

Implementing QR code and Geolocation Technologies for the Student Attendance System

Semmy Wellem Taju^{*1}, Yonatan Putra Mamahit², Jeremy Andrew Pongantung³

^{1,2,3}Universitas Klabat, Airmadidi, Manado 95371, Sulawesi Utara, Indonesia, 0431819036

^{1,2,3}Sistem Informasi, Fakultas Ilmu Komputer, Universitas Klabat, Airmadidi

e-mail: ¹semmy@unklab.ac.id, ²s21710466@student.unklab.ac.id,

³s21710268@student.unklab.ac.id

Abstract

Attendance is one of the important factors in supporting lecture activities that can be used to see how well the performance of student attendance in class. Traditional attendance systems used in various educational institutions often cause problems. This research aims to develop an innovative and efficient student attendance system to help the process of taking attendance by utilizing QR-Code and geo-location technologies at Klabat University. The research method employed for this development is the Prototyping Model, which involves iterative development and refinement processes. The system is designed as a web-based application and a mobile application, developed using PHP as the programming language, MySQL as the database management system, Bootstrap 5 as the CSS and JavaScript framework for creating responsive websites, Apache as the web server and Ubuntu 22.04 as the operating system for the server. QR-Code technology is proposed as a medium for recording and verifying student attendance, while Geo-Location technology is used to verify the presence of students in the right lecture venue. The results of this research are expected to make a positive contribution to Klabat University in terms of recording student attendance.

Keywords— QR code, GPS, geolocation, attendance system, website/mobile application

1. INTRODUCTION

Klabat University (UNKLAB) is a private university founded in 1965 by the Seventh-day Adventist Church, located in Airmadidi, North Minahasa Regency, North Sulawesi [1], Indonesia. There are 7 faculties in this university, including *computer science, economics, nursing, philosophy of Christianity, education, secretary, and agriculture* [2] faculties. All students enrolled at Klabat University hail from diverse domicile backgrounds, spanning various regions in Indonesia and abroad. At Klabat University, students are allowed to be absent for each course by the regulations governing class attendance, which stipulates a maximum of twenty percent of the total class meetings [3] or approximately 4 absences for 3 credits. Every student is provided with equal opportunities to access complete information regarding their attendance at Klabat University. This information encompasses the count of absences, and tardiness, as well as excused and unexcused permissions due to illness or bereavement. By ensuring equitable access to this information, universities can more effectively monitor and support student attendance, thereby taking appropriate measures to enhance participation and consistency in the learning process. If a student surpasses the maximum number of absences permitted, they are deemed to have failed the course. Hence, to monitor students' presence and engagement in lecture activities, class attendance must be enforced.

Taking attendance is an important aspect of facilitating class activities [4], [5]. There exists a process for gathering student attendance, which can be utilized to assess the performance of students in attending class [6]. Based on the results of interviews conducted by researchers with several lecturers at Klabat University, it was found that there are several methods employed

by lecturers to take student attendance. Some lecturers opt for paper forms containing the names of students, which are then signed by students during each class session. However, this approach presents certain disadvantages. Firstly, it necessitates a significant amount of paper forms, especially if multiple lecturers adopt this method. Secondly, it leaves room for students to engage in cheating by signing the attendance for absent peers.

Another approach to taking student attendance is through seating arrangements or by having lecturers observe and compare the seating plan with the actual placement of students in the class. If a student is not in their designated seat as predetermined, they are declared absent. However, this method has its weaknesses as students may mistakenly sit in seats that do not correspond to the plan, leading to their status being marked as absent. Alternatively, some lecturers take attendance by calling out student names one by one while completing a student attendance checklist. This method has several drawbacks. Firstly, it can be time-consuming, especially in large classes, as each student must be individually called out. Secondly, students may fail to hear their names being called by the lecturer, resulting in their status being marked as absent. Thirdly, there is a risk of human error, such as lecturers inadvertently marking the presence of students who do not respond. Another method involves using Google Classroom forms, where lecturers create attendance forms within the application for students to fill out. However, this approach also has its weaknesses as students can potentially take attendance or fill out forms from anywhere using the classroom application.

Although the students are not physically present in class, they are still able to have their attendance recorded. At Klabat University, the process of reporting student attendance is conducted through the lecturers initially taking attendance and subsequently completing an attendance form. This form contains details regarding the names of students who are absent or tardy during class sessions. Subsequently, the lecturer submits the attendance form to the registrar or the designated authority responsible for managing student attendance information at Klabat University.

