Functionality, Reliability and Satisfaction: A Users' Retrospective Evaluation of the UPTM's Class Attendance Management & Monitoring (UCAM) System

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Abstract. This research paper is related to the evaluation of the UPTM Class Attendance Management & Monitoring (UCAM) system in assessing items related to system functionality, data reliability, perception of effectiveness, and user satisfaction, and its role in class monitoring using a purposive sampling technique. The purpose of the UCAM system is to assist faculty in recording and managing student attendance and class schedules effectively using QR codes. This research answered the three research questions, which are how lecturers and students perceive the functionality and usability of the UCAM system for managing class attendance, to what extend does the UCAM system provide reliable data and effective features to reduce absenteeism and what is the level of user satisfaction among lecturers and students regarding the UCAM system's interface, navigation and impact of attendance awareness. This study has been conducted using a quantitative approach through the distribution of structured questionnaires. Data were collected based on a 5-point Likert scale distributed to 36 lecturers and 185 students at Universiti Poly-Tech Malaysia (UPTM). The descriptive statistical analysis had been performed and the results revealed that lecturers perceived UCAM system as an effective tool to improve their ability to monitor student attendance pattern in real-time. In conclusion, UCAM system is a well-received as a reliable system to supports effective attendance monitoring and students' accountability.

Keywords: Attendance, UCAM, QR Code, User Satisfaction, System Effectiveness

1 Introduction

1.1 Research Background

The process of recording students' attendance by university educators during each instructional session is an arduous endeavour, particularly in the context of large class sizes (Masalha & Hirzallah, 2014). Conventional academic doctrine posits that class attendance is a pivotal determinant of academic performance (Khan, 2022). According

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to Sampaio & Baptista (2019), absenteeism is characterized as the failure of an employee to be present at their place of employment, irrespective of the underlying causes. As articulated by Rosman et al. (2020), a notable limitation of the Malaysian educa- tional framework is the reliance on traditional methods of attendance record mainte- nance. These manual practices result in data redundancy, sluggish responsiveness in emergencies, potential occurrences of truancy, and the risk of mismanaged attendance records.

As mentioned by Caytuiro-Silva et al. (2024) and Jayusta et al. (2024), the increasing demand for efficient, accurate, and user-friendly attendance tracking in educational institutions has led to the need for research on the evaluation of attendance management systems using QR codes. The evolution of the manual attendance system to digital solutions using QR code integration, geolocation, and biometric technologies has happened over the preceding ten years (Mar'atuttahirah et al., 2024) (Sarkawi et al., 2022). While Nusantara et al. (2024) and Banesa et al. (2024) stated that this transformation had improved the administrative efficacy and the dependability of data, specifically in the educational sector, by signifying the more extensive transition towards the utilization of information technology. With research indicating a reduction of up to 50% in monitoring attendance and a notable reduction in taking attendance, Dabhade et al. (2024) highlighted the benefits of this system by their capacity to alleviate administrative burdens, diminish inaccuracies, and enhance student participation. Furthermore, the implementation of systems utilizing QR codes is congruent with sustainable methodologies by diminishing the consumption of paper resources. (Bhange et al., 2024) (Ikhsan & Helmina, 2024).

Compared to the conventional approach, QR code-based attendance management systems exhibit a persistent focus on augmenting efficiency, precision, and user contentment. Various academic inquiries suggest that QR code technology possesses the capability to curtail human errors, refine time efficiency, and elevate data accuracy. Furthermore, academic institutions frequently implement minimum attendance stipulations, correlating them with ongoing evaluations or qualification for final assessments. Variability in research methodologies and the presence of divergent contexts further influence the extent to which results can be generalized, thereby underscoring the necessity for more comprehensive investigations. Buchori et al. (2024) and Taju et al. (2024) assert that, notwithstanding these technological innovations, enduring challenges remain apparent in the assessment of the comprehensive functionality, data integrity, perceived effectiveness, and user satisfaction associated with QR code attendance systems.

A multitude of academic studies suggests the existence of usability issues, encompassing inadequate instructional support, ambiguous feedback systems, and barriers to technological acclimatization, all of which have the potential to hinder user acceptance and overall contentment, thereby influencing the successful execution of QR code attendance systems. In this scholarly article, the components pertaining to system efficacy, data dependability, the perception of effectiveness, and user contentment will be evaluated through the UPTM Class Attendance Management & Monitoring (UCAM) system.

