses blockchain innovation to guarantee that enlistment records are immutable and safely put away. Exchanges and records are confirmed and approved through a decentralized organization of hubs, imparting an elevated degree of confidence in the enrolment cycle. The system's ownership transfer functionality is critical, enabling secure and efficient transactions between vehicle owners. Whether it involves transferring ownership between individuals or manufacturers, the blockchain-based system ensures transparency and traceability throughout the process.

**Keywords:** *Blockchain, Supply chain, Automobile, Security, Decentralized.*

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## 1. Introduction

Blockchain technology is a novel way to store and distribute decentralized and unchangeable information. The blockchain is an electronic ledger that records information [1]. It enables the creation of digital ledgers that record transactions, events, or any data of value in a network of peer-to-peer nodes without the need for a central authority or intermediary. As a decentralized ledger technology (hereafter DLT), Blockchain technology has characteristics of transparent, secure, permanent, and immutable [1, 2], and it has the capability of improving the trust between market members. One of the key features of a distributed ledger is its consensus mechanism,

which determines how the network validates and updates the data on the ledger. Many types of consensus processes, such as proof-of-work (PoW), proof-of-stake (PoS), or Byzantine fault tolerance (BFT), can be utilized depending on the architecture and purpose of the blockchain. The significance of blockchain innovation arises from its ability to address fundamental trust, security, and productivity issues. By removing the need for middlemen and central authority, blockchain enhances transparency, decreases costs, and enables peer-to-peer transactions. It also includes cryptographic approaches for preserving data integrity and authenticity, allowing transactions to be confirmed and resistant to

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manipulation. These characteristics make blockchain an ideal solution for several fields, inclusive of finance, healthcare, supply chain management, and, in our case, the automobile registration system.

Automobile registration holds great importance as it serves as a vital mechanism for regulating and managing vehicles on the roads. It ensures that vehicles are properly identified and tracked and their ownership is documented. Registering automobiles provides a legal framework for ensuring compliance with safety standards and taxation requirements. It also plays a crucial role in preventing theft, facilitating law enforcement, and maintaining accurate insurance and accident investigation records. Overall, automobile registration is essential for promoting road safety, protecting public interests, and ensuring the smooth functioning of transportation systems.

*Paper Organization:* We present the problem statement, highlighting the limitations and challenges of the current automobile registration and transfer system in Pakistan in Section 2 and Section 3. In the next section, Section 4, we introduce the architecture of our proposed model, outlining the key components and their functionalities. Section 5 discusses the detailed process of automobile registration on our platform. Next, in Section 6, we discuss the utilization of smart contracts to automate and trigger events within the registration system. In Section 7, we will provide an overview of the tools and technologies employed in the implementation of our solution. Finally, we describe the outcome of our research and compare the traditional and our proposed system of automobile registration in Section 8, followed by a conclusion.

## 2. Related Work

This section will discuss relevant studies, papers, research, and work that closely align with our subject matter. Much research has been done on the use cases of blockchain technology, especially in supply chain management (SCM) and finance, exploring the potential and hurdles of utilizing blockchain

technology in the automotive industry's supply chain. For example, a recent work by Vuković et al. [3] explained how the automotive industry uses blockchain technology to revolutionize supply chain management. Moreover, Upadhyay et al. [4] further examine blockchain technology's challenges and potential benefits for operational excellence in the UK automotive industry by following a systematic review approach, which analyses existing academic published research papers in the top 35 academic journals. Research by Suprañee et al. [5] has illustrated the advantages and limitations of implementing blockchain in the automotive supply chain process by conducting a comprehensive study involving all stakeholders. It can serve as a roadmap for automotive industry stakeholders to implement Blockchain technologies into their organization's operations. Another work by Erol et al. [6] quantitatively assesses the feasibility of blockchain technology in diverse industries, especially automobiles, through an array of indicators. The study employs fuzzy AHP, fuzzy TOPSIS, and scenario analysis with expert input to identify the industries where blockchain is most feasible with an aim to optimize resource allocation. In their study, Rastogi, Sharma, and Gupta [7] proposed a blockchain-based framework called DriveLoop that uses blockchain technology to register and validate vehicles in a smart city environment. They used a local blockchain network called Ganache for their system with an aim to improve data security, privacy, transparency, and accountability of the vehicle registration system. Fraga-Lamas and Fernandez-Carames [8] discussed the benefits and challenges of blockchain technologies in the automotive industry, with a focus on its cybersecurity capabilities. It assesses blockchain's useability after reviewing the current situation and current state of the art and performing a SWOT analysis on blockchain in the automotive industry. Benarous et al. [9] presents a system that leverages blockchain technology to ensure the authenticity and traceability of vehicles by storing the owner's information and the vehicle's description in a

