



## Design of a Web-Based Vehicle Registration System Using QR Code

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### Abstract

The emergence of Information Technology (IT) and its application to our everyday life has made life easier by improving on the manual processes and operations across every facet of life. Information Technology has made great impacts on applications including health, finance, agriculture, and most importantly as this study is concerned with vehicle registration. In Nigeria, the whole vehicle registration process used to be purely manual; however, the current process is a combination of manual and technology-driven processes where problems such as inaccuracy, inefficiency and lack of flexibility still exist. Hence, this study is aimed to design and develop an online vehicle registration that would integrate different forms of registration needed for vehicle use. The designed system incorporates vehicle and user information page into a QR code such that the information can be accessible when the QR code is scanned. The study highlights related work from different studies, and provides useful recommendation for the improvement and deployment of the vehicle registration system in Nigeria.

**Keywords:** Information Technology, Vehicle registration, Technology driven, QR code.

### 1. Introduction

Vehicle registration is the process of adding a vehicle to the motor vehicle register and issuing its identification information, including registration plates, with the sole purpose of establishing clear ownership of vehicle(s) by the vehicle owner. Ideally, every vehicle must

The aim of vehicle registration is to be sure that all vehicles on the highways are safe, roadworthy, meet required standards and enforce traffic laws. To register a vehicle, one must provide the proof of ownership, proof of insurance, and payment of any registration fees or taxes, information about the vehicle, such as its make, model, year of manufacture, engine

have a license number assigned to its number plate to help in traffic management and keep track of vehicles [1]. It is, therefore, mandatory for each vehicle to have a license number, which is also known as a vehicle identification number (“VIN”), which makes them partake in public traffic and serves as their primary identifier after being registered [2].

number, chassis number, and other relevant details. The vehicle owner must also provide personal information, such as his name, address, and identification documents [1]. This registration in Nigeria used to involve the manual recording on ledgers of vehicle information that includes information on cars, buses, trucks and heavy-duty equipment, registration, roadworthiness test certificates, engine and chassis numbers, change of ownership and expiration of road licence. The question of the inefficiency of the registration could be a function of the nature of the manual process of these bulk sections.

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Information and communication technology (ICT) have revolutionised every aspect of human life, including the automation of vehicle registration systems [3]. The vehicle registration system collects data and stores information about the type of vehicle, the vehicle owner's data, and the vehicle's make and model, among others [4]. These data can become so enormous and need to be effectively managed, stored and processed. It is no news that technology has been discovered to be an instrument of very high efficiency that has played very significant roles in storing, managing, and even analysing data to give meaningful information. Incorporating computers in the registration of vehicles would certainly be a step to ensuring efficiency in the registration of vehicles especially as it would require the storage, management and processing of huge data. This process can be referred to as computerisation of vehicle registration.

In Nigeria, three arms of government agencies are responsible for automobile licensing, registration and control. They are the Federal Road Safety Commission (FRSC), the State Vehicle Inspection Office (VIO), and the State Board of Internal Revenue (BIR). The usual practice is for an individual to visit these three arms for the necessary payment, data collection and issuance of necessary documents and materials, such as plate numbers [5].

On the other hand, the State Vehicle Inspection Office (SVIO) has a specific role of testing for drivers' licenses and issuing a certificate of roadworthiness. Lastly, the Motor Licensing Authority (MLA) at the Local Government Level who collects revenue from motor vehicle-related activities.

Law enforcement officials will be able to track down stolen vehicles, identify abandon vehicles and those vehicles that were involved in accidents or other incidents on the road. The specific requirements for motor vehicle registration vary depending on the region, but in most cases, vehicles must be registered annually or biannually, and registration fees must be paid at the point of registration. In addition, vehicles may be required to undergo periodic inspections to ensure that they remain roadworthy and meet certain safety standards [1]. Vehicle registration can be done basically

in two ways which include manual process and computer-based process.

A manual system is a system that operates without the use of automated technology, such as computers or machines. It relies on human effort to carry out the process of vehicle registration and achieves desired outcomes. Manual systems have some advantages, such as low-cost, simple, and easy to use. They can also be more reliable in certain situations where technology may fail or break down. However, they also have some disadvantages, such as being time-consuming, prone to errors, and limited in terms of scalability and efficiency. Computer-based process involves the use of computers to automate all the processes involve in vehicle registration [1]. The computerized motor vehicle registration systems have a body that is legally recognized and they are the only ones that can execute the registration process [6].

Apart from other advantages, the computerised motor vehicle licensing system will replace the manual process of registering vehicles, issuing licenses, renewing expired licenses, and changing of ownership of the vehicle. Since the computerised mode of operation is flexible and accurate record keeping is assured, it will give the management of the motor licensing authority enough time for planning and decision-making rather than being immersed in the details of routine functions [5].

However, the computerised vehicle registration system in Nigeria has not really been effective. Hence, there is a need for a web-based vehicle registration for effective handling and processing of the huge amounts of data from these processes to avoid data and information loss and to encourage easy tracking and retrieval of this information when needed.