Based on the findings, it is evident that many universities and even schools are still employing a manual process for taking student attendance, which is undeniably inefficient. This process may consume a significant amount of time, especially if the number of students in the class is substantial [7]. There are also problems found during the process of taking attendance using this approach, it may require a lot of paper forms and human error [2]. Sometimes, during manual attendance-taking, instances of fraud, like falsifying absences, may occur among students. To address these issues, the utilization of QR-Code technology emerges [4], [8], [9], [10], [11] as an effective preventive measure. Researchers advocate for the implementation of QR-code technology to record and verify student attendance. Under this system, each student would be equipped with a QR-Code scanner on their smartphone device and would be required to scan the QR-Code at the designated class location.

2. RELATED WORK

QR (Quick Response) code is a type of two-dimensional matrix barcode that contains specific information and has become popular in various technological applications. A QR code is an image in the form of a two-dimensional matrix that represents data. It can be used to store data in the form of text, whether numeric, alphanumeric, or binary code [12]. The QR code is an evolution of the barcode, which consists of a pattern of black and white bars that can be read by a computer [12]. Essentially, QR codes can effectively address the aforementioned issues by facilitating the development of a QR code scanner application. This application can accurately and efficiently manage student attendance. However, QR codes have a drawback: their images can be duplicated through capture. Consequently, students can take attendance from any location as long as they possess the QR code image. This weakness can be mitigated by integrating a new feature: the Global Positioning System (GPS).

The geo-location feature entails the capability to pinpoint the physical location of a user's device or smartphone using geographical coordinates [13], [14]. One of the most commonly

utilized technologies for this purpose today is GPS (Global Positioning System). GPS functions as a satellite system employed for navigation, precise location tracking, direction finding, and speed determination [15][16]. By identifying the geolocation of students [17], [18], the issue of QR-Code image duplication can be mitigated by establishing the maximum distance between the device that scans the QR-Code image (students) and the device that displays the QR-Code image (lecturer). Students can utilize their smartphones to scan the QR-Code, while lecturers can generate the QR-Code image and display it in a web browser.

The integration of QR-Code and geo-location features has the potential to streamline and expedite the attendance-taking process for lecturers and teaching assistants (TAs) in classrooms. This includes efficiently recording attendance, summarizing it, reducing paper consumption, and mitigating human error associated with manual attendance tracking. Consequently, a QR-Code scanner application with a geo-location feature was developed specifically to support lecturers and TAs in managing student attendance at Klabat University. This initiative has spurred researchers to devise a QR-Code scanner coupled with GPS capabilities, titled "An Innovative Approach to Student Attendance System Using QR-Code and Geo-Location Technologies at Klabat University." Building upon this concept, both mobile-based and web applications were meticulously crafted and executed on Android devices and web browsers.

3. RESEARCH METHODS

In this research, as depicted in Figure 1, the author employs a prototyping model [19] as a method that involves iteration or looping in its implementation. At the outset, the process involves gathering requirements, creating a prototype model, conducting evaluations, refining prototypes, assessing the system under development, and revisiting the evaluation stage to determine readiness for utilization [20].

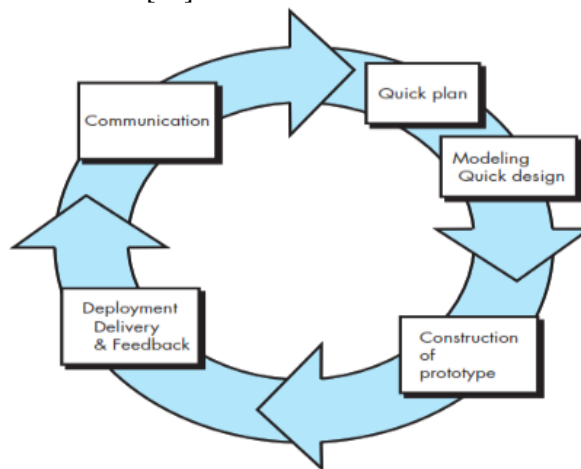


Figure 1. Prototyping Model

3.1 Research Instruments

In this section, the research instruments will be explained to better understand the data required for this research and the methods for data collection to support it. Researchers utilize both primary and secondary data types. Primary data in this study were directly obtained from the research sources, consisting of identified problems and needs. Data were gathered from several lecturers at Klabat University, supplemented by longitude and latitude data from each class obtained through applications developed by the researchers. Secondary data, essential for this research, were indirectly acquired through reliable intermediaries such as scientific journals, articles, books, and websites pertinent to the study. To gather the necessary data for addressing the research questions, researchers employed various data collection techniques, including

interviews to gather information on attendance processes, surveys of class areas for location data, and a literature review to access relevant theoretical frameworks.