Despite the growing body of literature on QR code–based attendance systems, many prior studies emphasize technical implementation or behavioral intention, with limited empirical evaluation of system functionality, data reliability, perceived effectiveness, and user satisfaction from multiple stakeholder perspectives within a single institutional setting. Moreover, comparative evidence focusing on both lecturers and students remains relatively underexplored in the Malaysian higher education context. Therefore, this study addresses this gap by providing a structured, retrospective evaluation of the UCAM system at Universiti Poly-Tech Malaysia (UPTM), focusing specifically on user-centered outcomes to support evidence-based improvements in attendance monitoring practices.

The following are the main research questions this research attempts to answer:

1. How do lecturers and students perceive the functionality and usability of the UCAM system for managing class attendance?
2. To what extent does the UCAM system provide reliable data and effective features to reduce absenteeism?
3. What is the level of user satisfaction among lecturers and students regarding the UCAM system's interface, navigation, and impact on attendance awareness?

Corresponding to these questions, the research objectives are:

1. To assess user perceptions of the UCAM system's functionality and usability for managing class attendance.
2. To evaluate the reliability and effectiveness of UCAM features in tracking attendance and generating reports.
3. To determine the level of satisfaction among users concerning the interface, security, and usefulness of the UCAM system.

2 Literature Review

2.1 Attendance Monitoring in Higher Education

During the contemporary era characterized by digitization, attendance has been recognized as a significant factor influencing student engagement and academic achievement. An extensive body of research demonstrates a positive correlation between consistent class attendance and academic performance. According to the findings of Credé, Roch, and Kieszczynka (2010), in contrast to conventional admissions assessments or previous academic accomplishments, class attendance emerged as a more accurate predictor of students' performance. In the contemporary educational milieu, regular attendance can enhance the efficacy of the instructional setting, thereby facilitating favorable learning outcomes. Furthermore, educational institutions frequently impose minimum attendance standards, correlating these stipulations with ongoing evaluations or qualifications for culminating assessments. For example, research conducted by Gump

(2005) and Moore et al. (2003) emphasizes that students demonstrating inadequate attendance frequently display diminished GPA metrics and an increased propensity for academic failure or withdrawal from courses. Consequently, the observation of attendance not only facilitates the evaluation of academic performance but also functions as a preliminary alert mechanism for identifying student disengagement and challenges related to retention.

With the progressive developments in educational technology, the utilization of digital attendance monitoring systems is increasingly becoming widespread. Biometric mechanisms (such as fingerprint or facial recognition technologies), QR code scanning, RFID/NFC-enabled cards, and mobile-based GPS tracking are being incorporated into pedagogical settings. The incorporation of QR codes with geolocation technology, facial recognition systems, biometric authentication methods, and SMS notification services is becoming more pronounced to advance attendance verification processes and enhance security implementations. These integrations counteract the vulnerabilities associated with separate QR systems, featuring the discouragement of fraudulent attendance and the augmentation of multi-factor authentication, subsequently enhancing the comprehensive resilience of the system (Jayusta et al., 2024) (Singh et al., 2024).

Learning Management Systems (LMS) such as Moodle and Google Classroom also integrate automated attendance functionalities, particularly within online or hybrid learning contexts. Integration with familiar platforms such as WhatsApp or Moodle enhances accessibility (Mar'atuttahirah et al., 2024) (Setiawan & Rahayu, 2022). During the COVID-19 pandemic, platforms such as Zoom and Microsoft Teams enabled instructors to track attendance through participant logs and usage analytics, further validating the role of digital tools in academic monitoring. Additionally, maintaining historical attendance records manually is inefficient and prone to data loss. These constraints hinder institutions from leveraging attendance data to improve academic support services, implement predictive analytics, or integrate attendance records into centralized academic dashboards.

Collectively, prior studies emphasize that consistent attendance is a critical indicator of student engagement, academic performance, and early risk detection in higher education. However, much of the existing literature concentrates on the impact of attendance itself rather than empirically examining the effectiveness, reliability, and usability of attendance monitoring systems. As a result, limited attention has been given to evaluating how digital attendance systems support lecturers' monitoring tasks and students' awareness simultaneously. This gap highlights the importance of assessing attendance systems such as UCAM from both instructional and user-experience perspectives within institutional settings.

