*International Journal of Research in Engineering and Science (IJRES)*
*ISSN (Online): 2320-9364, ISSN (Print): 2320-9356*
*www.ijres.org Volume 10 Issue 6 ǁ 2022 ǁ PP. 311-318*

# RFID-Based Monitoring Vehicle Management Information System with SMS Notification

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***Abstract***
*Transportation is becoming increasingly important as globalization progresses. The goal of this paper is the development of a computer-based system that provides a database for all registered vehicles by incorporating RFID technology that is capable of real-time information. During this study, each vehicle owner must register on the system with an RFID tag. The RFID tag taps into the RFID reader as the vehicle owner approaches the gate. The RFID reader detects and collects data before sending it to the server system for verification. If the vehicle owner is not authorized, an alert message will appear on the screen. The system sent a push notification to the vehicle owner if the RFID tag's validity will be expired and need for renewal. This study suggested that using RFID technology to monitor registered vehicles could improve security measures. This system allows the administrator to automatically monitor the in and out of each vehicle and reduce the amount of time it takes to execute transactions involving an individual's information. Moreover, the system is easy to use, easy to learn, and user-friendly. The system developed in this study is novel in terms of functionality, usability and performance efficiency. The system can be of great assistance to the administrator in managing and monitoring the vehicle's information.*

***Keywords:*** *Vehicle. Management Information System, RFID, Monitoring System, SMS Notification*

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Date of Submission: 25-05-2022 Date of acceptance: 05-06-2022

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## I. INTRODUCTION

Continuous technological innovation and development have had a significant impact on people's lives in society. Everyone became more at ease with a variety of cutting-edge control systems as technology advanced. Nowadays, security is the most important thing to us, so everyone should look for a safe and secure living environment. Transportation has become the most technologically integrated part of the industry, particularly in terms of investing in security technologies historically, and great improvements in transportation systems have been made over the years being made and created with the assistance of numerous scientific and technological advances.

Transportation is becoming increasingly important as globalization progresses. Vehicles have now become a significant mode of transportation. Car use has increased as a result of recent population growth and human needs. As a result, vehicle control has grown into a major issue that is becoming increasingly difficult to resolve. Vehicle management systems are used to achieve efficient control. Globally, the human population is increasing. As a result, their fleet will be larger. Monitoring has become a significant challenge. Maintaining vehicle and data records is a difficult task in a manual process, and creating reports is even more difficult. It is easier to use software to manage vehicle entries in the database than it is to do it manually.

Now RFID (Radio Frequency Identification) technology has been widely used in production, logistics, transportation, medical, anti-counterfeiting, tracking, equipment and asset management, commercial and industrial automation, traffic control management, and many other fields. And it has bright application prospects [1]. Radio Frequency Identification (RFID) is a contact-less non-line-of-sight auto-identification technology using RF communications to identify tagged objects [2]. RFID is used to identify and track the object or individual by an electromagnetic and electrostatic coupling, where these technologies used the radio frequency spectrum as their communication medium [3]. This is also an emerging technology that uses wireless radio in order to identify objects from a distance without requiring a line of sight or even substantial contact [4].

The RFID system consists of three main components which are an antenna, a reader, and RF tag that is programmed with unique information [5]. The tag has a unique ID that is initially stored in the database before being assigned to the user. The user must place the tag at a specific distance from the RFID reader. The tag contains a microchip that stores a unique sequence number that can be used to identify objects. The microchip contains micro circuitry as well as an embedded silicon chip. The tag has a rewritable and permanent memory that can be programmed multiple times.

With this, the researcher opted to design and develop an RFID-Based Monitoring Vehicle Management Information System with SMS Notification that provides a database for all registered vehicles by incorporating RFID technology that is capable of real-time information and enables the monitoring of the car-in and car-out records of the vehicles and minimize the guard time to manually check person by person. For this study, each vehicle owner must register on the system with an RFID tag. The RFID tag taps into the RFID reader as the vehicle owner approaches the gate. The RFID reader detects and collects data before sending it to the server system for verification. If the vehicle owner is not authorized, an alert message will appear on the screen. The system sent a push notification to the vehicle owner if the RFID tag's validity will be expired and need for renewal.

