

ORIGINAL ARTICLE

## Design and Development of Visitor Management System

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**ABSTRACT** – This report is mainly discussed about the design and develop the Visitor Management System (VMS) as an application that utilised the smart card advantages in University Malaysia Pahang (UMP) Pekan campus. This application is mainly focused on achieving an affordable VMS in UMP Pekan which aim to improve the existing visitor registration and information management activities. In fact, VMS replaces the manual recording of visitor information during visitor registration by using visitor's Malaysia Government Multipurpose Card (MyKad). The VMS allows retrieving visitor information from MyKad and given a badge which use to indicate their identity when they are new registration visitor. From this study, it shows that the percentage of improvement for new visitor by using VMS is 26% to 54% higher compared to manual recording method whereas the percentage of improvement for existing visitor by using VMS is 86% to 91%. Further research of this study included the implementation on biometric verification method such as fingerprint and face recognition, replaces the current MyKad reader to smart card device with higher reading speed, as well as the notification system to inform the arrival of visitor to the visiting person.

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### Introduction

Visitor management system, typically refer as a structure to keep tracking visitor's activities in organisation or public building. It can provide necessary output and information to the users and record the incoming and outgoing visitors within the shortest time. Nevertheless, VMS also capable to streamline the registration process and provide an authentic and integrated data of the visitors. [1]

Generally, there are many organisation or school are still using the conventional paper log or guest book to record the access of the visitors. This manual method consumes longer time when the number of visitors is exceeded the limit. Meanwhile, an increasing number of visitors indicates that the security issues should be concern in the organisation or school. [2] This is mainly because the operators are lack of time to verify the identification of each visitor when they are tons of guest entering the building. [3] Moreover, paper log is inadequate to offer greater traceability in which cannot be archived or efficiently retrieved after several years. [4]

Due to above circumstances, VMS contribute a good solution to solve the problems exist in the conventional method. An integrated VMS with the Malaysian Identification Card, MyKad as the credential to enter the building is an easy way to identify and record the visitor's personal information. [5] This authentication system also helps the security

officer to determine whether the visitors are giving the right to enter the building. [6] In this paper, an automated VMS is designed and developed in UMP Pekan to assure the simplification of enrolment process before entering the premises.

### Method

The overall research methodology flow chart is shown in Figure 1. The whole design and development of the VMS, including research strategy, research method and the research process will be outline. In general, each detail of the system design and development procedure will be explained briefly as following.

### System Requirement

Before starting to develop and design the VMS in UMP Pekan, it is necessary to identify the system requirement for the items that used in this project. The system requirement of the VMS is the configuration, functional and data requirement as well as the quality constraint of the laptop and MyKad reader. The objective of system requirement is to ensure the VMS is running smoothly and efficiently so that it could make the registration process faster and easier.

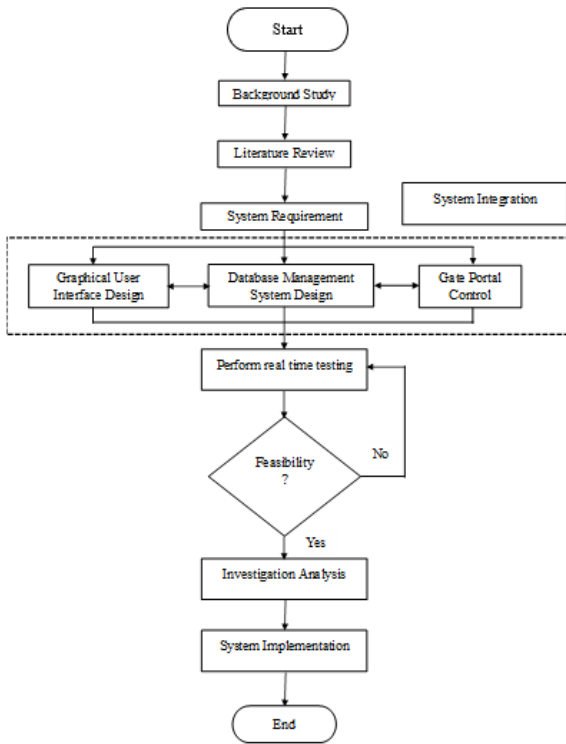


Figure 1. Overall research methodology flow chart.

