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THE METHODOLOGIES IN VEHICLE REGISTRATION AND TRACKING SYSTEM IN NIGERIA, A TECHNOLOGICAL APPROACH

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ABSTRACT

This research explores a technological approach to vehicle registration and tracking in Nigeria, focusing on Jalingo, Taraba State. Traditional vehicle registration processes in Nigeria are often time-consuming, prone to errors, and vulnerable to fraud. This paper proposes a real-time smart vehicle registration and tracking system integrating smart technology with GPS and GSM communication modules to enhance security, streamline registration, and enable efficient tracking of vehicles. The system aims to address challenges such as manual data entry errors, document forgery, lack of real-time tracking, and poor network connectivity seen in current models. A phased development methodology was adopted, involving requirements analysis, system development, testing, deployment, and evaluation. The proposed system promises improved vehicle management, faster registration processes, and enhanced law enforcement capabilities through real-time vehicle tracking and data accessibility.

1. Introduction

The procedure for adding a vehicle data to the register and issuing its identification information, which includes plates number, with the sole purpose of establishing clear ownership of vehicle by the vehicle owner is known as vehicle registration. In a clear sense, every vehicle must have a license number assigned to it which help in traffic management and keep track of vehicles on the road (Atianashi & Miracle, 2023). Therefore, it is mandatory for each vehicle to have a registered license vehicle identification number, which serves as their primary identifier after registration (Ibiyemi *et al*., 2020). Transportation is the movement of people, goods and services from one place to another. In Nigeria we can differentiate the common types of transportation in three categories. Such as Airline, water, railway and land transportation as the common mode of transportation this process of transportation have several methods of execution facing defaults in their processes. Because of this, the current vehicle registration and management system in Africa faces inefficient registration process, which makes registration process be time-consuming and involve complex paperwork, as documented by Rajesh and Sivaprakash, (2020). Data on registered vehicles may not be readily available to authorized personnel, hindering law enforcement and emergency response efforts. The current systems lack the ability to track vehicle in real-time, making it difficult to monitor stolen vehicles, and enforce regulations. Susceptibility to fraud registration documents is vulnerable to forgery and manipulation, posing security risks in Africa. Therefore, this research is to develop a software framework for real-time smart vehicle registration and tracking system using QR codes to address these issues in Jalingo, Taraba State Nigeria.

The aim of this research is to consider a technological approach to vehicle registration and tracking processes by carryout analysis of the current system to identify key requirements and specifications, and develop a technological approach into vehicle registration and tracking process improving vehicle registration and tracking within Jalingo Taraba state Nigeria in Africa.

2. Literature review

Public transportation systems have undergone significant changes in response to shifting demand patterns and technological opportunities. Real-time crowding information, predictive maintenance systems, and personalized service alerts have become standard features in leading transit networks (Davies & Smith, 2023). Many transit

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agencies have reconfigured service patterns to reflect changing demand. Bus network redesigns emphasizing frequency and connectivity have been implemented in over 30 major cities since 2021 (Cervero & Lin, 2024). Several cities, including Paris, Barcelona, and Seattle, have created extensive networks of dedicated bus lanes, increasing operational speeds by 15-30% by C40 Cities, technological hub in 2023.

2.1 Mobility as a Service (MaaS)

Transportation modes through digital platforms have continued to evolve to mobility as a service platform have expanded in scope and functionality. By 2024, leading applications in major urban centers integrated public transit, ride-hailing, micromobility, car-sharing, and parking services within unified interfaces. Payment integration across modes has become more seamless, with subscription models gaining traction in European and Asian markets (Jappinen & Shibata, 2023). The mobility as a service concept have expanded beyond urban cores to serve suburban and rural areas. Demand-responsive transit services integrated with digital platforms have been implemented in over 200 low-density regions worldwide by 2024, providing flexible first/last mile connections.

Transportation infrastructure has increasingly been designed with sustainability and resilience in mind. Green infrastructure elements, such as bioswales and permeable surfaces, have been incorporated into street designs to manage stormwater and reduce urban heat island effects. Despite significant progress, several challenges and uncertainties remain a concern to digital divides and economic disparities continue to affect transportation access. Low-income communities often have less access to new mobility services and electric vehicle charging infrastructure. Addressing these disparities requires intentional policy interventions and inclusive design approaches (Robinson & Washington, 2023). Sustainable funding mechanisms for transportation infrastructure remain challenging as fuel tax revenues decline with increasing vehicle efficiency and electrification. Road usage charging systems have been implemented in several regions, including Oregon and Singapore, but widespread adoption faces political obstacles.

2.2 Techniques for Vehicle Tracking System

The advent of technology has significantly transformed vehicle management systems, particularly in vehicle registration and tracking system. smart vehicle registration tracking systems utilizing new technologies will enhance security, improve streamline processes, and provide immediate access to vehicle information. Vehicle registration and tracking systems are designed to monitor the location and status of vehicles in real-time. These systems typically integrate hardware components with software applications that allow users to access location data, alerts, and other relevant information to enhancing user experience in different technologies.

