

## RESEARCH ARTICLE



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# Dormitory Management Information System with SMS Notification and Biometric Security

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## Abstract

**Objectives:** The purpose of this study is to develop a computer-based system capable of providing dorm occupants with real-time information using SMS notification and biometric security. **Methods:** During this study, each occupant must register on the system with a biometric scanner using their fingerprint. The fingerprint is automatically compared to the stored database of the tenant's information, and if the databases match, the tenants are allowed to enter or exit the dormitory area. After that, the data is saved in a database and sent to the tenant's parents via SMS notification using the GSM module. **Findings:** This study implied that fingerprint scanning with biometric technology enhanced the security measures. This system allows the administrator to automatically check the tenant's attendance and reduce its time to execute transactions involving an individual's information. The tenant's attendance can be limited and marked by the fingerprint detection process and send an alert SMS notification to the parents to increase security. Results show that the level of functionality in terms of security and accurateness were all interpreted as "Very Good." Likewise, in the level of usability in terms of learnability, operability and accessibility were also interpreted as "Very Good." Similarly, the level of performance in terms of reliability and time efficiency was also interpreted as "Very Good." Moreover, the system is easy to use, easy to learn, and user-friendly. This significant result indicated that respondents were conveniently impressed by the developed system's features. **Novelty /Applications:** The method developed in this study is novel in terms of functionality, accuracy, reliability, and efficiency. The system can greatly assist the administrator in managing the individual's information.

**Keywords:** Dormitory Management; Information System; Biometric Security; SMS Notification; Computer Based System

## 1 Introduction

With the rapid development of the digital world, we are becoming increasingly dependent on a wide range of digital apps and software. Information security is one of the most critical aspects of the daily operation of any organization, private or

public. Nowadays, biometric systems and short message services (SMS) play the most crucial role in this current century. Fingerprint identification is one of the foremost distinguished and familiar identity verification systems due to its individuality<sup>(1)(2)</sup>. The Short Message Service-based system makes life easier for people every day. They help to perform tasks quicker and communicate with friends and family. These functions are crucial.

College dormitories allow students to meet people, develop independence, and are a massive part of the college experience. The dormitory is the primary college students' daily lives<sup>(3)</sup>. Dorm safety is often overlooked when students look at different aspects of their potential new home. Security in the organization is one of the most persistent issues that an organization must address. Nowadays, security is a prime concern in each individual's life<sup>(1)</sup>. The most secured system is fingerprint recognition because one person's fingerprint never matches the other. They are secure to use, unique for every person and do not change in one lifetime<sup>(2)</sup>. Each finger has a distinct and immutable pattern of friction ridges. As a result, each person's fingerprint is a one-of-a-kind identification. Fingerprint recognition is a boon solution to these issues because it provides a high level of identification accuracy. It is one of the safest biometric authentication methods widely used, and it cannot be forged easily.

Colleges and universities have to count many students' dormitories every year, which is highly cumbersome. At the same time, many newcomers live in, leave, or change the dormitory every year, which is inconvenient for the dormitory management personnel to deal with<sup>(4)</sup>. Tenants' attendance is becoming a more critical factor for all organizations. Attendance is an essential criterion for measuring the performance of any institute. To simplify this attendance management procedure, fingerprints are one of the most common biometric identification methods<sup>(5)</sup>.

Entering and recording dormitory attendance is a time-consuming and labor-intensive administrative task in a dorm setting. Monitoring is becoming increasingly difficult. Keeping records and data is a difficult task in a manual process, and producing reports is even more difficult. It is easier to use software than to manually maintain entries and record tenants' attendance in a database. At present, the room management and information of the occupants are being handled using a manual-based system.

This study aims to design and develop a Dormitory Management Information System with SMS Notification and Biometric Security that help the dormitory management personnel of Northern Iloilo Polytechnic State College to increase security through fingerprint scanners and SMS features. It also aimed to assess the level of functionality in terms of safety and accurateness, level of usability as of learnability, operability and accessibility, and level of performance evaluation in terms of reliability and time efficiency. One of the significant features of this system is capable of providing real-time information to tenants that enter and exit the dormitory area using biometric and GSM technology, which can be used to send the attendance information of the tenants automatically to their parents for security measures.