3.2 Research Environment

In this research, we meticulously developed an environment to support the system. The research environment is divided into two parts: software and hardware, both of which are essential resources for this study. The software utilized by researchers includes Visual Studio Code for coding to create applications and websites, Figma for designing the appearance of mobile applications and websites, Draw.io for creating conceptual frameworks, use case diagrams, and activity diagrams, and Chrome browser for searching references, running created websites, and accessing virtual servers. Regarding hardware, researchers employ an HP 14-CM0078AU laptop with AMD Ryzen 5 2500U processor, 8GB DDR4 memory, 1TB storage, and a Windows 10 64-bit operating system. Additionally, they utilize a Xiaomi Poco M2 smartphone with a Mediatek MT6769 processor, 6GB memory, 126GB storage, and an Android 11 operating system. Researchers opted for these software and hardware choices as they meet the requirements necessary for developing a QR-code scanner app with GPS technology.

4. RESULT AND DISCUSSION

4.1 Student Attendance System Process

The researchers have successfully developed a web and mobile application that utilizes QR code and geo-location features for the process of taking student attendance. Within the website application, lecturers and administrators can perform Create, Read, Update, Delete (CRUD) functions to manage student data. Figure 2 elucidates the process of taking attendance through both mobile and web applications.

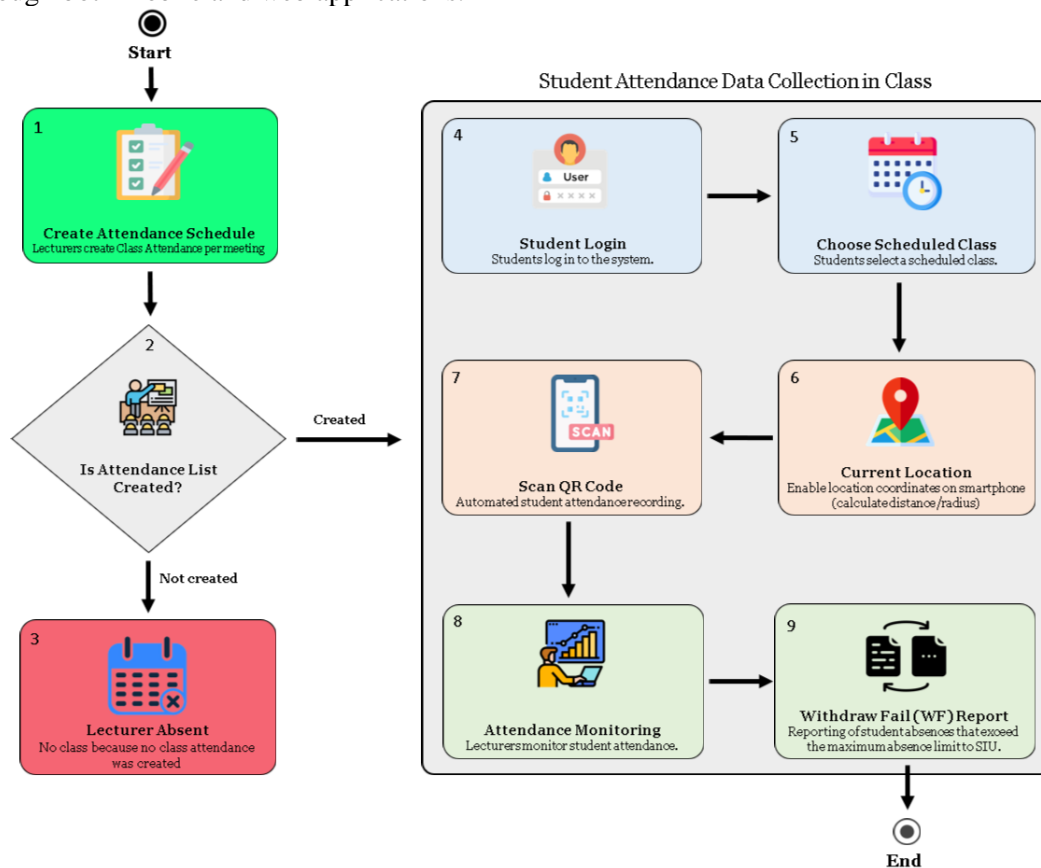


Figure 2. Illustrate the process of taking attendance

Figure 2 explains the process of taking attendance using mobile applications for students and web applications for lecturers. Initially, the lecturer creates a class from the web application and adds student emails. Subsequently, students sign up or create an account. Following this, students log in with their previously created account on the mobile application, select a class and schedule, and proceed to take attendance. Students must grant GPS and camera access to the application to scan the QR code for attendance. Lecturers then monitor student data to ensure all students are registered for the class and have completed attendance. Furthermore, attendance data is compiled into reports by lecturers and submitted directly to the registrar or the department managing student attendance data at Klabat University. The mobile and web applications' appearance and features have been developed by researchers.