2.3 RFID-Based Tracking

Radio-Frequency Identification (RFID) involves the use of tags and readers to track vehicles. RFID tags can be attached to vehicles, and readers positioned at strategic locations to identify and track the vehicle's movement. This method is useful for tracking within specific zones or facilities. Combining GPS, RFID, and QR code enhance tracking accuracy and reliability. A hybrid approach leverages the strengths of each technique, providing robust tracking capabilities across different scenarios.

2.4 GPS and GSM Integration

The integration of Global Positioning System (GPS) technology with Global System for Mobile Communications (GSM) is fundamental in vehicle tracking. GPS provides accurate location data, while GSM enables communication between the vehicle and a central server. Ashutosh *et al.* (2021) describe a system that utilizes GPS data transmitted via GSM, allowing users to track their vehicles in real-time through web interface. GPS is a satellite-based navigation system that provides accurate location information anywhere on Earth. It operates by triangulating signals from multiple satellites, enabling precise determination of a vehicle's coordinates (Zhou *et al.,* 2018). In vehicle tracking, GPS facilitates real-time location updates, speed monitoring, and route optimization, which are essential for effective fleet management and personal vehicle security (Sharma & Kumar, 2023). GSM is a mobile communication standard that enables voice and data transmission via mobile networks. It allows for continuous communication between vehicles and tracking servers (Singh & Gupta, 2021). By using GSM modules, the tracking system can send GPS data to a central server or a user's mobile application in real time, ensuring that users receive timely updates regarding their vehicle's location (Patel *et al.,* 2023). Integration of GPS and GSM in Vehicle Tracking Systems, a typical architecture for a vehicle tracking system involves a GPS module integrated with a GSM module. GPS module collects location data, which is then transmitted via the GSM module to a web server or mobile application, incorporation of QR codes allows for easy access to vehicle information, facilitating quick retrieval and updates on a user-friendly interface (Zhang *et al*., 2021).

The real-time tracking capability is achieved by periodic GPS data collection and GSM transmission. Users can

monitor their vehicle's location on a map interface, receiving alerts for unauthorized movements or deviations from predetermined routes (Ali & Kumar, 2022). It integration significantly enhances security, allowing vehicle owners to track stolen vehicles quickly. GSM networks provide a reliable means of transmitting GPS data. The use of SMS or data packets ensures that location information is sent to the server with minimal latency (Reddy & Rao, 2023). In cases of poor connectivity, stored data can be sent once the connection is restored, ensuring no loss of critical tracking information (Bansal & Singh, 2022).

2.5 Smart Vehicle Registration and Tracking Technologies

Smart systems and GPS integration in vehicle tracking systems are readability issues with accuracy in varying environmental conditions, GPS Signal Interference such as maintaining signal integrity in urban areas or under adverse weather conditions and Data Security concerns regarding the protection of sensitive vehicle tracking data from unauthorized access or cyber threats. The use of web-based technologies for remote access to tracking information. Khin *et al*., (2021) developed a vehicle tracking system that integrates Arduino with GPS and GSM modules, providing real-time updates displayed on Google Maps via a web application enhancing user experience by allowing flexible monitoring from any location. Node.js is effective for handling multiple concurrent connections in real-time data processing and tracking systems (Gupta & Sharma, 2023).

Its flexible schema allows for easy modifications, supporting the dynamic nature of vehicle data (Zhang *et al.*, 2021). MySQL as a relational database management system, MySQL can be used for structured data storage, particularly for user information and registration details. It provides robust data integrity and support for complex queries.

APIs and Web Services RESTful APIs Representational State Transfer (REST) APIs facilitate communication between the frontend and backend components of the system. They allow for seamless data exchange, enabling functionalities such as real-time location updates and user management (Khan *et al*., 2021). WebSocket for real-time communication, WebSocket technology provides a persistent connection between the client and server. This is essential for instantaneous location tracking and alert notifications (Ali *et al.*, 2022).

3. Methodology

The primary method of data collection for this research includes vehicle registration records, tracking data, information including vehicle details such as model, registration number, and owner information, as well as historical tracking data. Accordingly, data is collected from local vehicle registration authorities and transportation departments in Jalingo, Taraba State. This involves collecting records from government databases, vehicle registration offices, and field surveys to ensure comprehensive coverage.

Data processing steps include data cleaning, normalization, and integration. This process ensures that data is accurate, consistent, and formatted correctly for analysis and system implementation. Examining of missing values and duplicate records to maintain data integrity. The technological development approach is described in different phases as seen in Table 1.

Stages	Requirements
Phase 1: Preparation	Requirements analysis, stakeholder consultations, technical specifications development, hardware/software procurement.
Phase 2: Development	System coding using PHP/MySQL, QR code generation module integration, user interface design, database architecture implementation.
Phase 3: Testing	Internal testing with registration office staff, bug identification and resolution, user training programs.
Phase 4: Deployment	Phased rollout beginning with new registrations, gradual migration of existing records, parallel operation with manual system.
Phase 5: Evaluation	Performance monitoring, user feedback collection, system refinement based on operational experience.