2.2 Smart Attendance System and Technologies

In this digital age, student attendance monitoring is very important to ensure the students' presence can be tracked and the potential problems, such as fraud, can be reduced. Nowadays, there are a variety of smart attendance systems and technologies that already exist to replace the conventional process of taking attendance using paper-based methods. The problems with the traditional attendance system are so tedious that they

lead to time-consuming inefficiency, difficulty in monitoring student attendance, costing, and security issues. To replace the conventional method, the technology evolution in attendance systems comes up with a solution using Internet of Things (IoT) integration to get real-time data collection. According to Seftiani & Sutabri (2024), the Internet of Things (IoT) encourages the synthesis of various technological systems, including facial recognition and Radio Frequency Identification (RFID), into a systematic arrangement aimed at attendance verification. This integration enables the diverse sensors and identification methodologies to interact and collaborate efficiently in order to verify the presence of students. Furthermore, the technology of RFID has also emerged in the smart attendance system, as shown in the research by Aghakouchakzadeh et al. (2015), which states that RFID technology not only can automate recording, but it can also track the location of students during class time.

Besides that, the technology of QR codes is also very popular nowadays to eliminate the need for manual entry. As stated by Dolai et al. (2024), the QR code technology plays an important role in the Smart Attendance Management Systems (SAMS) as an authentication method in ensuring the accuracy of data and support for automation process. While Haq (2023) in his research mentioned that the use of bar code scanning in the application of MyOnTime that had been utilized in Sekolah Indonesia Kota Kinabalu (SIKK), shows a significant result in terms of streamlining the recording process, reducing manual effort, being environmentally friendly, and real-time data monitoring. Based on the User Acceptance Testing (UAT) that had been conducted at ITS NU Kalimantan, show a positive result where the system was evaluated utilizing a cohort of 45 participants, who attained a mean score of 83%, with perceived usefulness at 82%, ease of use at 84%, and user acceptance at 82%.

In addition, research by Ramakrishna et al. (2024) found that the application of a face recognition-based smart attendance management system used the pre-processing technique and feature extraction method, including Transductive Support Vector Machine (TSVM) and Histogram of Oriented Gradients (HOG). There are various types of biometric technologies, such as fingerprint recognition, facial recognition, and iris scanning, that can be implemented in schools. Finally, the implementation of biometric technology in managing school attendance and enhancing security protocols has demonstrated considerable efficacy. This technological enhancement refines attendance management and strengthens security protocols, thereby establishing a secure setting for both students and faculty (Mufron & Wei, 2024).

Overall, smart attendance technologies such as QR codes, biometric authentication, RFID, and IoT-based systems demonstrate strong potential in enhancing automation, accuracy, and security in educational environments. Nevertheless, many existing studies primarily emphasize technical design, system architecture, or feasibility testing, with less focus on user-centered evaluation and long-term system reliability. In particular, comparative assessments involving both lecturers and students remain limited. These gaps underscore the necessity of evaluating attendance systems beyond technological capability, focusing instead on functionality, data reliability, perceived effectiveness, and user satisfaction, as examined in the UCAM system.

2.3 Comparative Review of UCAM with Other Attendance Systems

Based on Table 1, comparative studies are conducted between attendance systems from different institutions, including UiTM, UKM, UUM, and UPTM. In terms of the aspect of low cost, real-time data recording, and mobile/web-based automation, UPTM's Class Attendance Monitoring System (UCAM) was aligned closely with the other Malaysian QR-based systems. The features that make UCAM different from other existing attendance systems are that this system involves both the student and lecturer perspectives to assess usability, data reliability, and user satisfaction. The other existing system only focusing on functionality and behavioral intention.

Conversely, biometric approaches like AttenFace and facial recognition technologies utilizing Raspberry Pi enhance security frameworks and diminish proxy threats, though they demand considerable financial outlay for hardware and provoke privacy concerns, while RFID and GSM-based solutions support real-time monitoring, yet demonstrate substantial reliance on hardware and the possible risk of card sharing. In summary, the efficient and versatile structure of UCAM, coupled with its emphasis on stakeholder-centered assessment, provides it with a distinct advantage when compared to more intricate or hardware-dependent alternatives.

This comparative synthesis reveals that while many attendance systems share similar objectives of improving efficiency and accuracy, they differ significantly in terms of system complexity, cost, user involvement, and evaluation scope. Several prior systems emphasize functional implementation or behavioral intention, whereas UCAM uniquely integrates feedback from both lecturers and students to evaluate functionality, reliability, effectiveness, and satisfaction concurrently. This user-centered evaluation approach positions UCAM as a more comprehensive attendance monitoring solution within the Malaysian higher education context.