This system should be consisting of the following requirement:

1. An integrated system that able to retrieve and validate visitor information through MyKad verification process.
2. A system that can track the time and date of visitor transaction and visitor in the premise list by day, week, month and year.
3. A system that can achieve the time and date of visitor blocked list and unblocked list by day, week, month and year.
4. An automated system that facilitates to generate the daily, weekly, monthly and annually report.
5. A system that able to calculate the amount of current visitor, transacted visitor, block-listed visitor, and unblocked list visitor.
6. A system that allow to create, edit, delete and update users' information.

### Graphical User Interface

One of the important elements on this VMS is the graphical user interface (GUI) design which includes graphical component, buttons, icons, and tables. In general, GUI is designing to provide a user-friendly and intuitive environment to the user where it does not take complicated method to display information and manipulator control. It is necessary to design and develop an ease to use interface in VMS so that it could facilitate the procedure and registration process. Therefore, the GUI of the proposed VMS must fulfil the intuitive, informative and interactive between the

human and computer device so that it enables the users easier to learn and use. [7]

### Database Management System

In the VMS, it is required to have an own database management system to record all the visitor's log and information when they have registered with the front counter. In fact, database management system (DBMS) is a system software that able to collect and manage the visitor's database. [8] As compared to manual system, the benefits of using computerised DBMS are rapid, accuracy and accessibility. VMS must be acquired DBMS so that it can store and track the visitor's database for administrative purpose. It also can provide high security and posted efficient data integrity capabilities.

### System Integration

System integration is an important step for every system especially VMS. It is consisting of process that iteratively combines component sub-systems into one system. Furthermore, it is also mainly implemented for successive and compatible levels of the system hierarchy. From this definition, it can be states that VMS should be integrated with both graphical user interface (GUI) and database management system (DBMS) as well as the access control panel, Arduino Uno. Hence, the whole system should be combined when every single unit or parts of the VMS is completed.

### Real time Testing

After designed the whole VMS, a real-time testing should be implementing to detect the error and failure of the system. Generally, real time testing is a trial and error process which useful to examine the complete and integrated systems. Also, the purpose of the system testing is testing the fully integrated application and evaluate the system's compliance with the designed requirements. Hence, it is mainly divided into three levels of testing procedure which are shown as Figure 2. [9]

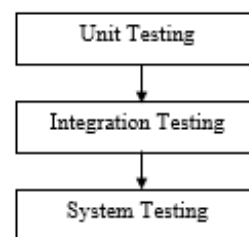


Figure 2. Levels of real-time testing.

1. Unit Testing: A level of the real-time testing process where each single unit, block module and components

of the system are examined. It means that individual part of the VMS should be isolating and perform test to validate each component is met with the desired functionality and requirement.

2. Integration Testing: A level of the real-time testing process where individual parts are combined and integrated as a group in order to evaluate if they work correctly together. By using this way, the fault or error can be determined when the parts or components of the VMS are interacting together.

3. System Testing: A level of the real-time testing process where a complete and integrated system are examined to ensure the overall products fulfil the specified requirements. In short, the whole VMS will be assessing by the examiner, so it could run smoothly before launch in the UMP Pekan. [10]

### Investigation Analysis

In this research, there are several investigations that must be determine so that the system is fulfil its specified requirements. For instance, the comparison between the conventional paper log method and the integrated visitor management system can be made. This comparison can be justifying through the time taken for visitor registration process via the conventional paper log method and integrated visitor management.

### System Implementation

At this stage of system implementation, the VMS can be made after undergoes several steps of real-time testing. The planned venue to implement the VMS will be at UMP Pekan's building block or guard house. Therefore, it is important to ensure the VMS is meets with the quality standard.

## Results and Discussion

### System Requirement

The In order to design and develop the VMS for UMP Pekan Campus accordingly, there are few specific hardware and software development tools to be included in this project.

#### Hardware Requirement

Hardware requirement is the physical computer resources that most commonly defined by the operating system (OS) and software application. The hardware requirement that specified in the VMS development process is listed and shown in Table 1.

**Table 1.** List of hardware requirement.

Hardware	Specification	Description
MyKad Reader Computer	FT-SCR301	To retrieve information from visitor's MyKad
Microcontroller	ASUS VivoBook S55ILN	To design and develop the GUI
Servomotor	Arduino Uno	To control the electronics component
	SG90 Micro Servomotor	To rotate the gate portal

#### Software Requirement

The software requirement specification is the essential role in the software development stages. It defines the features and behaviour of a software application in order to meet the overall requirement for the VMS. Hence, the specifications of the software requirement are as shown in Table 2.

