Covid-19 Spread Prevention System on Campus based on Student Population Monitoring

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Abstract: Various efforts have been made by the government in controlling the spread of covid-19, such as social restrictions of various scales, restrictions on community activities, social assistance, to vaccination. One of the sectors affected is education. This research aims to create a system to prevent the spread of virus covid-19 from monitoring the number of student populations on campus. Thus, phisical teaching can still be implemented. Every student who will access the campus area must scan the QR code on the mobile application. Algorithms are designed to access QR codes based on course schedules and based on permission. The system is also equipped with sanctions features for students late in or out of campus area. All section systems, namely mobile applications, scanners, virtual servers and web platforms, are successfully created according to the designed algorithm. The web platform can display the student population on campus in real-time. In addition, base64 encryption is used to secure the converted data in QR codes.

1 INTRODUCTION

The covid-19 pandemic is a primary concern that is being resolved around the world. The number of deaths worldwide reached more than two million (WHO Coronavirus Disease (COVID-19) Dashboard, 2021). Indonesia became one of the countries with a very high number of cases reaching more than one million people with the number of deaths of more than 32 thousand people (World Health Organization, 2021). The covid-19 virus can spread from an infected person's mouth or nose in the form of tiny particles (aerosols) when they cough, sneeze or talk. A person can contract this virus if the aerosol enters his mouth or nose (Centers for Disease Control and Prevention, 2020). In preventing the spread of the covid-19 virus, the Indonesian government has done various ways both at the central level and at the regional level, such as closing access to arrivals and departures to and from abroad (Satuan Tugas Penanganan Covid-19, 2020), the imposition of large-scale social restrictions (Kementerian Sekretariat Negara Republik Indonesia, 2020), to the enactment of restrictions on micro-based community activities (Menteri Dalam Negeri, 2021). Many sectors are affected by this policy. One of them is teaching and learning activities of various levels of education that have to be temporarily diverted online. The Ministry of Education, Culture, Research and Technology had announced that there would be a return to in physical teaching. However, the plan was delayed after the covid-19 delta variant spread and became a significant focus for the current government. In the face of a situation that continues to develop dynamically, various efforts continue to be made by multiple parties to innovate in offering solutions to diverse problems. In this research, innovation was carried out by creating a system to monitor the student population on campus. This research aims to succeed in management policies in limiting or controlling the number of daily students on campus to prevent the spread of covid-19. By preparing the system, it is expected to be still able to control the spread of covid-19 when phisical teaching begins to be implemented.

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2 LITERATURE REVIEW

Research on student population monitoring systems on campus includes engineering in terms of both hardware and software. The use of minicomputers and quick response (QR) readers from the hardware side and encryption algorithms and QR codes from the software side becomes one of the support in running the system.

2.1 QR Code

This research will use QR code as student access in and out of campus. QR code is a type of two-dimensional symbol developed by Denso Wave in 1994. QR stands for "Quick Response", indicating that the code contents should be decoded very quickly at high speed (Tiwari, 2016). Compared with 1-D Codes, 2- D Codes can hold more data in a smaller space. In Bar Codes, information is coded in one direction or one dimension only (Saranya, Reminaa, & Subhitsha, 2016). Table 1 shows the comparative study of QR code and Bar code. The QR code structure can be seen in Figure 1. Each QR code symbol is arranged in a square shape and consists of function patterns and encoding regions. A quiet zone boundary surrounds the entire symbol on all four sides. There are four types of function patterns, including finder patterns, separators, timing patterns, and alignment patterns. The encoding region contains data representing version information, information format, and error correction (Priyambodo, Novamizanti, & Usman, 2020).

Table 1: Comparison of QR code and barcode (Tiwari, 2016).

