EMERGENCY RESPONSE AND LOCATION TRACKING SYSTEM USING RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY

By

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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Approved by,

_____

(Izzatdin bin A. Aziz)

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgements, and that the original work contained herein has not been undertaken or done by unspecified sources or persons.

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(Ng Tong Wu)

ABSTRACT

Companies have forever been trying to improve their workplace HSE but occupational health and safety records are never perfect because accidents are unexpected. Traditional emergency response plan to alert the emergency response team and evacuate staffs from the vicinity of danger has its inefficiencies. It is found that the traditional emergency response system is slow and may introduce miscommunication. The major finding is that many existing emergency response system does not include human factor in its design. Existing evacuation plan does not take into account those people that may still be trapped inside the building.

Hence this research project aims to provide improvement to the current emergency response system by integrating location tracking features using Radio Frequency Identification (RFID) technology and speed up the alert process using mobile application. Result from the pilot study shows that head counting process and trapped person tracking take a long time to complete during evacuation drills and it should be improved.

A significant amount of research work has been done on the RFID which contributed to the maturity of RFID technology. It has been used extensively in various business processes for location tracking purposes. However, published studies showed very little effort is made on adapting RFID technology in the emergency response system which is believed to be able to reduce the time taken for industrial best practice of head-counting at muster point and also be able to provide accurate real time information of emergency scenes to the emergency response unit.

This research will be examined by building the prototype of the proposed system using active RFID technology and mobile application. Scenario based simulation will be done in order to compare the effectiveness of the proposed system against the current industrial best practice.

ACKNOWLEDGEMENTS

First and foremost, the author would like use this opportunity to express his utmost gratitude to the project supervisor, Mr. Izzatdin bin A. Aziz who had meticulously provided guidance throughout the project. His advice and constructive suggestions have made the project a success.

Another appreciation should be dedicated to Universiti Teknologi PETRONAS, especially the committee of the Final Year Project of Computer Information Sciences (CIS) department. Their excellent management of this course has helped produce a group of graduates that are strong in technical skills.

Lastly, the author would extend his gratitude to the respondents of the pilot study, the participants of the user testing, and also Consurv Technic Sdn. Bhd. for their assistance in the technicalities of the Activewave RFID products.

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CHAPTER 1:
INTRODUCTION

1.1 Background

Occupational health and safety is a priority for all industries. Factory, facility, or plant operators are often charged with the task to constantly monitor the safety of the working environment and improve the existing safety policy to ensure the safety of its workers. Many industry leaders have paid significant effort such as a comprehensive to achieve good occupational health and safety level in their facilities.

Facilities or factories in every industry are designed to perform at the maximum efficiency. However, the human factor is often disregarded in the design of a factory. The buildings or machineries are built together in a very efficient manner but it would be hard for workers to maneuver in the facility. In case of emergency, the workers would be trapped inside the facility before he or she could escape to safety or the assembly point.

Accidents are unfortunate events that happen unexpectedly and unintentionally which results in damage or injury, in worse case even death. No emergency response plans are perfect and able to eliminate workplace accidents entirely. According to statistics from [1], 120 cases of accidents in the manufacturing industry alone had been recorded since Jan 2013 to March 2013.

The standard emergency response plan in the industry includes two part, that are alerting the emergency response team such as fire brigade, police forces, and medical care; and evacuation of staffs from the vicinity of danger. However, these steps normally take a long time to complete and may reduce the chances of rescue. The incorporation of technology such as Radio Frequency Identification (RFID) and mobile technology into the emergency response system would be beneficial to improve the workplace health and safety performance. According to [2] "… many studies and reports have concluded the need to improve current manual evacuation procedure using technology."

1.2 Problem Statement

The industry practice to handle emergency situations is systematic but time consuming. It can be summarized into 7 major steps as shown in Figure 1:

Figure 1: Steps to Manage Fire Emergency

The overall emergency response and evacuation process can be further divided into two parts, which is to alert the emergency response team and to evacuate the employees. In real life, separating these two processes in the emergency response procedure will lead to longer response time.

The process to make an emergency call to lodge an emergency report will take a long time and more than often, miscommunication tends to occur in these reports. [3] states that detection and response time are critical factors to control the damage caused by a fire accident. Hence, it is important to reduce the time taken to alert the emergency response team and also thrive to reduce the communication error when doing so.

Furthermore, a lot of the procedures during an evacuation are conducted manually, especially the head counting procedure. This will cause a serious delay in the detection of trapped or missing personnel, thus reduces the chances of a successful rescue operation and lead to loss of life.

Lastly, the current emergency response and evacuation process that is regarded as the industry standard operating procedure to handle an emergency relied heavily on the ability of people to act logically during an emergency. However, the study of [4] found that human tend to be too shocked to act logically during an emergency and will affect the effectiveness of the evacuation process. As a result, it is important to include the human factor in the design of an effective emergency response system.

1.3 Significance of Project

In response to the above problem, this research paper suggests a more efficient system capitalizing on technology to be employed for emergency response situation. The proposed system will help improve the effectiveness of current emergency response and aim to minimize loss during an emergency. The significances of this project are as below:

i) The studying of the current emergency response system to find out areas that needs to be improved.

ii) The proposal of a solution design that will be able to improve existing emergency response.

iii) The building of a prototype based on the proposed solution and objectives.

1.4 Objectives

The idea of this research project is to design an improved emergency response system that can eliminate the setbacks of current systems and develop the prototype accordingly.

The aim of this research project is:

- To improve current emergency response system and ultimately help im.

The research objectives are as below:

i) Perform a literature study on current emergency response system in order to find out the area that can be improved.

ii) Perform a research on the feasibility and the effectiveness of using Radio Frequency Identification technology and mobile technology to assist emergency response.

iii) Propose a solution that can help to improve on the existing emergency response system.

iv) Building and developing the prototype based on the proposed solution that can improve the area identified.

1.5 Scope of Study

The efficiency and effectiveness of current emergency response system has been proven. Most of the existing emergency response system has been in use for a very long time. However, the author believes that RFID and mobile technology can be integrated with existing emergency response system in order to improve the chances of rescue and recovery.

This research is done to study the feasibility of improving an emergency response system using the technological features of Radio Frequency Identification (RFID) technology. RFID has been proven to be able to perform geo-location using certain algorithms which will be useful to identify the location of trapped personnel inside a facility.

On the other hand, the reliability of mobile application to send information in a fast and accurate way is examined to ensure it is the suitable platform to achieve the objective listed previously.

The improved features that are proposed for the system include:

i) Automate the headcount process of personnel in assembly point.
ii) Reduce time taken to alert emergency response team.
iii) Reduce time taken to identify missing personnel in an emergency situation and their current location.
iv) Provide the emergency response team the last known location of personnel trapped in the facility.

Other study on emergency scenario simulation should be carried out in order to verify the performance of the proposed system at the end of the prototype phase. The scale of the scenario should be determined to best reflect the real world application.

1.6 Relevancy of Project

Based on the problem statement and the objectives, the relevancy of this research project is highly significant to the development of the emergency response system. The outcome from this research project will be able to give better insights to improve existing emergency response system. In addition, this research project also proposed features in the system that could help improve chances of rescue and recovery in case of emergency. This project is based on the human factor when facing with danger situation. Human will be in a state of shock which stops their locomotors function and their ability to think logically. Thus, the human will be trapped inside a building during emergency. This research project will be relevant to improve chances of survival of those trapped victim.

Radio Frequency Identification (RFID) technology has been proven to be reliable and suitable for location tracking. This technology is highly relevant to be applied to track the location of trapped victims in a danger scene.

As a conclusion, this research project will be able to improve the occupational safety and health by introducing an improved emergency response system.

1.7 Feasibility of Project

This research project and its prototype is the expected outcome for the Final Year Project. The Final Year Project will be divided into 2 semesters, carried out over a period of 28 weeks.

A prototype that includes the proposed features is expected by the end of this research project. The prototype utilizes the RFID tags and readers, a system interface and also an android mobile application interface. The author's background in object-oriented programming and mobile programming language improves the feasibility of this research project.

Besides the prototype, the prototype is required to be submitted with complete documentations and a dissertation. Years of experience in the academic field has taught the author necessary skills to gather information and proper documentations format. The assistance from the author's supervisor, Mr. Izzatdin also ensures the project development is according to time frame given.

