Developing Computer-Assisted Safety Systems:

A Mobile Safety Support System for Confined Spaces

by

Firdaus Hani Bt Osman

Dissertation submitted in partial fulfilment of

the requirements for the

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Business Information Systems

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CERTIFICATION OF APPROVAL

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(BUSINESS INFORMATION SYSTEMS)

Approved by,

Dr. Alan G. Downe

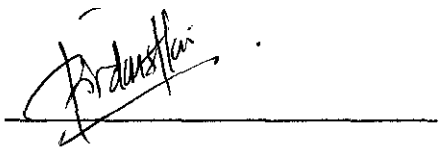
UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

September 2011

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 references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



FIRDAUS HANI BINTI OSMAN

Abstract

Some working environments are defined under the *Occupational Safety & Health Act* (1994; OSHA) as confined spaces. (e,g: storage tank interiors, drainage systems, manholes etc). Many workers lack awareness of safe working procedures in confined spaces. Further hazards, associated with this work environment can be complex and require information, knowledge and skill to prevent accidents. Thus, there is a need for a system that provides workers with information, communication and collaborative systems they need to work safely under the hazardous conditions found in confined spaces. The objective of this project is to create a mobile safety support system, specifically for use by persons supervising workers who are carrying out tasks in confined spaces. Besides that, this system is designed to improve worker safety behavior by making information, crisis alarms and collaborative problem solving networks available in a mobile format and last objectives is to reduce the frequency of accidents, lost-time injuries and fatalities. Basically, there are four main functionalities of this system which are background information, checklist and guidelines of work procedures before, during and after entering the confined spaces, quizzes and also buttons for communication if an emergency happens. This system is specifically for use by persons supervising workers who are carrying out tasks in confined spaces. The aim of this project is to save lives because the statistics of incidents in confined spaces is increasing day by day and hopefully, by having this system, more lives will be saved. Safety incident risk can be reduced by putting a suite of information and communication tools in the hands of persons supervising work operations in these environments. Besides that, it covers three main areas which are Health, Safety and Environment, Information Technology as well as Information Systems. Methodology that is used for the development of this project is prototyping. This methodology was chosen because it quickly provides users with a system to interact with. Preliminary research findings indicated that this system offers considerable potential for increasing safety in confined spaces.

ACKNOWLEDGEMENTS

First and foremost, I woud like to extend my utmost gratitude to my supervisors, Dr. Alan Giffin Downe and also Ms. Nazleeni Samiha Bt Haron whom without their full support and guidance would not have enabled me to go through and completed my final year project. It has been a great privilege for me to be supervised by both of helpful and experienced lecturers.

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Apart from that, I want to thank one of my friends, Raihanah Bt Mohd Tahir because without her support and giving me motivation, I think I would not come to this stage. Also to my friend, Mohd Syahid B Abdul Hanan, for being generous and giving me the chance to use the Android applications. Without his generosity, I will be unable to demonstrate my project successfully.

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CHAPTER 1

INTRODUCTION

1. BACKGROUND OF STUDY

The Department of Occupational Safety and Health, (2011) reported on their websites that on 17th April 2011, two workers were killed when they entered a a manhole located at Tanjung Tokong, Pulau Pinang. During the incident, they were finishing up their work of cleaning sewerage pipes. Upon entering the confined space, it caused them to suffocate and become unconscious. Both victims died at the scene and were sent to hospital for autopsy. The result of observation from this incident was that there were unsafe procedures for workers in confined space exposed to the risk of suffocation.

What is a confined space? Why it is dangerous? According to the **Occupational Safety and Health Administration (OSHA)**, definitions of a confined space are as below:

i) Is large enough and so configured that an employee can bodily enter and perform assigned work.

ii) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults and pits are spaces that may have limited means of entry); and

iii) Is not designed for continuous employee occupancy.

The fact that a confined space is large enough to enter and to work in means that a person can enter the space and be exposed to any hazards it may contain. It is said that for every person killed in a confined space, nearly two would-be rescuers are also killed. (Department of Occupational Safety and Health, 2011) Confined space accidents are responsible for many multiple fatality and injury cases.

Hence, the aim of this project is to build a system regarding occupational safety in confined spaces via mobile devices. According to Kotz, Gray, Noc, Rus, Chawla, & Cybenko, (1997) a mobile agent is an autonomous program that can move from machine to machine in a heterogeneous network under its own control. It can suspend its execution at any point, transport itself to a new machine, and resume execution on the new machine from the point at which it left off. On each machine, it interacts with service agents and other resources to accomplish its task, returning to its home site with a final result when that task is finished.

1.1. Problem Statement

1.1.1 Problem Identification

Many workers in Malaysia lack of awareness about safe working procedures in confined space. Information regarding how to work safely with the right procedure is important for all the workers that involved in confined space tasks. In addition, hazards associated with this work environment can be complex and require information, knowledge and skill to prevent accidents. The process of giving the information will prevent or reduce risk of injuries or fatalities that happened in confined spaces. Reports from DOSH websites indicate that there were 5 fatalities in confined space work environments throughout Malaysia in 2008-2011.As there were important to identify hazard that might be dangerous and the need to give information and control any health risk associated with the work activities that been done in confined spaces, safety incident risk can be reduced by putting a suite of information and communication tools in the hands of persons supervising work operations in these environments.

1.1.2Significance of the Project

This mobile system provides features to address the problems stated above. Companies can provide their workers with the information, guidelines and procedure to work in confined space. Besides the information, additional feature of this mobile system can be added such as quizzes to test the understanding of the worker. So, the workers are more aware of the hazard and danger of working in a confined space. Using this system also, it is reliable for users. For example, if emergency happen, users can send request from the mobile device to several other persons and to ask for suggestions and they can give feedback to the users to help them. Most importantly, this system can be an alert for the users to stay alert during the working time and to ensure that if the users are away from the system, it will alert the headquarters so that they can go and check the workplace in case if something bad happen.

From this, we are able to gather much more ideas and react faster if emergency happen. This system also will highlight the significance of the health risk by the dangerous and hazard items that may appear in the confined space. So, all the companies involved and the workers will know further actions to take to recommend appropriate control measure to prevent the risk or injury in the confined space.

By the end of this project, this mobile system will demonstrate that people can be effectively aware about procedures and guidelines on safety in confined space and with the content that users will be able to access from the system, it will save lives which will give a bigger impact and greater values on the industries, companies and the workers themselves.

1.2 Objective and Scope of Study

1.2.1 Objective

Generally, there are three (3) objectives to be achieved in this project:

To create a mobile safety support system, specifically for use by persons supervising workers who are carrying out tasks in confined spaces.

To improve worker safety behavior by making information, crisis alarms and collaborative problem solving networks available in a mobile format.