The system automatically records the presence of students in the dormitory, which benefits the administrator. It reduced the time it took to complete transactions involving an individual's information. It was also capable of automatically monitoring the in/out of tenants using a fingerprint scanner and sending an alert SMS to parents for their safety. Only valid tenants can enter a specific dormitory area using biometric devices that use fingerprints. The tenant's fingerprint is compared to a database of the tenant's information, and if the databases match, the tenants are allowed to enter or exit the dormitory area. Data is saved in a database when a tenant enters or leaves and sends to the tenant's parents via SMS notification using the GSM module. The researcher wants to make management easier by making the system more user-friendly and comfortable for both users and administrators. It can also serve to help the administrator manage the dormitory properly.

## 2 Materials and Methods

In this study, the following materials and procedures were used and followed to design and develop the Dormitory Management Information System with SMS Notification Biometric Security:

### 2.1 Software

In developing the system and device, this study used an Arduino IDE with a version of 1.8.9, Microsoft SQL Server Studio 17 as the database, C# and VB.Net were used for the scripting language. Base on Windows 10 Intel (R) Core (TM) i3-6006U CPU @ 2.00GHz.

### 2.2 Hardware

The researcher used Arduino Uno Rev 3, fingerprint scanner, and GSM Module. A laptop with a processor of 2.00GHz.

## 2.3 Software Development Life Cycle:

This study developed the Dormitory Management Information System with SMS Notification and Biometric Security using a Rapid Application Development (RAD) model. The RAD model is based on prototyping and iterative development with no explicit planning. The product development planning is incorporated into the software development process. Rapid Application development focuses on gathering customer requirements through workshops or focus groups, early testing of the prototypes by the customer using the iterative concept, reuse of the existing prototypes (components), continuous integration, and rapid delivery<sup>(6)</sup>. The RAD model consists of four phases: requirements planning phase, user design phase, rapid construction phase, and implementation phase<sup>(7)</sup>. The researcher performs specific activities leading to the phase's deliverable at each step. Since the RAD model heavily relies on the involvement of the users, the deliverables are presented to them to refine the final product further. Figure 1 shows the RAD model.

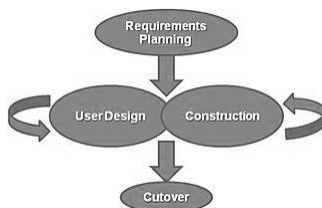


Fig 1. Rapid Application Development Model

### 2.3.1 Requirement Planning Phase

During this phase, the researchers conducted interviews with the NIPSC Dormitory Management to gather the necessary information and requirements for designing and developing the system. The researcher used the Arduino Uno Rev 3 as the central controller for the system, with the help of authentication devices such as a fingerprint scanner, for the instrument used in the study. It will also have GSM technology for SMS notifications. The device can save fingerprints. The notification will be in the form of "Good Day! SMS from NIPSC Dorm, Your son/daughter (Name of the tenant) has been logged in/out on (Date & Time). Reply Not Needed". The developed device will notify the parents of the tenant for their safety.

### 2.3.2 User Design Phase

In this phase, the researchers will discuss the detailed identification in constructing the system. The researcher also used the entity-relationship diagram, data flow diagram, logical architecture, and physical network topology.

**2.3.2.1 Entity Relationship Diagram.** 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. An ERD is a data modeling technique that can help define business processes and is the foundation for a relational database<sup>(8)</sup>. The E.R. diagram for the proposed system is shown in Figure 2.

