QRCode Recognition on Flutter Framework Mobile Application Implemented on Entrance Security System

Rosa Andrie Asmara[1], Rizky Putra Pradhana Budiman[2], Mungki Astiningrum[3], Brian Sayudha[4], Anik Nur Handayani[5], Cahya Rahmad[6]

[1,2,3,4,6] State Polytechnic of Malang, Malang 65141, Indonesia
[5]Malang University, Malang 65145, Indonesia
[1]rosa.andrie@polinema.ac.id
[2]rizkyputrapb@gmail.com
[3]mungki.astingrum@polinema.ac.id
[4]briansayudha@gmail.com
[5]aniknur.ft@um.ac.id
[6]cahya_rahmad@yahoo.com

Abstract. As the advancement of technologies becomes more progressive and efficient, State Polytechnic of Malang would like to start digitalizing most of the student attendance system by using mobile-based QR code scanning for student identification. They aim to improve their student attendance system to be more effective and versatile than the previous system. A contactless attendance system in offline events is urgently needed in the pandemic. The manual attendance system still uses papers and signatures can support the spread of the virus. The mobile-based QR code attendance system is expected to minimize direct and indirect physical contact between the event organizers and the attendee, thus minimizing the widespread of the virus. Besides, a paperless attendance system can help the environment by decreasing paper consumption, contributing to 42% of the global wood harvest. The previous student attendance system within the campus was still using a standalone, third-party QR code scanner that was connected to a laptop. After the student's QR code had been scanned, the student's data would be displayed instantly on a laptop web page. This cycle is inefficient since it requires two devices, and the QR code scanner cannot instantly display the scanned barcode data. Moreover, the device itself is bulky, thus making it less mobile than smartphones. To overcome those issues, the mobile-based QR code attendance system can be the solution, as it would only utilize one device for scanning and displaying the data instead of two. Furthermore, this system can be used on different occasions and events everywhere, from wedding invitation management to an academic graduation ceremony. Seven out of ten participants agree that this application helps to reduce the possibility of attendance fraud and attendance abuse, two out of ten are still unsure about it, and 1 out of 10 denies the statement. The optimal brightness for the smartphone screen used to display the QR code is between 25% and 50%. Moreover, the optimal distance of the scan for the smartphone screen used to display the QR code is between 10cm to 30cm.

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1 Introduction

As the advancement of technologies becomes more progressive and efficient, State Polytechnic of Malang would like to start digitalizing most of the student attendance system by using mobile-based QR code scanning for student identification. They aim to improve their student attendance system to be more effective and versatile than the previous system.

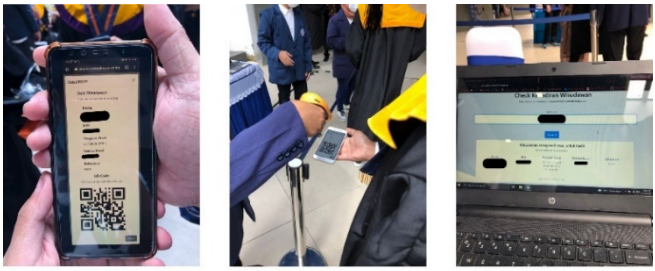
A Quick Response code, commonly known as a QR code, is a two-dimensional barcode of black and white patterns. The "Quick Response" refers to instant access to the information hidden within the code. The QR code is one of the most widely used two-dimensional bar codes, which has the advantages of large information capacity, strong error robustness, and a low cost computation.

A contactless attendance system in offline events is urgently needed in the pandemic. The manual attendance system still uses papers, and signatures can support the spread of the virus. The mobile-based QR code attendance system is expected to minimize direct and indirect physical contact between the event organizers and the attendee, thus minimizing the widespread of the virus [1]. Besides, a paperless attendance system can help the environment by decreasing paper consumption, contributing to 42% of the global wood harvest [2].