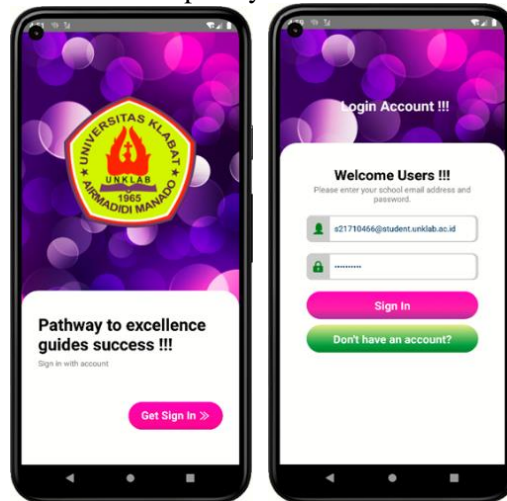


Figure 3. Splash Screen and Login Screen

4.2 Mobile App Features

Figure 3 depicts the interface implementation of the initial page upon opening the mobile application. This page prominently features the Klabat University logo and motto, alongside a "Sign In" button. Upon tapping this button, users are seamlessly directed to the sign-in page within the application. Furthermore, the figure showcases the interface design of the Login page integrated into the mobile application. Here, users are prompted to input their email and password to gain access to the main section of the application. Additionally, there exists a "Don't have an account" button, which, when activated, guides users to the sign-up page for creating an account that facilitates the signing-in process.

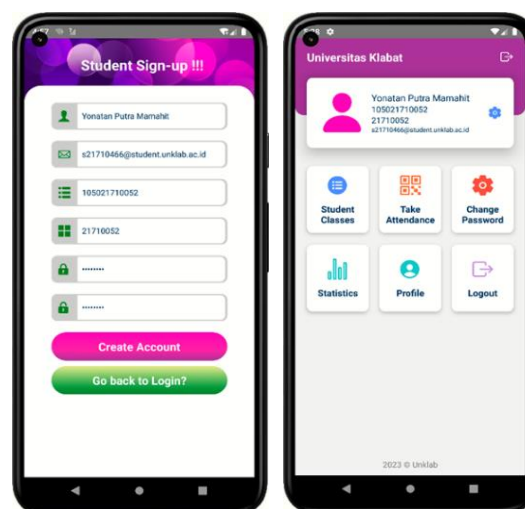


Figure 4. Sign Up and Home Display Screen

As can be seen in Figure 4, the figure illustrates the implementation of the sign-up page within the mobile app. Users are required to fill out the personal data form on this page before they can log in and access the main page of the mobile application. Additionally, Figure 4 presents the implementation of the main page interface within the mobile application. This main page features a list of functionalities that users can select according to their needs. These functionalities include the student classes feature, enabling users to view a list of existing classes; the take attendance feature, allowing users to scan QR-Codes generated by lecturers in the web application to take attendance; the change password feature for password modification; the statistics feature for viewing attendance statistics; the profile feature for accessing user profiles; and the logout feature for exiting the mobile application.