## **2. Related Works**

This section describes related studies that have been implemented or proposed as regards the design of vehicle registration systems around the globe. It features the process of obtaining vehicle registrations and the quality of the vehicle registration data. Recently, urban areas have experienced increasing problems due to the incremental nature of vehicular traffic. The main reasons are the development of urban cities and an increase in cars and vehicles. The

congestion of traffic, rules violations, and car stealing are the challenges of today's transportation and management system. Many solutions to these problems include intelligent traffic surveillance [7], autonomous vehicles and speed detection [8].

Jawale *et. al.* [9], talked about the Automatic License Plate Detection and Recognition (ALPDR) systems, proposing four steps. These include license plate extraction, image pre-processing, character segmentation and character recognition. Penmatsa *et. al.* [10] presented an image processing technique for Indian license plate detection and recognition with various conditions such as noisy environments, low light, non-standard license plates and cross-angled situations. They used pre-processing techniques such as Gaussian smoothing, morphological transformation, and Gaussian thresholding in their system.

Furthermore, Sathya *et. al.* [11] proposed a framework which checks the license plate number with the authorised user database and only allows authorised vehicles. In this feature extraction has been used by using the technique called histogram of oriented gradient. The number of identified vehicles shows the performance of this framework.

Oni *et. al.* [12] developed a web-based portal for vehicle licensing management. The authors presented the design framework for a client-server distributed vehicle administration database system to improve the system's performance and efficiency. The system was designed using PHP scripting, HTML, MySQL server, and Macromedia Dreamweaver. The system was tested using correctly chosen input data to ensure adequate reliability and accuracy, and its compliance with the specified requirement was evaluated.

Chimezie and Chukwudi [13] developed certain features, such as vehicle information storage and registration, from which the administrator of the system can control the entire system and change ownership. This framework is designed to help the management of vehicles retain vehicle registration licenses effectively, thus minimizing stress and manual effort.

A variety of technologies have been tested and used by many law enforcement agencies in

Nigeria. The technologies used in data collection and processing include various systems such as Mobile Phones and digital cameras. The use of online error checks and, subsequently the need for re-entering vehicle detailed data are not inevitable. Initially, these devices seemed to be the best solution to all the registration problems because they tackled the issue of payment of vehicle registration dues into the government's account. However, it still has its limitations, as it has not met the demands of the masses that anxiously await their demands to be met at the licensing/commission offices. Hence, full computerisation has not been achieved as expected, while technology and software programming have advanced in other countries.

### **3. Methodology**

The methodology of this research involves studying the existing vehicle registration systems in Nigeria i.e. both manual and online-based vehicle registration system. The study of these systems would provide insights into the drawbacks of the existing system and ways these drawbacks can be solved. Hence, a web-based vehicle registration system will be developed in this study to tackle the drawbacks of the existing vehicle registration system.

#### **3.1 Analysis of Existing Systems**

The existing system is a manual vehicle registration process that includes registration for plate numbers and driver's licenses, issuance of a certificate of roadworthiness and revenue payment process towards issuing the proof of ownership certificate. Different government systems do these processes and usually make the whole process slow, stressful, and ineffective. In addition, managing and processing vast amounts of data manually could result in data loss and inaccurate analysis.

#### **3.2 Drawbacks and Limitations of the Existing System**

The limitations and drawbacks of the existing systems provide a means to modify the new system. Overcoming the limitations of the existing system makes the new system more effective. For instance, the time-consuming caused utilizing the manual-based vehicle registration system makes the registration

process ineffective; people get stuck at one point or another and are always discouraged to complete the registration. The manual payment process brings about problems that need to be resolved manually, thereby taking days, weeks and even months to resolve. These and many more are the drawbacks the web-based vehicle registration system seek to solve. The automation of the registration process makes it very fast as long as the documents needed to be uploaded are ready. The payment process integrated with the system is made so that unsuccessful financial transactions do not affect the payer's account balance or the account that intends to receive the payment.

### **3.3 Analysis of the New System**

The web-based vehicle registration is an online system of vehicle registration that transits the manual process of vehicle registration online. This system helps vehicle owners carry out many vehicle registration processes on their own or through designated online centres. These processes include renewal of license, change of vehicle ownership and seeking new vehicle registration.

The web-based vehicle registration system consists of the frontend and backend of the system such that data inputted in the web is gathered, stored and effectively managed through a database management system such as MySQL at the back end. Many processes are done and controlled by the backend development, such as integrating the payment software (system), and managing the orders and registration processes by processing the issuance of certificates to anyone who registers.

Figure 1 shows a flowchart of the new system. The flowchart describes the process in the vehicle registration system, starting with a "Home Page". It then branches out based on whether the user is an admin or a customer. If the user is an admin, they are prompted to enter an admin password, and if the password is not valid, an error message is shown. If the user is a customer, they are prompted to enter a username and password, with a similar error message displayed for invalid entries.