CHAPTER 2:
LITERATURE REVIEW

2.1 Understanding Accident or Emergency in Industry

According to [5] and [6], accidents are undesirable event in the course of work that occurs unexpectedly which result in physical or mental harm, which means that accidents will occur no matter how good a workplace HSE is because it is unpredictable.

A lot of accidents happen in the heavy industry every year causing casualties and even deaths. The workers in these industries often have to operate power tools in a confined space. According to [7], hazardous working environment combined with limited maneuverability are often the main factor that reduces the chances of escape during emergency.

The works of [7], [8], and [9] agreed that the mitigation and prevention, preparedness, response, and recovery are important steps in an emergency response plan. Modern facilities are designed to reduce workplace hazards with heightened safety measures and proper evacuation routes. A minimal is a central fire alarm system and apparent indicators which act as guides for evacuation process. [3] concluded that the detection and response time are critical factors that impact the damage done by a fire accident.

2.2 Current Method to Manage Fire Emergency

An interview with workers from [10] to [20] has been conducted in order to understand the steps taken in the respective companies to manage a fire emergency. The outcome from the interview shows that there are normally 7 steps taken to handle a fire emergency. Starting from the first step to alert all staffs, followed by the first responder team, which in this case is the fire department and medical center. The third step is to evacuate staffs from the vicinity of danger. After the evacuation is complete, head count is performed at the assembly point to detect any missing person. The sixth step is to inform the first responder team of any missing person and lastly the first responder team will carry out the rescue mission. The steps are summarized into Figure 1.

In this research, the study on the existing emergency response plan will be broken down into two major parts, that is alerting the emergency response team and evacuation of staffs.

2.2.1 Alert

According to the [21], the emergency reporting system in our country is very limited. Any emergency or accidents in our country will be reported to respective departments by first making an emergency call to "999". Then the call will be assessed and forwarded to respective departments, either the fire brigade, police forces or the medical care. The steps taken are summarized into the Figure 1 below:

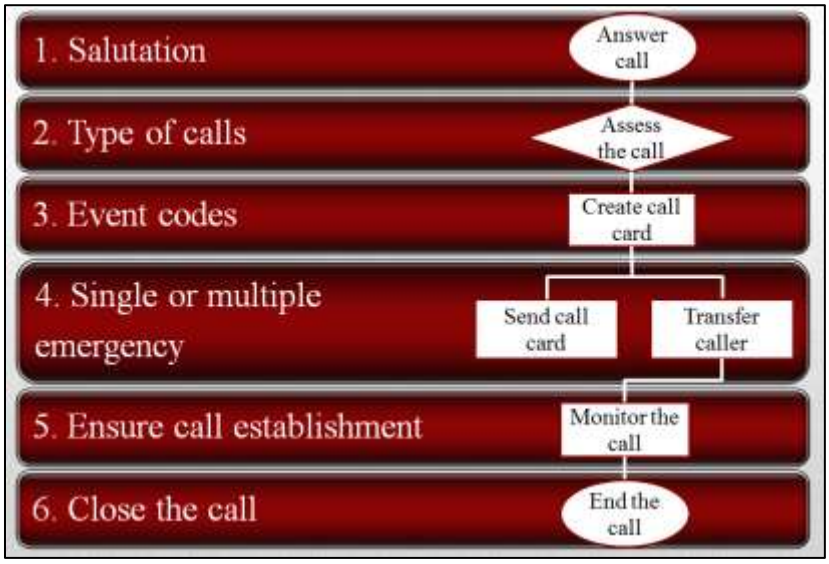

Figure 2: Emergency Call Procedure

The emergency call process takes a long time to complete and is very ineffective, general statistics shown the average time taken to be 7 minutes for a successful emergency call. The person that makes the emergency call often needs to wait a long period of time before the call is transferred to the correct party. Due to the fact that the person making the emergency call is in a distressed situation, the communication might be jumbled up and wrong information will be passed to the

emergency response team. Miscommunication will cause a disastrous impact on the chances of rescue.

2.2.2 Evacuation

Another focus of this research is the evacuation procedures being practiced in the industry. Interviews with correspondents [10] to [20] have gathered generally similar results. Steps included in the standard evacuation plan during an emergency in the heavy industry are usually done manually and time consuming.

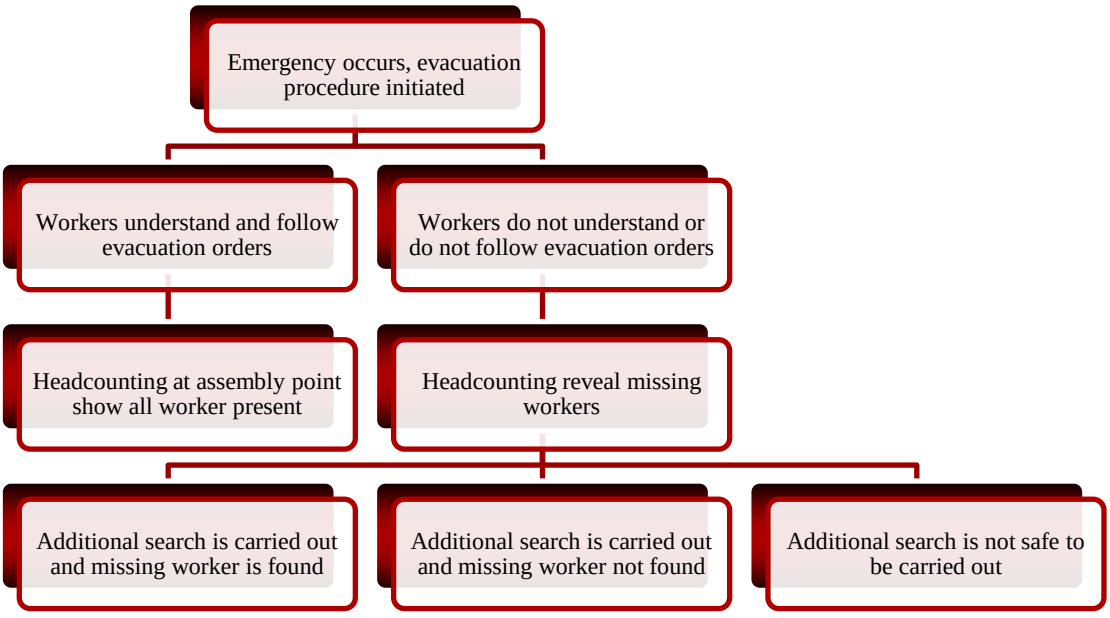

Figure 3: Standard emergency evacuation plan in the industry

As we can see from Figure 2, the above evacuation plan will take a long time to perform the manual headcount at the assembly point to check whether everyone is present. Also, there might be someone that gathers at the wrong assembly point and causes confusion. The delay in head counting process will reduce the chances of discovering a trapped person and might cause serious injury or even death.

All the steps are conducted manually and will consume a lot of time before the rescue team are ware of a trapped person and starts to rescue the victim. This delay will cost the lives of trapped victims. This process also may introduce miscommunication when

contacting the first responder team. [22] has stressed the importance of passing accurate information to the first responder team to carry out the correct rescue plan.

2.3 Comparative Study on New Emergency Response System

The most common building accident is fire disaster. The use of a centralized fire alarm system and reliable evacuation route planning is widespread among industries to help reduce the damage and casualties caused by building fire. But this elementary safety measure is not enough. Many parties have tried to implement more efficient techniques into the emergency evacuation system.

For example, the work of [23] has integrated RFID solution into a central fire alarm system to help fire victim identify the best evacuation route to exit the building. [24] also proposed a mobile system that capitalizes on the location-awareness capability of the RFID to support occupants to evacuate from a disaster scene. The work of [25] proposed another system that transmits real time information of a collapsed building to the first responder team through mobile application so that an accurate rescue and recovery plan can be made.

The works above are very informative, but it did not take into account trapped personnel that may have difficulties to evacuate from the disaster scene. The work can be further improved by including the ability to assist emergency response unit to identify the location of the trapped personnel so that appropriate recovery operation can be carried out. Human reactions during accidents are classified into flight, flee, and freeze. According to [4], human may be startled in the event of unexpected happenings. In the startled phase, human may not be able to react or think critically, which eliminate their chances of evacuating from a dangerous situation. Thus, a better emergency response system would essentially include the human factor in their design in order to improve the chances of rescue.