public blockchain, where anyone can verify the ownership history. The attack tree analysis evaluates the security and resilience of the system against forged transactions. Hossain et al. [10] proposed a blockchain-based system using distributed ledger technology that registers vehicles and manages information across platforms. The paper targets the issues of the current centralized system, such as security threats, single-point failure, and low transparency, that empower the government to have monitoring capacity over the system. Sharma, Kumar, and Park [11] present a blockchain-based distributed platform for the automotive industry in a smart city. The study addresses the problems of the centralized system, including security flaws, single-point faults, and lack of transparency. The paper also adopts a novel miner node selection algorithm for the blockchain-based distributed network design. The paper verifies the feasibility of the proposed platform by simulating it on a private Ethereum blockchain platform using a captured dataset of mined blocks from litecoinpool.org.

Based on our understanding, the majority of researchers have concentrated on specific phases of the automotive industry's lifecycle. However, there is a crucial requirement to develop a comprehensive framework that meets all key requirements for the automotive industry.

### 3. Problem Statement

In this paper, we present a use case of blockchain technology in developing an automobile registration system utilizing blockchain technology in Pakistan. The existing system faces challenges in ensuring transparent and efficient management of vehicle registration, ownership transfers, and compliance with regulatory bodies like the Federal Board of Revenue (FBR) for tax management. Our project aims to leverage blockchain's inherent properties to create a decentralized, secure, and reliable platform that enables seamless collaboration between manufacturers, vehicle owners, and regulatory authorities.

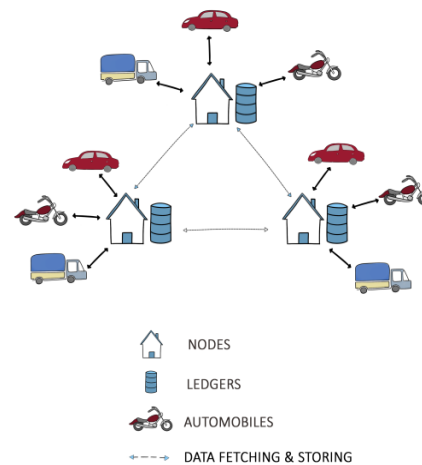


Fig. 1: Automobile Registration Process on Blockchain

By employing blockchain technology in the automobile registration system, we seek to deal with the problems of trust, transparency, and data integrity, ultimately streamlining the registration and transfer process. This also facilitates accurate tax management.

### 4. Architecture of the Proposed Model

The architecture of our proposed system is defined in figure [2].