From there, several options are available depending on the user's choices and the system's response:

- Admins can generate requests or view existing requests, update or delete records, and log out, which takes them back to the admin login page.
- Customers can register a vehicle, renew a license, change ownership of a vehicle, and log out, which takes them back to the login page.

The process includes decision points such as "Is login password valid?", "Register Vehicle?", "Renew License?", and "Change ownership?", with each leading to different actions based on a "Yes" or "No" response. The flowchart ends with a "Stop" step, which likely indicates the end of the process or the user exiting the system.

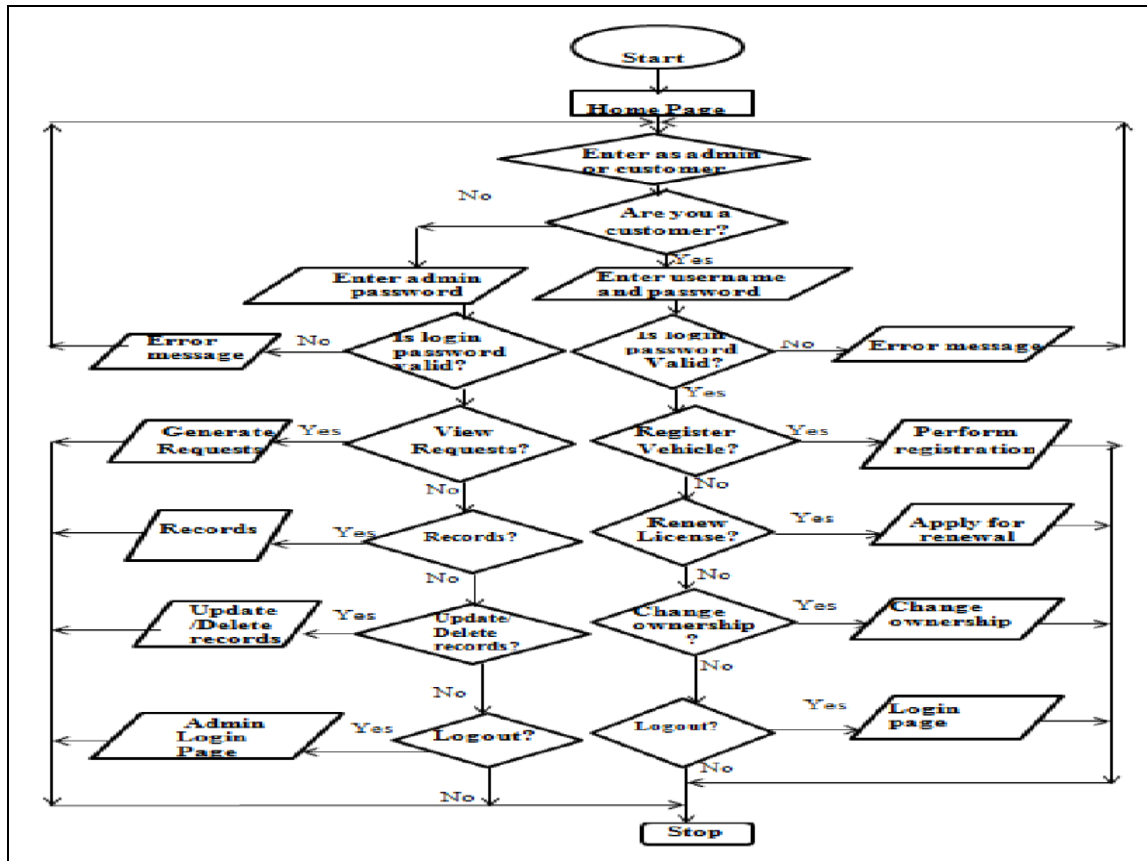


Figure 1: Flowchart of the new system

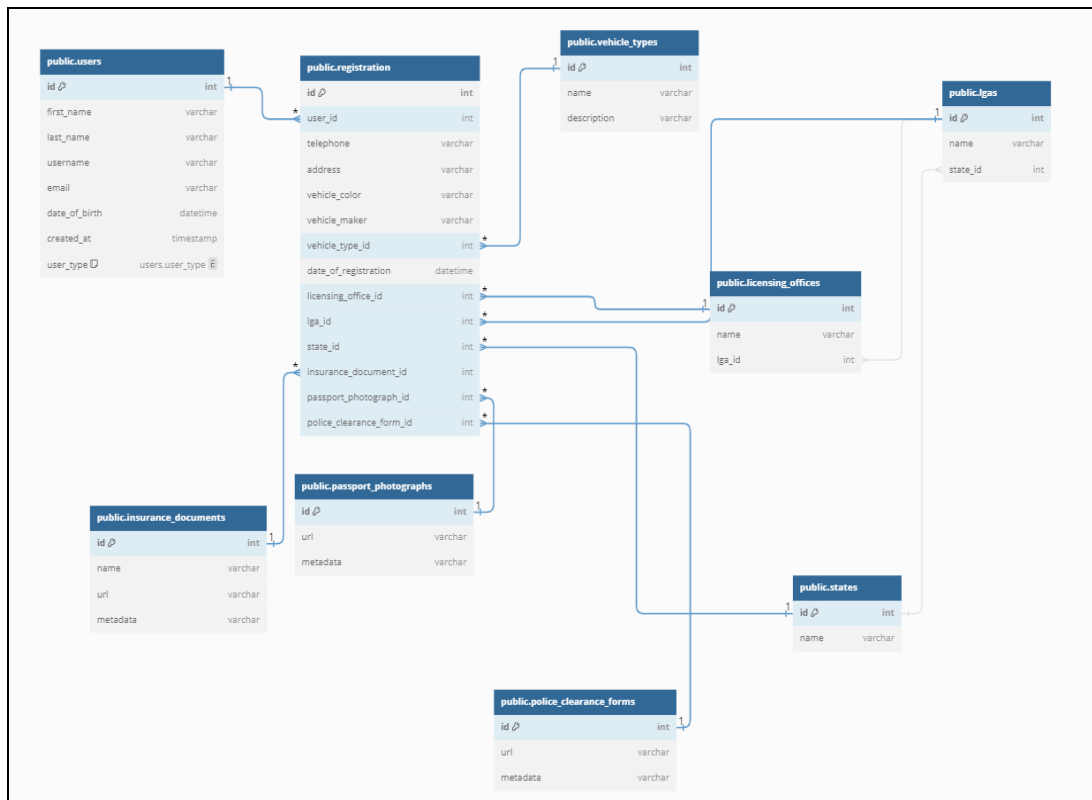
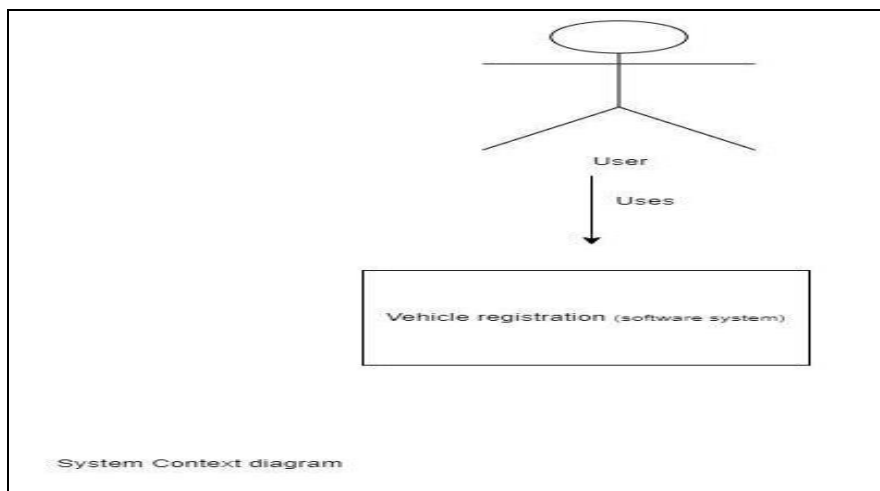


Figure 2: Database design of the new system.