This paper, also determine the level of functionality of the developed system in terms of security, and accurateness. Determine the level of usability in terms of learnability, operability, and accessibility. Evaluate the performance of the developed system in terms of time behavior and resource utilization. With the help of the system, it is great assistance in monitoring and managing vehicle's information.

### 1.1. Conceptual Framework

This paper was based on the concept of the Input-Process-Output (IPO) Model. The input–process–output (IPO) model is a widely used approach in systems analysis and software engineering for describing the structure of an information processing program or another process [6]. The procedure started with inputs, software development as the process, and the evaluation of the results as the output.

In this study, the inputs were the information of the vehicle owner, and vehicle information. These pieces of information were requirements for the system to manage. The process framework included the various modules that would perform the transactional processes. These processes were encapsulated in the RFID-Based Monitoring Vehicle Management Information System with SMS Notification. Finally, the output of the developed system included its evaluation of the level of functionality, usability, and performance. Figure 1 shows the conceptual framework of the study.

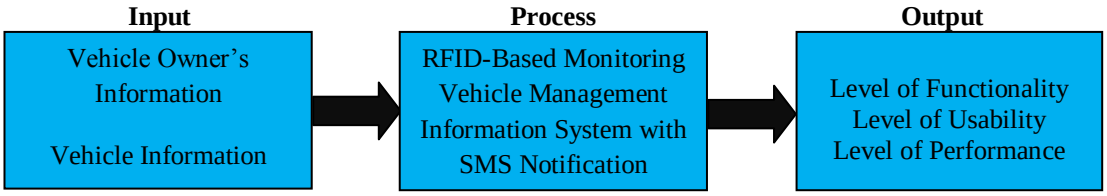


**Figure 1. Conceptual Framework of the Study**

## II. METHODOLOGY

In this chapter, the methodology used in this study was discussed. It includes the research design, software developmental model, and the statistical treatment used.

### 2.1. Research Design

A research design is a broad plan that states objectives of research project and provides the guidelines what is to be done to realize those objectives [7]. It is a framework that includes the methods and procedures to collect, analyze, and interpret data.

Developmental and descriptive research designs were applied in this study. Developmental research design is a systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness [8]. In this study, it described to illustrate the method and give the reader a better understanding of the approach and it was used to systematically plan, design and develop an efficient information system and to make the system functional.

Descriptive research design is typically concerned with describing problem and its solution. It is more specific and purposive study. Descriptive study rests on one or more hypotheses [7]. In this study, descriptive research was employed in the conduct of survey to determine the perceptions of the respondent based on the specific factors as define in the objectives of the study.

### 2.2. Software Development Life Cycle

Software Development Life Cycle (SDLC) is a set of steps used to create software applications. These steps divide the development process into tasks that can then be assigned, completed, and measured [9]. SDLC works by lowering the cost of software development while simultaneously improving quality and shortening production time. The researcher used Agile Software Development as the software development life cycle for

the software development. Agile Software Development (ASD) is used to cope with increasing complexity in system development [10]. Agile software development is a group of programming-centric methodologies that focus on streamlining the SDLC. Agile software development methodologies provide a more efficient and lighter way of development that build software iteratively and incrementally. Each iteration end with a workable product that help in getting early feedback of customer [11]. Figure 2 shows the Agile Software Development Model.