**Table 2.** List of software requirement.

Software	Specification	Description
Operating System	Windows 10.1	To execute all related software involved in this VMS development
Interface Design	Microsoft Visual Studio Community 2017	To design and develop the user interface
Database Design	MySQL Server	To store the data and information
Diagram Device Control	Lucidchart Arduino IDE	To create the ERD diagram To write the codes for Arduino

### Graphical User Interface

A graphical user interface (GUI) is often defines as a human-computer interface that uses graphical components such as windows, icons, buttons and menus that can be manipulated by the users. For this project, the GUI application is created by using the Microsoft Visual Studio 2017 with VB.Net as the programming language. After design and develop the GUI, the respective coding to manipulate the graphical components also can be coding in the same platform.

#### Login Form

Before entering to the main setup form in the visitor management system, a login form is pop up to allow the user to login with their own username and password. In fact, the function of the login form is to enter authentication credentials so that the users can access to the main form of the system. When the login form is submitted, the elemental code will used to check and compare with the existing credentials in MySQL database. If the result is matched, the users will be granted for further features in the system. The login form application for this proposed VMS is as shown in Figure 3.

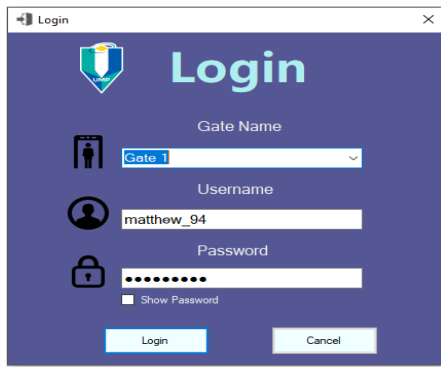


Figure 3. Login form.

**Visitor Sign in Form**

After login to the main interface of the visitor management system, the users are able to record the visitor’s information with two ways, which are MyKad and Generic Card method. For Malaysian citizens, the visitors can enter the university area when their sign in with their own MyKad. However, for those visitors from foreign country, they are required to sign in with the Generic Card method since they do not hold any MyKad. Basically, this sign in form is to track visitor’s activities inside the UMP Pekan campus so that authorities can determine the overall flow of the visitors. In this case, the sign in form is displayed in Figure 4.

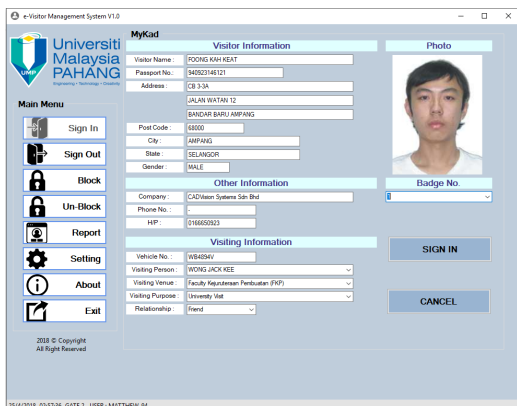


Figure 4. Visitor sign in form.

**Block and Unblock Features**

In the same time, both block and unblock visitors features also has been implemented in this system. This feature contains two modes to block access of the visitor, which are vehicle or MyKad number. When the visitor or vehicle in the blacklist is trying to access the system, the system will not allow the visitor or vehicle to enter university area. In contrast, this system also able to unblock the visitor from being listed in the blacklist. The Figure 5 demonstrated the visitor block and unblock interface for proposed VMS.

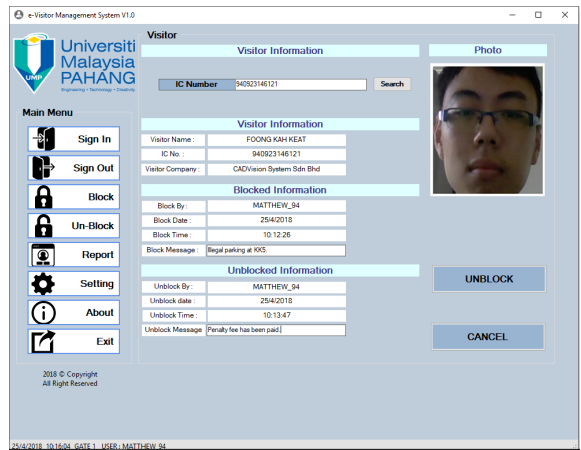


Figure 5. Visitor block and unblock interface.

