



## Journal of Advanced Research in Computing and Applications

Journal homepage:  
<https://karyailham.com.my/index.php/arca>  
2462-1927



# Integrating the Formative and Summative Evaluation in the Development of Face Recognition Attendance System

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### ARTICLE INFO

#### Article history:

Received 1 December 2025

Received in revised form 1 January 2026

Accepted 2 February 2026

Available online 8 March 2026

#### Keywords:

Attendance system; face recognition; formative evaluation; summative evaluation; system usability

### ABSTRACT

The advancement of computer vision technologies has facilitated the development of numerous applications across various sectors, including education. Among these innovations, facial recognition stands out as a prominent application, particularly when integrated with business processes such as attendance management systems. Traditional attendance systems often suffer from inefficiencies such as being time-consuming, susceptible to manipulation, and lacking in security and data integrity. In response, automated attendance systems leveraging facial recognition aim to overcome these limitations by offering a more efficient, accurate, and secure method of attendance tracking. This paper presents our experience in the development and evaluation of a facial recognition-based attendance system, with a particular focus on the critical role of both formative and summative evaluations. Formative evaluation, conducted during the development phase through expert reviews, was instrumental in identifying design flaws and ensuring that all essential user requirements were captured. In contrast, summative evaluation, carried out via online survey involving 30 respondents after system completion, provided valuable insights into system usability for guiding further refinements. The integration of both evaluations not only addresses different aspects of system quality but also ensures a more robust and user-centred system design. Employing this dual-evaluation approach enhances the reliability and practicality of face recognition-based attendance systems, aligning them with the evolving needs of modern organizations.

## 1. Introduction

The integration of face recognition technology into attendance systems represents a significant advancement in personnel management across various sectors, including education, government, and enterprises [1]. Such systems automate attendance tracking, thereby enhancing accuracy and efficiency while simultaneously minimizing the administrative burden associated with manual methods [2,3]. While the existing attendance system has many problems like easy manipulation, time

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consuming and very prone to inaccuracy, face recognition systems offer a contactless and non-intrusive solution, particularly beneficial in environments where hygiene and speed are critical [4]. These systems leverage biometric signatures derived from facial images, ensuring that attendance records are based on unique identifiers, thereby reducing the potential for fraud or manipulation [5]. Furthermore, the deployment of face recognition in attendance management streamlines operations and provides real-time data, which can be invaluable for monitoring presence, managing resources, and ensuring compliance with organizational policies [6].

Face recognition attendance system is based on computer vision technology that analysed human features (such as face structure), and become one of the important concept of artificial intelligence [3]. When implemented in the attendance system, this technology capable to monitor students present in educational institutions, meanwhile maintaining accurate attendance records [7]. To capture and analyse facial data effectively, modern face recognition systems incorporate sophisticated algorithms and hardware. These algorithms, which includes both detection and recognition, can automatically identify and confirm individuals from digital images or video feeds [8]. Implementation of these face recognition attendance system requires to evaluate both formative and summative evaluations to ensure its effectiveness in real world scenarios [7].

Briefly, the formative evaluation is an ongoing, iterative process aimed at improving the system during its development and implementation phases, whereas summative evaluation is conducted at the end of the development cycle to assess the overall effectiveness and impact of the system [9]. Both evaluations focus on identifying areas for improvement and optimizing the system's performance by continuously monitoring its operation in real-world scenarios [3]. For instance, during the formative evaluation, the system's ability to accurately detect and recognize faces under varying lighting conditions, angles, and occlusions can be assessed [10]. The feedback obtained during this phase is used to fine-tune the algorithms, enhance the user interface, and address any usability issues that may arise [5].