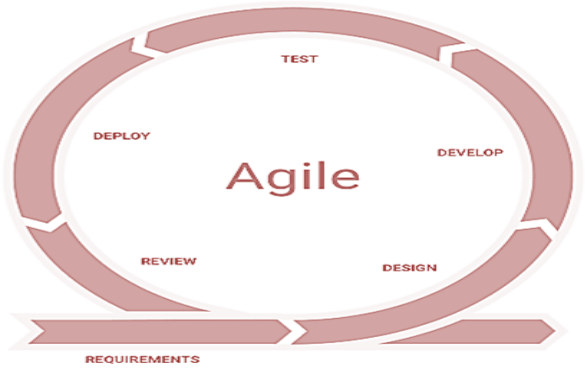


**Figure 2. The Agile Development Model**

### 2.3. Entity Relationship Diagram

Entity Relationship Diagram (ERD) is one of the popular and important concepts in database modeling. The design of the correct database (or good design) depends on the correct ERD that presents the requirements of the required system to the customer [12]. An entity-relationship diagram (ERD), also known as an entity relationship model, is a graphical representation of an information system that depicts the relationships among people, objects, places, concepts or events within that system [13].

The developed system has four entities contained in the database as follows: admin entity, vehicle owner entity, vehicle information entity, attendance entity, and SMS entity which is the associative entity. Relationships were set between these entities by the use of crow foot notations called cardinalities. Hence, following relationships were defined. The vehicle owner entity has one-to-many crow-foot notation with vehicle info entity. This means that a vehicle owner can have at least one or many registered vehicle. The vehicle owner entity can have many to many attendance on the attendance entity because there would be many vehicle owner who would make some attendance at the same time. The vehicle owner entity had a one-to-many relationship with the SMS entity. It means that there will be at least one or many messages that the system will send to the vehicle owner on some activity like expiration of RFID tag. The vehicle info entity had one-to-many crow foot notation to the attendance. This means that the vehicle would have at least one or many attendance to be recorded simultaneously to the attendance entity. Figure 3 presented the Entity Relation Diagram of the developed system.

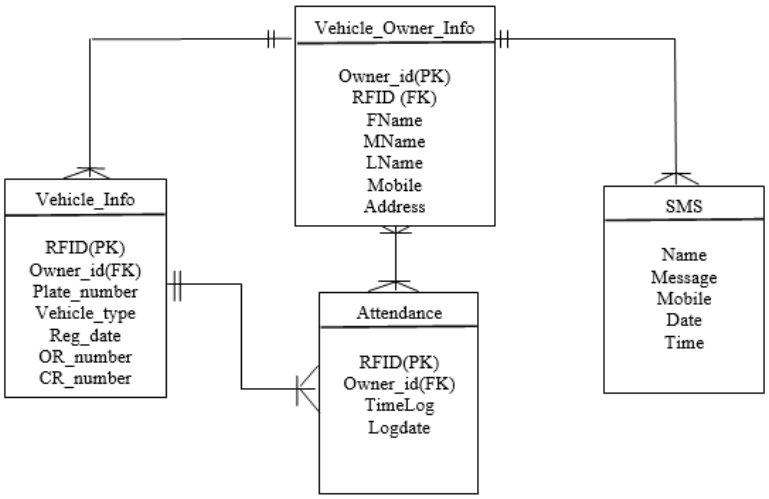


**Figure 3. Entity Relationship Diagram**

**2.4. Process Model**

The process modeling is a technique for organizing and documenting the structure and flow of data through the systems processes and/or the logic, policies and procedures to be implemented by the system's processes [14]. It is an important building block in a systems development activities as it defines what is going on now, and what should be going on in new system. Process modeling is normally presented using a data flow diagram (DFD). A DFD is a graphical representation of the "flow" of data through an information system, modeling it process aspects.

In this paper, the researcher used a context DFD was used to depict its logical design. A context data flow diagram is a top-level view of an information system that shows the system's boundaries and scope. At the center of the diagram is the RFID-Based Monitoring Vehicle Management Information System with SMS Notification. There are three external agents namely Admin, Security Guards and Vehicle Owners.