**Listing and Reports**

One of the aims of this visitor management system is to generate the report automatically. Hence, the report of the system can be display in the table form and export to the Microsoft Excel. This system consists of four types of visitor’s listing which are logging, transaction, block and unblock list. Each of the listing contains its own information and can be classified according to the type of registration method and action date. Visitor logging list in Figure 6 is one of the examples of the report listing in the proposed VMS.

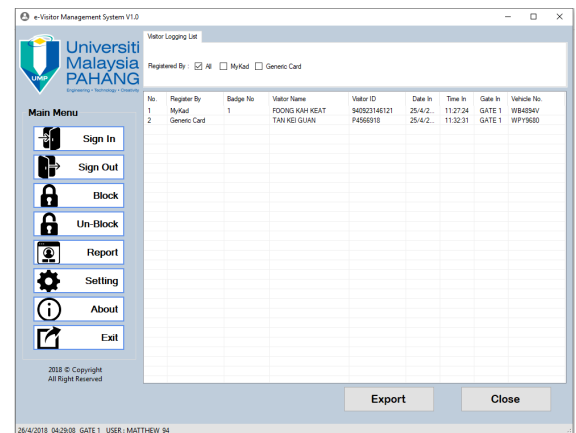


Figure 6. Visitor logging list.

**Database Architecture**

The database management system (DBMS) is the backbone of the whole system. It is extremely important to store the data and information of the visitor and users in the VMS. The software tools to develop the DBMS is using MySQL server. MySQL is an open source relational database management system (RDBMS) which based on Structured Query Language (SQL). Meanwhile, it is also needing to identify the relationship between each entity in the database system. Hence, the entity relationship diagram (ERD) for this research is established and demonstrated in Figure 7 below.



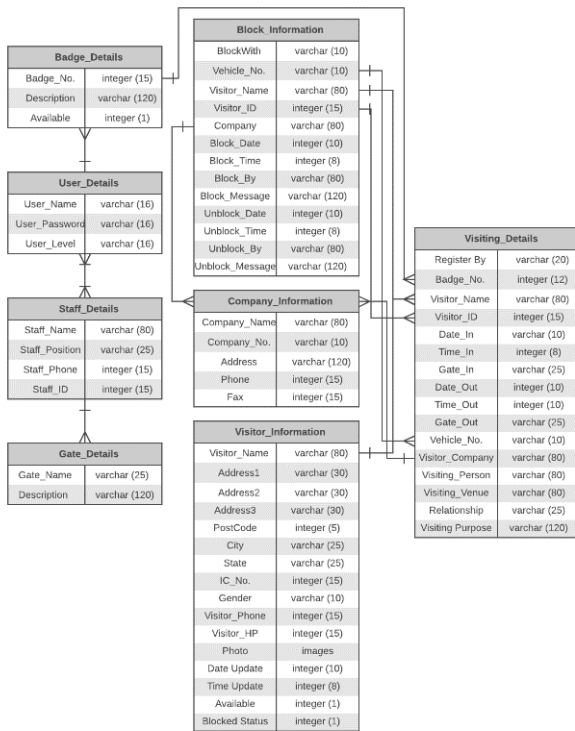


Figure 7. Entity Relationship Diagram.

### Overall VMS Framework

Before the stage the system implementation, it is necessary to ensure the flow of the VMS running smoothly and effectively. Therefore, the overall VMS framework of this research is built to assure a systematic and complete program flow in the VMS. The overall VMS framework as shown in Figure 8.

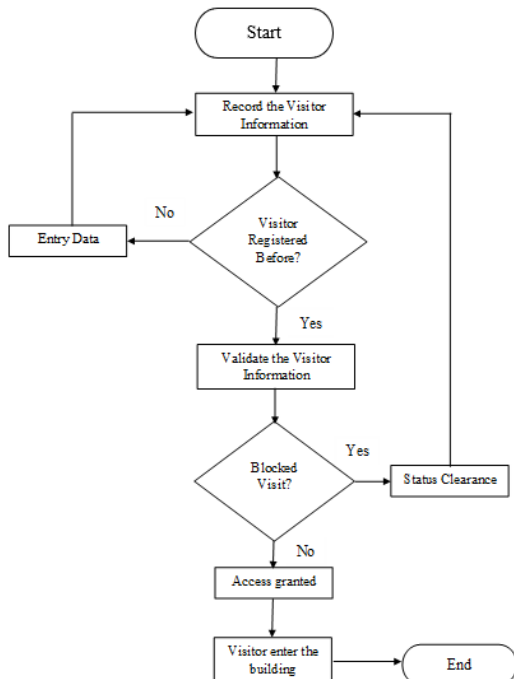


Figure 8. Overall VMS Framework.