The discussed systems assumed that the trapped victim will be able to follow the instruction precisely to evacuate from the building. This research on the other hand parked on the assumption that there are some people that are too shocked to act will be left behind and the rescue team should be able to find them at their last known location.

2.4 Radio Frequency Identification Technology (RFID)

Radio Frequency Identification (RFID) technology is an emerging technology that is very useful. Normally, an RFID system consists of an RFID tag and an RFID reader. According to [26] RFID tags are usually made up of an integrated circuit that collects and records information and the antenna that responds to the radio waves from the RFID reader. The RFID reader is connected to a computer system used to analyze and distribute the data collected from the RFID tag. Both components interact with each other using radio waves. However, "RFID technology can be branched into active RFID and passive RFID" [27].

The differences between active RFID and Passive RFID are summarized into Table 1:

Active RFID	Feature	Passive RFID
More than 90 meters	Range	About 10 meters
Required	Antenna	Optional
Bulky	Form factor	Small and thin
Battery powered	Power source	No power source
Very short, depending on rate of use (battery life)	Battery life	Up to 10 years
Higher cost	Cost	Lower cost

Table 1: Differences between Active RFID and Passive RFID

The feature of an RFID system allows it to be used as a suitable location sensing device. The work of [23], [24], [25], [28] and [29] had used RFID to perform indoor location sensing (ILS) and found the this technology is very suitable and reliable for the purpose of the proposed solution.

2.5 Mobile Application Technology

Besides that, emergency response system should be able to overcome situation where miscommunication or no communication occurs. According to [25], it is important to make available accurate information to the first responder of a disaster in order to be able to carry out recovery operations. [22] also acknowledged the importance of relaying accurate information to the emergency response unit in order to assess the situation and make the correct plan for rescue operation. [30] also stated that the "Push Notification" feature of mobile application will ensure the instant distribution of information. The previous work on emergency response and evacuation system ([23] to [25]) also uses mobile application as the chosen platform to transfer information.

2.6 Conclusion

From the literature review, it has been shown in the work of past researchers that RFID is suitable to be used as a solution for emergency response system. However, the author's research is focused on improving the emergency response system by including the human factor that has been disregarded by previous work into the proposed system. Moreover, the proposed system should utilize the mobile application to relay information in a quicker way to the first respond unit and shorten the time taken to locate and rescue trapped personnel in a disaster scene.

CHAPTER 3:
RESEARCH METHODOLOGY

3.1 Project Development Methodology

This research project on improving the emergency response system will be developed using the rapid application development (RAD) methodology. The RAD lifecycle was designed to allow a quicker system development alongside with high quality results. According to [30], the RAD lifecycle "drastically raises the quality of finished systems while reducing the time taken to build them". RAD lifecycle emphasizes on minimal planning which is interleaved with the development of the system.

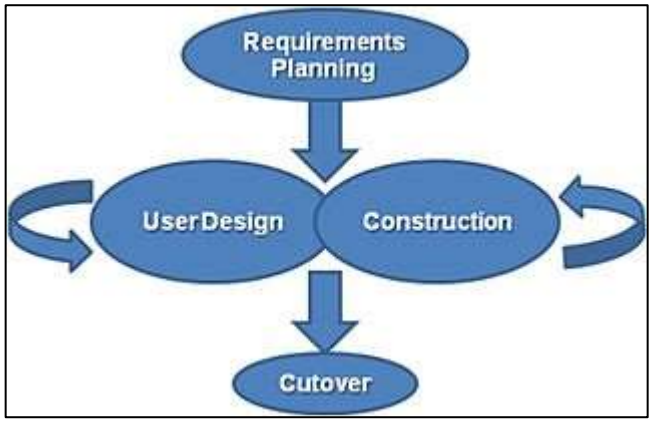

Figure 4: Rapid Application Development Lifecycle

Using the rapid system development lifecycle, a preliminary study will be conducted prior to the development phase to identify initial requirement and features to be included in the proposed system. Then the development phase will start to code the prototype of the proposed system into a working model. During the development phase, user is involved to continuously give input to the progress of the development. Additional features or requirements will be added into the prototype based on user input during the development phase. The construction phase and user design phase is iterative which will allow incremental build the prototype with more and more features. The cutover phase is where the final stage of the software development lifecycle where the prototype is validated and tested to conform to the objectives of this research project.

The rapid application development lifecycle is one of the better lifecycle for this research project. This is because a short timeframe of 28 weeks is given for the final year project. According to the Gantt chart, the time allocated for the system development is only 10 weeks. The RAD lifecycle allows for the quickest way of prototyping without sacrificing the quality of work. It eliminates excessive pre-planning as time is crucial for this research project.

3.2 Proposed Solution

The proposed solution will include two components, namely the emergency response system and the mobile application. The response system will be interfaced with RFID readers to continuously track the location of employees and once a fire accident broke out, the response system will alert the first responder team. The mobile application will be available for the first responder team. The mobile application will be the platform to pass the information to the first responder team and also retrieves the last known location of any trapped victim.

Due to the fact that this emergency response system is to be applicable in large scale facilities, active RFID technology is required to be able to work over longer distance.

The proposed system is to be integrated into an android mobile application that allows the alert and information to be passed to the emergency response team in the quickest manner. Mobile application is suggested rather than text messages or email because it utilizes the current internet framework and easier to be updated rather than email. This method can reduce the cost to set up the proposed system by eliminating the need to implement extra GSM architecture.

3.2.1 System Model

The conceptual model of the proposed system will be described in the Figure 5 using the architectural view:

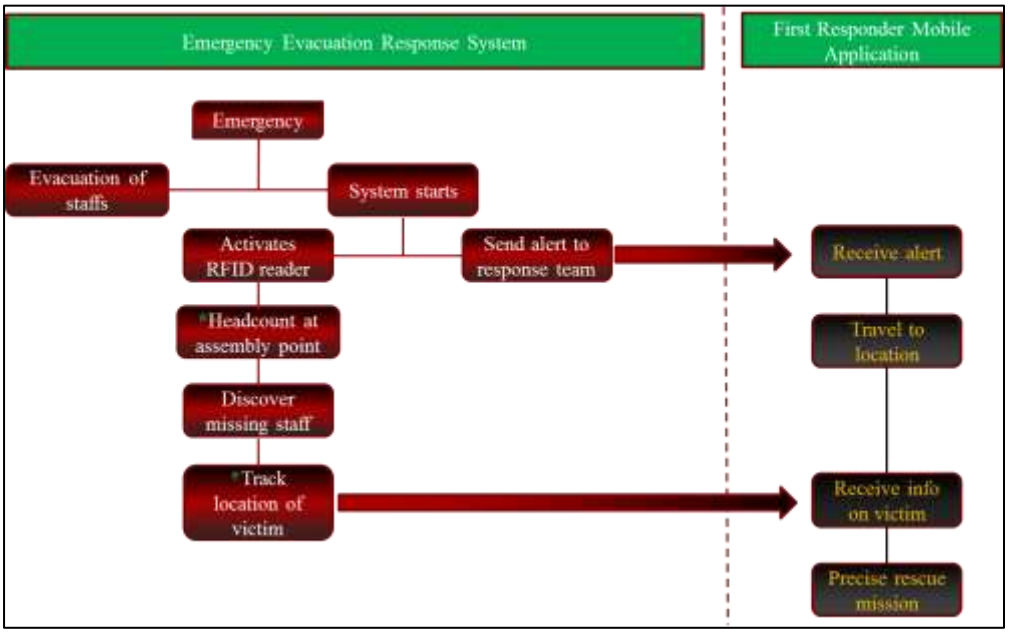

Figure 5: System Model

The information transfer between both components is represented by arrows pointing left to right. The red color coded represents the emergency response system, while the black color coded represents the emergency response mobile application.

A total of two cluster of information will be sent to the mobile application. The first one is the alert which tells the first responder team of the location and severity of the emergency situation. The second information is the last known location of trapped victim. It is delayed because of the head counting process needs to be completed before any missing person is detected. However, the head counting process is automated using the system instead of performed manually as in the traditional methods.