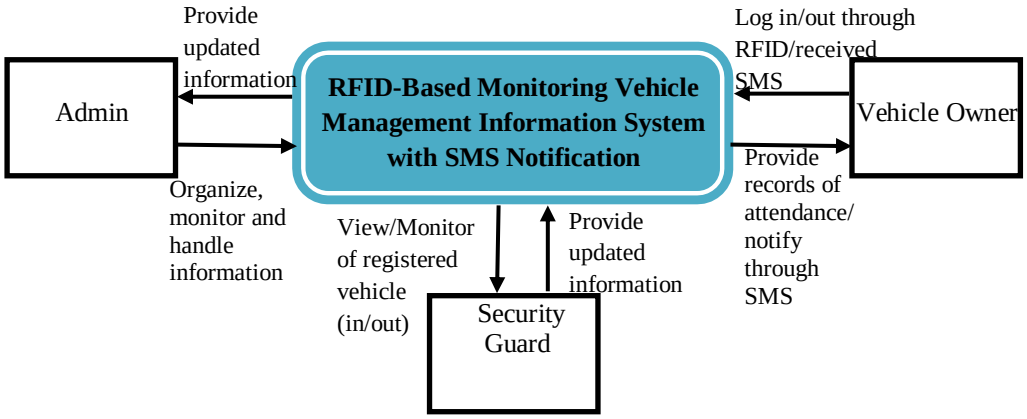


**Figure 4. The Context Data Flow Diagram of the Developed System.**

**2.5. Logical Architectural Design**

Logical architecture is the identification of the system component that provides the software services needed to meet the business goals/RFP requirements for deployment. Logical Architecture involve the process and documentation to derive a more precise, detailed and unambiguous depiction of the system components through the provision of well-defined interfaces and component specifications, and key architectural mechanisms [15]. In this study, the N-tier architecture were employed. N-tier is also called multi-tier architecture because the software is engineered to have the processing, data management, and presentation functions physically and logically separated [16]. Figure 5 shows the logical architecture of the developed system.

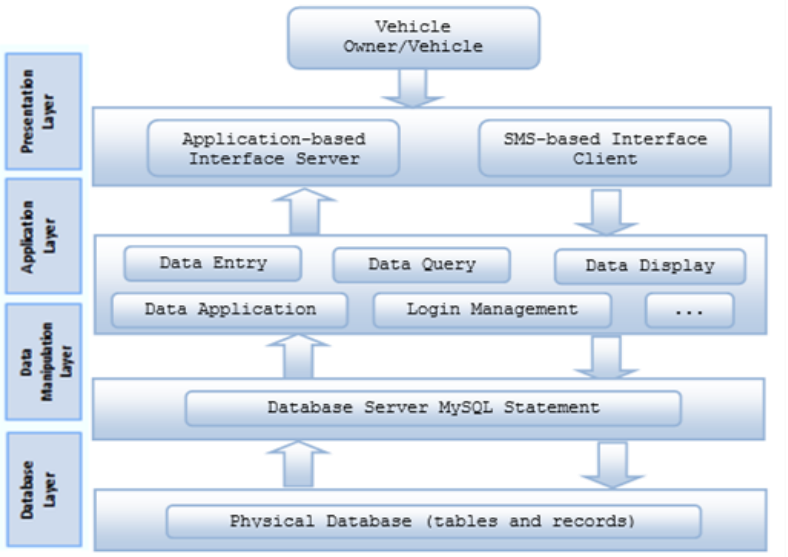


**Figure 5. The Logical Architecture Design**

**2.6. Physical Network Topology**

Since the developed system was implemented using a RFID and SMS technology. The system will be operated when a vehicle approaches the gate, the vehicle owner taps his or her RFID tag against the reader. Within milliseconds, the RFID tag will respond and send the received data to the database. The information received will then be compared to existing information in the database for verification and for the SMS, it used the existing infrastructure of the telecommunication companies as the carrier of the notification. A GSM modem would be attached to the server computer to notify the vehicle owner for the validity of rfid tag with the use of SMS. Figure 6 shows the physical network topology.