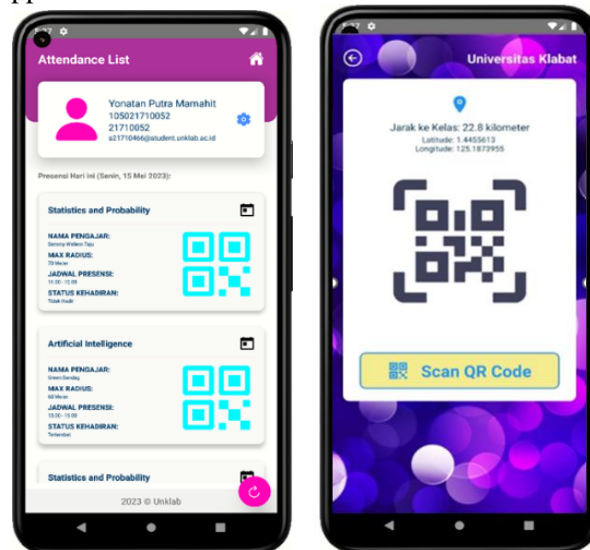


Figure 5. Attendance Class List and Distance View with Geolocation Coordinates

Figure 5 illustrates the implementation of the class list page interface within the mobile application, showcasing a comprehensive list of classes available for attendance tracking. Upon selection of a class from this list, users are seamlessly redirected to a page presenting distance and geolocation coordinate details. Additionally, the interface includes a convenient option to scan QR codes, facilitating efficient attendance logging. This screen not only exhibits the proximity between students and their respective classes but also provides longitude and latitude coordinates for precise location identification. Once a student's proximity falls within the predetermined radius set by the lecturer for attendance purposes, they can promptly utilize the scan QR-Code feature, streamlining the attendance process.

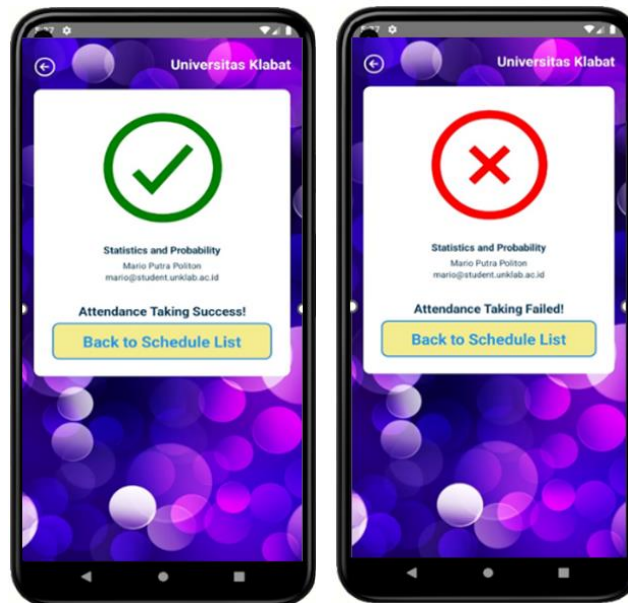


Figure 6. Notification After Taking Attendance

Figure 6 depicts the implementation of the QR-Code scanner page interface within the mobile application. Upon granting the application access to the camera, users can proceed to scan the QR code for attendance purposes. Additionally, the interface features a flashlight button to activate the smartphone's flashlight, a button facilitating navigation back to the previous menu, and another button dedicated to QR-code scanning. Furthermore, Figure 6 also shows the implementation of the notification page interface in that the user has successfully taken attendance by scanning the QR code.

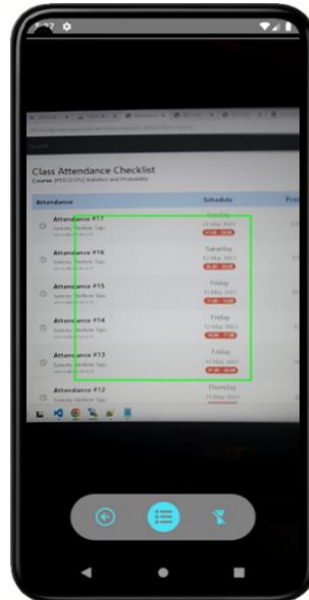


Figure 7. Scanning QR-Code Screen

As presented in Figure 7, the implementation of the notification page interface that the user has successfully taken attendance by scanning the QR-Code that has been provided previously by the lecturer. In the mobile app used by students to take class attendance at Klabat University, there are still some shortcomings in terms of User Interface (UI) and User Experience (UX) because it is hoped that future researchers can improve the quality of UI and UX from this application or add new features that maximize the function of the application from this research.

Figure 8. Login Page

4.3 Web AppFeatures

Figure 8 presents the implementation of the login page interface on the website. Before entering the home page, the user must first select a role, and enter an email and password on this login page. If the data entered is appropriate, then the user can press the login button and be directed to the home page. When the users enter the home screen, On this screen there is user session information that is being used such as session role and session email.