Table 1. Comparative Review of Attendance System

Attendance System	Source / Authors	Key Features & Context	Comparison with UCAM
UCAM (QR-based system at UPTM)	UPTM	QR code attendance via web/mobile; multi-role admin; real-time monitoring; editable records; promotes accountability	Efficient, low-cost, scalable, reliable data control; promotes awareness as reported by lecturers and students
UiTM QR-Code Attendance System	Hamzah et al. (2021)	Developed for UiTM Terengganu; automates attendance, calculates %, generates warnings; built via SDLC waterfall.	Similar QR-based functionalities; fewer stakeholder perception insights compared to UCAM
UiTM Perlis QR-code Mobile App (Norazman, 2019)	Norazman, (2019)	QR scanning via mobile/web; warning emails for low attendance; cloud-based; tested on 30	Comparable features but smaller sample; lacks lecturer-student comparative perception data

		respondents; positive satisfaction	
UKM GO: Mobile QR Attendance System	Yusniza (2019)	QR-based mobile app; cloud storage; designed for large lectures; reduces manual signatures.	Similar automation; limited evaluation of usability and satisfaction metrics
UUM QR Code Attendance Monitoring (UTAUT study)	Aini & Yaacob (2020)	Studied performance expectancy, effort expectancy, and social influence on intention to use a-QR-based system.	Emphasis on intention rather than effectiveness or satisfaction; UCAM adds real-user satisfaction and reliability data
AttenFace: Face Recognition System	Rao (2022)	Automated real-time face recognition using classroom snapshots; integrates with LMS; reduces proxy risk.	More sophisticated biometric security, higher cost, and privacy concerns; lacks the mobile simplicity of UCAM
Embedded Facial Recognition System on Raspberry Pi	Touzene et al. (2024)	Raspberry Pi + camera device for facial recognition; web UI for attendance management; embedded intelligent system.	Edge-device complexity, compared to UCAM's web/mobile-only approach, has higher setup and maintenance needs
RFID-Based Attendance via ID Cards & GSM	Bhat et al. (2023)	RFID card scan tied to remote database via GSM; also used for room security; real-time status updates.	Similar real-time, higher hardware dependency, risk of shared cards, UCAM simpler with low device requirements

3 Methodology

This section describes the research methodology used in the research that covers all the processes involved in the Perceptions of Effectiveness and Satisfaction Towards UPTM's Class Attendance Monitoring (UCAM) System project, including phases, activities, methods, and deliverables. The quantitative research approach was adopted in this study to collect all data related to the project. Five phases in this research methodology were conducted, consisting of research planning, data gathering, data analysis, and finally the documentation phase. Figure 1 shows the flow of the research.

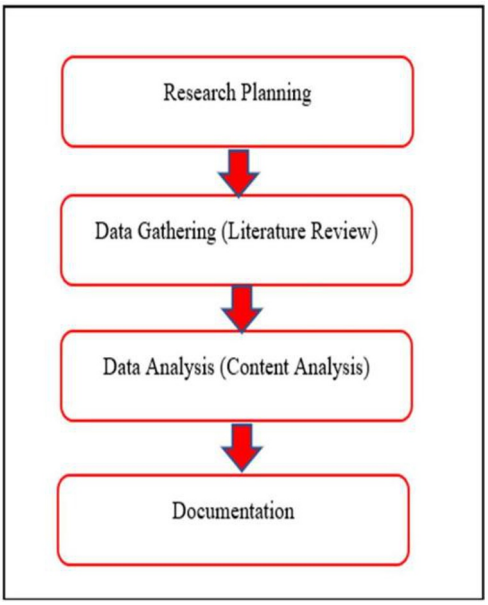

Fig. 1. Research Methodology

The research methodology for this project is structured into four main phases consist of research planning, data gathering, data analysis, and documentation. Each phases are mapped with activities, objectives, methods, and deliverables related to the research. The mapping table is important in ensuring the flow of the system can be tracked through each activity and method, and at the same time, the objectives and deliverables can be achieved, as shown in Table 2.

Table 2. Research Methodology Mapping table

Phases	Activities	Objectives	Methods	Deliverables
Research Planning	**Activity 1:** Identify and understand the research problems	To identify objectives, scope and the significance of the research.	Literature Analysis (Search Method)	Defined objectives, scope of the study.
	Activity 2: Review the literature on smart attendance systems and technologies	To compare the smart attendance system technologies and their adoption in universities.	Comparative study	The summarization of the smart attendance system and technologies supported by many authors and sources.