Table 1: Development Approach for vehicle registration system

The development process for Vehicle Registration and tracking is seen in five phases from requirement analysis to performance monitoring as shown in Table 1.

4. Results and Discussion

The existing system approach for vehicle registration process are; Manual form filling, reviewed, archived in physical storage and Paper Based Registration model this process faces a lot of challenges which includes errors in manual entries and illegible handwriting, Risk of document loss or damage, Delays in processing and retrieving data, and Forgery of documents increases security concerns, and poor networking capabilities even with a bit of an electronic registration system. Processes with digital databases store vehicle information via electronic forms, this process faces several challenges such as; no real-time tracking capabilities, limited user-friendly features, poor networking functions and leverage on localized storage dependences. Figure 1 illustrates the mode approach in vehicle registration system process.

The Design process is a movement from the logical to physical stage of the system for real time vehicle registration and tracking system is classified into two phases, the system design and detail design. The system requirement identified in the analysis stage of the development to this approach are the principal input into the design phase. The word "SYSTEM" has different definition to various people depending on their discipline. According to Corbado, 2025, A system refers to an integrated collection of components that work together to accomplish specific functions or goals. This involves the abstraction, from hardware configurations to software architectures or is a set of interrelated components that interact toward achieving a purpose Systems can be physical (hardware), logical (software), or a combination of both. Example are information system, embedded system, security systems, distributed system and operating systems. This framework system design involves unified modeling system diagram.

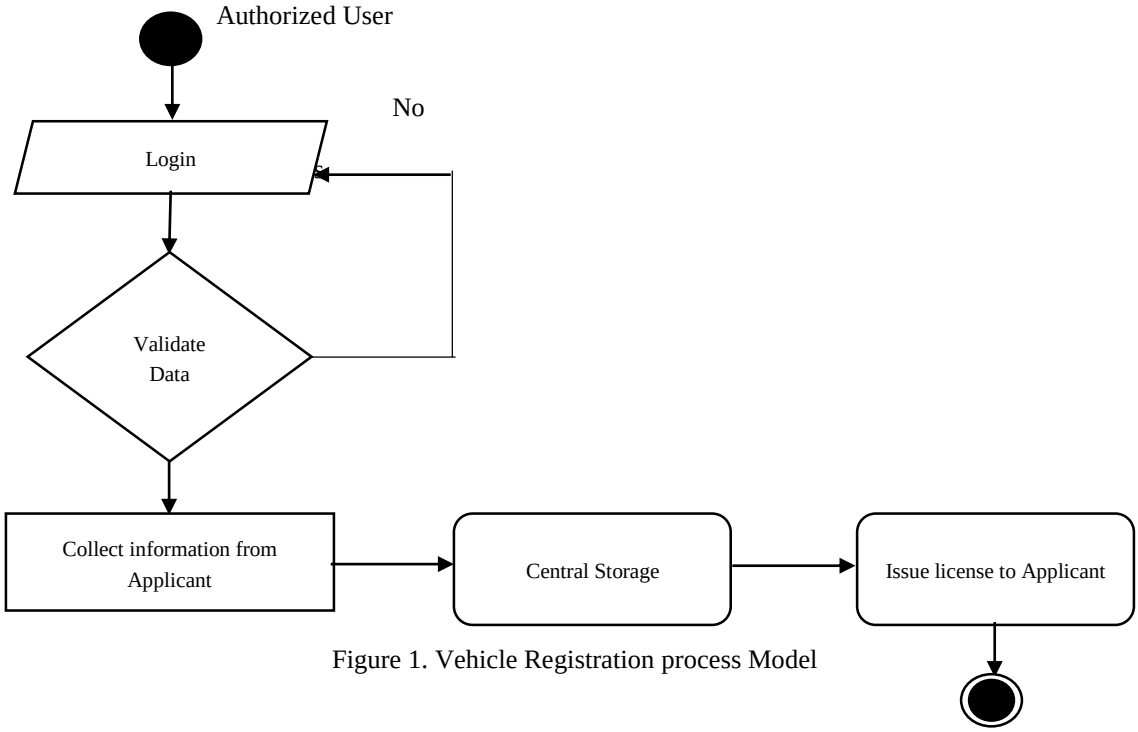

Figure 1. Vehicle Registration process Model

The administrator in operation of the software validates collected vehicle data, send to the central database system integrated to authorize vehicle user with license as show in Figure 1.

5. Conclusion

This paper discus vehicle registration and tracking system using smart systems integrated with GPS and GSM technologies, which significantly improve the efficiency, security, and reliability of vehicle registration processes in Nigeria. Transforming from manual, paper-based registration methods to integrated technological platforms, vehicle data can be managed more accurately and accessed in real-time, aiding law enforcement and public safety. Despite challenges such as network limitations and environmental factors affecting GPS performance, the process provides a

scalable and practical solution for Jalingo vehicle registration office, Taraba State, addressing issues and development of smart technological approaches to vehicle management in Nigeria.

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