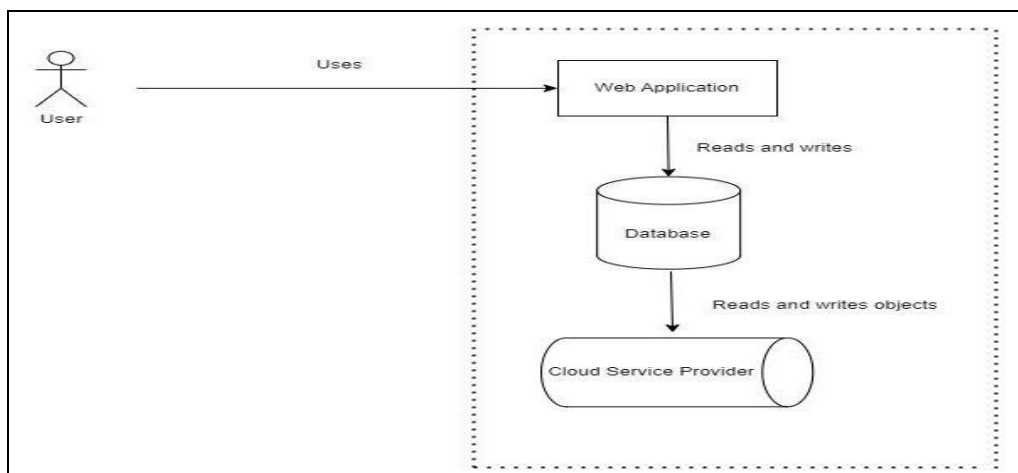
The database schema as shown in Figure 2 encapsulates a robust model for managing vehicle registrations in Nigeria. The schema is structured around normalized tables, adhering to fundamental principles of database management. It encompasses entities crucial to the vehicle registration process, including users, vehicle types, states, local government areas (LGAs), licensing offices, and insurance documents. Notably, file uploads such as passport photographs and police clearance forms are intelligently abstracted, with dedicated tables storing URLs and metadata. This design choice enhances scalability and encapsulates best practices in database management. Foreign key constraints are meticulously employed to maintain referential integrity, ensuring the coherence and reliability of the dataset. The system design framework used features a C4 (Context, Containers, Components, and Code) model approach.