3.2.2 System Architecture

The system architecture diagram (Figure 6) will explain on the design of the proposed solution.

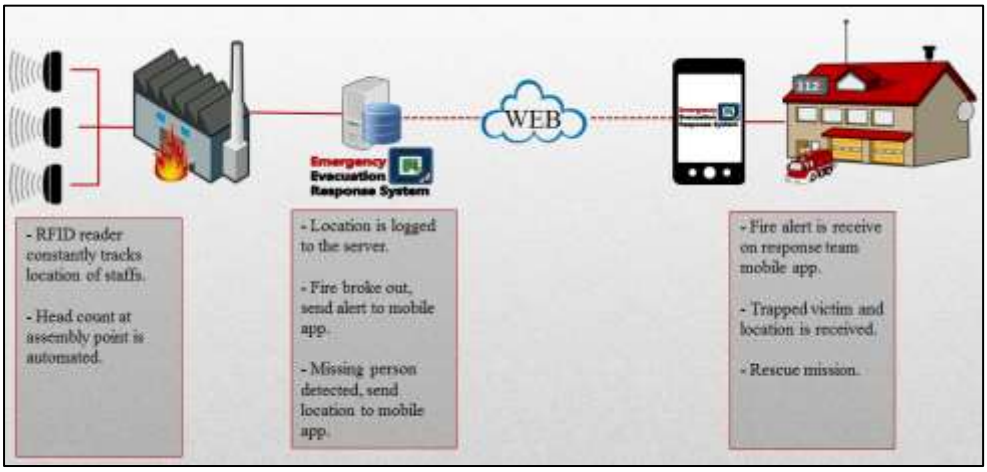

Figure 6: System Architecture

The office building will be equipped with a network of RFID readers which will constantly track the location of the staffs and update the latest location to a server log. Whenever an emergency situation broke out, the system will send an alert to the mobile application used by the first responder team. Then the system will perform the head counting automatically and report for missing staffs. Then the system will retrieve the last known location of the trapped staffs and transmit the information to the first responder team. With accurate and timely information, the first responder team can plan out a precise rescue mission.

3.3 Project Framework and Activities

The research framework highlights the effort to present the solution for the aforementioned problem statements. Gantt chart and Key Milestones are identified to outline the timeline of the project to keep track of the progress and guide the author throughout the FYP timeframe.

The research project is divided into four phases over the period of FYP1 and FYP2. Each of these phases cover distinctive tasks, where the FYP1 will focus more on

research study and literature study; while FYP2 will focus on the development and testing of the prototype that addresses the problem statements.

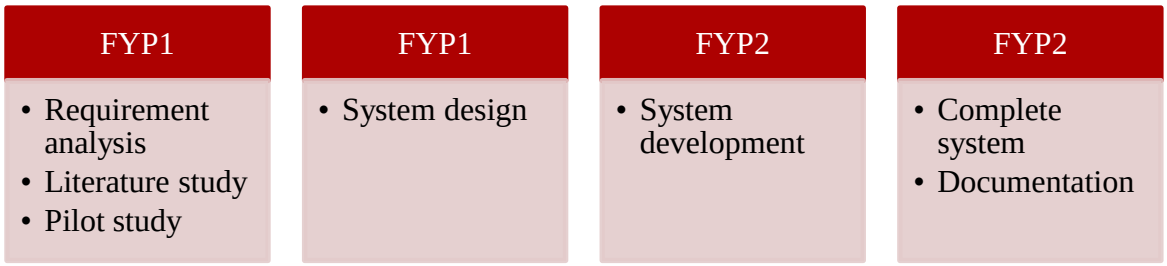

Figure 7: Project Development Phases

3.3.1 Requirement Analysis

The major output for the requirement analysis phase is the identification of the research problem. The research problem identified in this phase is the lack of human factor and inefficiency in existing emergency response system design.

The literature study and pilot study are conducted to perform validation to the research problem. Further analysis of the collected results will provide functional requirements to be added into the proposed system to achieve the objective.

3.3.2 System Design

The design stage is where the proposed system is produced as a solution to the identified problem statements. System architecture and system model are the output that show the operational flow within the system. It is a continuously phase that will overlay with the system coding.

3.3.3 System Development

The development phase is executed in parallel and iteratively with the design phase with major focus on the application programming of the prototype. A total of two systems are developed, a Visual Studio Desktop Application and the Android Application.

3.3.4 Complete System & Documentation

This phase will oversee the completion of the prototype followed by the necessary documentation. Documentation is important to ensure a smooth handover of the project and also as a fulfillment of the course requirement for the Final Year Project.

3.4 Tools and Equipment

3.4.1 Software

i) Eclipse IDE

- Use for the hardcoding of Java-based based Android mobile application.

ii) MIT App Inventor

- Use for the initial design of the interface for the prototype.

iii) Microsoft Visual Studio 2010 Ultimate

- Use for the hardcoding of the VB.NET -based system.

iv) Oracle MySQL Server

- Use for the storing and extraction data into the server.

v) Activewave RFID Devices API

- Use for system development to interface with the RFID reader and tags.

vi) Adobe Photoshop CS5

- Use for the design of templates, buttons, backgrounds, and images for the applications.

3.4.2 Hardware

i) Activewave RFID Reader and Tags

- Use for the location tracking component in the system.

Figure 8: Activewave wristband tag and RFID reader

ii) Android Smartphone

- Use for testing and development of the mobile application.

3.5 Challenges

In the course of the development stage, various challenges were met. One of the major challenges is the hardware limitation. Due to the limitation in hardware equipment such as only 2 wristband tags and 1 RFID reader are available for use; the prototype cannot be tested in further details.

Another challenge faced is the implementation of the Activewave API in the prototype development. The integrity of the API and sample code possessed by the university is dubious. Many sleepless nights have been dedicated to coding blankly due to faulty API.

Luckily with help from Consurv Technic Sdn. Bhd., the system integrator of Activewave RFID Solutions Inc. in Malaysia, a new copy of the API was acquired.

CHAPTER 4:
RESULT AND DISCUSSION

4.1 Pilot Study

A pilot study ([9] to [19]) was conducted in order to seek justification and validation for the listed problem statement. An online survey questionnaire is designed with Likert-scaled answers (1-Strongly Disagree to 5-Strongly Agree) to ease the participation of respondents. The questionnaire was separated into 2 main parts, one on the existing emergency response system, the second one on proposed solution. The survey form is targeted to working class which will definitely have experience with workplace HSE. The online survey form was distributed to past associates and colleagues from internship period through email and also through business forums.

There are 14 questions in the survey. The author would like to highlight 4 of them as the more important findings and would contribute to this research paper.

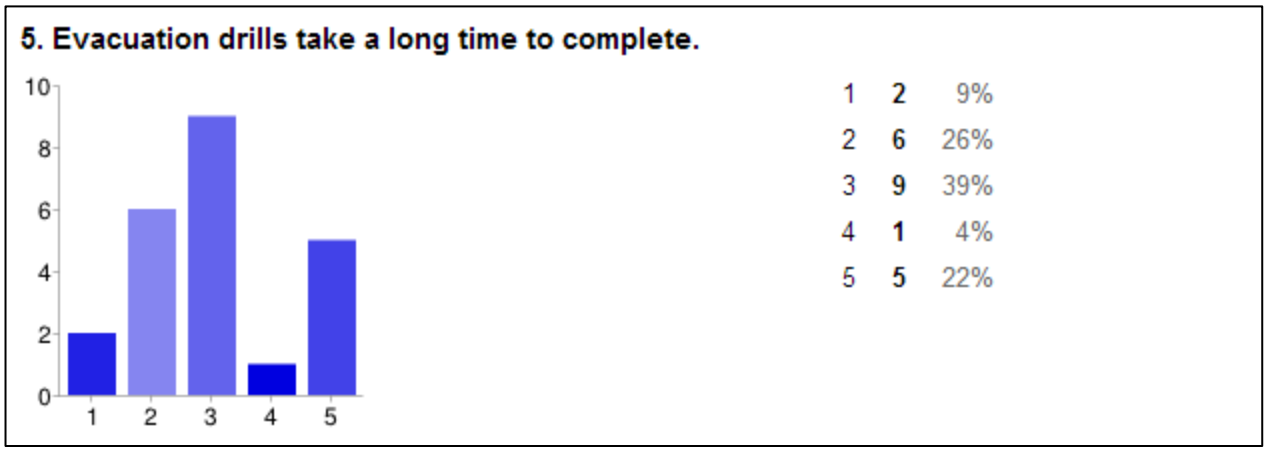

Figure 9: Part B Question 5 of Pilot Study

The response on the above question are neutral. Most people have found that the evacuation drills conducted at their company takes a short time to complete. This could be due that the drills conducted are not full scale. However, a large number of respondents also found that the evacuation drill at their company takes a long time. This

is because they are working in large companies, and a large number of personnel needs to be evacuated, thus causing a longer time to complete evacuation drills.