	Activity 3: Review the literature on the system functionality and usability in educational tools	To identify the features in UCAM for assessing the user perceptions of the UCAM system's functionality and usability for managing class attendance.	Procedure and samples	Identified features in UCAM for assessing the user perceptions of the UCAM system's functionality and usability for managing class attendance.
	Activity 4: To identify the population	To get the sample.	Literature Analysis	Population frame
	Activity 5: To identify the sample size	To get the sample size.	Purposive sampling	Sampling technique and sample size.
Data Gathering	**Activity 6:** To conduct testing (for 1 semester during July 2023 session)	To evaluate the reliability and effectiveness of UCAM features in tracking attendance and generating reports.	Pilot test	Descriptive statistics report
Data Analysis	**Activity 7:** Analyze the data based on the target user evaluation.	To determine the level of satisfaction among users about the interface, security, and usefulness of the UCAM system	Quantitative analysis (descriptive statistics), questionnaires with Likert scales and content analysis	Tables and figures of analysis and interpretation of findings.
Documentation	**Activity 8:** Summarizing finding and conclusions	To summarize the user feedback and future recommendations.	Report writing	User feedback summary and recommendation report.

3.1 Attendance Monitoring in Higher Education

The data for this study were collected using structured questionnaires designed to capture user perceptions of the UCAM system. Separate questionnaire sets were administered to lecturers and students to reflect their respective roles and system usage experiences. The questionnaire items were measured using a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree, covering dimensions such as system functionality, data reliability, perceived effectiveness, and user satisfaction.
Instrument validity was established through content validation, whereby the questionnaire items were developed based on an extensive review of prior studies related to

attendance monitoring systems, system usability, data reliability, perceived effectiveness, and user satisfaction. The questionnaire was reviewed by subject matter experts in information systems and higher education to ensure clarity, relevance, and alignment with the research objectives. A pilot test was conducted prior to full-scale data collection to evaluate item clarity and consistency. The results indicated that the instrument demonstrated acceptable internal consistency and reliability, supporting its suitability for evaluating user perceptions of the UCAM system.

3.2 Sampling Technique and Data Collection

The population of this study consisted of lecturers and students at Universiti Poly-Tech Malaysia (UPTM) who utilized the UCAM system during the July 2023 academic session. Data collection was conducted over one academic semester to ensure that participants had sufficient exposure to the system. The questionnaires were distributed to respondents after they had experienced using UCAM for class attendance monitoring.

Purposive sampling was employed to ensure that respondents had direct and relevant experience using the UCAM system. This sampling approach was deemed appropriate as the study aimed to obtain informed feedback from actual system users rather than from the general population. A total of 36 lecturers and 185 students participated in the study, which is considered adequate for descriptive statistical analysis and aligns with sample sizes used in similar user evaluation studies within higher education contexts. This approach supports the reliability and relevance of the findings in reflecting authen- tic user perceptions.

3.3 Data Analysis

The collected data were analyzed using descriptive statistical techniques, including frequency distribution, mean values, and standard deviation. These analyses were conducted to examine user perceptions of the UCAM system in terms of functionality, data reliability, perceived effectiveness, and user satisfaction. The results are presented using tables and figures to support interpretation and discussion.

4 Result and Findings

In the present investigation, empirical data were gathered through the distribution of questionnaires to a cohort of 36 lecturers and 185 students at Universiti Poly–Tech Malaysia (UPTM). The device applied by the teachers encompassed 32 factors, split into five individual divisions: demographic information, system functionality evaluation, data reliability evaluation, perceptions of the effectiveness of the system and user satisfaction. In the next phase, the polls conducted among the student demographic consist of 16 components, systematically divided into four parts: background details, review of system operations, opinions on the system's success, and overall user happiness. Each

item was evaluated employing a five-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. The participants were chosen utilizing purposive sampling methodology.

Table 3 presents the demographic characteristics of the lecturer, which highlights key factors such as gender, age group, and working experience. Most of the lecturers who participated in this study were female (86.1%), while the remaining 13.9% were male. The age distribution of the lecturers is categorized into four groups, with the highest age group falling within the 35-44 years category (52.8%). The working experience is divided into six levels, and the majority of the lecturers have more than 20 years of experience (30.6%).