The system context diagram in Figure 3 is a good starting point for our vehicle registration system. It is lacking in technical details as it allows a high-level overview of the entire system. The focus is on how the user interacts with the vehicle registration system.

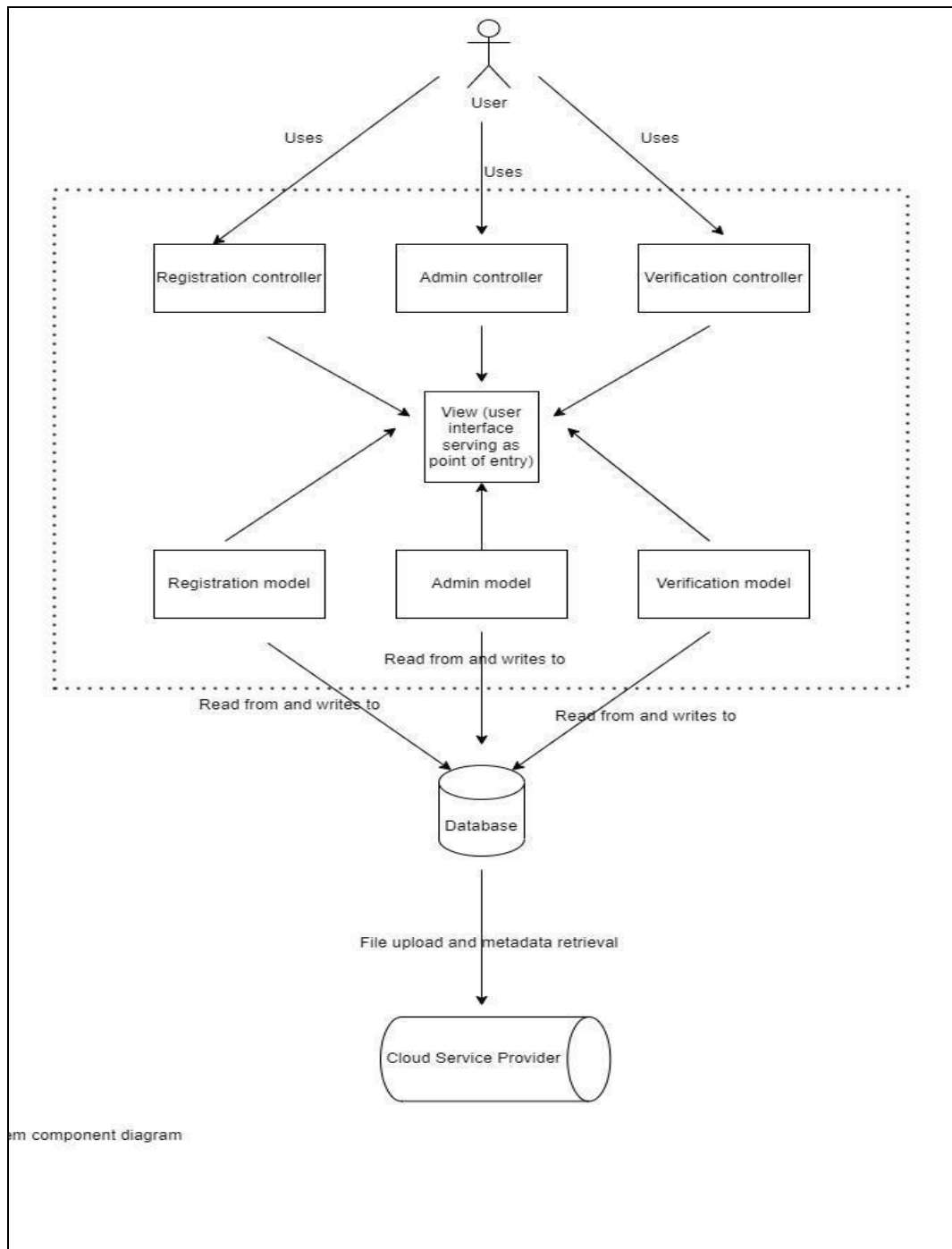
The system container diagram in figure 4 gives an indepth details into the major technology building block of our application. Essentially, a container is a separately deployable unit that executes code or stores data, allowing us to see major technological choices made for the software. For our application, we have 3 major containers: the web application, the database and the cloud service provider. The web application gives users the ability to interact with the entire application, the database allows for data upload and reading while the cloud service provider helps with file storage



**Figure 3:** System Context diagram



**Figure 4:** System container diagram



**Figure 5:** System components diagram

The system component diagram in Figure 5 features a further breakdown of each container into components. This component has primary responsibilities and focus on key areas of the container. Within the web application container, components like the controllers,

views and models handle various aspect of the application logic. The C4 diagram aims to offer a simplified view of the complex structure of a software system, making it easier for various stakeholders at various technical level to understand the overview of the entire system.