Features	QR Code	Bar Code
High capacity	Upto 7089 numeric digits	10-20 digits
Durability against damage	Reading is possible (upto 30% damaged)	Reading is impossible
Reduced Space	40 digits numeric	10 digits numeric
360°	Supports 360° reading	Horizontal reading
Language Supported	Numeric,Alphanumeric,Kanji,Kana etc	Numeric,Alphanumeric

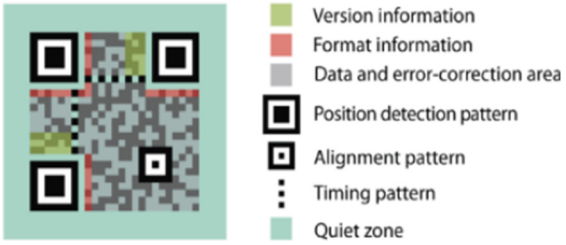

Figure 1: QR code structure (Priyambodo, Novamizanti, & Usman, 2020).

QR code will be built on the android application that every student must enter the campus area. The QR reader device is used to read QR codes in mobile applications.

2.2 Base64 Encryption Algorithm

Real-time monitoring systems involve the use of information between the user and the system. Information encryption technology can meet the security requirements of confidentiality of the information and avoid the leakage of critical information security threats. Therefore, encryption technology is the base of authentication technology and other security technology, and it is also the core technology of information security (Yu, Wang, & Wang, 2012). The base64 algorithm is used for encoding and decoding data before it becomes a QR code. The base 64 algorithm works to convert data into an ASCII format based on the base number 64. The resulting character in this base64 transformation consists of A. Z, a. z and 0..9, plus the symbols "+" and "/" and one character equal to (=) in the last two characters used for pad charging or in other words adjusting and completing binary data. The character of the symbol to be generated will depend on the process of the algorithm running. The stage in convert a string with base64 algorithm are as follows (Yu, Wang, & Wang, 2012):

- Break the bytes string to 3 bytes.
- Combine 3 bytes into 24 bits. with a record of 1 bytes = 8 bits, so 3 x 8 = 24 bits.
- Then 24 bits stored in-buffer (put together) devided into 6 bits, and it will produce four fractions
- Each fraction is converted into a decimal value, where the maximum value of 6 bits is 63.
- Finally, make the decimal values into an index to choose

And so on until the end of the bytes string that will undergo conversion. If there is a remaining divider in the encoding process, then add the character pad (=)

as the remaining sucker. Therefore, sometimes at base64 will appear one or two characters (=). Base64 table index can be seen in Table 2.

Table 2: Base64 index table (Wen & Dang, 2018).

Val	Char	Val	Char	Val	Char	Val	Char
0	A	16	Q	32	g	48	w
1	B	17	R	33	h	49	x
2	C	18	S	34	i	50	y
3	D	19	T	35	j	51	z
4	E	20	U	36	k	52	0
5	F	21	V	37	l	53	1
6	G	22	W	38	m	54	2
7	H	23	X	39	n	55	3
8	I	24	Y	40	o	56	4
9	J	25	Z	41	p	57	5
10	K	26	a	42	q	58	6
11	L	27	b	43	r	59	7
12	M	28	c	44	s	60	8
13	N	29	d	45	t	61	9
14	O	30	e	46	u	62	+
15	P	31	f	47	v	63	/

2.3 Message Queuing Telemetry Transport (MQTT)

MQTT was invented by Andy Standford-Clark and Arlen Nipper. The communication model used is publish and subscribe and provide quality of service (QoS) support. The publish mechanism is usually used to send the data to the broker and the subscribe mechanism is used to get the data from the broker (Vyas, Rudani, & Student, 2018). The MQTT structure can be seen in Figure 2. With QoS, the MQTT protocol can ensure higher delivery capabilities than HTTP. There are three levels of QoS (Shinde, Nimkar, Singh, Salpe, & Jadhav, 2016):

- QoS – 1 (at most once): guarantees the best delivery efforts.
- QoS – 2 (at least once): Messages are sent at least once, but it could be more.
- QoS – 3 (exactly once): guarantees that a message sent is received once.