Table 3. Lecturers Demographic Profile (n=36)

Item	**Lecturers**	
	Frequency	**Percent**
Gender		
Female	31	86.1
Male	5	13.9
Age Group		
25-34 Years	5	13.9
35-44 Years	19	52.8
45-54 Years	11	30.6
Above 55 Years	1	2.8
Working Experience		
Less than 1 year	5	13.9
1-5 Years	5	13.9
6-10 Years	0	0
11-15 Years	9	25.0
16-20 Years	6	16.7
More than 20 Years	11	30.6

Table 4 displays an overview of the demographic characteristics of the students in the study. The data are organized into three categories: Gender, Age Group and Field of Study. 51.9% of the respondents are female, while 48.1% are male. The majority of the respondents fell within the 18-20 years category (68.6%), with minimal representation in the 26-30 years category (0.5%). The classification of students based on their field of study indicates that 84.3% were enrolled in Computing courses, 2.2% in Business, 1.1% in Corporate Communication, 0.5% in English and 11.9% in other fields. While Figure 2 shows the combination of students and lecturers demographics chart that presents the gender-diverse student body and highly experience teaching staff.

Table 4. Students Demographic Profile (n=185)

Item	Students	
	Frequency	Percent
Gender		
Female	96	51.9
Male	89	48.1
Age Group		
18-20 Years	127	68.6
21-25 Years	57	30.8
26-30 Years	1	.5
Working Experience		
Computing	156	84.3
Business	4	2.2
Corporate Communication	2	1.1
English	1	.5
Others	22	11.9

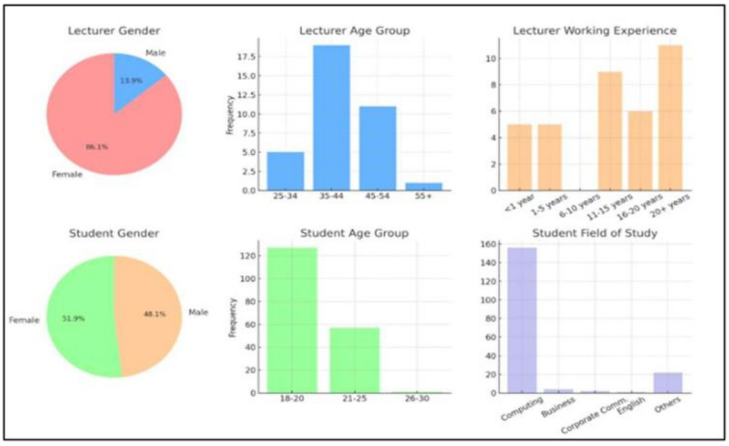

Fig. 2. Students and Lecturers Demographic Chart

According to the descriptive statistics as shown in Table 5, faculty members appraised the functionality and evaluation of UCAM's system favorably, with average scores fluctuating between 3.86 and 4.28, thereby signifying contentment with attributes including QR code attendance verification, the production of warning letters, and the facilitation of communication for the reporting of absences. Regarding the dependability of the data, the scores were strikingly high (from 4.19 to 4.39), which demonstrates a solid confidence in the system's accuracy, reliability, and swiftness in tracking attendance records. Concerning perceived effectiveness, the scores spanned from 3.94

to 4.33, illustrating the system's skillfulness in managing absenteeism, yielding analytical insights, and supporting accurate attendance tracking; however, the element of QR code rotation applied for fraud prevention acquired a somewhat lesser score. When looking at user satisfaction metrics, average ratings of 3.97 to 4.06 show that educators perceive the interface as intuitive, secure, and capable of supporting successful attendance achievements. The combined results highlight that educators identify UCAM as a sturdy, effective, and user-friendly solution for overseeing attendance.

Table 5. Descriptive Statistics of Response (From Lecturer's Perspectives)

Items		N	Minimum	Maximum	Mean	Std. Deviation
Objective 1: System Functionality Evaluation	How user-friendly do you find the system for managing class schedules and attendance?	36	2	5	4.08	.692
	How satisfied are you with the functionality of the QR code feature for attendance verification in the system?	36	1	5	4.14	.990
	Does this system facilitate the process of uploading medical leave certificates or formal letters to inform lecturers about student absences?	36	1	5	3.86	1.018
	How would you rate the system's ability to generate warning/barred letter automatically for students' absences?	36	1	5	4.28	.944
	How satisfied are you with the system for distributing warning letters to students and parents by email?	36	2	5	4.11	.854