#### 4. Results and Discussion

This section presents some of the interfaces of the developed vehicle registration system.

##### 4.1 Homepage

The home page houses the summary of the designed system for easy navigation to any task that needs to be carried out within the system, as shown in Figure 6.

##### 4.2 Vehicle Registration

This section of the designed vehicle registration interface would automatically populate information from the sign-up page, and other information would be filled such as information on the vehicle, attachment of passport photograph, vehicle clearance form and insurance document as shown in Figure 7.

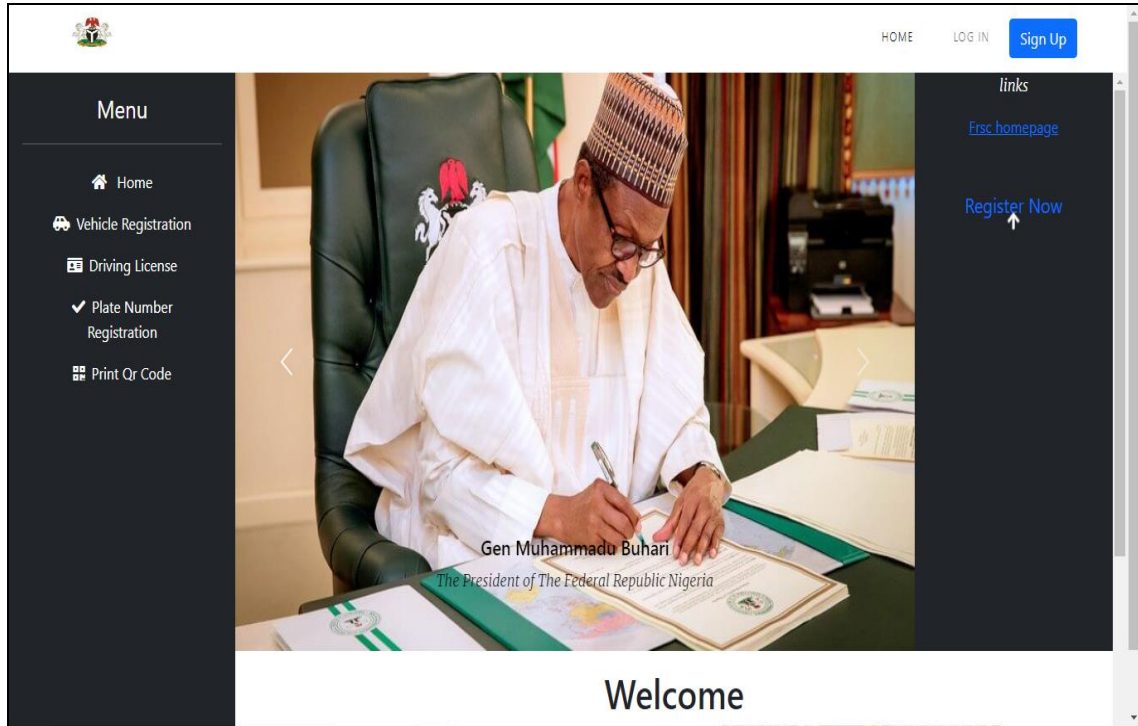


Figure 6: Homepage of the Designed Vehicle Registration System

Figure 7: Vehicle Registration Page of the User



### 4.3 Information Page

The information page consists of a summary of the information entered on the vehicle registration page. This enables road officers to glance at the vehicle registration status and the user. This is the page to be embedded in the QR coding system and the information displayed

when the code is scanned, as shown in Figure 8.

### 4.4 QR Code Page

Figure 9 shows the generated QR code for the information system. The generated QR code can then be scanned to show the information page.