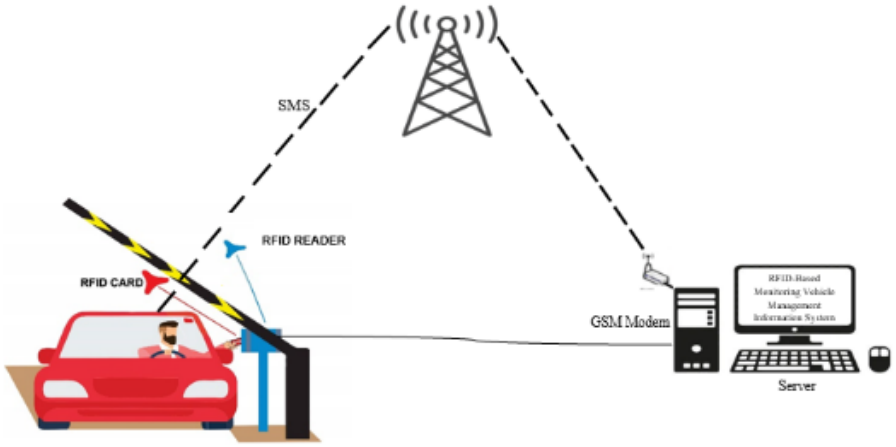


**Figure 6. Physical Network Topology**

**2.7. Testing and Evaluation**

The system development was completed by testing the functionality, usability, and performance of the system prototype. The researcher asked the testers to use a survey questionnaire to evaluate the system's level of functionality, usability, and performance. The system prototype would be tested using a 5-point Likert scale with 1 being poor and 5 being excellent. The Mean statistics would be used to compute statistically whether the developed system met the evaluation criteria. The mean is calculated as follows:

$$\overline{X} = \frac{\Sigma X}{n}$$

where $\bar{x}$ is the mean

$\sum x$ is the summation of individual raw scores

n is the number of the population

The obtained mean score was described verbally as follows:

| Mean Score | Descriptive |
|---|---|
| 4.21 – 5.00 | Excellent |
| 3.41 – 4.20 | Good |
| 2.61 – 3.40 | Acceptable |
| 1.81 – 2.60 | Needs Improvement |
| 1.0 – 1.80 | Poor |

**2.8. Prototype Evaluators**

As mentioned in previous sections, the system prototype is subjected to software evaluation. Testing the system prototype was an important part of the design and manufacturing process. Testing and evaluation, simply confirm that the product worked as planned, or if it needs refinement.

The respondents who participated in the study were composed of forty-five (45) vehicle owners, five (5) security guards, and five (5) expert evaluators with a total of fifty (55) respondents.

**Table 1. Distribution of Respondents**

| Evaluators Classification | No. of Evaluators | Percentage |
|---|---|---|
| Vehicle Owners | 45 | 81.82% |
| Security Guards | 5 | 9.09% |
| Expert Evaluators | 5 | 9.09% |
| Total | 55 | 100% |

## III. RESULTS AND DISCUSSION

This chapter provides the presentation, analysis, and interpretation of results that addressed the objectives defined herein.

### 3.1. Level of Functionality of the Developed System as Perceived by End-Users in terms of Security, and Accurateness

Table 2 shows the mean result of the respondents' feedback on the functionality of the developed system in terms of security and accurateness. The level of functionality is the capability of the software to provide functions which meet the stated and implied need of users under specified conditions of usage [17]. Security is the degree to which a product or system protects information and data [18]. Accurateness is the level to which the result as expected [17].

Based from the respondents' feedbacks, the level of functionality of the RFID-Based Monitoring Vehicle Management Information System with SMS Notification was computed with an overall mean of 4.65 being interpreted as "Excellent". In terms of security (M = 4.67) and accurateness (M = 4.63) were interpreted as "Excellent".