The other drawbacks of using the manual paper-based attendance system are that it is prone to fraud or violation, is hard to manage and organize the data, and cannot track the timestamp of when the user is attending the event. By utilizing the QR code-based attendance system, the attendance data will be safely and neatly organized in the system database. In addition, QR code encrypts the unique ID of each user, making it less fraudulent. The system can also track the user presence timestamp by storing the QR code when it is scanned.

The previous student attendance system within the State Polytechnic of Malang still used a standalone, third-party QR code scanner connected to a laptop. After the student's QR code had been scanned, the student's data would be displayed instantly on a laptop web page. However, this is inefficient since it requires two devices, and the QR code scanner cannot instantly display the scanned barcode data. In addition, the device itself is bulky, thus making it less mobile than smartphones.

This research objective is to solve the abovementioned problem by implementing a mobile-based QR code attendance system to improve efficiency as it would only utilize one device instead of two. It will no longer need another device such as a laptop to display the data. Instead, it will be displayed instantly from the user's smartphone. Furthermore, this system can be used on different occasions and events everywhere, from wedding invitation management to an academic graduation ceremony. Fig 1 below shows the previous application used in one event.



(a) (b) (c)

Fig. 1. The current attendance system that is used during the graduation ceremony.

2 Literature Study

2.1 Barcode

Barcode is a type of data representation in visual, machine-readable form. Barcodes usually represent the data by varying the widths and spacing of parallel lines. Barcodes are commonly referred to as one-dimensional barcodes and are widely used in a wide variety of consumer goods as their product SKU ID or Stock Keeping Unit ID number to distinguish each product from the others. Later, two-dimensional barcodes were invented. 2D barcodes commonly use rectangles, dots, or other patterns to represent the data instead of bars. 2D barcodes can store more data and have a lesser error rate, less space, and more versatility than 1D barcodes. Fig 2 below shows the barcode image example.

Fig. 2. Barcode image example.

2.2 QR code

QR code, an initialism of Quick Response code, is a type of two-dimensional barcode that consists of squares and lines to represent and encrypt the data. QR code is the most used type of two-dimensional barcode due to its reliability and greater storage capacity [3],[4]. In addition, QR codes can store a wide variety of data, from alphanumeric data to kanji/kana alphabets. Recently, QR codes have been frequently used as a payment method, object hyperlinking, and Augmented Reality (AR). The QR code structure consists of modules like position markers, timing patterns, version

numbers, format identifiers, alignment markers, and data indicators [5], [6]. Fig 3 below shows the QRCode Image example.

Fig. 3. QRCode Image example.

2.3 Android

Android is an open-source mobile operating system developed by Google. It is the world's most used mobile operating system, topping at 70.75% of mobile operating system market share in November 2021 [7].

Android offers much more customizability and free, open-source software than its counterpart, Apple iOS. It is used in smartphones and in a wide variety of gadgets such as smartwatches, smart TVs, and automotive head units. Developing an Android application is much more flexible than iOS and can be developed in various operating systems such as Windows, macOS, and Linux using an Integrated Development Environment (or IDE) called Android Studio [8].

2.4 Flutter

Flutter is an open-source multiplatform framework developed by Google and the community aimed to build a cross-platform application based on a single code. Flutter used Dart as their programming language of choice. Flutter offers “Hot Reload” and “Hot Restart” features. UI changes can be quickly compiled to the software, making it easier to debug and build the UI. Since it is compiled directly to the operating system, Flutter apps performed as fast as natively developed applications. Recently, many companies started to build applications using the flutter framework, such as Google Ads, Hamilton, Cryptograph, Etc. [9].

3 Implementation (Presentik)

Presentik is an attendance/presence management system that utilizes QR code attendance as one of its attendance methods. The QR code offers quick and easy presence marking without a little to no physical contact. This application helps to alleviate the possibility of attendance fraud/attendance abuse by limiting the attendance marking location within 100m from the venue.

Presentik utilizes mobile_scanner package, a QR code scanner package which is based on Google MLKit, an advanced machine learning kit that is optimized for mobile development.

Presentik currently targeted towards event organizers that wants to easily manage their guests' attendance, track the time of attendance, easily spread the invitation through email, and quick attendance process. Fig 4 below shows the application landing page.