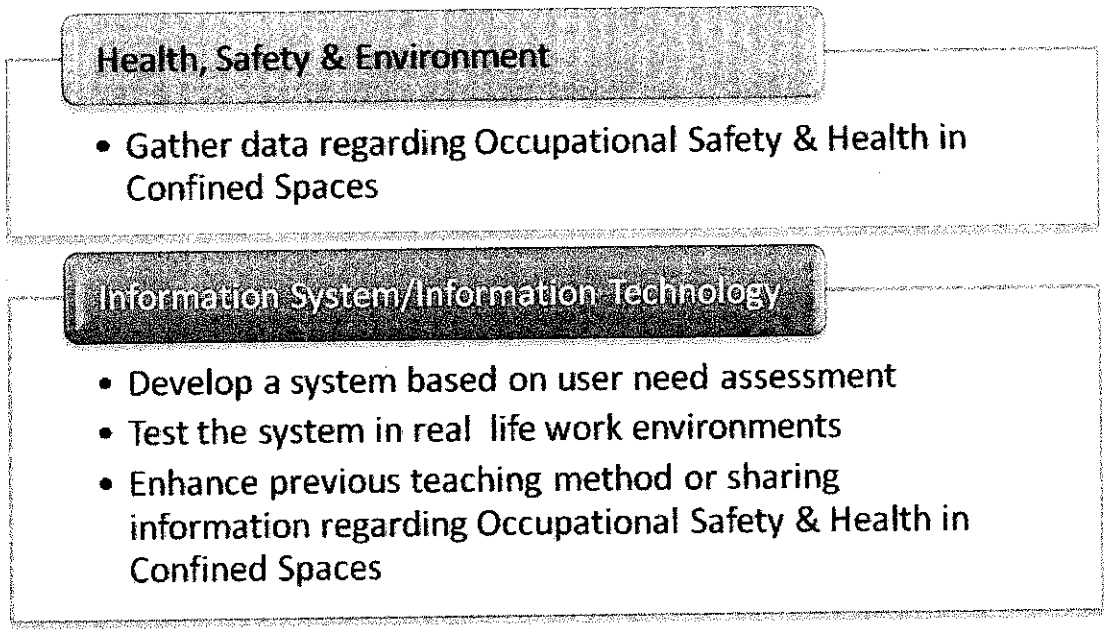
To reduce the frequency of accidents, lost-time injuries and fatalities.

This system will have background information about occupational safety in confined spaces, specific guidelines and checklists before doing job in confined spaces, self-test and quizzes and also emergency page to guide workers if any incident happen. By having this system, it may reduce the fatalities or incident that keep on happening, to save lives and also to create awareness and make sure that workers really know what they should do and what actions to take if incident happen in confined space.

1.3 The Relevancy of the Project

This project will be developed to address the problems identified above. The objective of this project is to develop an integrated workplace companion for Occupational Safety & Health in Confined Space.

As the scope of study, there are two (2) aspects need to be covered:



1.4 Feasibility of the Project within the Scope and Time frame

The project was completed over two semesters which consisted of about nine months. The first part of the project (3 months) was allocated to research about safety being practiced in confined spaces, gathering data and some technical research. Technical research was focused on how the ideas could be implemented. It included research on how to develop the system, learning on the programming language that is feasible to implement the system and complete the system prototype. This first part covers the paperwork writing as well. The analysis of the ideas is also implemented in this part. The second phase was the implementation phase. Four months are allocated for development process. The system is anticipated to be completed within this duration. The remaining two months is for testing purposes and development.

CHAPTER 2

LITERATURE REVIEW

i) Confined Space Work Environments

Rekus (1994) stated that confined space accidents don't happen often, but when they do, they're usually fatal. Even more alarming is that many confined space incidents involve multiple fatalities. How is that these accidents which occur so seldom, claim so many lives in a single event?

According to Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH), the factor that most often turns a single confined space incident into a multiple death catastrophe is an unsuccessful rescue attempt. These ill-fated rescue efforts are usually made by well intentioned but untrained employees, who being unaware of invisible hazards posed by confined spaces; respond to an emergency emotionally rather than rationally.

This shows that how important for employees to be exposed to the right procedures and be aware of the potential hazards posed by confined space. Most of the employees who tried to rescue their colleagues respond to the emergency fast but without thinking of other factors that might harm their life.

A typical scenario involves a worker who enters a space such as a chemical storage tank for cleaning or inspection. Suddenly he is overcome by either an oxygen-deficient atmosphere, or a toxic air contaminant. A second worker, seeing a fellow employee unconscious at the bottom of the tank, enters to rescue him. He is too overcome. A third, fourth or even a fifth worker may make further fatally unsuccessful rescue attempts.

From the above case study, it shows that the domino effect of worker after entering and being overcome has been well documented, and as many as six people have been killed in a single incident.

According to C.Healey (2005), there are several factors that may present a risk when conducting confined space entries.

"Even an experienced Entrant, including our Inspectors, may encounter serious issues when performing these inspections." A few of these factors include:

- Follow sound, written confined space entry procedures at all times.
- Assemble a confined space entry team.
- Evaluate and eliminate or control hazards of confined space at all times.
- Test the atmosphere for hazards.
- Maintain contact with the attendant at all times.
- Ensure the space was properly prepared for inspection.

Similarly, some items for consideration that relate to all Entry personnel:

- Aging workforce
- Lack of training
- Limited mobility and agility
- Failure to physically prepare for the inspection
- Being complacent with the activity
- Improper awareness of other hazards (i.e., heat)
- Claustrophobia
- Open and communicative Host Employer/Contractor Employer relationship
- Appropriate contractor screening

Based on the summary from the case study conducted by the Hartford Steam Boiler Inspection and Insurance Company (HSB), it shows that it is highly important for all the workers and even inspectors to know and understand the right guidelines to work in confined space. Besides that, they need to be concern about other factors such as people who are having claustrophobia and aging workers. Thus, this shows that a system need to be developed to gather all the information and to teach all the workers how to work safely in confined space and be prepare if any incident happen.

According to Department of Occupational Safety and Health (DOSH), they have found that most confined space accidents were due to the lack of co-ordination and control of activities, when executing more than one task at the same time. For example, working in a confined space can be hazardous when maintenance work on a piping system, connected to the confined space and containing flammable substances, is conducted without proper co-ordination and control.

Besides that, DOSH also noticed that one of the main reasons for these accidents is the sub-contracting of work to contractors that do not have the knowledge and experience of working in a confined space. These contractors normally do not have proper work procedures and equipment for working in confined spaces.

Petit & Herb, (1987) stated that "lack of hazard awareness and unplanned rescue attempts led to the following deaths:"

i) On July 23, 1985, a city worker was removing an inspection plate from a sewer line in a 50-foot deep pump station, when the plate blew off allowing raw sewage to enter the room. Two fellow workers and a policeman attempted to rescue the worker from the sludge filled room and were unsuccessful. All four were dead when removed from the pumping station.

ii) On February 21, 1986, a self-employed truck driver died after entering the top of a 22-foot high x 15-foot square sawdust bin. He suffocated when the sawdust inside the bin collapsed and buried him.

iii) On July 5, 1986, a worker entered a chemical degreaser tank to clean out the bottom and collapsed. Two fellow workers noticed the man down and went in to rescue him. All three workers died.

2.0.2) Confined Space Hazards

According to (Rekus, 1994), confined space hazards may be broadly divided into two categories: atmospheric hazards and physical hazards (Figure 1). Atmospheric hazards include oxygen – deficiency, oxygen enrichment, explosive gases and vapors, and "toxic" air contaminants. Physical hazards, on the other hand, include such things as moving mechanical equipment, energized electrical conductor, ionizing and non-ionizing radiation, heat, cold, in-flowing fluids and finely divided solids like grain or saw dust that can engulf and trap a victim. Even gravity can be a hazard if tools and equipment fall through an elevated opening onto the heads of workers below.