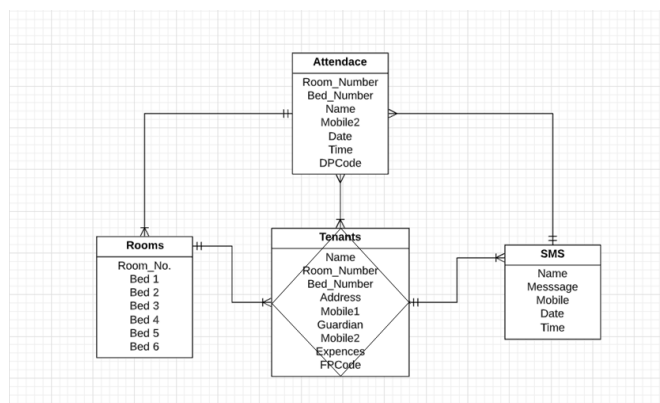


Fig 2. Entity Relationship Diagram

**2.3.2.2 Data Flow Diagram.** A Data Flow Diagram (DFD) is a graphical representation of data "flow" through an information system that models its process aspects. Data Flow Diagram is a diagram chart that shows the movement of information from one place to another as part of a particular processor in general<sup>(9)</sup>. Figure 3 shows the DFD of the developed system.

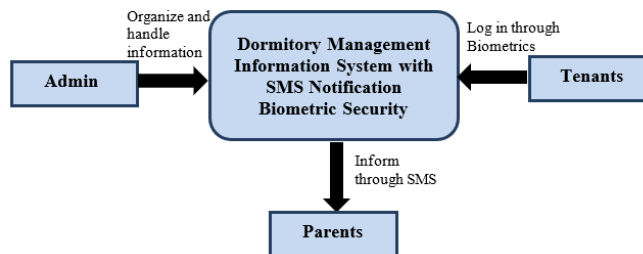


Fig 3. Data Flow Diagram

**2.3.2.3 Logical Architecture Model.** The logical architecture is considered a type of structural design used to provide a detailed description of the system without defining the system technology or environment<sup>(10)</sup>. In this study, the 3-tier architecture was employed. The 3-tier architecture is client-server architecture. The functional process logic, data access, computer data storage, and user interface are developed and maintained independently on separate platforms<sup>(11)</sup>. The design consisted of three tiers: presentation, application, and data. The production or GUI layer is the front end of a three-tier system, including the user interface. The functional business logic that drives an application's core capabilities is housed in the application layer. This layer contains the various modules and sub-modules of the developed system. Figure 4 shows the logical architecture model of the developed system.

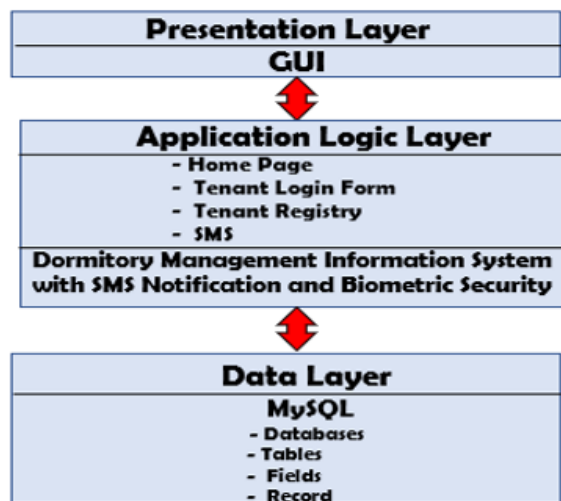


Fig 4. Logical Architecture Model

**2.3.2.4 Physical Network Topology.** Physical Network Topology is the placement of the various components of a network, and the different connectors usually represent the physical network cables. The nodes typically represent the physical network devices<sup>(12)</sup>.

Since the developed system is a Dormitory Management Information System with SMS Notification and Biometric Security, the occupants need to register with their fingerprints using a biometric scanner. Every time the occupants leave the dormitory, they need to scan their fingerprints to enter the dorm. The biometric scanner detects the fingerprint of the occupants, then

sends it to the server system for verification and notifies the parents of the occupants using SMS. Figure 5 shows the Physical Network Topology of the developed system.

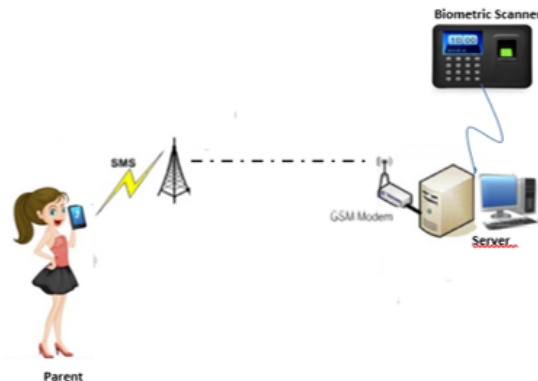


Fig 5. Physical Network Topology

### 2.3.3 Construction Phase

The construction phase's objectives are to complete the detailed design of the developed system; create and test the software that implements the developed system; generate a system that operates at an acceptable level of performance; prepare documentation required to use the developed application; design, develop, and test the required transition software; and perform the transition.