**Table 2. Level of Functionality of the Developed System in Terms of Security and Accurateness.**

| Implementation Indicators | Mean | Verbal Interpretation |
|---|---|---|
| **A. Level of Functionality** | **4.65** | **Excellent** |
| **A1. Security** | **4.67** | **Excellent** |
| **A2. Accurateness** | **4.63** | **Excellent** |

Legend: 1.00-1.80 (Poor); 1.82-2.60 (Needs Improvement); 2.61-3.40 (Acceptable); 3.41-4.20 (Good); 4.21-5.00 (Excellent)

### 3.2. Level of Usability of the Developed System as Perceived by the End-User in Terms of Learnability, Operability and Accessibility.

Table 3 presented the mean result of the respondents' feedback on the usability of the developed system in terms of suitability, operability and accessibility. The level of usability is the capability of the software product to be understood, learned, used and provides visual appeal, under specified conditions of usage [17]. Suitability refers the degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions [18]. Operability is the ability to keep an equipment, a system or a whole industrial installation in a safe and reliable functioning condition, according to pre-defined operational requirements [19]. Accessibility is the degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use [18].

The results shown below indicated that the RFID-Based Monitoring Vehicle Management Information System with SMS Notification, its level of usability was computed with an overall mean of 4.87 being interpreted as "Excellent". In terms of learnability (M = 4.90) was verbally interpreted as "Excellent". For the operability, the computed mean score was (M = 4.83) verbally interpreted as "Excellent" while for its accessibility (M = 4.88,) was also interpreted as "Excellent".

**Table 3. Level of Usability of the Developed System in Terms of Learnability, Operability and Accessibility.**

| Implementation Indicators | Mean | Verbal Interpretation |
|---|---|---|
| **B. Level of Usability** | **4.87** | **Excellent** |
| **B1. Learnability** | **4.90** | **Excellent** |
| **B2. Operability** | **4.83** | **Excellent** |
| **B3. Accessibility** | **4.88** | **Excellent** |

Legend: 1.00-1.80 (Poor); 1.82-2.60 (Needs Improvement); 2.61-3.40 (Acceptable); 3.41-4.20 (Good); 4.21-5.00 (Excellent)

### 3.3. Level of Performance of the Developed System in terms of Time Behavior and Resource Utilization

Level of performance efficiency refers to the characteristic that represents the performance relative to the amount of resources used under stated conditions [18]. Time behavior is the degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements [18]. Resource utilization is the degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements [18].

Table 4 revealed the overall mean for the level of performance of the developed system was composed with a mean of 4.78 being interpreted as "Excellent", the time behavior (M = 4.72) was interpreted as "Excellent" while resource utilization (M = 4.87) was also interpreted as "Excellent".

**Table 4. Level of Performance of the Developed System in Terms of Time Behavior and Resource Utilization.**

| Implementation Indicators | Mean | Verbal Interpretation |
|---|---|---|
| **C. Level of Performance** | **4.78** | **Excellent** |
| **C1. Time Behavior** | **4.72** | **Excellent** |
| **C2. Resource Utilization** | **4.87** | **Excellent** |

Legend: 1.00-1.80 (Poor); 1.82-2.60 (Needs Improvement); 2.61-3.40 (Acceptable); 3.41-4.20 (Good); 4.21-5.00 (Excellent)

## IV. CONCLUSION

The study's findings indicated that the developed RFID-Based Monitoring Vehicle Management Information System with SMS Notification had been successfully tested and demonstrated. This is accomplished by incorporating RFID technology capable of real-time information and sending a push notification to the vehicle owner if the RFID tag's validity is about to expire and the need for renewal via SMS. In addition, the developed RFID-Based Monitoring Vehicle Management Information System with SMS Notification has been tested and found to be functional. It was also novel in terms of functionality, usability, and performance efficiency.

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