Confined Space Hazards

Atmospheric Hazards

- Oxygen deficiency atmospheres
- Oxygen enriched atmospheres
- "Toxic" or irritating atmospheres

Physical Hazards

- Fixed and portable mechanical equipment
- Electrically energized conductors
- Fluids: liquids, powders and gases
- Thermal condition: hot or cold
- Engulfment by finely divided material
- Ionizing and non-ionizing radiation
- Contact with corrosive substances

Figure 1: Confined Space Hazards by Complete Confined Spaces Handbook (Rekus,1994)

ii) Learning through online and mobile systems

The online system can overcome the problem found when use the paper-based or

ii) Learning through online and mobile systems

The online system can overcome the problem found when use the paper-based or manual system. Mahar (2003) said that, "...manual systems present numerous problems that are solved by computer and communication technologies. Sickness, worry, moodiness and other inherently human variables can also contribute to high error rates in manual systems. Source documents and file folders are easily lost and misplaces."
From his explanation shows that manual system or paper-based system cause many problems and this will affect the system in terms of efficiency and effectiveness.

Tromthy, Trainor, & Krasnewch, (1994) discussed the drawbacks of manual system. They said that, "... manual systems are labor intensive and therefore, costly." Manual system will involve many workers in organizing files, folders and data keeping. In addition, Wilkinson & Joseph (1986) said "The level of service support in manual system is often inferior".
It will be hard to obtain information for decision making as well as provide sources for knowledge sharing if the management still use the manual system. Files consists of reports that are not stored in the database will cause difficulties during data retrieval and this will be a matter for HSE division or department to ensure the efficiency and effectiveness of the existing HSE system.

There are many mobile tools currently used to provide learning opportunities to learners. They include mobile phones, 'smart phones', PDAs, game consoles and Tablet PCs and laptops that have wireless capabilities.

According to Kukulska-Hulme, 2009,the proliferation of mobile phones and other handheld devices has transformed mobile learning from a researcher-led, specialist endeavour, to an everyday activity where mobile devices are personal tools helping people learn wherever they go, through formal training or informal support and conversation.She also said that "mobile learning can work, reaching places that other learning cannot, it is best provided as part of a blend of learning activities, it offers a collection of pieces to be fitted to a learning need rather than a single solution, it is not simply a tool for delivering teaching material but can be used for learning through creativity, collaboration and communication, and that the best way to get

started with developing mobile learning is to try it in practice through trial and experiment with simple tools."

From her statement above, it shows that learning through mobile system is really helpful and isvery flexible to learn anywhere and anytime.

Computer-Assisted Safety Learning System for Working in Confined Spaces is a system via mobile device which offers flexibility and user-friendly functions so people can conveniently learn about the safety procedures and guidelines and do some exercises to test their understanding regarding safety procedures in confined space. HSE department also can use this system to conduct test to workers to ensure that they really understand the procedures and give them the permit.

CHAPTER 3

METHODOLOGY

The development of this system is based on the prototyping methodology. This methodology has been chosen because it quickly provides users with a system to interact with. Also, the prototyping methodology helps in the process of further refining the system. Using the prototyping methodology, the analysis, design and implementation phase will be done simultaneously and repeatedly until the completion and integration of the project modules as shown in Figure 4.

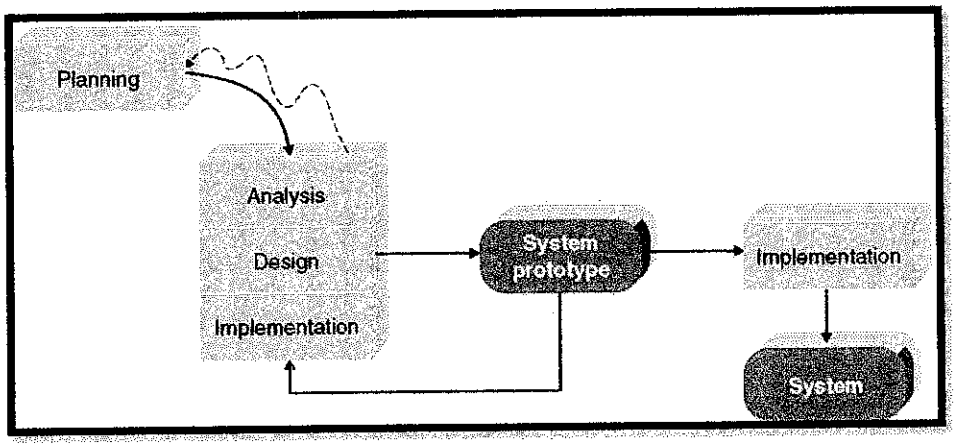


Figure 2 : Prototyping Methodology

Based on the gure above, the project consists of four phases which are:

i) Planning Phase :

During the planning phase, the author had already come out with project activities and the milestones of the project. Hence, the outcome of this activity is the Gantt chart. The author had already conducted feasibilities study to determine the success of the project within the given time frame. In the planning phase also, the author had chose among several factors so that overall goals for the application can be set. Among the goals will include anticipating and deciding on the target audience, purpose and objectives for the project.

ii) Analysis Phase :

The Analysis phase involves activities such as user requirements gathering. Interview had been conducted with workers that work in confined space regarding the cause of incident that keep on happen and also some user-need assessment been done to identify how the system need to be develop based on their need and to ensure that they are comfortable using it. Besides that, in order to improve the application's overall quality, the author had already gone through the process of gathering and comparing information about the application and its functionality. The author also had to weighs all the alternatives and gathered information to help with a decision in the other processes of planning, design and implementation or development. In this phase also, the author did draw several diagrams to show how the system will look like.