	Does this system facilitate the communication process with mentors, counsellors, and related units regarding reporting student absences?	36	2	5	3.97	.845
Objective 2: Data Reliability	How would you rate the reliability of the system in recording attendance data?	36	2	5	4.22	.722
	Are you confident that the accuracy of calculating the percentage of a student absenteeism in the warning letter generated by the system complies with the university's requirements?	36	1	5	4.19	.889
	Do you believe this system can minimize human errors in attendance tracking compared to traditional methods?	36	1	5	4.19	.856
	Rate the system's consistency in recording attendance data over time.	36	3	5	4.28	.615
	How quickly does this system take to update and reflect changes in attendance records?	36	3	5	4.39	.645

Objective 3: Perceptions of Effectiveness of the System	Is this system effective in helping lecturers generate class schedules?	36	1	5	3.97	.941
	How effective is the system in handling students' absenteeism?	36	2	5	4.22	.832
	Is this system effective in generating and managing warning letters for student absenteeism?	36	1	5	4.33	.894
	Is this system that automatically generates data analytics capable of identifying students with frequent absenteeism?	36	1	5	4.14	.833
	Is the system capable of providing absenteeism information to help faculty take appropriate preventive actions to address student absenteeism issues?	36	3	5	4.25	.692
	Do you agree that the system can provide accuracy in student attendance tracking functionality?	36	3	5	4.28	.615
	Do you agree that the QR code generated every 10 minutes by the system can effectively help faculty to prevent fraudulent attendance by students?	36	1	5	3.94	.984

	Do you agree that device authentication effectively serves as an additional layer of security in the student attendance tracking process (e.g., students need to enter a password, use fingerprint, face recognition, or a pattern on their mobile phone before being allowed to scan the QR code)?	36	1	5	4.14	.798
Objective 4: User Satisfaction	Are you satisfied with the overall user interface of the system?	36	1	5	3.97	.810
	Are you satisfied with the security features provided by this system?	36	2	5	4.03	.736
	On a scale of 1 to 5, how easy was it for you to navigate through the system?	36	2	5	4.06	.826
	Can this system have a positive impact on the awareness and understanding of how important it is to attend classes to avoid falling behind in their studies?	36	1	5	4.03	.941
	How likely are you to recommend the smart class attendance analytics system to others?	36	2	5	4.17	.845

5 Conclusions

The collective research on QR code-based class attendance management systems, particularly in educational contexts, consistently underscores significant improvements in operational efficiency, data reliability, user acceptance, and overall system effectiveness compared to traditional attendance methods. The time-consuming errors due to the manual system can be reduced through the use of a mobile and web platform to automate attendance recording. In addition, the process of reporting and attendance registration was increased as much as 50% and has been emphasized by numerous scholarly investigations.

Besides, the current technology of QR code attendance consists of elements such as multi-factor authentication strategies, including biometric verification, device identification, or geolocation validation. There are various advantages of this integration that not just increase the security tactics, but also can reduce the chances of fraudulent attendance entries. The implementation of encrypted QR codes alongside sophisticated hashing algorithms further augments data confidentiality and the resilience of the system. Nevertheless, more intricate multi-factor systems can sometimes present usability challenges, which encompass elevated rates of false rejection and user discontent stemming from unclear feedback or inadequate guidance.

In addition, the comparative study between the traditional attendance approach with the QR code attendance system highlighted the efficiency and accuracy in terms of monitoring the students' attendance, issuing the warning letter, producing the teaching report that tallies with the real-time class, and at the same time can help to save the earth by reducing paper utilization. Delving into the integration of hybrid models that merge age-old relationship-building practices with contemporary tech advancements might improve inclusivity and sustain user interaction. Although there are many benefits of implementing the QR code attendance system, there are some challenges that should be considered, such as system scalability, offline capabilities, and stable internet connections to support extensive deployment.

Finally, the elements of cloud computing, machine learning, and IoT integration can be added as a future enhancement in the automated attendance system. It is not just for showing promising results in system functionality and security enhancement, but also can improve the scalability, predictive analytics, centralized data access, and seamless integration. While these technology offers various benefits, their complexity and cost may limit accessibility in certain educational environments. Overall, the body of evidence supports QR code-based attendance systems as efficient, reliable, and user-centric solutions with demonstrated benefits, provided that design considerations carefully balance technological sophistication with usability and contextual adaptability.

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