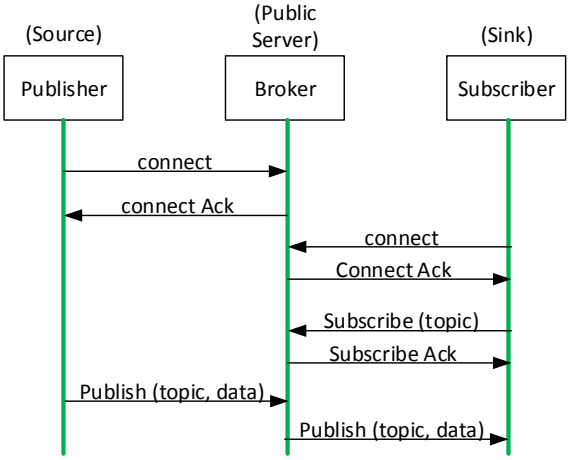

Figure 2: MQTT structure (manmeetjuneja5, 2020).

2.4 Hyper Text Transfer Protocol (HTTP)

HTTP was initially designed as a protocol for web browsing (Jin & Choi, 2012). HTTP is used by the world wide web (www) to determine how its messages will be sent and formatted. HTTP formulates the specifications for messaging between Web servers and clients. Since 1990, HTTP has been in usage by the Worldwide Web global information initiative (Huang, Xia, Sun, & Xue, 2015). This protocol is responsible for the actions that servers must take when sending information over the network. When the URL is being entered into the browser, this protocol sends an HTTP request to the server, and then the HTTP response is sent back to the browser. The protocol is also responsible for controlling web pages on the World Wide Web to format and represent data. The HTTP structure can be seen in Figure 3.

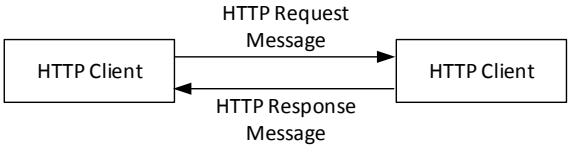

Figure 3: HTTP structure (manmeetjuneja5, 2020).

3 SYSTEM DESIGN

3.1 Block Diagram

The system is designed to limit the number of students in the campus area. The designed system consists of several builder components: mobile applications, scanners, virtual servers, and web

platforms. The block diagram of the system can be seen in Figure 4 below.

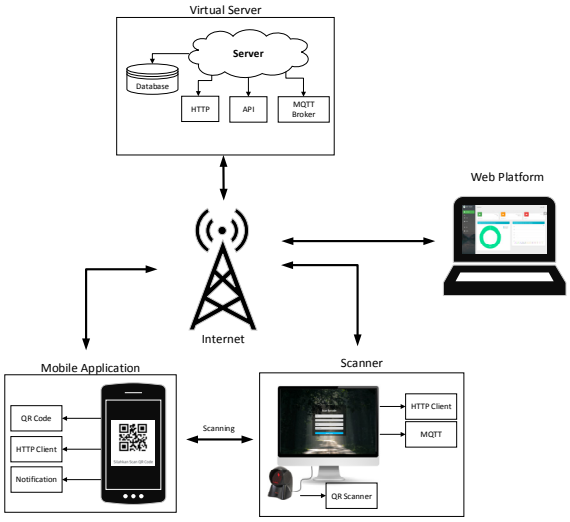

Figure 4: Block diagram system.

The Mobile Application block consists of an HTTP client that plays a role in retrieving or requesting data from the server using the http protocol. Furthermore, a QR code is an image generated by the mobile application to be scanned by the QR code scanner in the scanner block section. The scanner section consists of a QR Code Scanner to scan the QR code of the mobile application to be processed by the Mini PC and then verified to the virtual server by making http requests through the Internet Provider. A virtual server section is a component that governs all needs. This block consists of servers that play a role in capturing requests from other sections, processing data to the database, integrating requests with APIs and providing responses to requests received. A web platform section is a block that runs on a computer or mobile device to view the combined data of all sections with the role of administrator.