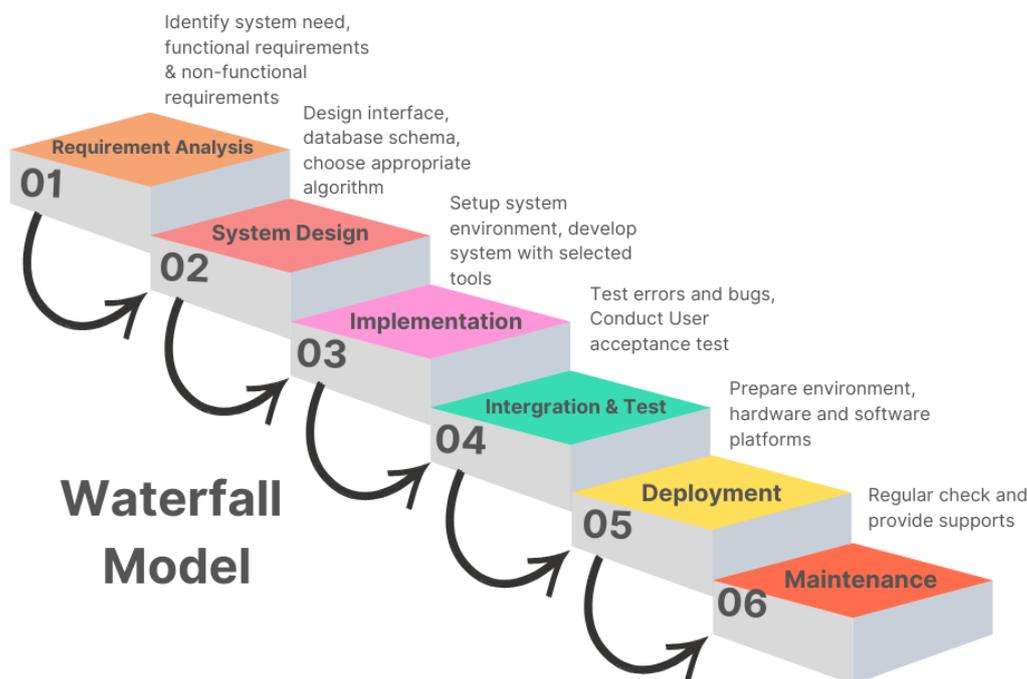
The summative evaluation, on the other hand, provides a comprehensive assessment of the final product, typically conducted after the system has been fully developed and implemented [11]. This type of evaluation aims to determine the overall effectiveness of the system in meeting its stated goals and objectives, often focusing on quantifiable metrics such as accuracy rates, processing speed, and user satisfaction. Summative evaluations often involve comparing the performance of the face recognition attendance system against traditional methods, such as manual attendance sheets or biometric fingerprint scanners, to quantify the improvements achieved in terms of time savings, reduced errors, and cost efficiency. The results of summative evaluations provide valuable insights into the long-term impact of the system and its contribution to the organization's overall efficiency and productivity.

## **2. Face Recognition Attendance System**

Face recognition attendance systems provide a promising substitute to conventional attendance-tracking techniques, potentially saving time, improving accuracy, and lowering administrative expenses [5]. Face recognition technology automates data gathering, reduces manual labour, and provides real-time insights into attendance patterns, improving overall organizational efficiency and decision-making. One key advantage of face recognition systems is their capacity to offer a non-intrusive and contactless method of attendance tracking [12]. Students are simply required to look at a camera or sensor, and the system automatically detects and recognizes their faces, eliminating the need for physical contact with attendance devices. To enhance operational efficiency and data synergy, these automated attendance systems can be architected for seamless integration with