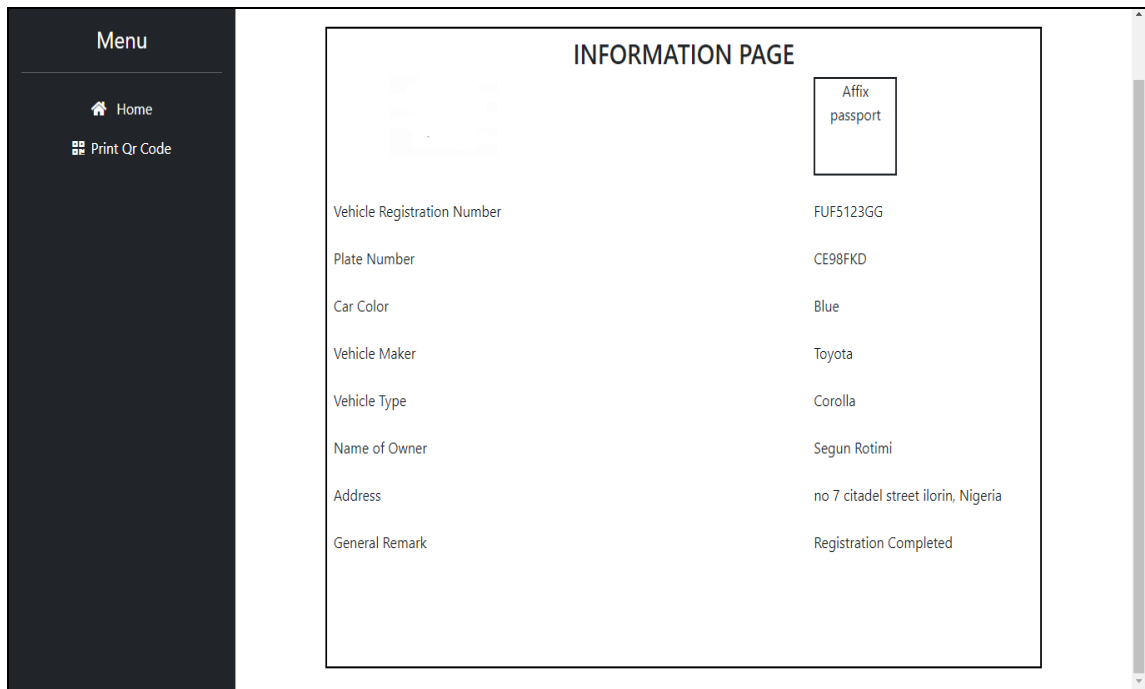


Figure 8: Information Page of the Vehicle Registration System



Figure 9: The QR code Page of the Vehicle Registration System.

#### 4.5 Print QR Code Login

Users who have generated their QR code can further print it out. The QR code can further be scanned by road officers or for other necessary purposes. Users are required to input their login details as an added security process as shown in Figure 10.

#### 4.6 Administrator's Login Page

The administration login page enables the system administrators to modify the users' web applications and data. This enables the

administrator to manage the system fully as shown in Figure 11.

#### 4.7 Testing and Evaluation

The testing in this study primarily aims to verify the fulfilment of functional requirements. This was carried out using potential users and stakeholders of the system. The system's functional assessment is presented in Table 1, encompassing the test process of each component. As shown in Table 2, the results indicate the achievement of the research objectives, and summarises the system's core functional requirement alongside its corresponding test outcomes.