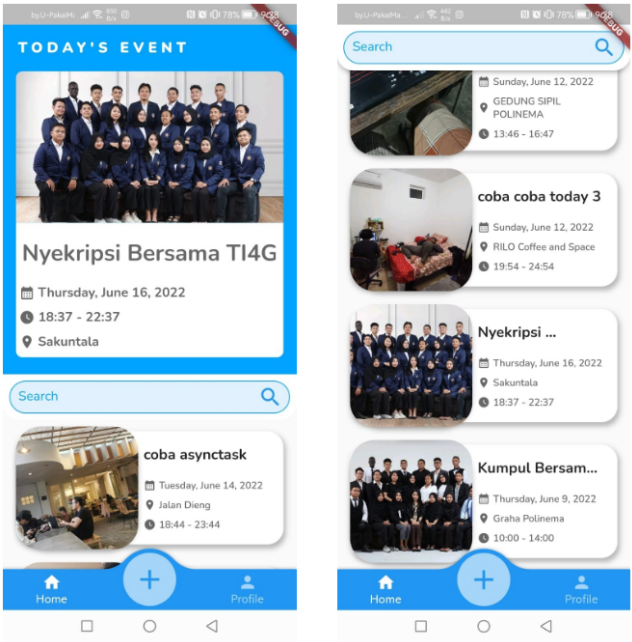


Fig. 4. Presentik home page.

The QR code attendance system flowchart shows in the fig 5 below. It is start when the user opens the event detail page that the user wants to mark the attendance. After opening the event detail page, the user clicks on the screen QR code button at the bottom right corner. The user will be redirected to the QR code scanner screen. Then, the user scans the QR code of the invitees located in the email invitation. After the code has been scanned, the system will check if it is a valid QR code or not. The invitee's attendance will be automatically marked if the QR code is valid. Otherwise, the user will be prompted to scan a valid QR code.

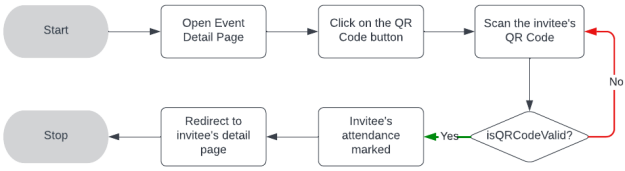


Fig. 5. QR code attendance system flowchart.

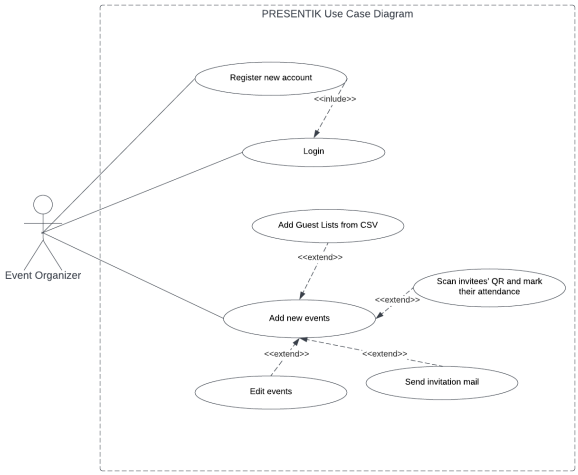


Fig. 6. Presentik use case diagram.

As shown in Fig 6 above, this application only utilizes one actor: the event organizer. The event organizer can manage all the events that they created. First, the event organizer can register a new account in the system. Then, the event organizer can log in and choose the 'event organizer' role while logging in. To create a new event, the event organizer can add a new event to the system by filling in the detailed information regarding the events.

After the event is added, the event organizer can edit the event's information if there is a change. The event organizer can also add the guest lists to the event by uploading a CSV file formatted by the system. When the guests are already added to the event, the event can no longer be edited by the event organizer.

After the guests are already added to the event, the event organizer can send the invitation through email. The invitation contains the event's information such as event place, address, date, time, and the QR code to mark the invitees' attendance. On the event day, the invitees may come to the event and show the event organizers their QR code invitation. The event organizer scans them, and it will automatically mark the attendance. If the attendance takes place more than 100 meters from the location, the attendance will be invalid.

