



(RESEARCH ARTICLE)



Web-based smart attendance monitoring system using QR code and GSM module for SMS notification

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Abstract

The study was designed and developed to address certain problems and concerns of the school administration and parents of students attending Ciriaco Mariano Elementary School. The system was used to provide the school an innovative way to record attendance of students, provide parents with real time updates regarding the entry and exit of their children in the school premises, and be able to monitor students by generating attendance reports.

The Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification was developed through the implementation of the Iterative System Development Life Cycle Model. This iterative model ensures that the web-based system conformed to the all of the requirements from the CMES and of the requirements set by the ISO 25010 criteria.

To assess the quality of the developed web-based system, the researcher adapted the ISO 25010 Software Quality Standard as evaluation tool. Two sets of questionnaires were developed and were given to respondents who were selected using purposive sampling. The first set of questionnaires were given to IT experts to assess the technical qualities of the system which includes functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The second set of questionnaires were given to the school principal, teachers, and parents to assess the web-based system quality on selected criteria which includes functional suitability, performance efficiency, and usability.

The Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification was successfully developed using the iterative SDLC model and found conformed to the ISO 25010 software quality standards as implied by the results from the evaluation of IT experts, school principal, teachers, and parents.

Keywords: Attendance; Evaluation; Innovation; Monitoring; QR Code; Web-based.

1. Introduction

According to Epstein and Sheldon (2002), the academic achievement of students in schools and universities is greatly influenced by their attendance. Consistent attendance decreases the likelihood of students engaging in harmful behaviors, and frequent absences increase the risk of academic failure and early dropout (Bruner et al., 2011). Addressing these issues, various attendance management systems have been developed (Jain et al., 2011). Santos et al. (2021) emphasize that current technological advancements offer methods to record, verify, and produce attendance data efficiently, automating routine classroom procedures like attendance monitoring. Despite these advancements, schools in Nueva Ecija, including Ciriaco Mariano Elementary School (CMES), struggle to implement such systems. CMES faces challenges in manually monitoring student attendance and ensuring student safety, concerns shared by parents.

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In this context, the integration of AI into business operations, as discussed by Santos (2023), is highly relevant. AI's contributions in automating repetitive tasks and enhancing operational efficiency can be paralleled in educational settings. Its potential in improving attendance systems by eliminating human errors and streamlining processes is significant. However, the ethical considerations and potential biases associated with AI, as noted by Santos (2023), must be carefully managed. Additionally, the study by Santos (2023) on digital payments in Nueva Ecija highlights the increasing acceptance of technology-driven solutions. This trend reflects a growing readiness to embrace digital transformations, similar to the proposed attendance system.

The research on digital payments underscores the importance of addressing concerns over security and privacy, which are also pertinent in the context of a school attendance system. Lastly, Santos (2023) points out the importance of effective Human Resource Management practices in successfully implementing new technologies. This is directly applicable to the school environment, where training and managing staff in the use of new attendance systems is crucial for their success. This connects the study's focus on attendance monitoring with broader technological trends and challenges, emphasizing the need for careful implementation, consideration of ethical issues, and effective management in the context of CMES.

In response to the challenges identified at Ciriaco Mariano Elementary School (CMES), this study is focused on the development of a Web-based Smart Attendance Monitoring System, specifically designed for CMES. This innovative system will utilize QR code technology coupled with a GSM module for SMS notification. It's intended to address the concerns of both the school administration and the parents regarding the tracking of student attendance and ensuring their safety.

The system is designed to feature an integrated attendance monitoring process using QR codes, which will streamline and modernize the way attendance is recorded. It will also include an SMS notification feature, providing immediate updates to parents about their children's entry and exit from the school. To further enhance communication, the system will incorporate SMS blasting for school-wide announcements. A comprehensive database will be maintained, capturing essential student information. This database will enable the generation of detailed attendance reports, provide alerts for any missed clock-ins, and offer insightful attendance analytics.

The development of this system will be explored through various stages of the System Development Life Cycle (SDLC), encompassing planning, analysis, design, coding, testing, and implementation. The study will also seek to understand how IT experts evaluate the technical quality of the system against the ISO 25010 Software Product Quality Standards. These standards include aspects such as functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. Additionally, the research will gauge how the school principal, CMES teachers, and parents of CMES students assess the system, focusing on criteria like functional suitability, performance efficiency, and usability, as per the ISO 25010 standards.