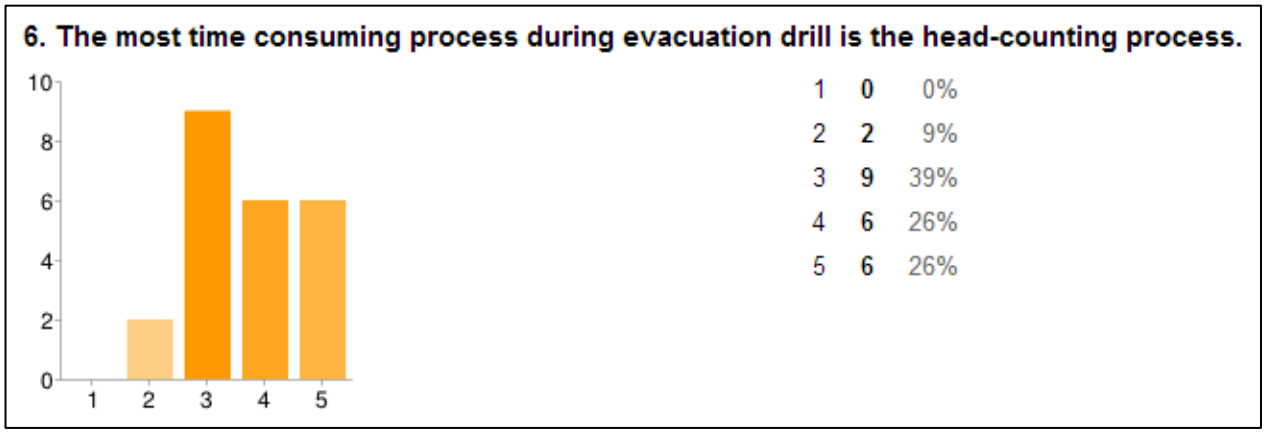

Figure 10: Part B Question 6 of Pilot Study

Most of the participants agreed that head counting process the most time consuming process during an evacuation drill. This shows that there is a need to improve on this process in order to increase the overall effectiveness of an evacuation during emergency. Using RFID technology to automate the head counting process is one way to reduce the time taken for head counting.

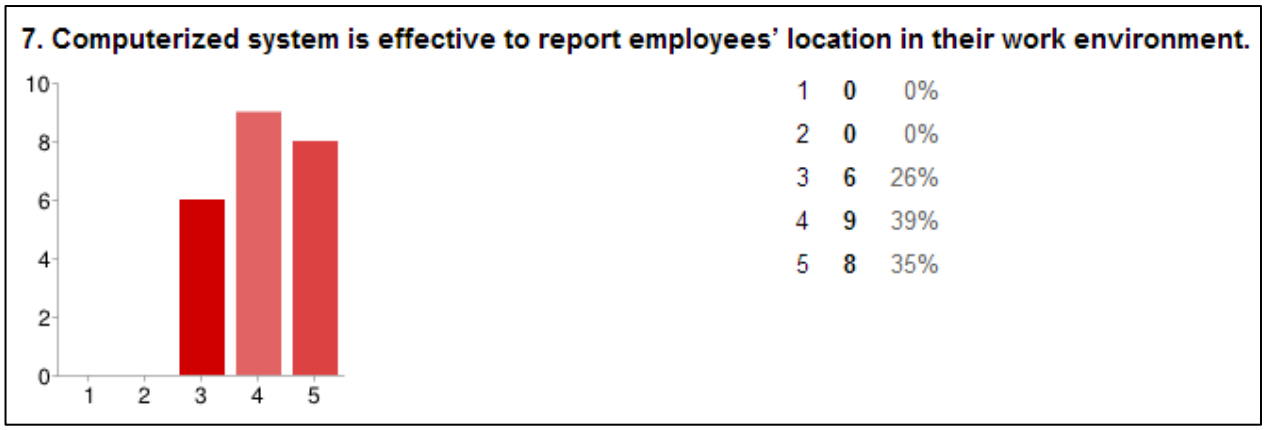

Figure 11: Part B Question 7 of Pilot Study

Majority of the respondents agree that a computerized system is very effective to track the location of staffs. None of the respondents feel uncomfortable with their location being tracked continuously when at work. They also agreed that it is easier for the company to locate and contact them in case of any updates. This result coincides with the findings from past literatures that computerized location tracking is an effective way to know the location of employees at all time.

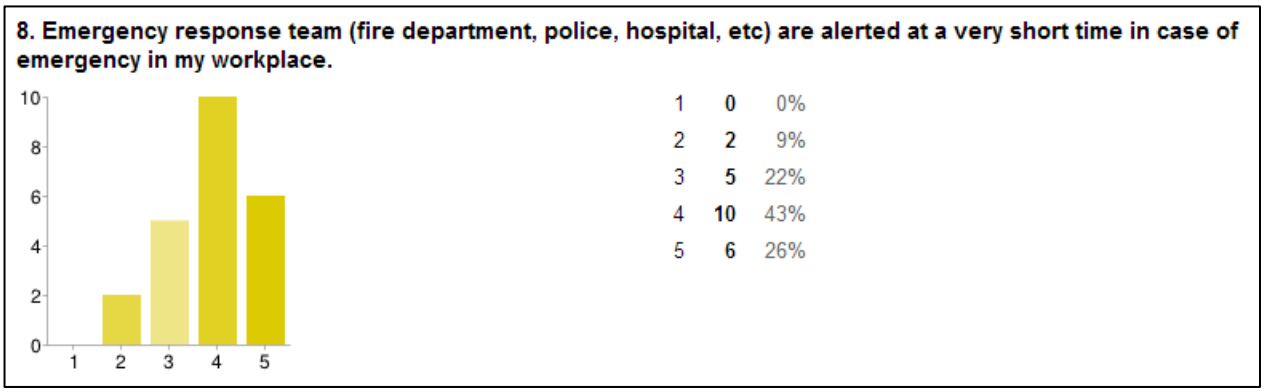

Figure 12: Part B Question 6 of Pilot Study

Lastly, the majority of the respondents found that the communication infrastructure at their workplace is very efficient and their company is able to alert the emergency response team in a very short time. Due to the inefficiency of the survey question, the author is not able to determine the exact time period required to alert the response team. However, the author believes that the proposed solution will be able to further reduce the time taken to alert the emergency response team.

4.2 Interface Design

This chapter will demonstrate the initial interface design of the expected prototype. There will be two interfaces, namely the emergency response system and also the mobile application.

4.2.1 Visual Studio Desktop Application

The location of all staffs will be constantly monitored and updated to a server log.

The system will have a simple home screen with only two buttons. One button is to send an alert to the emergency response team. The second button will initiate the head counting process which brings us to the second screen.

The second screen will take the head count for personnel that successfully evacuated to the assembly point and detect for trapped personnel. Then the last known location of the trapped personnel will be transmitted to the mobile application used by the first responder team.