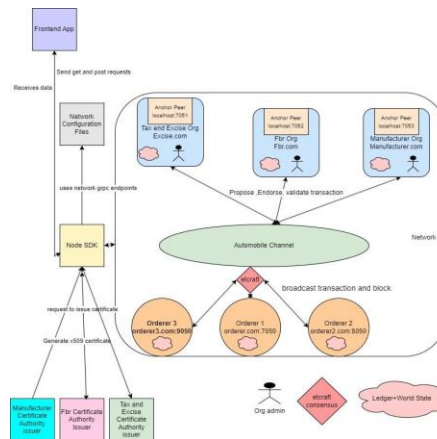


Fig. 2: Automobile Registration System Network Architecture

- There are 4 Organizations named as Tax and Excise, FBR, Manufacturer and Orderer. Each Organization has unique GRPC URL to send requests and receive responses from that component.
  - Each Organization has a separate anchor peer, which sends transactions for validation to orderer component. Each Organization also has an admin identity, which is known to the network; admin authorities are to make an identity associated with a particular organization, make a peer component for holding ledger data separately, send chain code updation proposal, endorse chain code proposal, validate the chain code by running into on peer component and other authorities decided on network configuration yaml file.
  - Ledger is the blockchain containing all blocks of transaction with data and world state is current assets state stored in database.
  - Etdraft is a consensus mechanism in which multiple orderer components are available to ensure the availability of transaction proposal acceptance and validation.
  - Three Orderers are connected through etcdraft mechanism and have a separate grpc url to contact in the network, which accepts transaction proposal and, after validation, sends to leader peers(role) component of each organization.
  - Automobile channel is the major component where all the details of network, Organizations, channel details, Orderer components, consensus mechanism are stored.
  - Chain code are installed on peers by admins and update and commit requests are also made by admins.
  - Orderers, Organization's anchor peers and leader peers, admin identities consensus mechanism, chaincode updation, installation, commit and network based rules are defined at layer 1 named Network layer.
  - Hyperledger Fabric provide Node software development Kit (SDK) to use Network configuration files(files where all the urls, addresses are defined of each component) and then send and receive requests and response using particular identity wallet stored in configuration files.
  - Fabric CA server a component which is used to make identities e.g: peer, user and also assign roles to these identities. Each Organization has separate Certificate Authority(CA) servers to issue identities whose end points are also defined in Network configuration files.
  - Node sdk layer 2, where APIs (Application Programming Interface) are defined using Fabric Node SDK to interact with network environment.
  - Application are connected through to this SDK to send and receive http requests.
- The proposed architecture for our blockchain-based automobile registration system consists of multiple organizations, including the Manufacturer, FBR, and Tax & Excise Organization, each with their designated peers and ledgers. The subsequent sections will cover the process of automobile registration using our system and smart contract implementation.

## 5. Current Automobile Registration & Transfer System in Pakistan

Blockchain is revolutionizing the supply chain. Due to its attractive features, such as traceability, transparency, and accessibility, blockchain is being used by many users from supply chain industries, particularly food, agriculture, and pharmaceutical industries [12, 13].

The auto industry in Pakistan is the 6th biggest manufacturing sector, growing at a rate of over 7% each year. This sector has experienced considerable expansion in recent years. The automotive industry contributes approximately USD 6 billion annually to the

Gross Domestic Product (GDP). Additionally, it creates 215,000 direct employment opportunities and USD 0.82 billion in indirect tax revenue. This sector also accounts for 16 per cent of the manufacturing sector in Pakistan [14].

### 5.1 Vehicle Registration

Vehicle registration system in Pakistan is very complicated. A number of documents are required for vehicle registration, including proof of ownership, previous histories, and information about the owner. As a result, the Excise department requires the owner of the vehicle to submit a number of documents detailing the required data records during the registration process. The information and documents are then checked for accuracy by the excise department before being entered into the government database.

Many people prefer outsourcing this task to agents who charge hefty amounts for getting the job done. Common steps for vehicle registration are as under:

1. First you need to possess the following documents:
  - Form for registration of Vehicle – Form-F
  - Copy of CNIC(Computerised National Identity Card) of Owner
  - Original Vehicle’s Certificate of Sales
  - Original Vehicle’s Sales Invoice
  - Payment of registration fee, number plate fee and other applicable taxes
2. Register vehicle via agent: You being the owner of the vehicle provide those documents to some agent for registration process. That agent charges some commission along with the required tax and fees to register your vehicle. The agent then submits those documents to a relative government department (Excise) and gets your vehicle registered.

### 5.2 Vehicle transfer of ownership

Vehicle transfer to another owner's name

is also very complicated as it again requires number of documents. In order to transfer vehicle to another owner’s name, the following process is followed.