**2.3.3.1 Preparation of the Rapid Construction.** The first task under this phase was preparing the necessary application development software used and the needed equipment and materials deemed essential in the actual construction of the system prototype. It included identifying the programming language that could address the database requirements. The researchers designed a prototype and developed a computer-based system for the Dormitory Management Information System with SMS Notification and Biometric Security. For the hardware, the researchers used Arduino Uno Rev 3 as the mainboard to construct the biometric security, using a fingerprint scanner and a GSM module for SMS notification. For the software, this study used the Arduino IDE version 1.8.9, Microsoft SQL Server Management Studio 17 as the database, C#, and VB.Net were used as the scripting language.

**2.3.3.2 Construction of the System Prototype.** In this phase, the researcher developed a system prototype, model, and a cellular phone number to notify the tenant's parents of the simulation process.

**2.3.3.3 Testing and Evaluation.** The development of the system prototype will not be complete unless the functionality of the system prototype will not be finished until the functionality of the various modules is tested to ensure that it meets user requirements. As a result, testing must be as close to real-world data as possible. The researchers ran tests to ensure that the end user's system and device were ready for use. Because the RAD model was used in this project, the construction phase can iterate back to the U.D. phase to confirm that the system prototype meets the user design. Revisions to both the user design and the system prototype must be complementary to produce the final product as soon as possible. As a result, each modification must be appropriately documented. The researchers asked a group of beta-testers to evaluate the system's reliability, functionality, efficiency, and overall acceptability before finalizing the developed system product. Following the product testing, these testers will be given a questionnaire. The questionnaire is based on the ISO 9126 standard, which describes a software quality model that divides software quality into six characteristics (factors) and sub-factors (criteria). The Likert scale with 5 points will be used. The questionnaire will be content validated by three members of a panel of information technology experts to assist the researchers in determining whether the developed system meets the user's requirements and satisfaction and testing the system's reliability, functionality, and efficiency. There will be five options on the questionnaire used for the final evaluation: Very Good on a scale of 4.21-50.00; Good on a scale of 3.41-4.00; Average on a scale of 2.61-3.40; Fair on a scale of 1.81-2.60; Poor on a scale of 1.00-1.80. The researcher will provide an arbitrary scale describing the level of acceptability.

**2.3.3.4 Finalizing the Developed System Product.** After each data testing of the system prototype, it will be subjected to a conformity test with the target users. Revisions will be made based on the feedback coming from the users. However, the

researcher will only allow three significant corrections so that excessive revisions will not drag down the project timeframe. After the third major revision, the final system product will be presented for acceptance and will become ready for deployment.

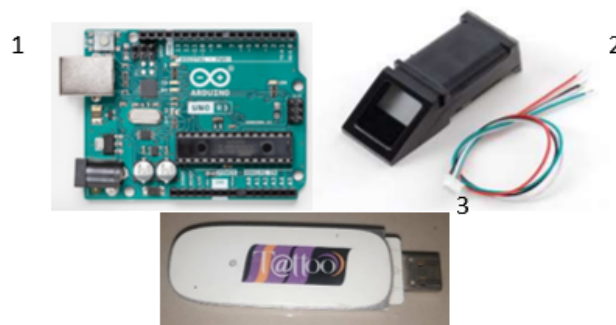
#### 2.3.4 Cutover Phase

The system has been deployed to the end-user by the researchers at this point. In addition, the researcher trained and assisted the end-user in using the developed system. User documentation and a user manual were created to inform users about operating and maintaining the device.