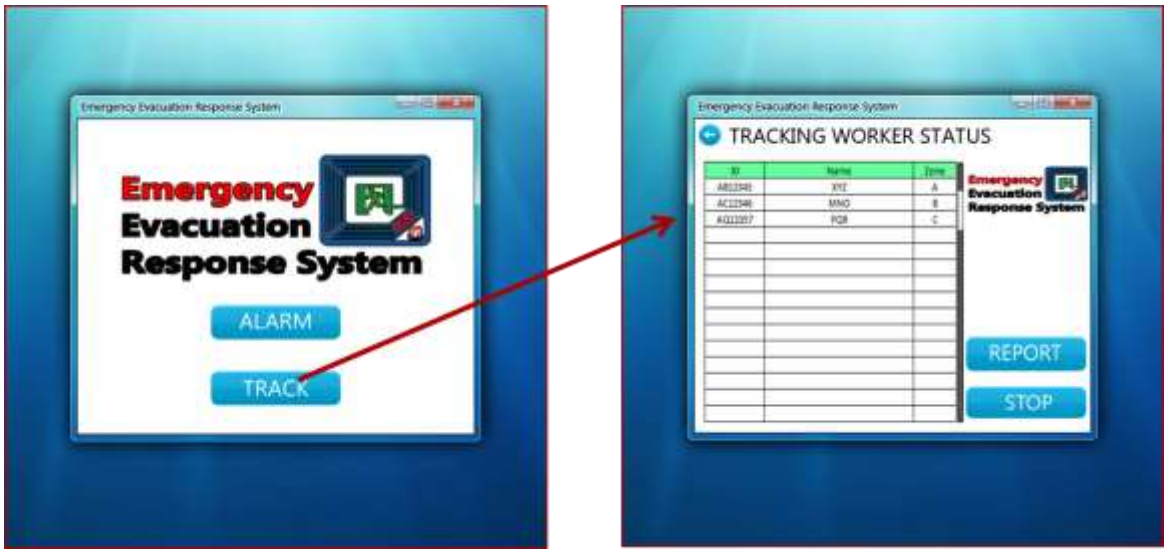

Figure 13: Initial Interface Design for System

4.2.2 Android Mobile Application

In case of any alert generated by the emergency response system, the mobile application with the response team will pop up an alert showing the emergency (Figure 11.1). Pressing the “Details” button will bring the mobile response team into the second screen (Figure 11.2) which will retrieve the last known location of

trapped victim and show it on the screen. The third screen (Figure 11.3) will show the direction to guide the emergency response team to the location of the emergency.

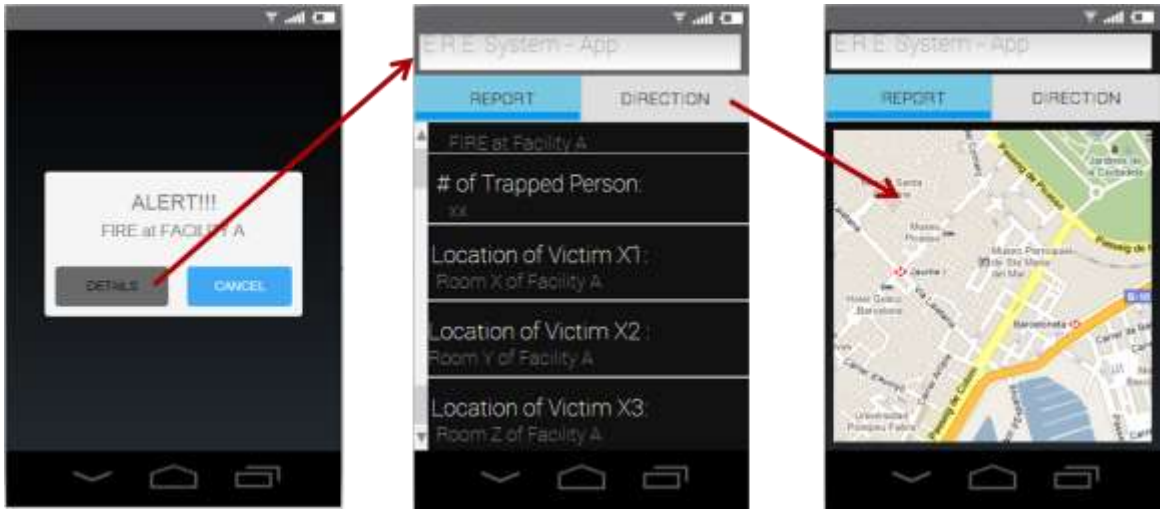

Figure 14: Initial Interface Design for Mobile Application

4.3 User Testing Results

A User Acceptance Testing (UAT) was carried out to measure the user perception on the usability of the prototype. The survey was conducted using face to face testing and facilitated through a 3 item Likert scale questionnaire. A total of 30 respondents were surveyed to gather their perception of the usability of the prototype. The respondents are workers in the heavy industry, mainly in the Oil & Gas industry which are more likely to face an emergency situation in their working environment.

The first part of the testing is to test the ease of use of the prototype. Users are expected to navigate through the prototype easily and appropriately.

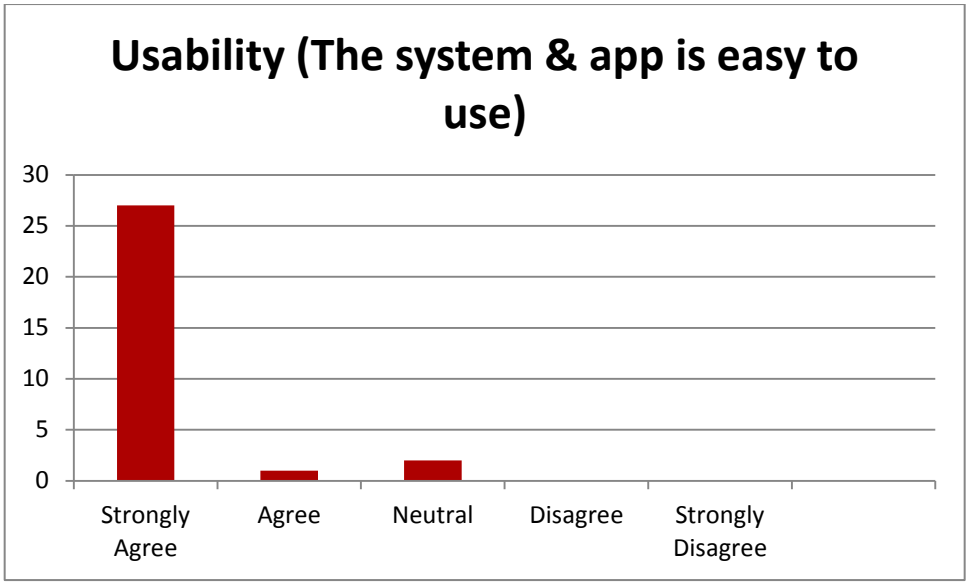

Figure 15: User testing on Usability

Generally, 90% of the respondents rated that the prototype is very user friendly. This is due to the simplicity of the design with only 2 screens to perform the specified functionality.

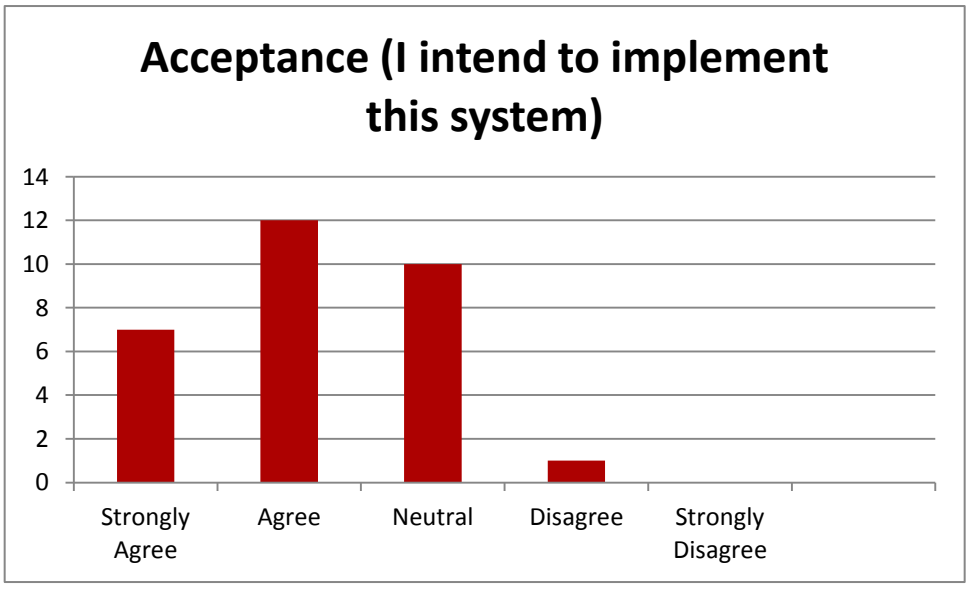

Figure 16: User testing on Acceptance

On the question whether the respondent is willing to implement the system in their company, a variety of results are collected. Only 23% are highly interested to implement the system in their company. 73% of the respondents maintain a little skeptical about the proposed system. And 3% of the respondents are non-willing to see the system in their company. This could be due to the possibility that RFID is a relatively new technology in Malaysia and they are dubious about the cost and effectiveness of the system.