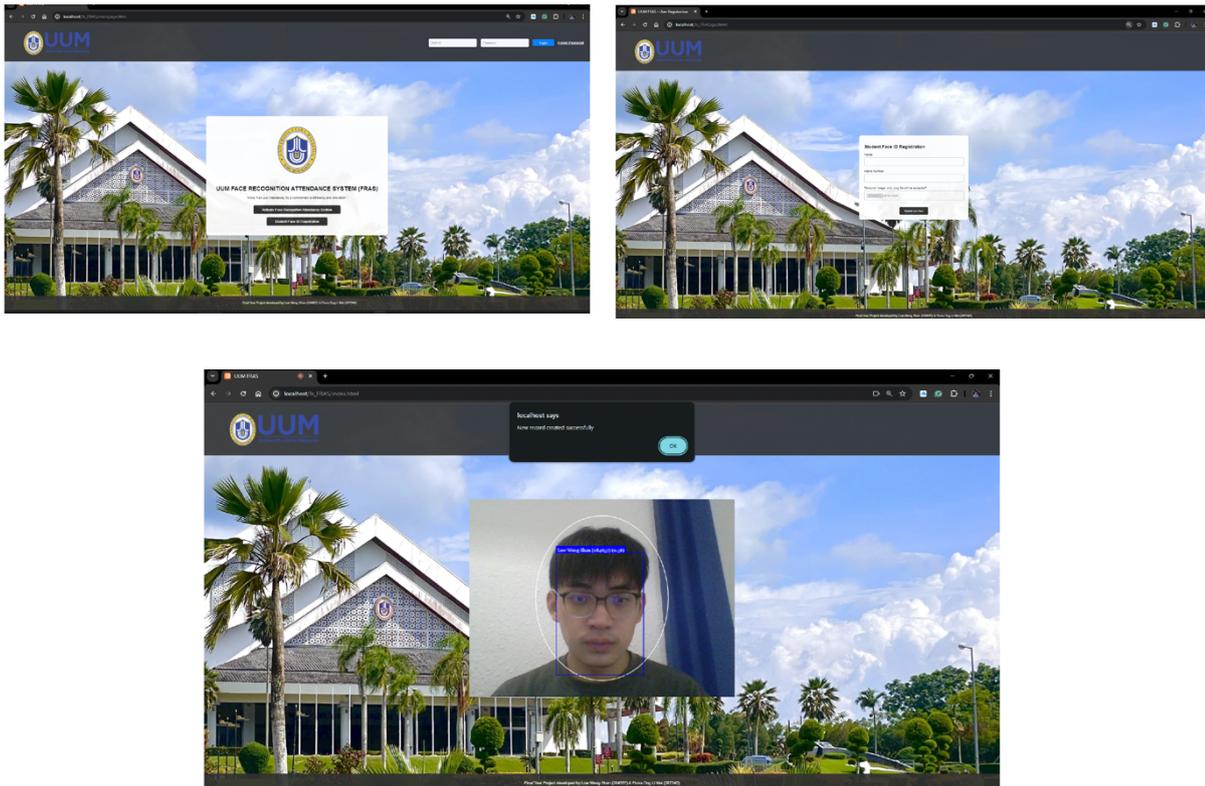
existing institutional frameworks, encompassing student information systems, human resources databases, and access control systems; this integration fosters a unified and streamlined [13].

In this paper, we shared our experience develop a face recognition attendance system. The system was built mainly for testing purposes and become part of the final year project carried out in the classroom. In order to develop the system we applied Water-fall model; a step-by-step approach on system development. Basically, Water-fall model is a sequential approach development, where each stage must be completed fully before moving on to the next stage [3]. There are six main phases in the Waterfall model and these include requirement analysis, system design, implementation, testing, deployment, and maintenance. Fig. 1 depicts the all phases in the Water-fall model as well as required tasks that we have implemented to develop the face recognition attendance system.



**Fig. 1.** System development tasks sequence based on Waterfall model

The process began with the requirement analysis, where we collected detailed input from stakeholders like lectures, IT officers and students. This helped in defining essential features, such as student enrolment and face recognition requirements, as well as performance expectations. Next, in the system design phase, the project’s architecture was planned out. Related tasks include designing a user-friendly interface, setting up the database to manage user and attendance data, and choosing the right technologies for face detection and recognition. Detailed diagrams and flowcharts were created to map out how the system would function. During the Implementation phase, the design was turned into a working system. The front-end was developed with HTML, CSS, and JavaScript, while the back-end, built with PHP and face.api from Tensorflow.js, handled face recognition and data processing. Careful coding and integration ensured all parts of the system worked together smoothly. We name our prototype as Face Recognition Attendance System (FRAS). Fig. 2 show some screenshot of FRAS.



**Fig. 2:** Screenshot of FRAS

During the integration and testing phase, each individual component of FRAS were tested for functionality, followed by integration tests to check how well the components worked together. The system testing confirmed that the system met all requirements, and user acceptance testing was performed to gather feedback and make final adjustments. In the deployment phase, the system was supposed to final set up for actual use, however since FRAS is just a prototype, we executed the Formative and Summative Evaluation to gather feedback from students on the system usability. Finally, in the maintenance phase improve the system performance by taking out bugs and errors so that most derived issues were resolved and improvements were made based on user feedbacks.

### 3. Formative and Summative Evaluation for FRAS

Fig. 3 shows the formative and summative processes that we did to evaluate FRAS. We conducted two rounds' evaluations to obtained feedbacks for FRAS through these processes. In Round 1, we conducted the formative evaluation. The evaluation is intended to collect comprehensive feedback from three experts throughout the development phase to guarantee that the system satisfies user demands successfully. This aimed to improve the accuracy and efficiency of attendance tracking by incorporating cutting-edge face recognition technology. There are eight questions asked during the Expert Interview. These questions are:

- How effective has the FRAS been in accurately recording attendance?
- How satisfied are you with the performance and reliability of the FRAS?
- How does the system ensure the privacy and security of biometric data?
- Have you encountered any issues with the system's performance in different environmental conditions, such as low light or outdoor settings?