3.2 System Algorithm

System algorithm is designed in such a way as to accommodate the needs of students greeting the campus area but still meet the goals to be achieved. There are 5 types of users in the system as a whole with their respective functions. The following Table 3 is an explanation of each user.

Table 3: Users role.

No	User	Description
1	Administrator	The administrator of the entire management system
2	Head of Department	Permit applicant verifier
3	Head of Study Program	Permit applicant verifier
4	Department Technician	Sanction verifier
5	Student	Target user

Each student can access the campus area in only two conditions, when there is a schedule of courses and if they have urgent needs. The system algorithm for the first condition can be seen in Figure 5.

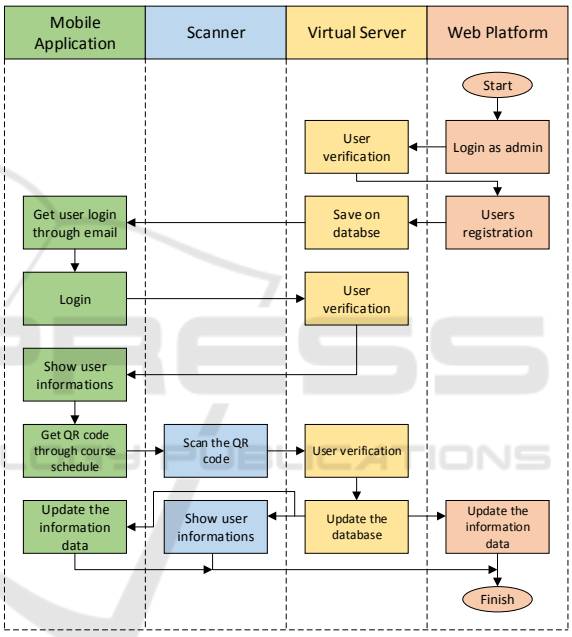

Figure 5: An algorithm based on courses schedule.

Each student will be registered by the user administrator and get an account to log in to the mobile application via email. Based on Fig. 6 above, the system algorithm generally describes the system's flow in each section. In addition, there will be a notification in each mobile application every 15 minutes before the beginning of the course as a reminder to every registered student user. Notices will also appear 15 minutes before the student must leave the campus area. This reminder system is used so that every student user can obey all the rules applied. The following condition system algorithm is based on permission when students have an urgent need by applying for approval on the mobile application. The system algorithm designed for the second condition can be seen in Figure 6.

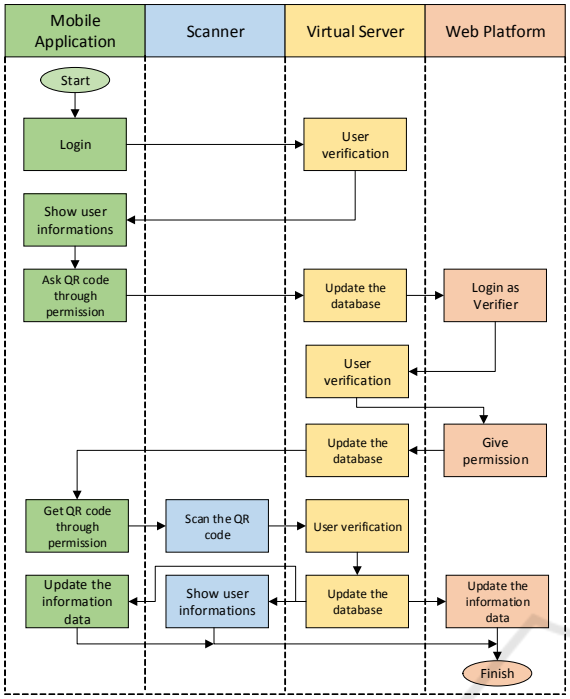

Figure 6: An algorithm based on permission.