Further interview with two correspondents have shown some highly useful feedbacks. The CEO of Consurv Technic Sdn. Bhd. which is also the system integrator for Activewave RFID Solutions Inc. in Malaysia, Mr. Faiz Hussin provided a positive feedback when interviewed regarding the prototype. He found that the integration of the RFID and Android technology as an improvement to the current emergency response system to be highly useful, especially to reduce the time taken to alert the first responder team. In another interview, Mr. Nasrul Annuar, the HSE Director of Dyna Segmen Sdn. Bhd. suggested to include fire drill performance KPI in the system as a way to help conduct emergency drills in companies which would increase the selling point of the system.

4.4 System Functionality Testing Results

A test to compare the time taken to generate an emergency report using various methods is conducted. Using the statistics provided by [21], the time taken to generate a emergency notification on the proposed system is compared against the time taken by calling the Emergency Call Center (999), calling the district or local Fire Department, and using the RakanCops SMS (32728).

The proposed system only require the user to press one button and an emergency message will be sent to the android application of the emergency response team. This feature is tested for 10 times and the results are tabulated in Table 2:

Trial Run	Time Taken (sec)
1	2
2	1.5
3	1.7
4	1.8
5	1.1
6	1
7	1.5
8	1.5
9	1
10	1
Average	1.41

Table 2: Time Taken to Generate Notification on Android Application

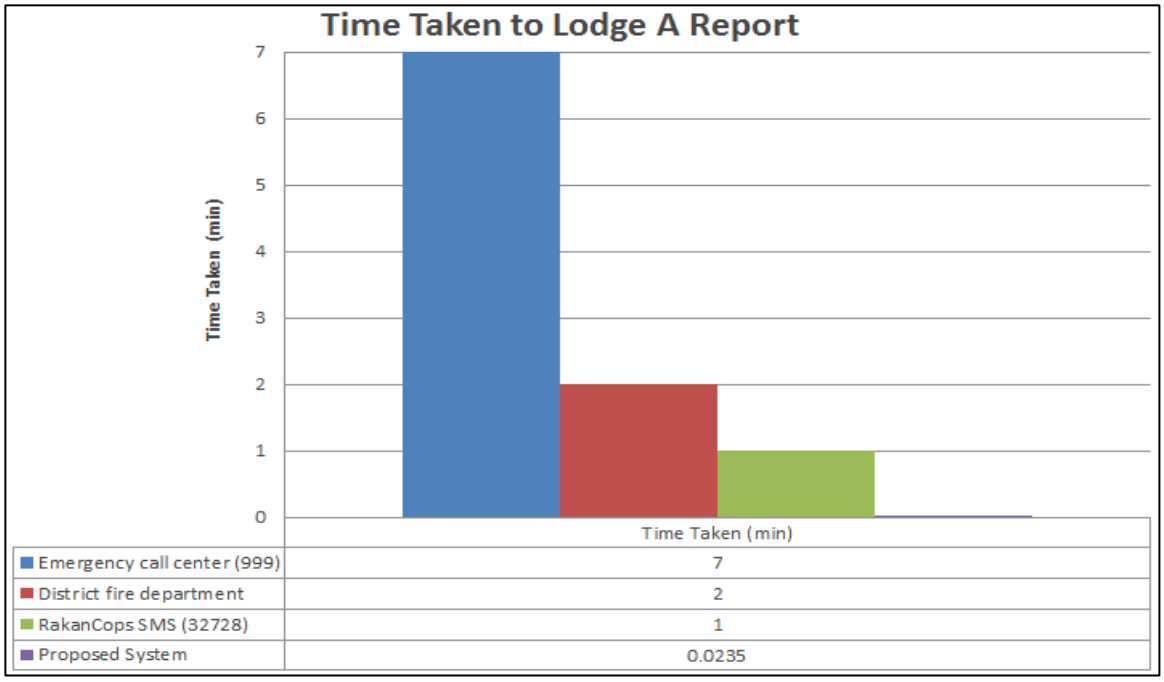

Figure 17: Comparison of Time Taken to Make Emergency Report

As shown in the result above, the proposed system is very quick as compared to the conventional ways to generate the emergency report. It also reduces the miscommunication by limiting the communication between both parties.

CHAPTER 5:
CONCLUSION & RECOMMENDATION

5.1 Relevancy to the Objectives

The proposed solution will be a novel approach to improve existing emergency response system using the location tracking capabilities of RFID technology and also the efficiency of mobile application to transfer information quickly. The proposed system will be able to:

i) Automate the head counting procedure during evacuation.

ii) Reduce time taken to identify trapped victim and report their location.

iii)Reduce time taken to alert emergency response team

The above research objectives will ultimately lead to the development of a more efficient emergency response system that is designed based on human factor. It is believed to be able to improve the chances of rescue mission and saves more lives.

5.2 Suggested Future Works for Continuation

Future works could be focused on adding additional features to the proposed system. One very good suggestion collected during the pilot study is to have a navigation to guide the emergency response team to the scene.

Another proposed feature is to integrate performance KPI evaluation of emergency drill process so that HSE officers can automate the process of evacuation drills.

Other future works will include solutions to overcome the battery life limitation of active RFID tags.

REFERENCES

[1] Department of Occupational Safety and Health Malaysia, *Occupational Accidents by Sector Until March 2013(Investigated)*, http://www.dosh.gov.my/index.php?option=com_content&view=article&id=843&Itemid=545&lang=en. Accessed: July 14, 2013.

[2] Erik Vanem, Joanne Ellis, *Evaluating the Cost-effectiveness of A Monitoring System for Improved Evacuation from Passenger Ships*, Safety Science, Volume 48, Issue 6, July 2010.

[3] U.S. Fire Administration, National Fire Data Center, *Large Loss Building Fire*s,Volume 12, Issue 4, June 2011.

[4] J. Barnett, W. Wong, D. Westley, R. Adderley, M. Smith, *Startle Reaction: Capturing Experiential Cues to Provide Guidelines Towards the Design of Realistic Training Scenarios*, Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 26 October 2012.

[5] European Agency for Safety and Health at Work, *"What is Accident at Work?"*, https://osha.europa.eu/en/faq/faq1/what-is-an-accident-at-work. Accessed: July 28, 2013.

[6] Dictionary.com, *"accident"*, Dictionary.com Unabridged, July 2013, http://dictionary.reference.com/browse/accident. Accessed: July 28, 2013.

[7] Natural Sciences and Engineering Research Council of Canada, *Strategic Project Grants Target Area Descriptions*, Safety and Security, Issue 6, http://www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=target_areas#6. Accessed: July 15, 2013.

[8] Jingkai Liu, *Establishment of Emergency Management System Based on the Theory of Risk Management*, Procedia Engineering, Volume 43, 2012.

[9] X. Liu, W. Li, Y.L. Tu, W.J. Zhang, *An expert system for an emergency response management in Networked Safe Service Systems*, Expert Systems with Applications, Volume 38, Issue 9, September 2011.

[10] F. Hussin, *Interview on Workplace HSE and Emergency Response System*, Consurv Technic Sdn. Bhd. July 20, 2013.

[11] N. Anwar, *Interview on Workplace HSE and Emergency Response System*, Dyna Segmen Sdn. Bhd. July 20, 2013.

[12] O. Mah, *Interview on Workplace HSE and Emergency Response System*, PETRONAS Process Safety Management, July 20, 2013.

[13] L.Y. Goh, S.Y. Eng, *Interview on Workplace HSE and Emergency Response System*, Baker Hughes (M) Sdn. Bhd., July 20, 2013.

[14] K.J. Ng, *Interview on Workplace HSE and Emergency Response System*, Schlumberger (M) Sdn. Bhd., July 20, 2013.

[15] K.Y. Lim, *Interview on Workplace HSE and Emergency Response System*, Cameron International Corporation, July 20, 2013.