Figure 9. Create Classes Menu Page

Course	People/Room	Schedule	Status	Actions
CM123 Computer Networking 1 Fakultas Ilmu Komputer Senny Taju	2 Students GK3-205	Selasa – Kamis 13.00 – 15.00	active	Options +
APC496 Fundamental Apache PHP5 Fakultas Ilmu Komputer Senny Weilem Taju	3 Students GK2-103	Senin – Rabu 09.30 – 11.00	active	Options +
GAC3678 Sentiment Analysis Fakultas Ilmu Komputer Senny Weilem Taju	3 Students GK2-103	Selasa – Kamis 09.00 – 10.00	active	Options +

Figure 10. Active Classes Page

Figure 9 shows the way a lecturer creates a class on the website. Lecturers must fill in class information such as class code, subject, lecturer, faculty, department, SKS (*credits*), room, and schedule to create a class. Figure 10 demonstrates the active classes screen on the website. Users can see and change what class information is currently active, furthermore, users can see and select several menus provided in the options menu such as creating new classes, viewing class information, adding new students, viewing student attendance, and archiving classes. Figure 11 displays an archived classes page that displays complete information from classes that have been

archived by the user, and there is a menu to delete and restore the class to the active class list.

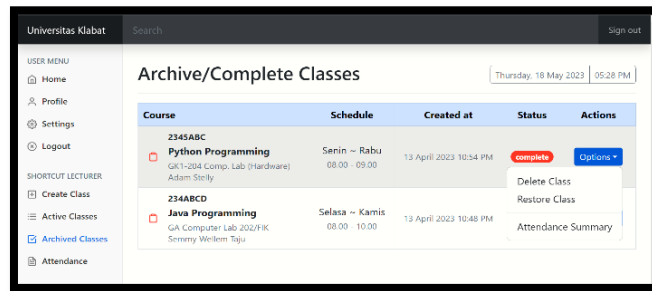


Figure 11. Archived Classes Page

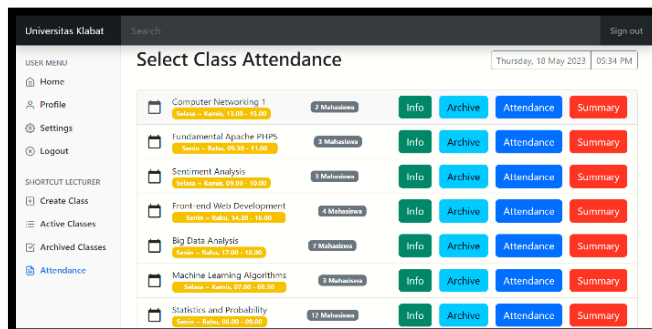


Figure 12. Attendance Menu Page

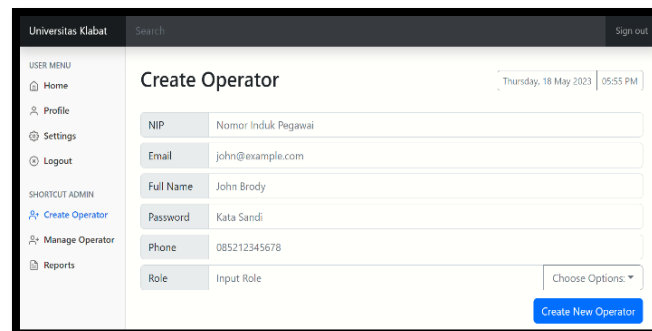


Figure 13. Create Operator Page

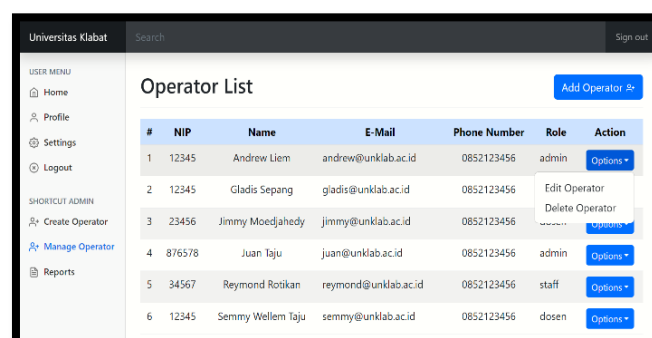


Figure 14. Manage Operator Page

Figure 12 presents the attendance menu displayed on the website. This attendance page contains shortcuts that can make it easier for users to access the main menu on the “active classes” menu. Figure 13 is a view of the create operator page or adding a new operator. This page contains

a menu to add a new operator. Figure 14 is a menu to perform CRUD on operator data. There is also an add operator button which, if pressed, directs the user to the create operator menu, and an options button which contains the edit operator button or change the operator data and delete the operator or delete the operator permanently.