Students who apply for permission to visit the campus area will only get a QR code on the mobile application when the verifier obtains approval. Two users must permit the applicant, namely:

- Head of the applicant's study program
- Head of the applicant department

In addition, sanctions are also applied to every student user who is late, either entering the campus area or leaving the campus area. Sanctions are converted into sanction points where every minute of delay is interpreted as one point of sanctions. The sanction points will appear on the main page of the student user mobile application. A compensation system is implemented to pay for the sanctions where students can submit them to registered technician users. User technicians will reduce the value of points per appropriate compensation.

4 RESULT

4.1 Platform

The realization of the design results at this stage has been done. The creation of a web platform as in Figure 7 named MPM - Pollan. The web-based platform has several features, including :

- Real-time monitoring dashboard
- Users management
- Courses schedule management
- Class management
- Sanction management

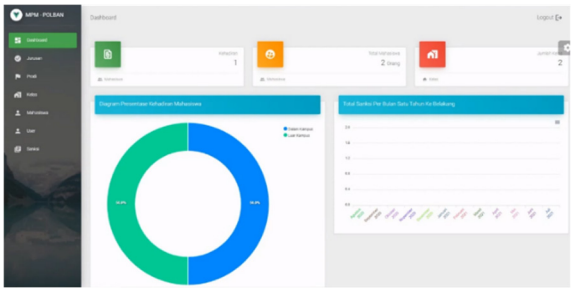

Figure 7: Web platform dashboard.

4.2 Scanner

Student access using QR code makes it easier for security to conduct supervision. The scanner dashboard can be seen in

Figure 8. The application is a local web-based platform that will be installed on a mini PC and installed on the entrance and exit gates of the campus.

Figure 8: Scanner dashboard.

4.3 Mobile Application

Students obtain access in and out of campus through the android application, as in Figure 9. Features contained in the android application include the following.

- User management
- Course information
- QR code builder with base64 data encryption
- Notification
- Sanction information
- Permission form

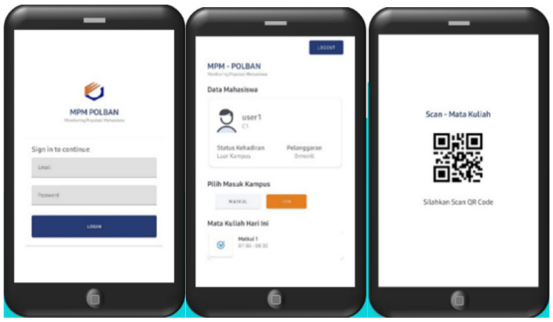

Figure 9: Mobile application.

4.4 Overall Testing

The overall testing is done by integrating the entire system section. Testing is also done on the algorithm based on the course schedule and based on permission. The overall test results can be seen in Table 4 below. All the commands that are parameters in the test work well.

Table 4: Overall function testing.

Command	Worked	Output
User Account Registration	✓	User account is added to the database, and email account information is sent to the user.
User Account Login	✓	Display the main page of the application.
Notification	✓	Generate notifications on smartphones that have been logged in in the mobile application. Notifications appear 15 minutes before the initial course schedule and 15 minutes before the user has to leave campus area.
QR code based on course schedule	✓	QR code access appears if the user has a course schedule. The mobile application can display QR codes.
Ask QR based on permission	✓	QR code access appears when the verifier gives permission.
Scan QR code	✓	QR readers can read QR codes from the mobile application.
Scanner UI	✓	User information can be displayed on a web-based dashboard scanner.
Sanction	✓	Sanction points appear on each user's mobile application page. User technicians can reduce the value of points through the web platform.
Realtime monitoring	✓	User status, sanction points, and the number of student populations on campus can be displayed on the dashboard of the web platform in real-time.

5 CONCLUSIONS

The system of monitoring the student population to prevent the covid-19 from spreading has been successfully developed. All sections systems, namely mobile applications, scanners, virtual servers and web platforms, are successfully created according to the designed algorithm. The Web Platform can display the student population on campus in real-time. In addition, base64 encryption is used to secure the converted data in QR codes.

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