## 3 Results and Discussion

### 3.1 Device Prototype

Figure 6 depicts the prototype model of the device. The diagram shows three components: 1) an Arduino Uno Rev 3 board, 2) a fingerprint scanner, and 3) a GSM module. The Arduino Uno Rev 3 serves as the device's primary controller (part 1). Part 2 of the fingerprint scanner allows tenants to enter and exit the dormitory area. The GSM module (part 3) will notify the tenant's parents of the emergency



**Fig 6.** Device Architecture

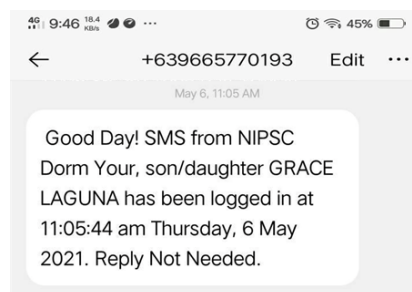
Figure 7 depicts the developed device's prototype.



**Fig 7.** Prototype of the Developed Device

When their son or daughter enters or exits the dormitory area shown in Figure 8, the parents receive SMS notifications in the format shown in Figure 8.





**Fig 8.** SMS Notification Format

## 3.2 System Prototype

### 3.2.1 Login Form

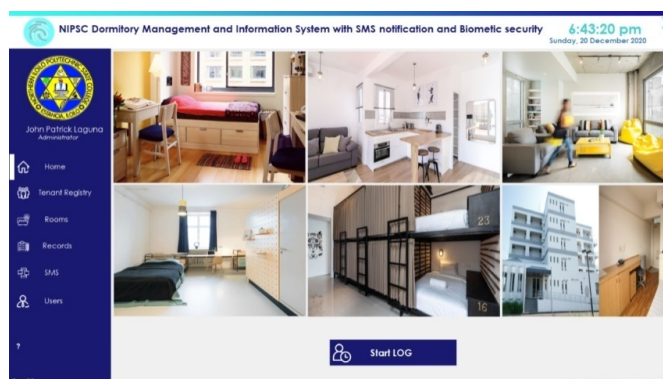
The page shown in Figure 9 shows the administrator login form of the system. Only the administrator has the right to access the system.



**Fig 9.** Administrator Log-in Form

### 3.2.2 The Main Interface

Figure 10 shows the main interface of the system. This form is used to navigate the whole system and comprises six (6) tabs: Home, Tenant Registry, Rooms, Records, SMS, and Users.



**Fig 10.** The Main Interface

### 3.2.3 Tenant's Log-in Form

Figure 11 shows the tenant's login form of the developed system. The tenants must log in first using the biometric scanner. If the tenants successfully log in/out, a message will send to the parents/guardians informing them that their child has entered/exited the dormitory.

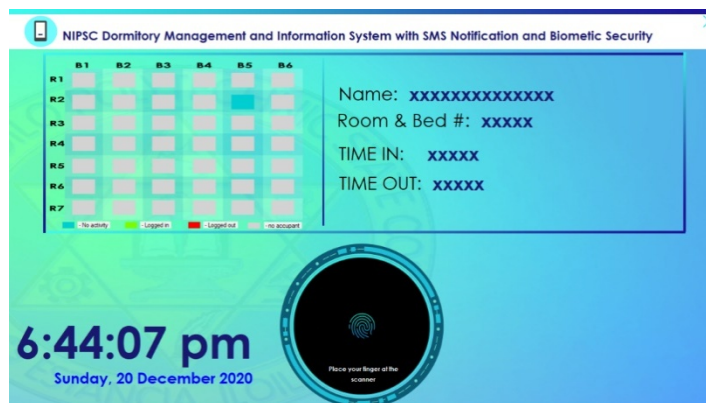


Fig 11. Tenant's Log-in Form

The summary of the evaluation of the functionality of the system product in terms of security and accurateness is shown in Table 1.

The findings implied that the Dormitory Management Information System with SMS Notification and Biometric Security could manage records in the NIPSC Dormitory's day-to-day transactions. The most important application of this system is to secure the attendance and information of every occupant in the dormitory using the biometric scanner and provide real-time notification to the guardian after checking every occupant's attendance. Users believe that this system will provide accurate information and real-time SMS notifications, particularly in monitoring the attendance and records of every occupant/tenant in the NIPSC dormitory. The study on functionality strengthens why preventing unauthorized entry into buildings through the main doors uses ordinary, electronically operated locks, digital codes, and biometrics techniques like fingerprint technology. Some are based only on thumb printing<sup>(13)</sup>. Table 1 shows the results of the functionality of the system.