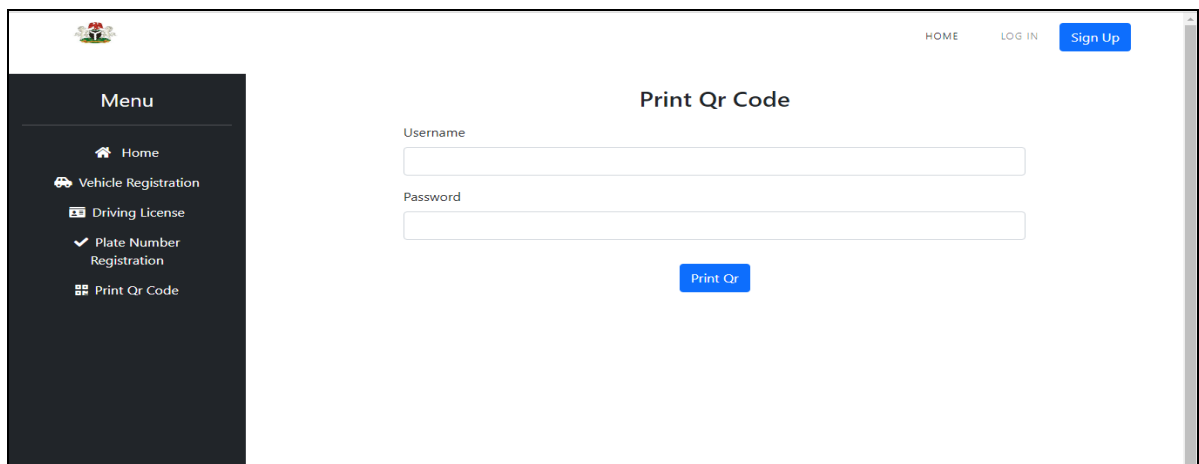


Figure 10: Print QR Page of the Vehicle Registration System

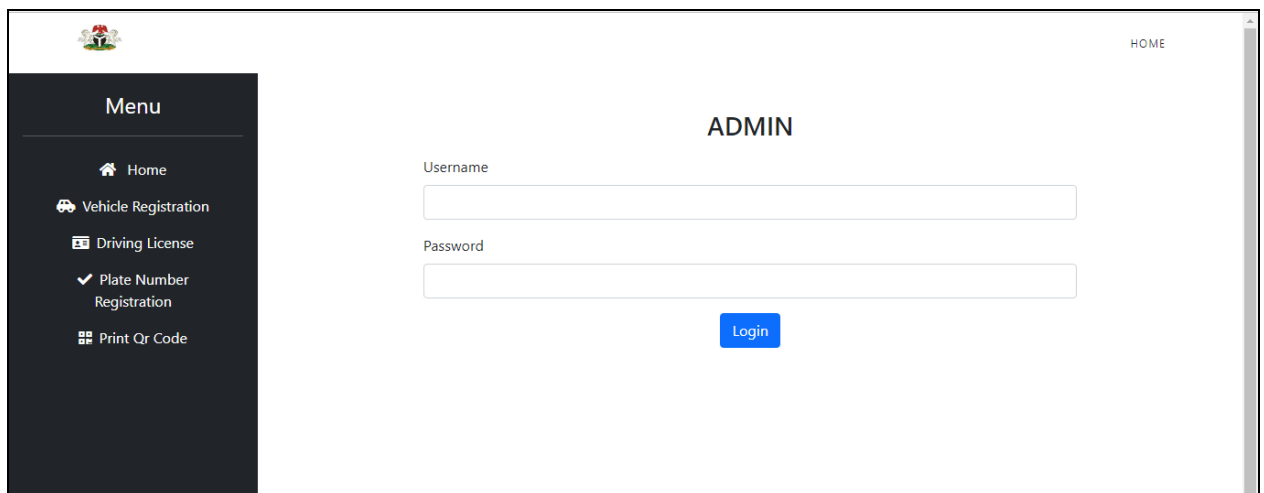


Figure 11: Administration Login Page of the Vehicle Registration System

**Table 1: Vehicle Registration System Testing and Evaluation Results**

	<b>Requirement</b>	<b>Test Process</b>	<b>Expected Result</b>	<b>Result</b>
1	System Implementation	Confirm that the system implementation aims to design and develop an online vehicle registration system	The system should be able to create an online vehicle registration system with QR code functionality.	Passed
2	The system's homepage should be functional and responsive	Verify the presence and functionality of the homepage	The homepage should provide a summary of the system for easy navigation	Passed
3	A user should be able to navigate through the system's menu function	Check if the menu functions correctly and displays the required options	The menu provides access to various functions, including vehicle registration, printing of QR code, signup, and login.	Passed
4	New registrants should be able to sign-up	Test the signup process for new users	New users can create accounts successfully	Passed
5	Existing users and new registrant should be able to login and perform all activities seamlessly	Test the login functionality for existing users and new user registration	Users can successfully log in with valid credentials, and new users can sign up.	Passed
6	A user should be able to register and upload the required documents for the vehicle registration	Verify the functionality of vehicle registration, including uploading attachments.	Users can complete vehicle registration and upload required documents.	Passed
7	A user should be able to see the data input on the information page	Confirm the presence of the information page and its content	The information page displays a summary of entered vehicle registration details for user	Passed
8	The vehicle registration system should be able to generate a QR code for the registered vehicle	Generate a QR code for the registered vehicle information	A QR code is generated for registered vehicle information	Passed

9	The QR code generated should be able to be printed	Test the ability to print QR codes	Users with login details can print their registered vehicle QR codes.	Passed
10	The administrators should be able to access, monitor and modify how the system works	Test the administration login for system management	Administrators can access and modify system settings and data	Passed
11	The users should be able to evaluate and give feedback on how easily navigated and user friendly the system is	Assess system usability, navigation, and user-friendliness	Users find the system easy to use, navigate, and user-friendly	Passed
12	The vehicle registration system should be able to be managed and controlled effectively by the professional in charge	Evaluate effective integration of vehicle registration processes and system management	Professionals confirm effective integration of processes and effective management	Passed

## 5. Conclusion and Recommendations

In an effort to alleviate the manual complexities associated with vehicle registration and consolidate the various registration requirements for vehicle use, this study focused on designing an online vehicle registration system. The primary objectives were to create a system that integrates diverse vehicle registration forms and encodes essential vehicle information and user data into QR Codes for easy access. By employing existing online QR Code scanning tools, this study demonstrates the need for continuous exploration of system enhancements and sustainability measures.

The integration of Information Technology (IT) into various aspects of daily life has significantly streamlined processes and operations. In Nigeria, the vehicle registration process has transitioned from a purely manual system to a mixed one, combining manual and online procedures. However, issues such as inaccuracy, inefficiency, and inflexibility persist in this mixed system. To address these challenges, this study proposes an online vehicle registration system that maintains automation throughout the entire vehicle registration process.

The system's front end was designed using HTML, JavaScript, and CSS within the Visual Studio work environment. The resulting system encompasses all the stages of online vehicle

registration and offers additional functionalities, such as generating a QR Code containing a summary of vehicle particulars. This QR Code can be scanned by anyone to access the embedded information, providing a more convenient and efficient registration process.

In the light of the design and implementation of the online vehicle registration system examined in this study, key recommendations include the realization of authorities responsible for vehicle registration to expand the online system's capabilities to offer a more comprehensive service. Also, it is essential to provide thorough training for officials to ensure the efficient implementation of the system, mitigating user-related issues. Additionally, equipping officials with modern ICT devices for registration and QR Code scanning would simplify the process, enhancing the overall experience for all stakeholders.

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