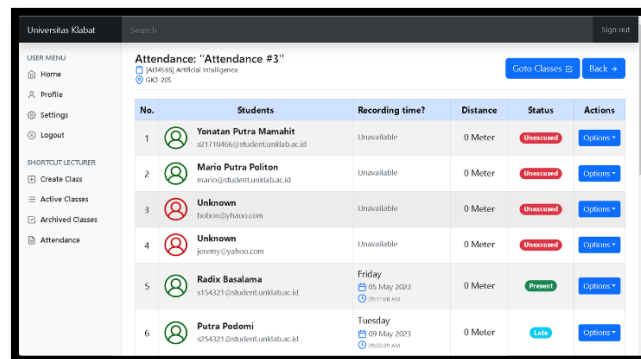


Figure 15. View/Manage All Students For Each Class

Figure 15 illustrates the interface of an innovative student attendance system that uses QR-Code and geo-location technology that allows users (*lecturers*) to view and manage the attendance information of all students for each specific class. This interface may display a list of students enrolled in the class. In this way, lecturers can easily monitor the attendance of students in one class comprehensively.

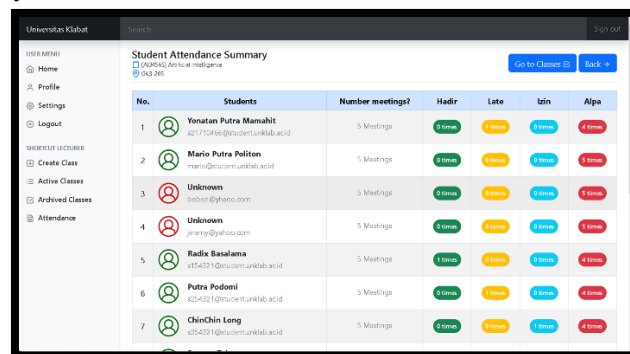


Figure 16. Student Attendance Summary For Each Class

Meanwhile, Figure 16 represents a summary view or report on student attendance for each class at Klabat University. In this figure, there is compiled data that presents information about overall student attendance for each class, such as average attendance percentage, total number of absences, tardiness, as well as permits with reasons such as sickness. This report helps to provide an overall picture of student attendance patterns in various classes, making it easier to make the right decisions and actions to improve general student attendance management at Klabat University.

5. CONCLUSION AND FUTURE WORK

5.1 Conclusion

This research successfully implemented an innovative student attendance system at Klabat University using a QR code and geolocation technology. The attendance system has been enhanced through the integration of QR-Code and geo-location technologies, allowing for more effective recording, monitoring, and processing of student attendance. By implementing the latest QR-Code and Geo-Location features, this system has significantly improved the management and oversight

of student attendance at Klabat University. This successful implementation demonstrates the potential for this system to be a model for similar applications in other educational institutions.

5.2 Future Work

Although this research has successfully presented an innovative attendance system, there are several suggestions for further development to improve its quality and functionality, including (i) Future developers need to consider improving the system interface design both in terms of UI and UX to make it more attractive. (ii) Future developers can consider adding additional relevant features such as setting up class schedules, announcements, or student academic tracking. (iii) Future developers can consider integrating computer vision technology, especially face recognition, into this system. (iv) Future developers can ensure the system has a strong security layer to protect students' attendance data from security threats. (v) Future developers should consider methods to measure and improve the system's efficiency and accuracy to ensure reliable performance and user satisfaction.

REFERENCES

- [1] J. Moedjahedy, "Implementasi Point to Point Jaringan Internet Nirkabel di SMA Universitas Klabat," *CogITO Smart Journal*, vol. 2, no. 2, p. 240, 2016, doi: 10.31154/cogito.v2i2.33.240-249.
- [2] O. H. Lengkong, D. H. Fiden, and A. Masrikat, "Sistem Informasi Absensi Real-Time di Universitas Klabat," *CogITO Smart Journal*, vol. 2, no. 2, p. 216, 2016, doi: 10.31154/cogito.v2i2.31.216-228.
- [3] Universitas Klabat, *Buku Panduan Universitas Klabat*. Airmadidi, Minahasa Utara, Sulawesi Utara: Universitas Klabat, 2017.
- [4] Y. Supendi, I. Supriadi, and A. A. Isto, "Pemanfaatan Teknologi QR-Code Pada Sistem Presensi Mahasiswa Berbasis Mobile," presented at the SEMINAR NASIONAL APTIKOM (SEMNASTIK) 2019, 2019, pp. 550–558.
- [5] N. Hermanto and N. R. D. R. Riyanto, "Aplikasi sistem presensi mahasiswa berbasis android," *Simetris: Jurnal Teknik Mesin, Elektro dan Ilmu Komputer*, vol. 10, no. 1, pp. 107–116, 2019.
- [6] M. Al Satrio, L. A. Abdillah, and A. Syazili, "Aplikasi Presensi Mahasiswa dengan Menggunakan QR Code Berbasis Android pada Universitas Bina Darma," *Seminar Hasil Penelitian Ilmu Komputer Ke-2 (SENTIKOM2017)*, pp. 7–12, 2017, doi: 10.17605/OSF.IO/NMHRX.
- [7] S. I. Adam, O. Lengkong, and S. Pungus, "Pengembangan Aplikasi Mobile Presensi Mahasiswa Berbasis QR-Code Di Universitas Klabat," *Cogito Smart Journal*, vol. 7, no. 2, pp. 349–359, 2021.
- [8] R. Gunawan, A. M. Yusuf, and L. Nopitasari, "Rancang Bangun Sistem Presensi Mahasiswa Dengan Menggunakan Qr Code Berbasis Android," *Elkom: Jurnal Elektronika dan Komputer*, vol. 14, no. 1, pp. 47–58, 2021.
- [9] L. A. Muharom, "Penerapan model presensi ujian semester berbasis quick response Code (QR Code) di Universitas Muhammadiyah Jember," *JUSTINDO (Jurnal Sistem dan Teknologi Informasi Indonesia)*, vol. 1, no. 2, 2016.