Using a mobile-based multiplatform information system requires a fast and lightweight implementation of the database management system to ensure the application is fast and snappy. Therefore, using the Google Cloud Platform and its APIs and frameworks as the platform to develop and maintain the backend system is suitable for the requirement specified before. Furthermore, Google Cloud Platform ensures that the backend system of this application can be integrated flawlessly and within the same environment.

NoSQL database schema, especially Google Firestore, is suitable for developing the database system thanks to its fast read speed. Flask is used for the backend development framework and deployed using Cloud Run with Docker. Alongside Cloud Build, which has been integrated into a GitHub repository, ensures the CI/CD of the backend systems is applied seamlessly. The backend integration to the frontend system is done using Rest API deployed using Cloud Run with Gunicorn container. Cloud Storage Bucket stores media and files such as attendance logs, event photos, and invitees' photos.

Other APIs are also implemented in the backend systems to support the feature of this information system, such as Maps API and Gmail API. Maps API is applied for the event location selected by the user. Maps API provides a beautiful Google Maps interface integrated into the system, making the user pinpoint the event's exact location. Maps API also provides a repository consisting of thousands or millions of places data that can be searched to ease the user to choose the event's location. Gmail API helps develop the email broadcast system that is used to send the invitation to the invitees.

4 Experiment

The objective of the experiment is to test the application's usability and customers' interests in the application. The other experiment aims to find the optimal phone screen brightness level and the optimal distance to scan the QR code.

4.1 Usability Testing

The usability testing was performed by 10 participants, of which three people do not have an IT-related background. The test resulted in some positive feedback implemented to this application to improve the overall experience of using this application. Although several bugs are found during the testing, it is quickly resolved, fixed, and patched on the newest application.

From the usability testing, it can be concluded that 6 out of 10 participants considered using this application for their future events, while the rest were willing to use it for their upcoming events. 7 out of 10 participants agree that this application does make it easier to manage the guest's attendance at an event, while the other three participants are still unsure about it. Almost all participants agree that this application can be used on various occasions and events. One even states that this application needs to be implemented to track students' attendance on LMS. 7 out of 10 participants also admit that this application can reduce the attendance fraud and attendance abuse practice, while one of the 10 participants refuses to agree with the idea that this application can reduce attendance fraud/attendance abuse. Fig 7, 8, and 9 below shows the quessionaire of the potential users on their experience trying the application.

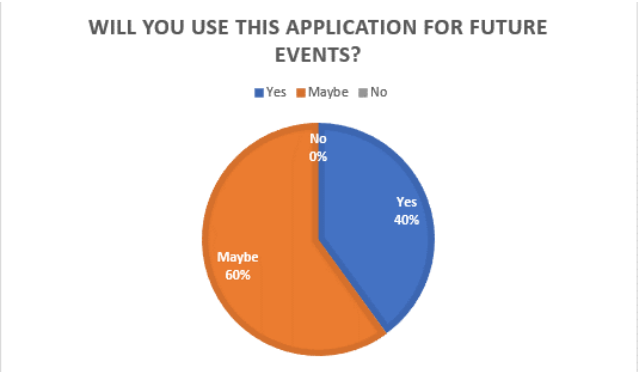


Fig. 7. Chart of participant interested in using this application for future events.

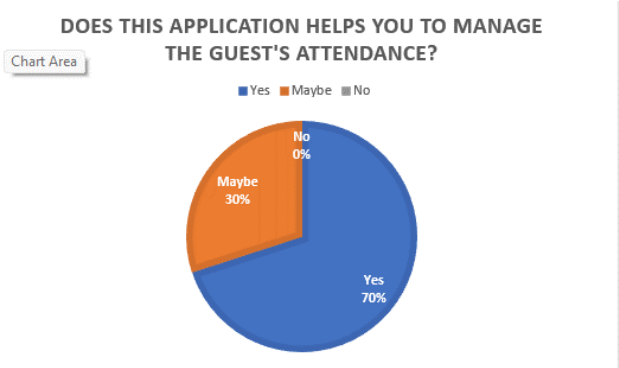


Fig. 8. Chart of participant agrees that this application helps to manage the guest's attendance.