[16] C.K. Wong, *Interview on Workplace HSE and Emergency Response System*, Pricewaterhouse Coopers Services (M) Sdn. Bhd., July 20, 2013.

[17] Dqeen Qeenu, *Interview on Workplace HSE and Emergency Response System*, Astro Holdings (M) Sdn. Bhd., July 20, 2013.

[18] K.S. Goh, *Interview on Workplace HSE and Emergency Response System*, Intel Malaysia Sdn. Bhd., July 20, 2013.

[19] K.S. Ng, L.W. Yeo, *Interview on Workplace HSE and Emergency Response System*, Siemens (M) Sdn. Bhd., July 20, 2013.

[20] F.W. Lai, Roselind Wan, T.J. Low, *Interview on Workplace HSE and Emergency Response System*, Universiti Teknologi PETRONAS, July 20, 2013.

[21] Fire Preventors Society (Malaysia), *Interview on Fire Safety and Emergency in Malaysia*, August, 2013.

[22] Adriana S. Vivacqua, Marcos R.S. Borges, *Taking advantage of collective Knowledge in Emergency Response Systems*, Journal of Network and Computer Applications, Volume 35, Issue 1, January 2012, Pages 189-198.

[23] Liou Chu, *A RFID-Based Building Fire Evacuation System on Mobile Phone*, 2010 Sixth International Conference on Intelligent Information Hiding and Multimedia Signal Processing, October 2010.

[24] L. Chittaro, D. Nadalutti, *A Mobile RFID-Based System for Supporting Evacuation of Buildings*, Mobile Response, 2009, Pages 22-31.

[25] Z. Aziz, F. Peña-Mora, a. Chen, T. Lantz, *Supporting Urban Emergency Response and Recovery using RFID-Based Building Assessment*, Disaster Prevention and Management, Volume 18, 2009.

[26] Active Wave Inc., *RFID Technology Overview*, http://www.activewaveinc.com/technology_rfid_overview.php. Accessed July 27, 2013.

[27] French National RFID Center, *Features of RFID Tags*, http://www.centrenational-rfid.com/features-of-rfid-tags-article-19-gb-ruid-202.html. Accessed July 27, 2013.

[28] Nan Li, Burcin Becerik-Gerber, *Performance-based evaluation of RFID-based indoor location sensing solutions for the built environment*, Advanced Engineering Informatics, Volume 25, Issue 3, August 2011.

[29] L.M. Ni, Y.H. Liu, Y.C. Lau, A.T. Patil, *LANDMARC: Indoor Location Sensing Using Active RFID*, Wireless Networks, 10, 701-710, 2004.

[30] MobileAppSolution.com, *Key Benefits*, 2011, http://www.mobileappsolution.net/key-benefits/. Accessed: July 28, 2013.

[31] CASEMaker Totem Inc., "What is Rapid Application Development", www.casemaker.com/download/products/totem/rad_wp.pdf. Accessed: July 28, 2013

APPENDICES

5.3 Gantt Chart

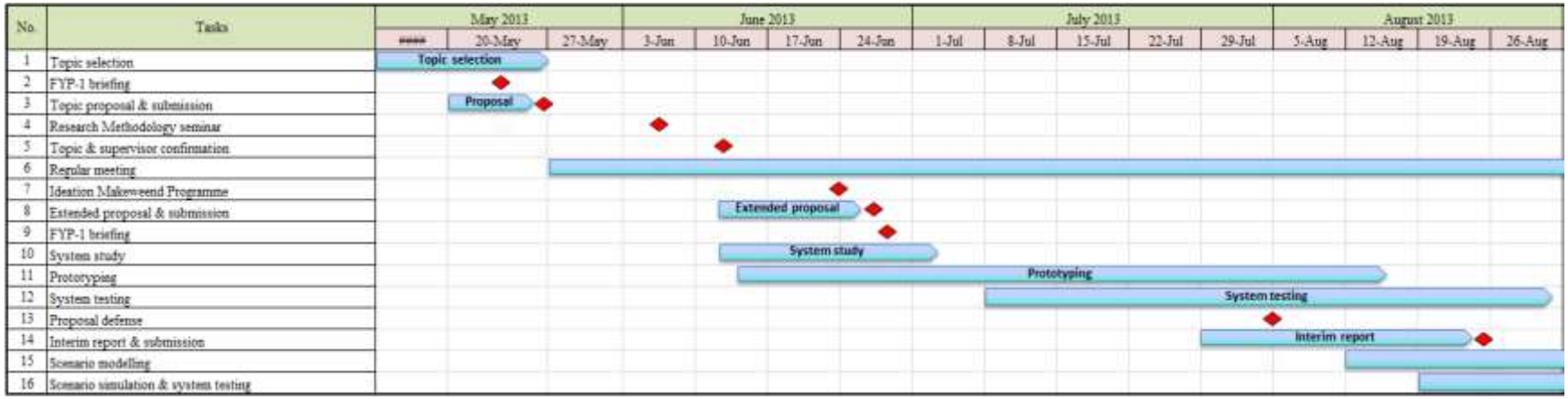

Figure 12: Gantt chart for FYP-1 timeline

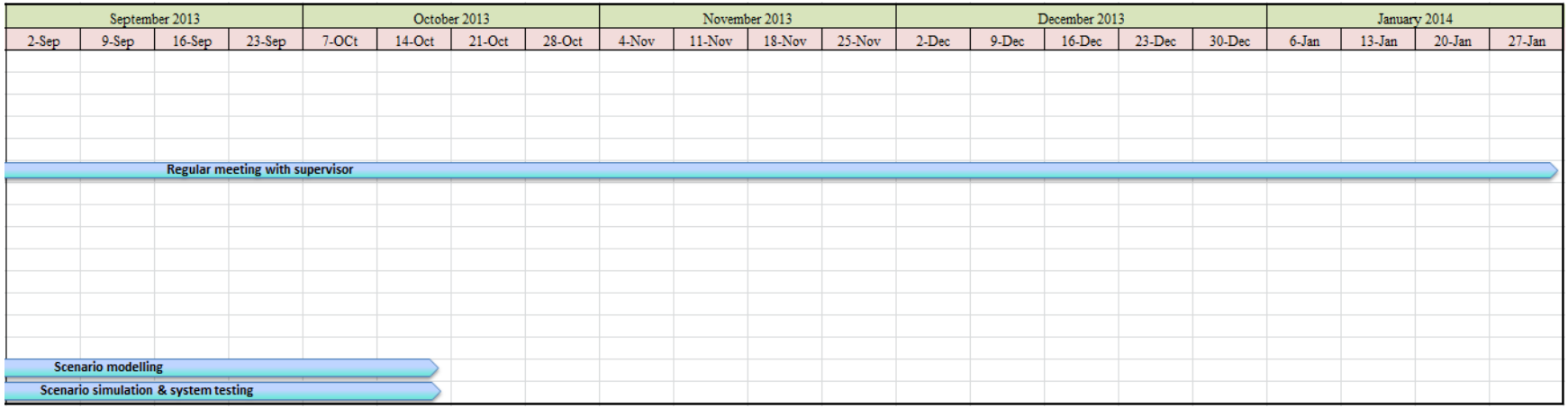

Figure 13: Gantt chart for FYP-2 timeline

7.2 Key Milestone

No	Week	FYP 1 Milestone	Date
1	1	FYP 1 Briefing	20 May 2013
2	1	Selection of Project Topic	20 May 2013
3	3	Submit Proposal to Research Cluster	4 June 2013
4	4	Topic and Supervisor Confirmation	13 June 2013
5	5	Ideation Makeweekend Rapid Prototyping	22 June 2013
6	6	Submission of Extended Proposal	25 June 2013
7	6	Briefing on Plagiarism	26 June 2013
8	12	Viva: Proposal Defense and Progress Evaluation	31 July 2013
9	13	Prototype Completed	5 August 2013
10	13	Scenario Simulation Testing	12 August 2013
11	14	Submission of Interim Report	20 August 2013
12	4	Progress Report	14 October 2013
13	10	Pre-SEDEX	27 November 2013
14	11	Dissertation	2 December 2013
15	13	VIVA	19 December 2013

Table 2: Key Milestones for FYP