- [10] S. N. Mahmuda, “Perancangan Aplikasi Presensi Mahasiswa Teknik Indutrsi UNSIKA Menggunakan QR-Code dan Geotagging Berbasis Android,” *Jurnal JTIK (Jurnal Teknologi Informasi dan Komunikasi)*, vol. 6, no. 2, pp. 319–324, 2022.
 - [11] M. Rahmatuloh, A. P. Rizani, and W. Resdiana, “Rancang Bangun Aplikasi Presensi Mahasiswa Magang Berbasis Web Menggunakan QR Code,” *Jurnal Teknik Informatika*, vol. 15, no. 3, pp. 103–109, 2023.
 - [12] N. Ani, R. Deby, M. P. Nugraha, and R. Munir, “Pengembangan Aplikasi QR Code Generator dan QR Code Reader dari Data Berbentuk Image,” *Konferensi Nasional Informatika – KNIF 2011*, pp. 148–155, 2011.
 - [13] N. D. N. Nanda, R. M. Akbar, and Y. D. Rosita, “IMPLEMENTASI GEOLOCATION DAN PENGENALAN WAJAH PADA APLIKASI PRESENSI MAHASISWA PKL BERBASIS ANDROID,” presented at the SEMINAR NASIONAL FAKULTAS TEKNIK, 2023, pp. 122–127.
 - [14] M. B. Firdaus, G. M. Putra, M. W. P. Putra, N. W. W. Sari, M. K. Anam, and E. Yumami, “Rancang Bangun Aplikasi Presensi Pegawai Berbasis Area Menggunakan Geolocation,” *METIK JURNAL*, vol. 7, no. 1, pp. 36–41, 2023.
 - [15] E. Memoriano, “Augmented Reality and Global Positioning System (GPS) for Indoor and Outdoor Navigation using Features from Accelerated Segment Test (FAST) Corner Detection Algorithm and A-Star Algorithm,” *Journal of Advances in Informations System and Technology*, vol. 2, no. 1, pp. 31–36, 2020.
 - [16] P. Perkasa, “Use of Global Positioning System (Gps) for Basic Survey on Students,” *BALANGA: Jurnal Pendidikan Teknologi dan Kejuruan*, vol. 7, no. 1, pp. 22–33, 2019, doi: 10.37304/balanga.v7i1.553.
 - [17] M. A. Rosid and S. Sumarno, “Rancangan Sistem Presensi Mahasiswa Menggunakan Qr Code Dengan Fitur Geolocation Dan Enkripsi Aes,” *JIKA (Jurnal Informatika)*, vol. 5, no. 2, pp. 167–173, 2021.
 - [18] B. M. Nanda, “APLIKASI PRESENSI MAHASISWA MENGGUNAKAN AUTENTIKASI SCAN QR CODE DAN GEOLOCATION BERBASIS ANDROID,” 2021.
 - [19] M. Carr and J. Verner, “Prototyping and software development approaches,” *Department of Information Systems, City University of Hong Kong, Hong Kong*, pp. 319–338, 1997.
 - [20] L. J. Erawati Dewi, “Media Pembelajaran Bahasa Pemrograman C++,” *Jurnal Pendidikan Teknologi dan Kejuruan*, vol. 7, no. 1, 2012, doi: 10.23887/jptk.v7i1.31.
-