Table 1. Summary of the Evaluation of the Functionality of the System Product

Implementation Indicators	Mean	Verbal Interpretation
Security	4.67	Very Good
Accurateness	4.63	Very Good

1.00 - 1.80 (Poor); 1.81 - 2.60 (Fair); 2.61 - 3.40 (Average); 3.41 - 4.20 (Good); 4.21 - 5.00 (Very Good)

Usability characteristics are the capability of the software product that describes its ease of use. The level of usability of the developed system was evaluated in terms of learnability, operability, and accessibility. The respondent's feedback for the level of usability in terms of learnability (M=4.64), operability (M=4.70), and accessibility (M=4.62) was described as "Very Good."

The findings imply that the developed system is simple to operate and monitor, which is greatly needed in day-to-day transactions. Also, the interface of the system can be quickly learned. It showed that the user and the occupants believed that the system would help serve its clientele. The result of the study of usability strengthens the reason why the dormitory management department realizes the daily management of students' dormitory information; it is convenient for the dormitory management personnel to master the situation of students; accommodation and dormitory distribution in a timely and comprehensive way; provides users some simple data query and output of various information; at the same time, it realizes quick and convenient retrieval; it also carries out daily management such as dormitory arrangement for new students<sup>(14)</sup>. Table 2 shows the result of the level of usability of the developed system.

The summary of the evaluation of the performance of the developed system showed the result was composed with a mean score of 4.56 and interpreted as "Very Good." It was rated as "very good" in terms of reliability (M=4.62) and time efficiency (M=4.50).

The findings implied that the evaluation of the system's performance, the respondents believed that the time efficiency was impressive. The plan provided real-time information by managing the occupants' records in the day-to-day transactions. It also



**Table 2.** The summary of the evaluation of the Usability of the System Product

Implementation Indicators	Mean	Verbal Interpretation
Learnability	4.64	Very Good
Operability	4.70	Very Good
Accessibility	4.62	Very Good
1.00 - 1.80 (Poor); 1.81 - 2.60 (Fair); 2.61 - 3.40 (Average); 3.41 - 4.20 (Good); 4.21 - 5.00 (Very Good)		

provided the correct result with utmost precision and accomplished the specific tasks they wanted for the system to perform. The development of the study of reliability strengthens why the hostel management software package is designed to manage numerous activities within the hostel; it reduces the workforce and investment of the management and passes the information to the parents<sup>(1)</sup>. Moreover, in terms of the reliability of the developed system, the respondents agreed that it is operational, accessible, and responsive every time the respondents quickly scan their fingerprints and send a notification to the parents. This study of reliability strengthens the reason that the management finds the device reliable and helpful to their units because it handles errors and continues working after any failure<sup>(15)</sup>. Table 3 shows the result of the performance evaluation of the system.

**Table 3.** The Summary of the Evaluation of the Performance Evaluation of the System Product

Implementation Indicators	Mean	Verbal Interpretation
Reliability	4.62	Very Good
Time efficiency	4.50	Very Good
1.00 - 1.80 (Poor); 1.81 - 2.60 (Fair); 2.61 - 3.40 (Average); 3.41 - 4.20 (Good); 4.21 - 5.00 (Very Good)		

## 4 Conclusion

The above results demonstrate that the system was able to secure the profile and other confidential information of the users and provide accurate records of the occupants. The system's interface is very user-friendly and provides near real-time notification to the users. It provided an acceptable level of usability due to its simple interface that is easy to learn, operate, and easy access to the respondents. The performance evaluation of the system in terms of time efficiency and reliability of the information provided to the clientele was impressive. It gives the correct result with the utmost precision and can accomplish specific tasks. It is reliable where the respondents agreed that it is operational, accessible, and responsive every time that provides real-time information via SMS notification and biometric security.

## 5 Acknowledgement

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