1. You need the following documents:
  - Transfer Order (T.O) Form
  - Photo copy of Seller’s CNIC.
  - Photo copy of Purchaser’s CNIC.
  - Photocopies of Witnesses.
  - Original Registration Certificate containing update payment of Token Tax.
  - Original Registration File in case of vehicles registered under the “File Return Scheme”
  - Duplicate Registration Certificate.
2. Transfer a vehicle via agent: In order to transfer a vehicle on the purchaser’s name, you submit all the required documents to an agent who charges some commission to transfer your vehicle. The agent then submits those documents to a relative government department (Excise) and the transfer process begins. This process is also time taking and needs time from 10 days to even 1 month.

### 6. The Process of Automonile Regisration on Proposed Platform

Hyperledger fabric platform was used to implement the proposed system. High-Level Functioning (HLF) is a type of permissioned blockchain network in which participants are familiar and identifiable, but do not have complete trust in one another. As a result, organizations can take advantage of DLT without the need for a cryptocurrency [15].

- Fabric is composed of modular building blocks that can be connected together to make the following components:
- An ordering service atomically transmits

state changes to its peers and consensus on the sequence of transactions.

- A membership service provider (MSP) is responsible for connecting peers with cryptographic identities and preserving the authorized nature of Fabric.
- A peer-to-peer gossip protocol disseminates the block's output by ordering service to all peers.
- In Fabric, smart contracts are executed in a container-based environment for isolation. These contracts can be implemented using standard programming languages, but they do not directly interact with the ledger.
- The ledger is maintained locally by each peer, in the form of an append-only blockchain, and serves as a record of the most recent status in the key-value store [16].

Stakeholders involved in the Blockchain Automobile Registry Platform are as follows:

- **Manufacturer:** A person who creates ownership first time, pays tax to FBR, transfers pkr token access and interacts with the seller and gets the ownership.
- **Customer:** A person who observes the list of owned cars, transfer pkr token, transfer owned vehicle to another person.
- **FBR:** A person who handles tax management.

#### A. Sign In/Sign Up:

To access the features of the Automobile Registration System website, you need to sign in or sign up for an account. Follow these steps to get started:

Sign In:

1. Visit the website's homepage.
2. Enter your registered email address and password.

3. Click on the "Sign In" button to log in to your account.

Sign Up:

1. Visit the website's homepage.
2. Press the "Create Account" button.
3. Provide the required information, including your name, email address, password, and any additional details.
4. Click on the "Sign Up" button to create your account.

#### B. Vehicle Manufacturing (For Manufacturers):

The Automobile Registration System website offers an exclusive section for vehicle manufacturers to register the manufactured vehicles. Follow these steps to register a vehicle being a manufacturer:

1. Log in to your manufacturer account.
2. Click on the "Manufacture Vehicle" button located at the bottom of the homepage.
3. Fill in the necessary vehicle details, including the make, model, manufacturing date, and other required information.
4. Review the manufacturing details and ensure they are accurate.
5. Click on the "Manufacture" button to initiate the vehicle manufacturing process.

#### C. Buy PKR Tokens:

The Automobile Registration System website allows you to transfer PKR tokens securely. Follow these steps to transfer PKR tokens:

1. Log in to the authority account.
2. Click on the "Transfer PKR Tokens" button at the top right corner of the

homepage.

3. Enter the recipient's CNIC and the number of PKR tokens you wish to transfer.
4. Review the transaction details and ensure they are accurate.
5. Click on the "Transfer" button to initiate the PKR token transfer.
6. You have successfully transferred PKR tokens

#### D. Buy PKR Tokens:

The Automobile Registration System website enables you to transfer vehicle ownership securely. Follow these steps to transfer vehicle ownership:

1. Log in to your account.
2. Navigate to the list of vehicles that are in your ownership.
3. Click on the "Transfer Ownership of Vehicle" button on the desired vehicle.
4. The vehicle details will be automatically filled based on the vehicle that you click on.
5. Provide the details of the new owner, including their name and CNIC.
6. Review the transfer details and ensure they are accurate.
7. Click on the "Transfer Ownership" button to initiate the vehicle ownership transfer