- Do you think the FRAS is accurate in recognizing and logging faces?
- Are there any delays or slowdowns in the system's processing speed that you have noticed?
- Is the layout of the interface intuitive and well-organized?
- How would you rate the FRAS on a scale of 1 to 10? Can you explain your rating?

Later, based on the experts' feedbacks, we can react accordingly to improve the system.

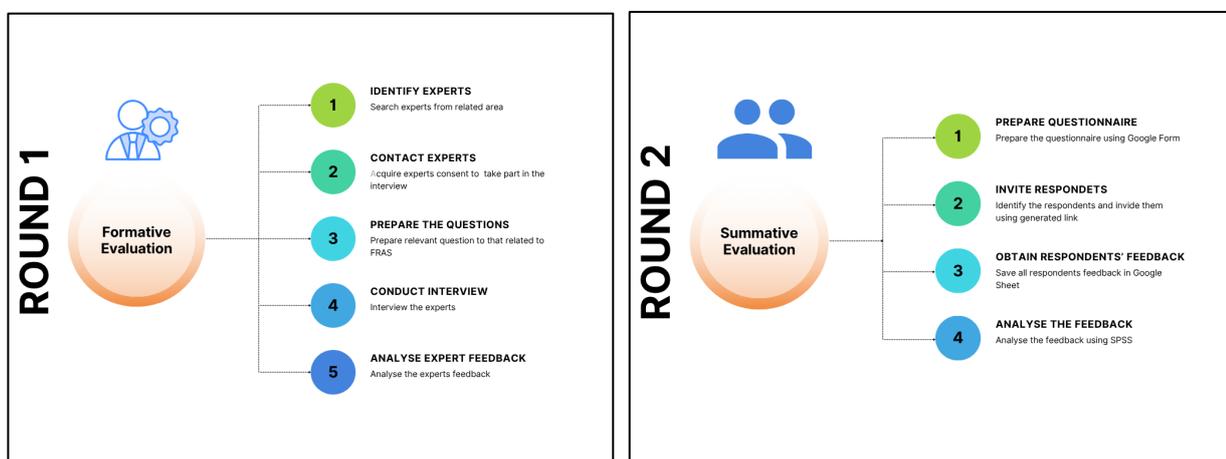


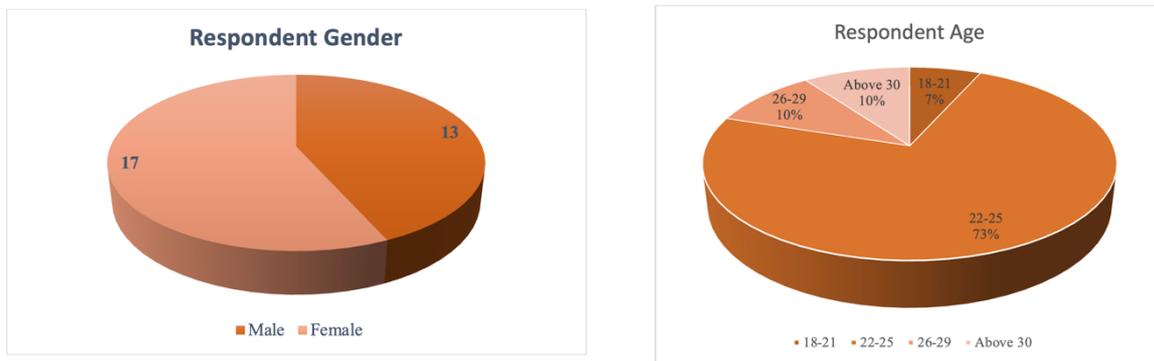
Fig. 3. Formative and Summative processes to evaluate FRAS

Meanwhile in Round 2 of this evaluation, we conducted the summative evaluation using online survey method with 30 respondents (university students) where they assess the usability and overall satisfaction with the system. Respondents are plead to answer questions from an online form created in Google form. There are 15 formulated questions in the form written based on the Common Standard Usability Criteria ISO 9241-11 (Effectiveness, Efficiency, and Satisfaction) adapted from [14]. The link for the form is shared through social media for respondents to try using FRAS before they can answer the Google form. We divided the form into five sections, namely for demographic information, effectiveness, efficiency, satisfaction, and comments of the system. We also applied five scale Likert Scale from point 1 to 5 that represent 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4- Agree and 5- Strongly Agree. Once every respondent answered in the Google Form, their feedbacks are stored and organized in Google Sheet. Later, we conducted descriptive statistical analysis using IBM SPSS.