- **Diagrams :**

  i) Conceptual Flow Model

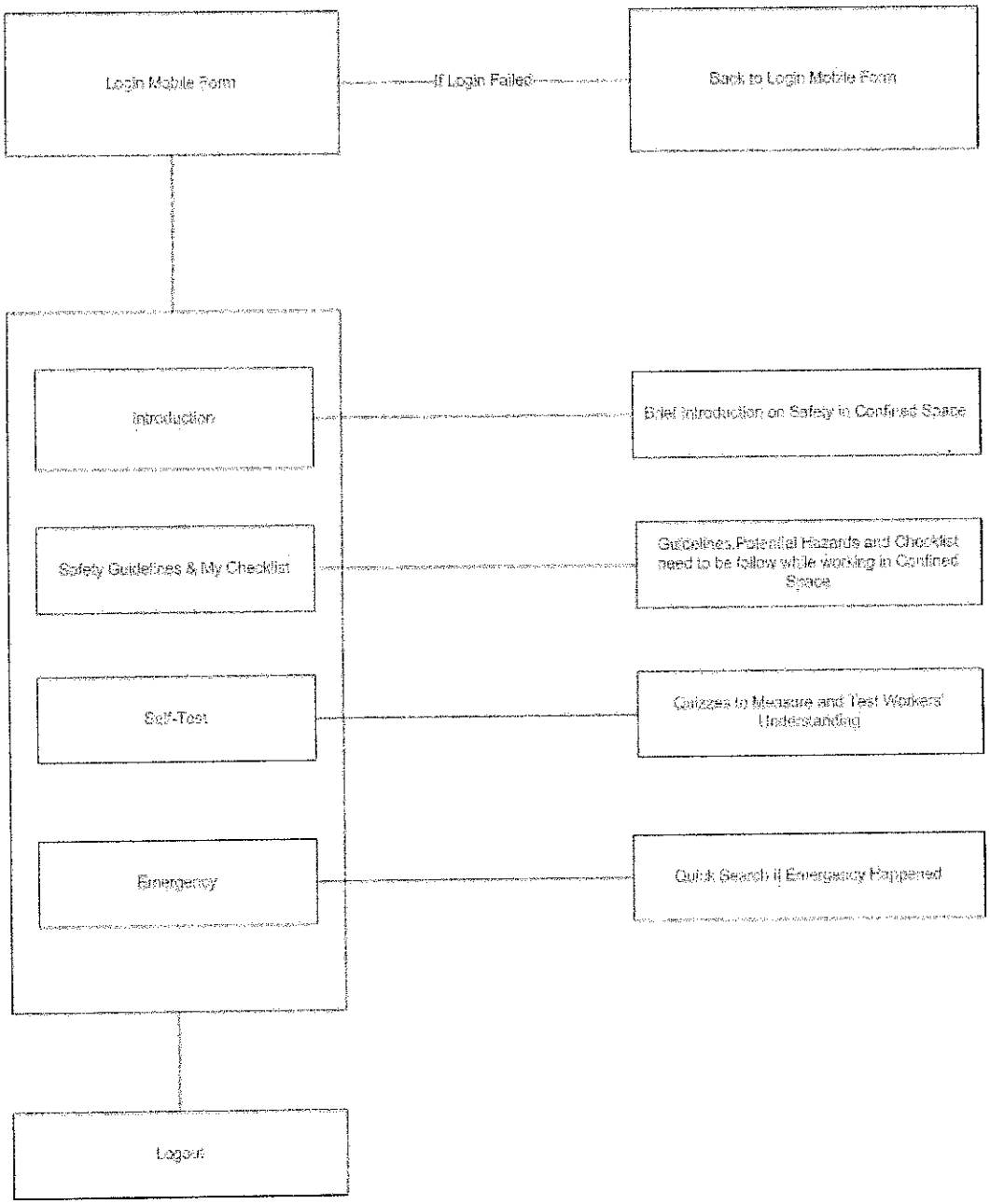


Figure 3: Conceptual Flow Model

ii) Activity Diagram

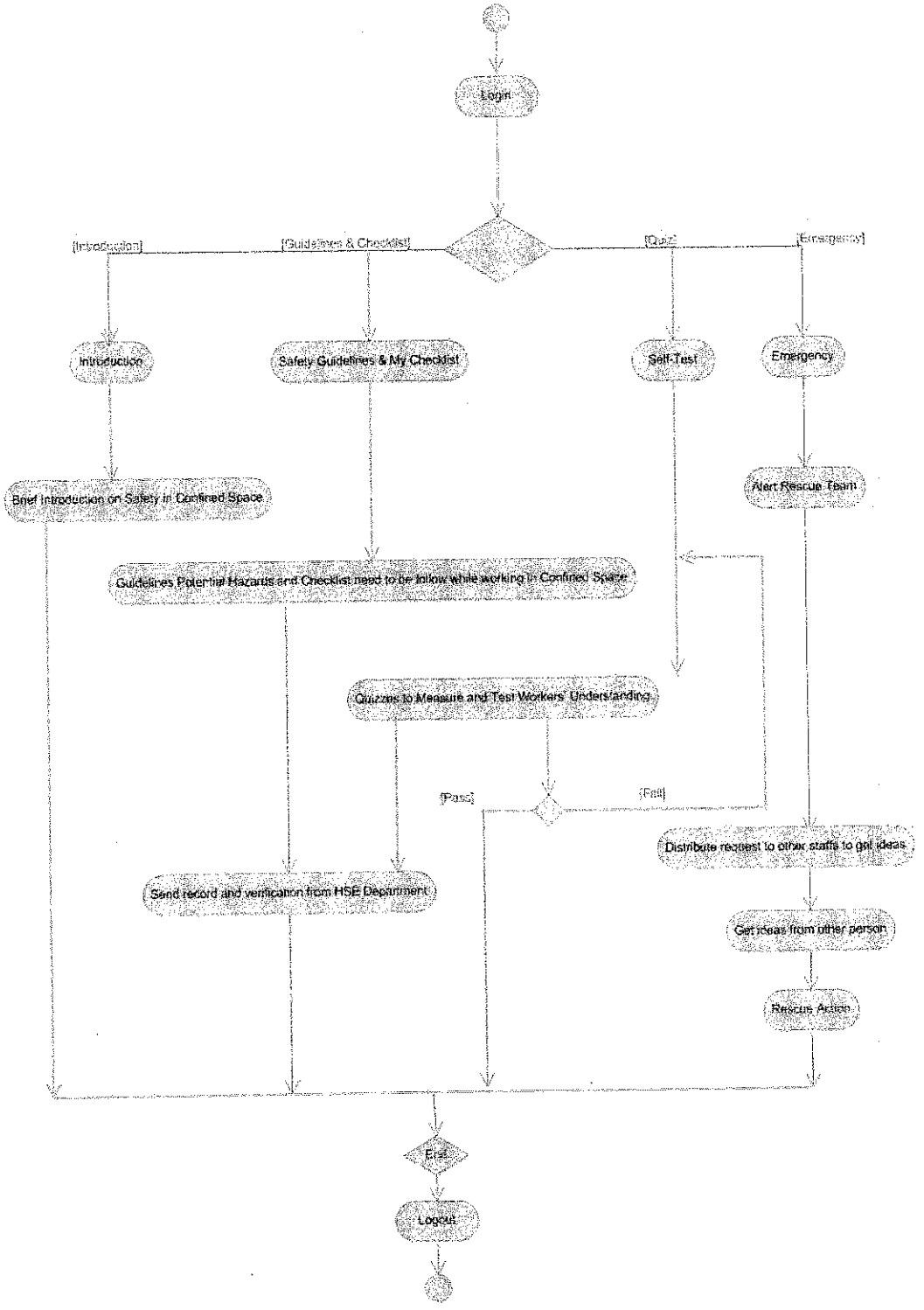


Figure 4: Activity Diagram

iii) Use Case Diagram

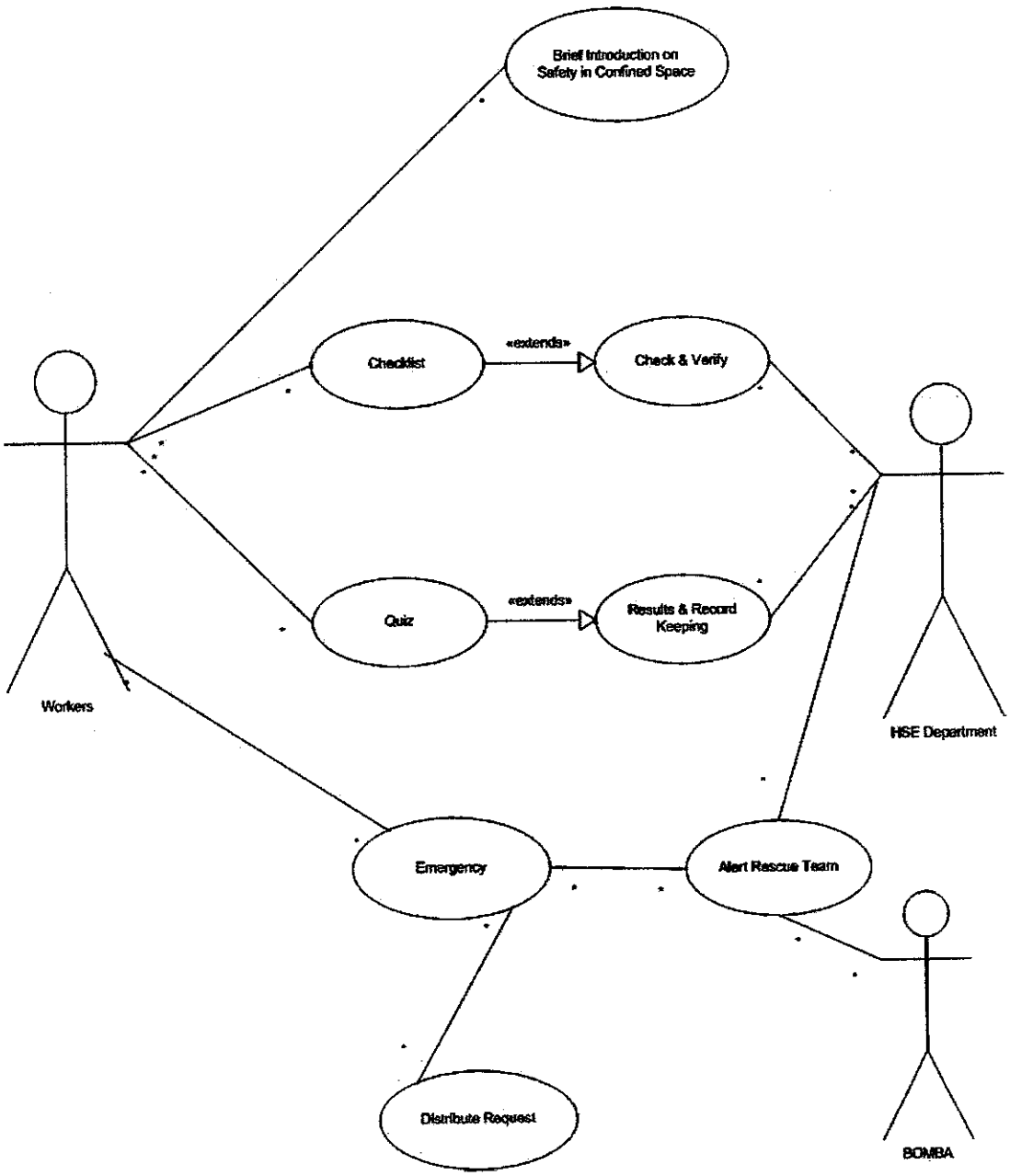


Figure 5: Use-Case Diagram

iii) Design Phase :

During this phase, the author had done some working on the application's specification and need to makes decision about how the application actual components have been constructed. This process involved considering the application's purpose, audience and objective. It rely heavily on the other processes and elements in the system development. The design phase also emphasize on the user interface of the system. Eclipse HELIOS and Android SDK Manager is the software used by the author to develop the system and also to run the emulators to debug the system.

iv) Implementation Phase:

Finally, the Implementation phase involves the coding and testing of the system. For the first prototype, the system already have most of its basic functionalities. Based on this first prototype, it will then be further refined and improved on as further requirements and/or modifications are required until a fully functioning, stable and reliable system has been created.

3.1 Project Activities

There are several project activities that already been done for this project. First of all, research and data gathering had been done to collect all the data required and came out with the standard guidelines that can be practiced by all the companies in Malaysia that have confined space workplace. Next, questionnaires had been created and been distributed to workers that work in confined space. The questions cover two aspects which are:

i) Safety in Confined Space (Eg: Incident occurred, cause of incident, degree of awareness about safety in confined space to workers and more)

ii) System to be develop (Eg: What type of system they preferred? Web based? Mobile Applications? System and more).

Besides that, several visits to plant and construction places will be done throughout the project development to get more exposure towards the real

scenario working in confined spaces and interviews will be conducted during the visits.

Next, after gathering and analysing the data, the author started to build the system according to the results found and after the system is done, the author tested the system. The author used the method of black box and also white box testing to test the system.