#### 7. Smart Contracts to Trigger the Events

A smart contract is a program executed in a blockchain system that utilizes consensus protocol to execute a sequence of transactions. A smart contract may be used in a variety of ways to eliminate the third-party transaction and automate the system [17, 18]. We developed the smart contracts, or chaincode, using the Go programming language. This

enables us to define the business logic and rules governing the registration system, ensuring transparency and consistency. Below are the contracts:

##### 7.1 For Vehicle Manufacturing:

In the below smart contract function, we will create a new structure instance for registering a vehicle. We decrease the 16 percent of pkr tokens from the manufacturer's wallet, transfer them to tax authority and register the vehicle as a manufacturer. Pseudocode is the following:

```

1: procedure Manufacture (
    manufacturerCnic,
    engineNo,
    chassisNo,
    companyName,
    year,
    type,
    model,
    ownerCNIC,
    sold,
    launchingPrice,
    transferDate
)
    » Get wallet details by cnic
    » calculate tax e.g 16%
2: Manufacturerwallet ← GetState (manufa
    cturerCnic)
3: TaxAmount ← launchingPrice * 0.16
    » transfer 16% amount to fbr wallet
4: transferResult ← transfer(manufacturer
    Cnic, FBRCnic, TaxAmount, "FBR"
)
5: if transferResultStatus ≠ 200 then
6: return transferResult
7: return SaveNewVehicle(

```

```

    manufacturerCnic,
    engineNo,
    chassisNo,
    companyName,
    year,
    type,
    model,
    ownerCNIC,
    sold,
    launchingPrice,
    transferDate )

```

8: **end**

### 7.2 For Vehicle Manufacturing:

Below is pseudo code for vehicle transfer of ownership.

```

1: procedure TransferOwnership (
    EngineNo,
    ChasisNo,
    CompanyName,
    RequestorCnic,
    newOwner
)
2: Key ← CreateKey (
    EngineNo,ChasisNo, CompanyName
)
3: vehicleData ← GetState(Key)
4: if vehicleData.OwnerCNIC ≠
    RequestorCnic then
    return error
5: vehicleData.OwnerCNIC ← newOwner
6: vehicleData.TransferDate←
    CURRENTDATE
7: UpdateState(Key, vehicleData)

```

8: **return** success

9: **end**

### 7.3 For tracking the history of vehicle:

The pseudocode for tracking the history smart contracts is the following:

```

1: procedure GetVehicleHistory (
    EngineNo,
    ChassisNo,
    CompanyName)
2: key ← CreateKey(
    EngineNo,ChassisNo,CompanyName)
3: vehicleHistory ← GetHistoryByKey(key)
4: counter ← 0
5: resultJSON ← ""
6: While(records←
    vehicleHistory.HasNext())
7: resultJSON ← concatenate(resultJSON,
    records)
    counter ← counter+1
8: return resultJSON
9: end

```

## 8. Tools and Technologies

To implement the system, we utilized various technologies and tools:

**Hyperledger Fabric:** We chose Hyperledger Fabric as the underlying blockchain framework. The Hyperledger Fabric is a permissioned blockchain platform aimed at business use. It is open-source and based on standards, runs user-defined smart contracts, supports strong security and identity features, and uses a modular architecture with pluggable consensus protocols [19]. It provides the necessary infrastructure to create a secure and efficient network.

**Chaincode in GoLang:** We developed the smart contracts, or chaincode, using the Go



programming language. This enables us to define the registration system's business logic and rules, ensuring transparency and consistency.

**CouchDB:** We utilized CouchDB as the state database for storing the immutable ledger of transactions. CouchDB provides a distributed, fault-tolerant, and highly available storage solution that ensures data integrity and accessibility.

**MongoDB:** For managing user data, we implemented MongoDB as the database. It allows us to store and retrieve user information for the purpose of authentication.