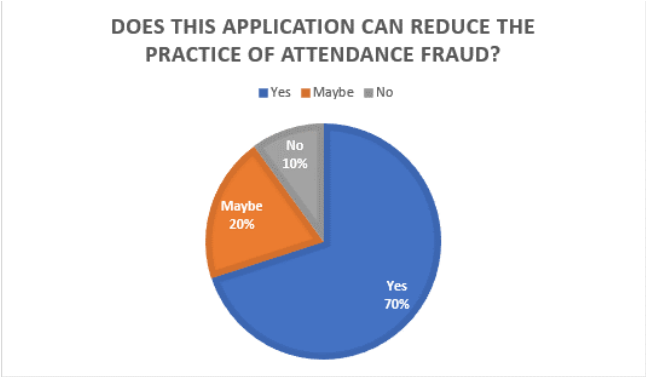


Fig. 9. Chart of participant agrees that this application helps reduce attendance fraud.

4.2 QR code Testing

For the QR code test, there are two media of displaying the QR code: printed on a sheet of paper and displayed on a smartphone screen. The paper used in this experiment is A4 HVS paper, and the smartphone used to display the QR code is Apple

iPhone X 5.8” Super Retina OLED with 625 nits brightness. The camera used to sca n the QR code is Huawei P30 Pro’s primary camera, with 40 MP, f/1.6. The test is performed by scanning the QR code on smart devices and printed versions at various angles and four levels of display brightness. Another examination is performed to find the optimum distance of QRCode with the cameras. Fig 10 below shows the example of 9 different angles, distance, and brightness level on scan mode.

(a) (b)

Fig. 10. Example of 9 different angles of scan.
a) QR code displayed on phone screen, b) QR code printed on paper.

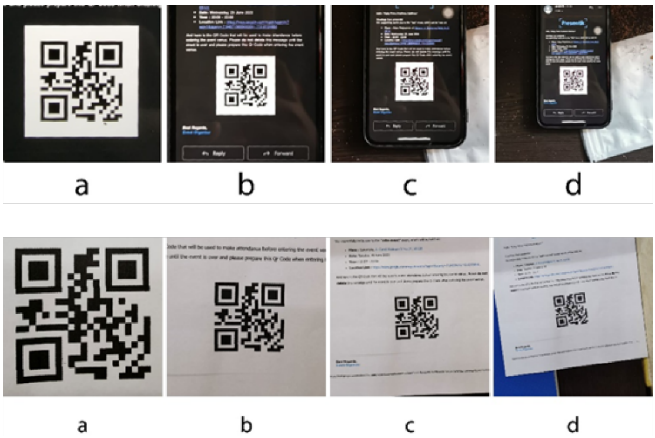


Fig. 11. Example of 4 distance levels of scan.
a) QR code displayed on phone screen, b) QR code printed on paper.

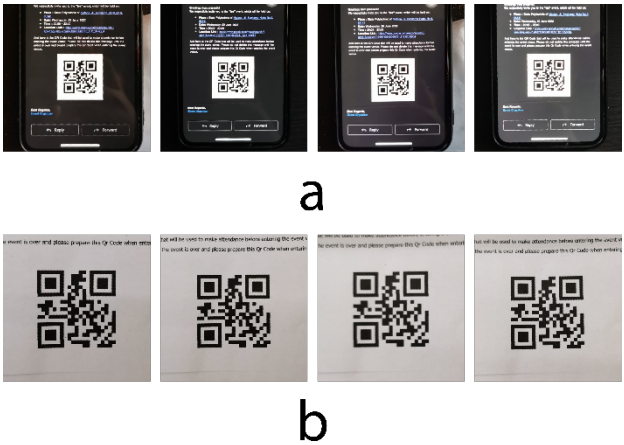


Fig. 12. Example of 4 brightness levels of scan.
a) QR code displayed on phone screen with 25-100% screen brightness, b) QR code printed on paper with 25-100% ambient light brightness.