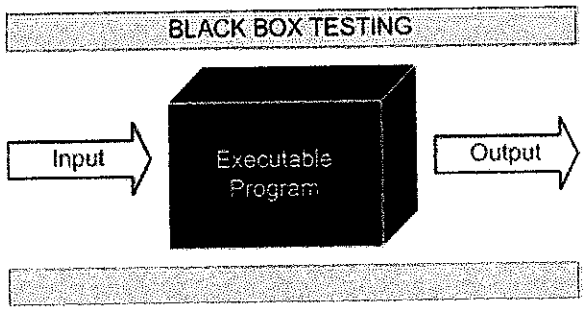


Figure 6: Black Box Testing

In the black box testing method, the tester does not ever examine the programming code and they just test the system functionality itself. By using this method, the author can get the user point of view and test cases can be designed as soon as the specification complete. The variable that are tested during this method are the number of incidents happened after the implementation of the system. (Eg: Is the number of incidents decreasing?).

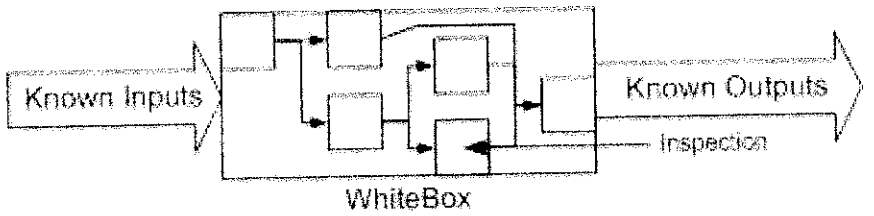


Figure 7: White Box Testing

As for the white box testing method, it provides the information necessary to test all the possible pathways. It will include not only correct inputs, but incorrect inputs, so that error handlers can be verified as well. The advantage of this method is that the author will know how the box handles errors and can usually write tests that verify all code pathways.

According to White Box Testing (2010), for a complete software examination, both white box and black box tests are required.

The following are types of tests to include in system testing :

- Graphical User Interface testing – Test the system's graphical user interface to ensure it meets its written specifications and users are comfortable working with the interface. What are their impressions when using the system? Is it "attractive"? Or "just nice"? Is it hard to understand? User-friendliness? How about the colors, buttons, font type/size?

- Usability Testing – Gives direct input on how real users use the system and to meet its intended purpose. If the content on the system will help them work safely? Give a rate from 1 to 10? What other valuable contents can be added into the system? From 100 trials, how frequently do users make mistakes? (Clicking the wrong button, displaying the wrong screen?) Test whether human-computer interaction can be carried out using a single finger, or does it require more? Do some elements of the interface distract users thus they perform functions incorrectly?

- Performance Testing – A qualitative and quantitative procedure. To determine the speed or effectiveness of the system. (Eg: response time, reliability, scalability and interoperability).

- Installation Testing – What users will need to do to install and set up the system successfully?

- Ease of Use: How they feel when using the system? Is it easy to use? Are there any other functions or components they need to use? How do they rate the system from the scale of 1 to 10?