2. Materials and Methods

2.1. Methods

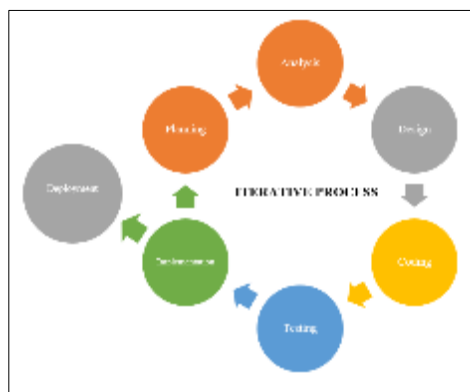


Figure 1 Iterative SDLC Model

This study will employ developmental method of research. A developmental research design deals with designing, developing, and evaluating programs, processes, and products that must meet the criteria of internal consistency and effectiveness (Richey, 1994). Data gathering will be conducted to obtain significant information like forms and process flow vital to the development of the system. In developing the system, Iterative System Development Life Cycle approach will be used where development starts with a simple implementation of a small set of the software requirements and iteratively modified to add new functional capabilities until the final product is delivered.

2.2. Research Locale

This study will be conducted and implemented at Ciriaco Mariano Elementary School; a school situated at the heart of barangay Communal, at the eastern part of Cabanatuan City that caters grade 1 to grade 6 students from barangay Communal and nearby barangays.

2.3. Respondents of the Study

There were two groups of respondents in the study and both were chosen using purposive sampling. The first group is composed of five (5) IT experts and the second group is composed of thirty (30) end-users, which are composed of the school principal, teacher of CMES, and parents of CMES students.

Table 1 Distribution of Respondents

Respondents	Number of Respondents
IT Experts	5
School Principal	1
Teachers	7
Parents	22
Total	35

2.4. Sample and Sampling Procedure

Purposive sampling will be used in selecting the respondents of this study. This technique will be employed because of the small population of teachers in CMES. Also, the IT experts likewise, will be purposively chosen because of their technical knowledge about the system's functionalities and technicalities. On the other hand, parents of CMES students will be randomly selected for unbiased representation of the total population.

2.5. Research Instruments

To elicit data on the study, three sets of questionnaires will be used to evaluate the Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification. The first questionnaire will be used by the IT experts to evaluate the system's technical characteristics based on the ISO 25010 Software Product Quality Standards on functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability.

The second questionnaire will be for the school principal, CMES teacher, and randomly selected parents of CMES students to evaluate only on the selected ISO 25010 Software Product Quality Standards criteria as functional suitability, performance efficiency, and usability.

The first and second set of questionnaires will be given during the testing phase of the system. Respondents will be provided with printed questionnaires personally.

The third questionnaire will be given to all respondents to describe the level of effectiveness of the implementation of the web-based application. The third set of questionnaires will be composed of items which comprised of the main functions of the system which will be given to the respondents after the successful implementation. Questionnaires were also provided personally to all the respondents.

In treating the data from the questionnaire, data will be analyzed using frequency, percentage, and weighted mean. The items in the questionnaire will be scored using five-point scale criteria.

2.6. Validity and Reliability of the Instrument

To test the content validity of the instrument, it will be subjected to scrutiny of committee/research critics. Consultation and discussion will be done to make sure that the items in the questionnaires are reliable and valid. Also, a pilot testing will be conducted and questionnaires will be administered to the respondents to assess the content of the instrument. Responses will then be considered for the final draft of the system. Moreover, the instrument will be tested on another set of respondents aside from the selected respondents to test the reliability of the instrument.

2.7. Procedure of the Study

After gathering the needed information from the interviews with the school principal, CMES teachers, and parents of CMES students, development of the system will begin by following the six stages of the System Development Life Cycle namely planning, analysis, designing, coding, testing and implementation.

Initially, planning and requirement analysis will be conducted for the identification of the required resources and system requirements. Also, schedule of activities will be plotted in a Gantt chart. After which, detailed requirements gathered in the planning and analysis stage will be transformed into a complete and detailed system design which will focus on how to deliver the intended functions of the web application. The coding phase then follows, the HTML and CSS framework will be used to develop the systems' front-end. PHP scripting language and JavaScript will then be used to create the back-end of the system. In addition, MySQL server will be used as the database.

After development of the system, it will undergo testing to ensure that all the functionality expected from the system are delivered, thus ensuring that the system is error or bug free. IT experts and other chosen respondents will then be requested to evaluate the system based on the ISO 25010 Software Product Quality Standards. Recommendations and suggestions derived from the questionnaires will be taken into consideration and to be given possible actions to ensure that the system fits on users need.

After the successful implementation of the developed web-based application, the school principal, CMES teacher, and parents of CMES students will be asked to evaluate the level of effectiveness of the implementation of the web-based application based on the valid and reliable questionnaire

To determine the acceptability of the web-based application, the results of the evaluation will be calculated using weighted scores and weighted mean of the responses. Consequently, these were then analyzed on the different software criteria based on the ISO 25010 Software Quality Standards.