**Dockerization:** Each service, including the peers, orderers, and CouchDB instances, is containerized using Docker. This ensures easy deployment, scalability, and management of the system components in a consistent and isolated environment.

**Hyperledger Node SDK:** We utilized the Hyperledger Node SDK and related libraries to facilitate communication with the network layer. This SDK provides a set of APIs and tools to interact with the blockchain network, submit transactions, query data, and manage identities.

### 9. Results and Discussion

We have seen above the procedure to register and transfer vehicles using our system. Below we have provided a comparison table of features between the existing and proposed system.

**Table 1** Comparison between the existing system and our proposed system

Existing system	Our proposed system
Data loss and chances of hacking	Immutable and secured due to distributed ledger technology

Lack of physical infrastructure - downtime	No downtime and able to operate 24/7.
Complex system and inaccurate information	The smart contract verifies legal ownership and transfer of assets.
Lack of technical competency	Hybrid Blockchain as it provides transparency and privacy.

The proposed blockchain system removes many vulnerabilities and increases the efficiency of the automobile registration and transfer system by reducing the time required to process the records. All the transactions on the blockchain network are immutable, preventing unauthorized changes to vehicle registration and owner's data. Self-executing smart contracts automatically verify the legal ownership and transfer of assets, providing transparency and eliminating ambiguity. Furthermore, our system provides real-time tracking features, enabling stakeholders to monitor the status of vehicle registrations. This real-time visibility further contributes to the transparency throughout the entire process.

In addition, we added the feature to track the history of the vehicle. Our system takes the vehicle engine number, chassis number, and company name as input and returns the history of the vehicle from the first owner to the current owner in JSON format. The function creates a composite key using the provided arguments, iterates through the history records, and appends the transaction ID and corresponding value to a local variable in JSON format. It finalizes the JSON response by adding the total count of transactions and wraps the transaction data in a JSON object and returns the final JSON response as a

success response.

```
7899_6456_yamaha
Wallet path: C:\Users\qadil\Desktop\basicNetwork\BasicNetwork\Finalized-Docker\BasicNet
{"counter": 2, "txns": [{"txn": "0334be8e0f1b247ad37dada70bb93eb20fc81afce1341e56f4871b
engineNo": "6456", "chassisNo": "7899", "year": "2023", "type": "car", "make": "", "model": "city",
299610969", "ownerCNIC": "CNIC.123456789000", "soldPrice": "2500", "launchingPrice": "2600",
09cc45bfc0f9eb846584d9181b27f47580602a1f3ab22657ee3c0bf", "value": {"docType": "VehicleA
r": "2023", "type": "car", "make": "", "model": "city", "companyName": "yamaha", "manufacturerCnic
soldPrice": "2500", "launchingPrice": "2600", "transferDate": "0/5/2023"} ]}]
```

**Fig. 3:** Automobile Registration Process on Blockchain

## 10. Conclusions

Our research has presented a novel blockchain-based framework for the automobile registration system, comparing it with the traditional web 2.0 system. A decentralized computing paradigm has been introduced by leveraging blockchain technology, effectively addressing the challenges associated with centralized trust [20]. The blockchain solution offers enhanced privacy, traceability, and ownership validation, addressing the challenges of data manipulation and fraud faced by conventional systems. By exploiting the transparency and immutability of blockchain technology, the proposed system ensures secure registration records that cannot be tampered with by any single entity. The ownership transfer functionality provides a secure and efficient means of transferring vehicle ownership, maintaining transparency and traceability throughout the process. The implementation of the Hyperledger Fabric demonstrates the validity of the proposed approach, utilizing privacy algorithms and efficient consensus mechanisms. The performance evaluation of the system indicates that the introduction of privacy algorithms has minimal impact on blockchain performance, while the privacy analysis confirms the robustness of the system in protecting sensitive information. The Automobile Registration System on Blockchain presents a groundbreaking solution that establishes a trustworthy and tamper-proof framework for vehicle registration, paving the way for secure and efficient transactions in the automotive industry.

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