3.2 Key Milestones

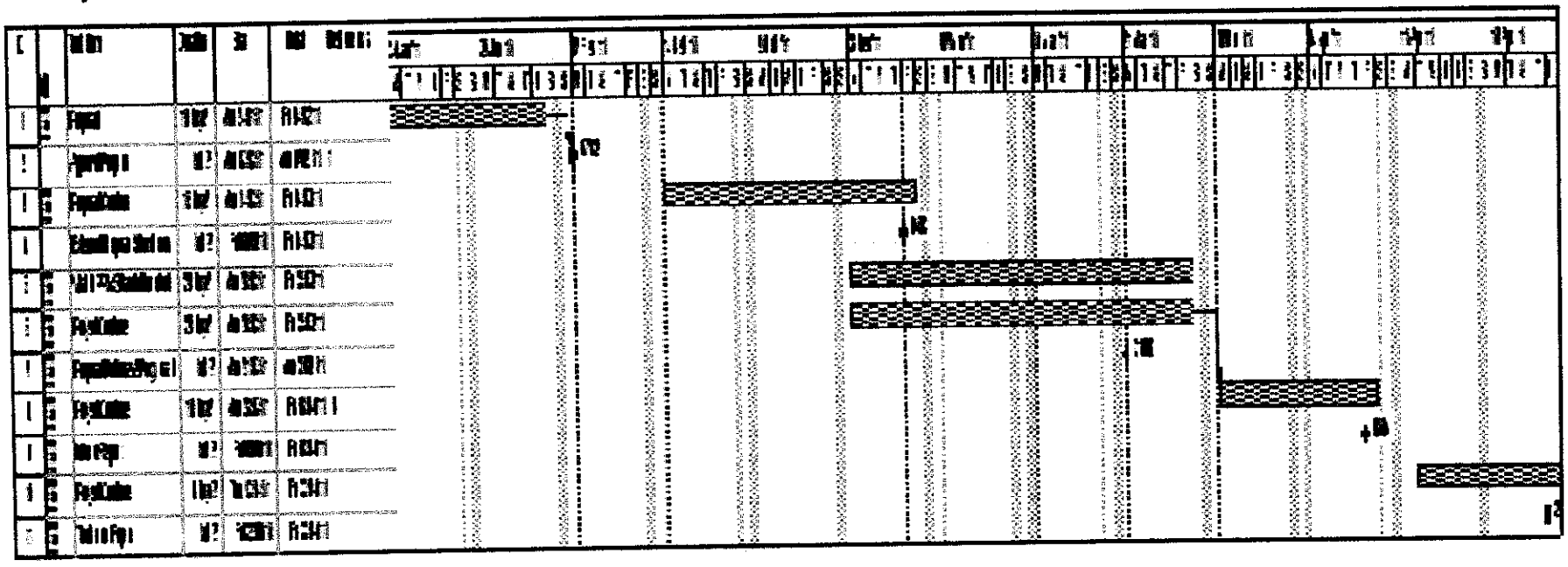


Figure 8: Key Milestone

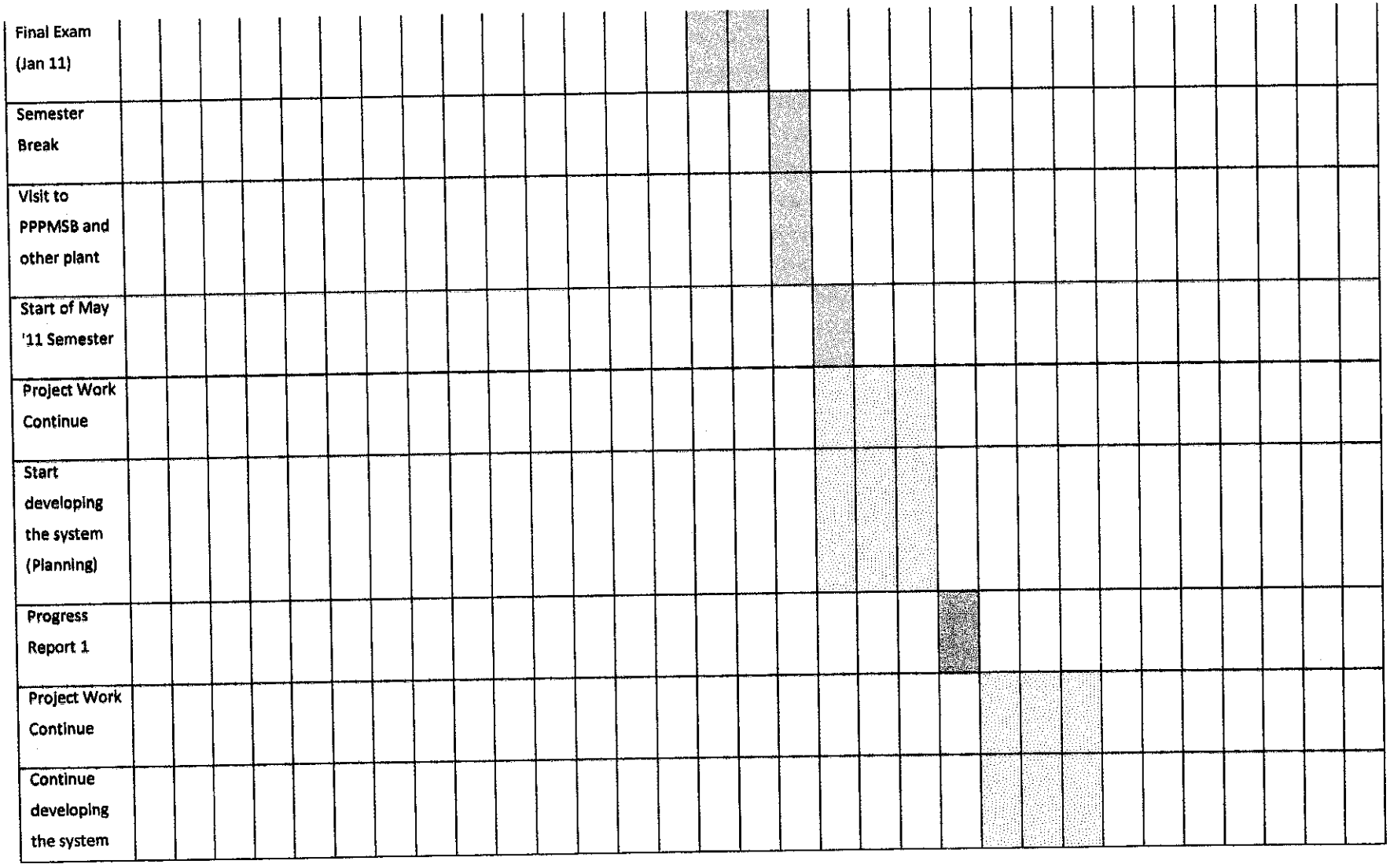
3.3 Gantt Chart

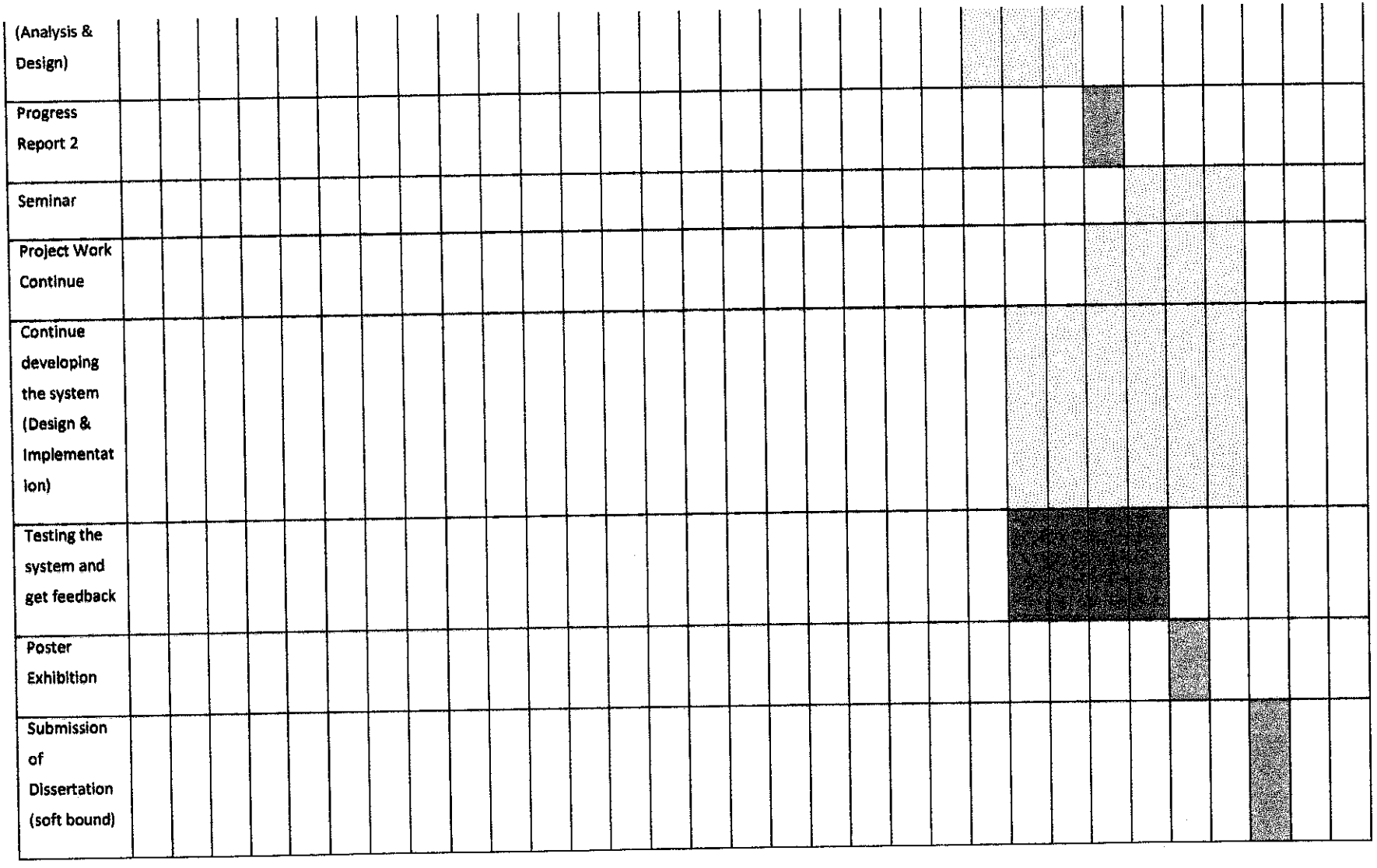
	Week 1 (24/1)	Week 2(31/1)	Week 3(7/2)	Week 4(14/2)	Week 5(21/2)	Week 6(28/2)	Week 7(7/3)	Week 8(14/3)	Week 9(21/3)	Week 10(28/3)	Week 11(4/4)	Week 12(12/4)	Week 13(18/4)	Week 14(25/4)
Proposal														
Approved Proposal														
Extended Proposal														
Visit to PPPMSB and other plant														
Proposal Defense & Progress Evaluation														
Interim Report														
Technicl Report														

Dateline (Key Milestone)	
Progress	

Figure 9: Gantt Chart for Short Semester

	Week 1 (24/1)	Week 2(31/1)	Week 3(7/2)	Week 4(14/2)	Week 5(21/2)	Week 6(28/2)	Week 7(7/3)	Week 8(14/3)	Week 9(21/3)	Week 10(28/3)	Week 11(4/4)	Week 12(12/4)	Week 13(18/4)	Week 14(25/4)	Week 15(2/5)	Week 16(9/5)	Week 17(16/5)	Week 18(23/5)	Week 19(30/5)	Week 20(6/6)	Week 21 (13/6)	Week 22(20/6)	Week 23(27/6)	Week 24(4/7)	Week 25(11/7)	Week 26(18/7)	Week 27(25/7)	Week 28(1/8)	Week 29(8/8)	Week 30(15/8)	Week 31(22/8)
Proposal																															
Approved Proposal																															
Extended Proposal																															