2.8. Data Analysis Technique

- The development phase of the Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification will be described textually based on the different stages of SDLC.
- The technical characteristics of the system based on ISO 25010 Software Product Quality Standards will be assessed using the rubric shown in table 2.

Table 2 Rubric of Evaluation

Numerical Rating	Qualitative Rating	Description
3.51 – 4.00	Excellent	The system meets ALL the quality standards of the criterion. No modification is required / recommended.
2.51 – 3.50	Good	The system meets ALMOST ALL the quality standards of the criterion. Minimal modification is required / recommended.
1.51 – 2.50	Fair	The system FAILS to meet the quality standards of the criterion. Major revisions are required / recommended.
1.00 – 1.50	Poor	The system FAILS to meet the quality standards of the criterion. Needs to be redone to serve its purpose.

3. Result

3.1. Description of the Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification through the Software Development Life Cycle

Several activities were included in the **planning phase** of the software development life cycle, including end-user meetings and interviews, task identification to complete the system, and the establishment of a development schedule using a Gantt chart.

The use case diagram, which assisted in determining the responsibilities that each end-user could play within the system, and the identification of the hardware and software required to run the system were both part of the **analysis phase** of the software development life cycle.

Data flow and database design were done during the **design phase** of the software development life cycle using entity-relationship diagrams, data flow diagrams, data normalization, and data dictionaries.

During the **coding phase**, various software packages such as Angular and Bootstrap were used to construct the web application. Also, the system's information repository was developed using MySQL.

In order to make sure the system operates as intended and without any problems, the researcher, a few IT specialists, and end users conducted several **testing phases**. The generated web-based application was also evaluated during this phase using the standards outlined in ISO 25010 Software Product Quality Standards.

The **implementation phase** involved the installation of the system on a computer with a QR code scanner. The system was implemented for 2 weeks. After the successful implementation of the system, selected respondents were requested to evaluate the system based on its functional suitability, performance efficiency, and usability.

3.2. Evaluation of the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification by IT expert

The first set of questionnaires was used by the IT experts to assess the technical qualities of the system based on the ISO 25010 Software Product Quality Standard on functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

Table 3 shows a summary of the IT expert's evaluation of the developed web-based system using ISO 25010 Software Product Quality Standard.

Table 3 Summary of Evaluation of the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification by IT expert.

Software Product Quality Categories	Weighted Mean	Verbal Interpretation
1. Functional Suitability	3.67	<i>Excellent</i>
2. Performance Efficiency	3.75	<i>Excellent</i>
3. Compatibility	3.75	<i>Excellent</i>
4. Usability	3.90	<i>Excellent</i>
5. Reliability	3.89	<i>Excellent</i>
6. Security	4.00	<i>Excellent</i>
7. Maintainability	3.75	<i>Excellent</i>
8. Portability	3.75	<i>Excellent</i>
Grand Mean	3.81	<i>Excellent, the system meets ALL the quality standards of the criterion. NO modification is required / recommended</i>

The web-based system received a 3.81 rating from IT experts in all areas. The evaluation results from IT experts indicate

that the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification met all the ISO 25010 Software Product Quality Standard's various software quality criteria and that no modification is required nor recommended.

3.3. Evaluation of the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification by the school principal, teachers, and parents.

The second set of questionnaires was used by the school principal, teachers, and parents to assess the selected qualities of the web-based system based on the ISO 25010 Software Product Quality Standard on functional suitability, performance efficiency, and usability.

Table 4 shows a summary of evaluation from the school principal, teachers, and parents of the developed web-based system using selected ISO 25010 Software Product Quality Standard.

Table 4 Summary of Evaluation of the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification by school principal, teachers, and parents.

Software Product Quality Categories	Weighted Mean	Verbal Interpretation
1. Functional Suitability	3.48	Good
2. Performance Efficiency	3.22	Good
3. Usability	3.28	Good
Grand Mean	3.33	Good, the system meets ALMOST ALL the quality standards of the criterion. Minimal modification is required / recommended.

The web-based system received an average of 3.33 rating from school principal, teachers, and parents on selected areas. The evaluation results from IT experts indicate that the Web-based Smart Attendance Monitoring System using QR Code and GSM Module for SMS Notification met almost all the ISO 25010 Software Product Quality Standard's various software quality criteria and that minimal modification is recommended.

4. Discussion

In the development and assessment of the web-based application, the findings are as follows:

- The Web-based Smart Attendance Monitoring System using QR code and GSM module for SMS notification was successfully developed based on the different phases of the Software Development Life Cycle.
- The web-based application complied with all the requirements specified in the ISO 25010 Software Product Quality Standard as established by the rating given by IT experts.
- The web-based application complied with the requirements specified in the selected ISO 25010 Software Product Quality Standard criteria as exhibited by the ratings given by various end-users which include the school principal, teachers, and parents.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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