4.3 Result

The experiment shows that the phone brightness level affects the QR code accuracy. The brighter the phone screen, the less accurate the QR code scan will be. On the other hand, ambient light does not affect much on the printed QR code. The printed QR code scan result remains the same regardless of the ambient lights dim or bright. The optimal brightness level of the smartphone screen is between 25%-50% brightness level. This result may vary across different phones with different screen specifications. From both media, the most challenging angle to scan is the left 45 degrees side and the bottom middle side of the QR code. Fig 13 and 14 below shows the chart of QR code angle and distance scan test succession rate.

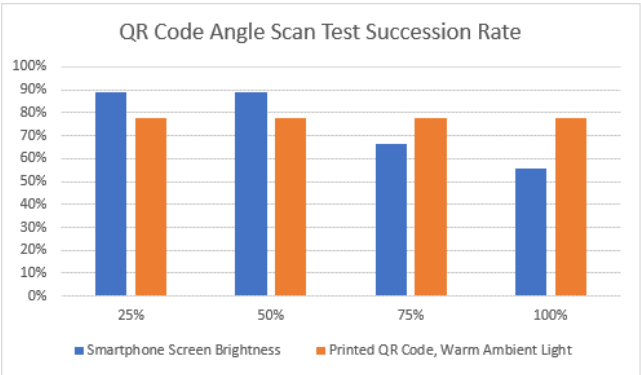


Fig. 13. Chart of QR code angle scan test succession rate

The experiment also shows that the maximum distance to scan the QR code displayed from the phone screen is 30cm. On the other hand, the printed QR code can

still be scanned even as far as 40cm. This experiment proves that the printed QR code is more readable to the scanner. Therefore, this experiment concludes that the optimal distance of scanning the QR code is between 10cm to 30cm. Surprisingly, the brightness level of the smartphone screen and the ambient light on the printed QR code does not affect the accuracy much, unlike the angle scan test.

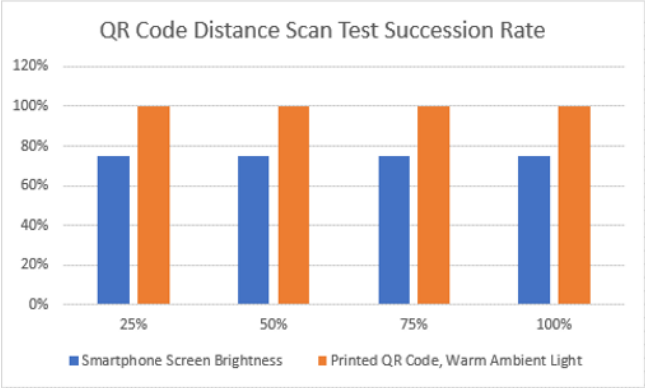


Fig. 14. Chart of QR code distance scan test succession rate

5 Conclusion

Based on the results of the tests and development of the Mobile Based QR Code Attendance System, it can be concluded that almost all the usability testing participants agree that this application can be implemented on various occasions and events, supporting the objective of this research. Most of the participants from the usability testing agree that the application helps to organize or manage the guests' attendance and consider using the application for their future events. Furthermore, 7 out of 10 participants agree that this application helps to reduce the possibility of attendance fraud and attendance abuse, 2 out of 10 are still unsure about it, and 1 out of 10 denies the statement. Several bugs happened when the usability testing took place, and they were immediately fixed, resolved, and deployed in the new patch.

It can also be concluded that the optimal brightness for the smartphone screen used to display the QR code is between 25% and 50%. Moreover, the optimal distance of the scan for the smartphone screen used to display the QR code is between 10cm to 30cm. Conversely, the ambient light brightness within the printed QR code does not affect the accuracy of the scanning process. The printed QR code also succeeded in passing the 40cm distance, meaning that the printed QR code is proven to be more scannable than the QR code displayed using a smartphone screen.

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