Visit to PPPMSB and other plant																															
Proposal Defense & Progress Evaluation																															
Interim Report																															
Technicl Report																															
Study Week																															


Final Exam (Jan 11)
Semester Break
Visit to PPPMSB and other plant
Start of May '11 Semester
Project Work Continue
Start developing the system (Planning)
Progress Report 1
Project Work Continue
Continue developing the system


(Analysis & Design)
Progress Report 2
Seminar
Project Work Continue
Continue developing the system (Design & Implementation)
Testing the system and get feedback
Poster Exhibition
Submission of Dissertation (soft bound)

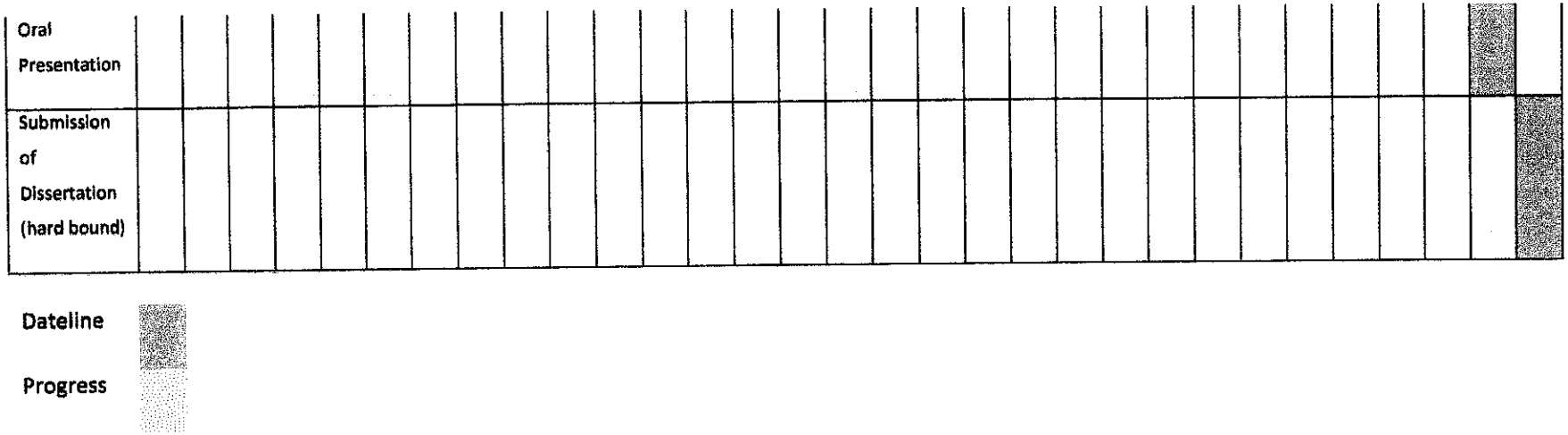


Figure 10: Gantt Chart for Semester 1 & 2

3.4 Apparatus

3.4.1Tools

These are tools that are used throughout the project

NO	ELEMENTS	TOOLS
1	Project Management	Microsoft Visio
2	Documentation	Microsoft Word
3	System Modeling	Eclipse HELIOS
4	Hardware	• 166 MHz processor or higher • Hard disk space 1.5 GB (at least) • 256 MB RAM or higher • HTC Incredible • SAMSUNG Galaxy S
5	Software	• Java Platform (JDK) • Android SDK Manager • Eclipse HELIOS • ADT plugins