#### 4. Result and Discussion

Based on the Experts feedback in the formative evaluation, we can concluded that overall, all experts agreed that FRAS is effective and accurate at recognising the faces and can be used as a new way to record students' attendance. These experts also satisfied with the system performance and believe that the system can maintains good privacy and data security for users. Additionally, they also satisfied with the system feedback they discovered that FRAS processing speed at recognising the face is nearly to real-time performance. However, at the back side, they believed that FRAS can be improved if small issues especially those related to hardware and environment limitation can be resolved. For example, since the system main input is the user face, then high-end camera is required to maintain the quality of face captured before they can be processed. Next, the environment for the system to operate must be suitable like space with bright light area to ensure enough light to capture the face. Low light condition will hinder the system to work properly and effect the face recognition process.

There are a total of 30 respondents who have responded to the online survey during the summative evaluation. The demographic information about all respondents can be illustrated in Fig. 4.



**Fig. 4.** Demographic information of respondents

There are 17 (56.7%) females and 13 (43.3%) males involved in this evaluation. From this gender differences, it is found that most of the respondents are between 22-25 years old, which are 73.7%, 7% from these respondents are between 18-21 years old, and there are equal percentage at 10% for both age categories 26-29 and those above 30 years old.

All survey results obtained from the online survey are analysed using IBM SPSS. Since the objective conducting this survey is to assess the usability and overall satisfaction of FRAS, we only applied descriptive statistical analysis for the data we collected. Descriptive statistical analysis allowed us to indicate the central tendency result for the effectiveness, efficiency, and satisfaction on FRAS usability. Table 1 list the result from the descriptive statistical analysis executed in SPSS.

**Table 1**  
 Descriptive statistic analysis from SPSS

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
MeanEF	30	2.40	5.00	4.4867	.55007
MeanEC	30	2.80	5.00	4.4733	.53430
MeanST	30	3.20	5.00	4.6000	.51193
Valid N (listwise)	30				

In Table 3, MeanEF referred to mean of effectiveness (EF), MeanEC referred to mean of efficiency (EC), and MeanST referred to mean of satisfaction (ST). The analysis show that respondents reported highest effectiveness with FRAS usability with a mean score of 4.4867 with standard deviation of 0.55007 (M=4.4867, SD=0.55007). This suggests that respondents generally find FRAS is effective to capture the attendance with face recognition. Meanwhile the mean for efficiency scored 4.4733 with standard deviation of 0.5353 (M=4.4733, SD=0.5353). This indicator shows that respondents perceive the system as efficient in its operation. Finally, the mean of satisfaction scored 4.6000 with standard deviation of 0.51193 (M=4.6000, SD=0.51193) is the highest among the three metrics, implying that user satisfaction towards FRAS is very high. This could mean that users are pleased with their overall experience of using FRAS for capturing the attendance.

## 5. Conclusion

In this paper, we share our experienced conducting formative and summative evaluation for the FRAS, a system that occupied face recognition technique to capture the attendance. In the formative evaluation, we seek feedback from three experts so that to get guidelines to develop FRAS efficiently. On the other hand, the summative evaluation permits us to assess the usability of FRAS in three aspects that are effectiveness, efficiency, and satisfaction that respondents feel about the system. Before both evaluations can be done, we developed FRAS as a prototype following a popular system development model called Waterfall model. Later, these two evaluations are carried out.

Feedback from experts revealed that FRAS is effective and accurate at recognising the faces to record students' attendance however, there are still new improvements need to be done to the system especially those related to hardware and environmental issues. On the contrary, the result from the summative evaluation indicated that overall, FRAS managed to meet the usability requirements needed by respondents to capture the attendance using face recognition technique. All the aspects that asked related to usability of FRAS scored high mean value. This shows that in term of system usability, FRAS managed to satisfy user need.

In the future, we plan to conduct similar study other advanced system especially those related to new and popular technology such as real-time system, prototype system that based on artificial intelligent generative development, or immersive system development. This proposed study can lead to new findings as these types of system are widely used among used nowadays. We also expect that the proposed study can lead to broader knowledge dissemination for future researchers.

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