### System Integration Framework

At the stage of system integration, the hardware and software components of this system will be integrating together. Therefore, the system integration framework should be used to illustrate the system description and operation as well as contributing a clear set of operations that are associated with the VMS. This framework also acts as an excellent mechanism for complexity reduction which reduces the volume of text to describe the system. The system integration framework of the VMS in UMP Pekan campus is shown in Figure 9.

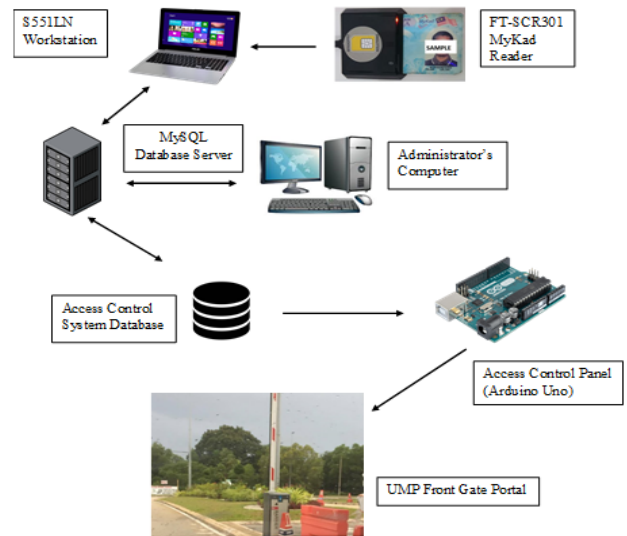


Figure 9. Overall VMS Framework.

### Real Time Testing

When the whole GUI and DBMS is designed, a step by step troubleshooting process should be performing to resolve certain failures or bugs in the system. It is a logical and systematic approach to figure out the source of the problem. Each of the testing categories indicates that the overall VMS should be conduct testing under different conditions. The faulty bug and the error in the system will displayed through the message box. So, when the system is encounter problem, the users can immediately know the source of problem through the error message. This step is also ensuring that the whole system is fulfil the specified requirement as stated above. An example of the error message box when username or password is wrong shown in Figure 10.

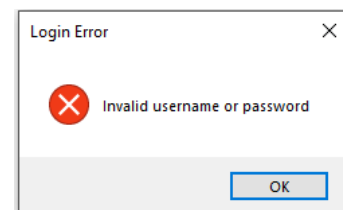


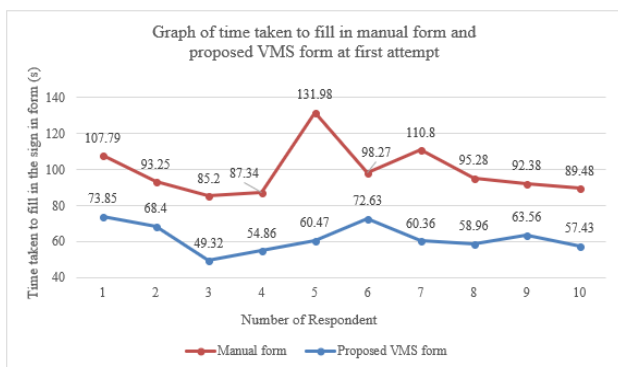
Figure 10. Error message box when invalid username or password.

### Time Investigation Analysis

After the overall VMS is successfully built, a series of analysis is conducted to investigate the improvement and efficiency with respect to time. Firstly, this investigation will be focus on the time taken to complete both manual and proposed VMS sign in form. A manual sign in form is printed as same as the proposed VMS and it is distributed to 10 corresponding respondents. The respondents are required to fill up the manual and proposed VMS sign in form within the shortest time. At first attempt, the respondent must fill in all the necessary information on both manual and proposed VMS form. The results of the time taken for respondent to fill in manual form and proposed VMS form at first attempt will be collected in Table 3 and a comparison graph will be plotted in Figure 11.

**Table 3.** Time taken for respondent to fill in manual form and proposed VMS form at first attempt.

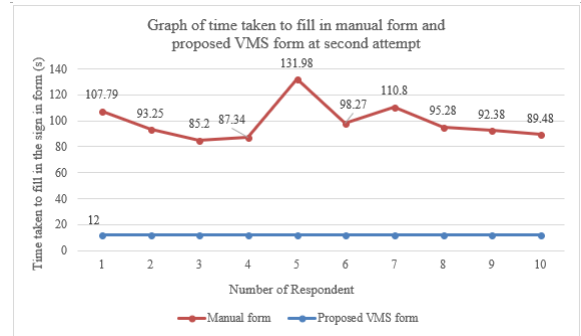
Test	Time taken using manual form	Time taken using VMS	Difference (%)
1	107.79	73.85	31.49
2	93.25	68.40	26.65
3	85.20	49.32	42.11
4	87.34	54.86	37.19
5	131.98	60.47	54.18
6	98.27	72.63	26.09
7	110.80	60.36	45.52
8	95.28	58.96	38.12
9	92.38	63.56	31.20
10	89.48	57.43	35.82



**Figure 11.** Graph of time taken to fill in manual form and proposed VMS form at first attempt.

Based on the Table 3 and Figure 11, it can be determined that the time taken to fill in the manual form is ranging from 85.20 s to 131.98 s which mainly depends on the respondent’s handwriting speed and completeness of information. However, the time taken to fill in the proposed VMS form is only need 49.32 s to 73.85 s where it is highly relying on the MyKad reader speed and completeness of information. From the results, the average time taken to fill in the proposed VMS is about 26% to 54% shorter than the

manual form method. This shows that the proposed VMS is successfully streamline the registration process in term of time.



**Figure 12.** Graph of time taken to fill in manual form and proposed VMS form at second attempt.

Apart from that, when the registered visitor enters to the university area at second time or above, the proposed VMS will be able to display the visitor’s last sign in details by inserting the MyKad. When the system successfully matches the visitor’s information, the system will automatically input all the data into the sign in form without rewrite the same information. By assuming the MyKad reader takes 12 seconds to retrieve the data and no extra information need to be add on or modify, a graph of time taken for respondent to fill in manual form and proposed VMS form at second attempt is plotted in Figure 12.

Based on the Figure 12, it can be understood that the time taken for respondent to fill in proposed VMS form at second attempt is shorter than the first attempt. This is because the visitor’s data is already saved in the database system. It also can be noticed that the proposed VMS form registration time reduced from 86% to 91% when the visitor is register at second attempt or above. Moreover, the proposed VMS also provide the image of the visitor which is way better than the conventional manual method. It allows the user to capture the visitor’s face and retrieved the genuine information from the MyKad in the same time. Furthermore, the bad and slow handwriting of the visitor in the manual form also is one the reason that caused reading difficulties by the user. Therefore, it can prove that the proposed VMS is excellent than the manual form method with respect to time.

### Conclusion

This project is conducted under the objective of design and develop a VMS that is affordable for the UMP Pekan visitors. In this project, the overall cost of the proposed VMS is cheaper than other existing VMS in the market. Based on the analysis results, the proposed VMS is able to shorten the time taken for enrolment process for UMP Pekan visitors. Furthermore, the usage of the VMS also greatly

reduced the burden of the security officer as it could generate an overall report instantly.

In fact, there are much can be enhanced despite of out of project budget and approach the deadline of the submission. VMS developed in this project is lack of the verification tools to authenticate the visitor's identity. This may cause that visitor with bad intentions to embezzle others' information to enter university area. Hence, biometric fingerprint device can be introducing to enhance the security level of the visitor management system. Moreover, face recognition method also can be implemented on this visitor management system as it could provide higher safety level compared to other biometric method. To succeed this, a higher quality of camera should be used in order to obtain greater pixels of visitor's face image. In addition, the reading speed of the MyKad should be increase so that the enrolment process can be faster. This could be improving by using the higher reading speed of MyKad reader. With the higher reading rate, the time taken for retrieving information could be scale down from 12 seconds (current MyKad reader) to lesser. Last but not least, this project can be further improving from many aspects since it could always update and modify according to the user's need. Therefore, it can be seen that there are many possibilities to enhance this project from day to day which not only limit to certain aspect.

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