Table 1: Tools Used throughout the Project

CHAPTER 4

RESULTS AND DISCUSSION

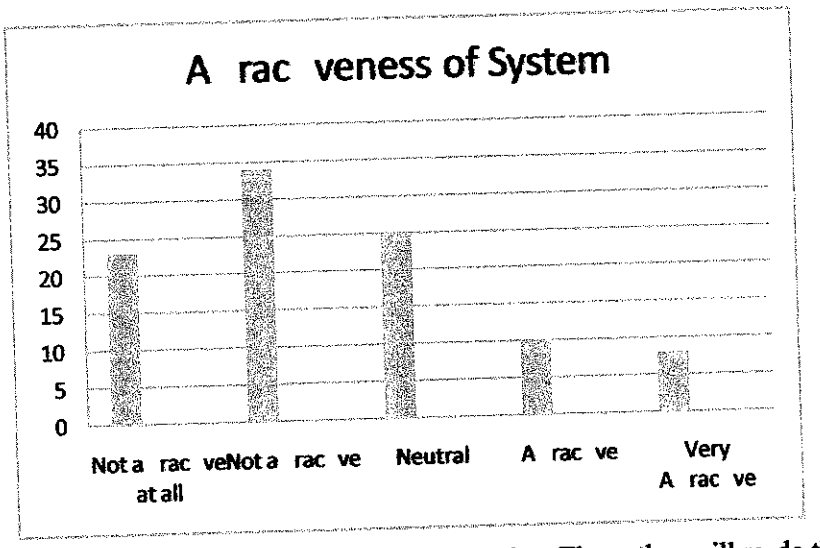
4.1 Data Gathering and Analysis

4.1.1 Results

These are several set of questions that has been distributed to users after they test the system and here are the results from the feedbacks.

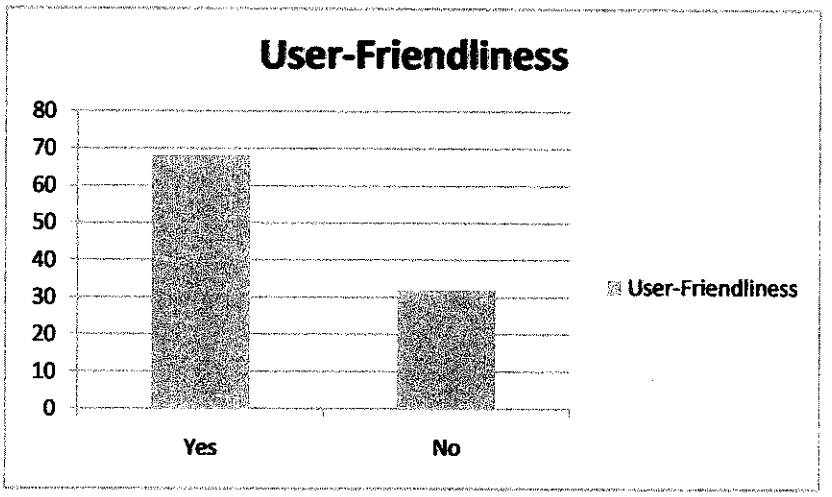
Graphical User Interface testing – Test the system's graphical user interface to ensure it meets its written specifications and users are comfortable working with the interface.

i) What do you think of the system interface? (Not attractive at all – Very attractive).



Majority of the users said that the system is not attractive. The author will re-do the interface to make it become more attractive and in line with users need.

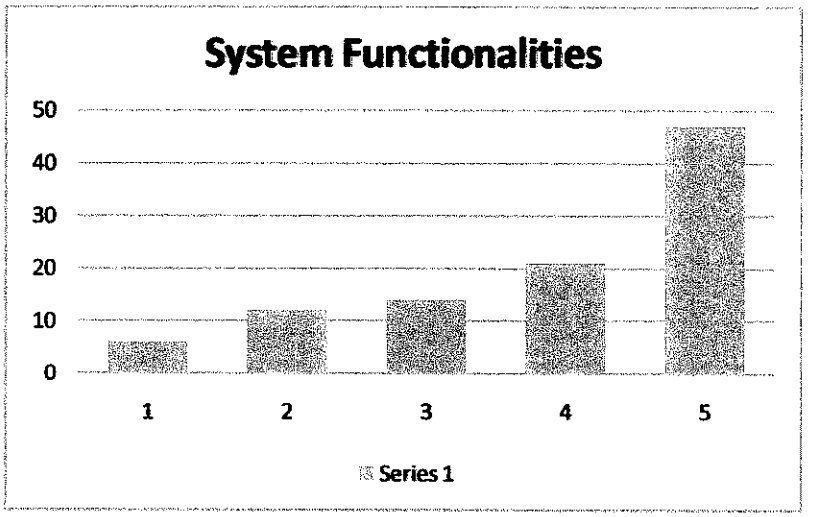
i) What do you feel about the system user-friendliness?



Most of the users feel that the system is user-friendly.

- **Usability Testing** gives direct input on how real users use the system and to meet its intended purpose.

ii) From the scale of 1-5 (the best), how do you feel about these system functionalities? Is the system making your works become easier and safer?



Majority of the users vote the systems as the best but there are still users that said this system is not good. So, the author will do some research on how to improve the system to make it better in the future.

- **Performance Testing** – A qualitative and quantitative procedure. To determine the speed or effectiveness of the system.

  i) While testing the system performance, the author found out that the response time to go to next page is less than 1 second. As for the time to complete the checklist, it took almost 5-7 minutes to complete the checklist compare to the old ways which took almost half an hour to complete the checklist.

- Installation Testing – What users will need to do to install and set up the system successfully?

  i) The users just need to transfer the system file, (Eg: confinedSpace.apk) into their SD Card and when they insert it into their Android device, they just launch the system from the installation manager.

  ii) They can directly use the system once they click the launch button.

  iii) The author already installed the system into three different devices with three different platform and it is compatible with two out of three devices and platforms.

Example of checklists currently in use:

APPENDIX B

SAMPLE PERMIT FORM FOR CONFINED SPACE ENTRY

1. (a) Location of Work: _____
   (b) Employer Assigned: _____
   (c) Outside Contractor: _____

2. (a) Description of Work to be Undertaken: _____
   (b) Purpose of Report: _____ Date: _____
   (c) Entry Date: _____ Time: _____

THE WHOLE OF THE REMAINING DETAIL OF THIS PERMIT MUST BE AUTHORISED BEFORE WORK IS TO PROCEED AND ONLY WORK LISTED MAY BE DONE

3. ISOLATION OF CONFINED SPACE
   The items listed below have been isolated or made safe:
   (a) Pipelines (Water, Steam, Gas, etc.)
   (b) Mechanical/Electrical drives
   (c) Sealed/Capped/Blank
   (d) Harmful materials
   (e) Electrical services
   (f) Moving rollers, locks or jigs have been fixed to means of isolation

   Authorised person: _____

4. ATMOSPHERIC TEST REQUIREMENTS
   The atmosphere has been tested to ensure adequate oxygen content and for the following contaminants:
   (Fill in details and results of tests)
   (a) 1. Oxygen ____ %
   (b) 2. _____ ____ %
   (c) 3. _____ ____
   (d) 4. _____ ____

   Continuous monitoring of the atmosphere considered required*. (* Delete as appropriate)
   The conditions are safe for entry under the conditions listed below:
   (a) With a suppliedair respiratory protective device.
   (b) With an air purifying (non-suppliedair) respiratory protective device.
   (c) Without a respiratory protective device.

   Testing by: _____ Date: _____ Authorised person: _____

5. PERSONAL PROTECTIVE EQUIPMENT (PPE)
   The following PPE listed below shall be worn:
   (a) Suppliedair respirator.
   (b) Air purifying respiratory protective devices.
   (c) Safety belt, harness and/or safety line or lifeline/rescue line.
   (d) Eye protection.
   (e) Hand protection.
   (f) Foot protection.
   (g) Protective clothing.
   (h) Hearing protection.
   (i) Safety helmet.

   Authorised person: _____

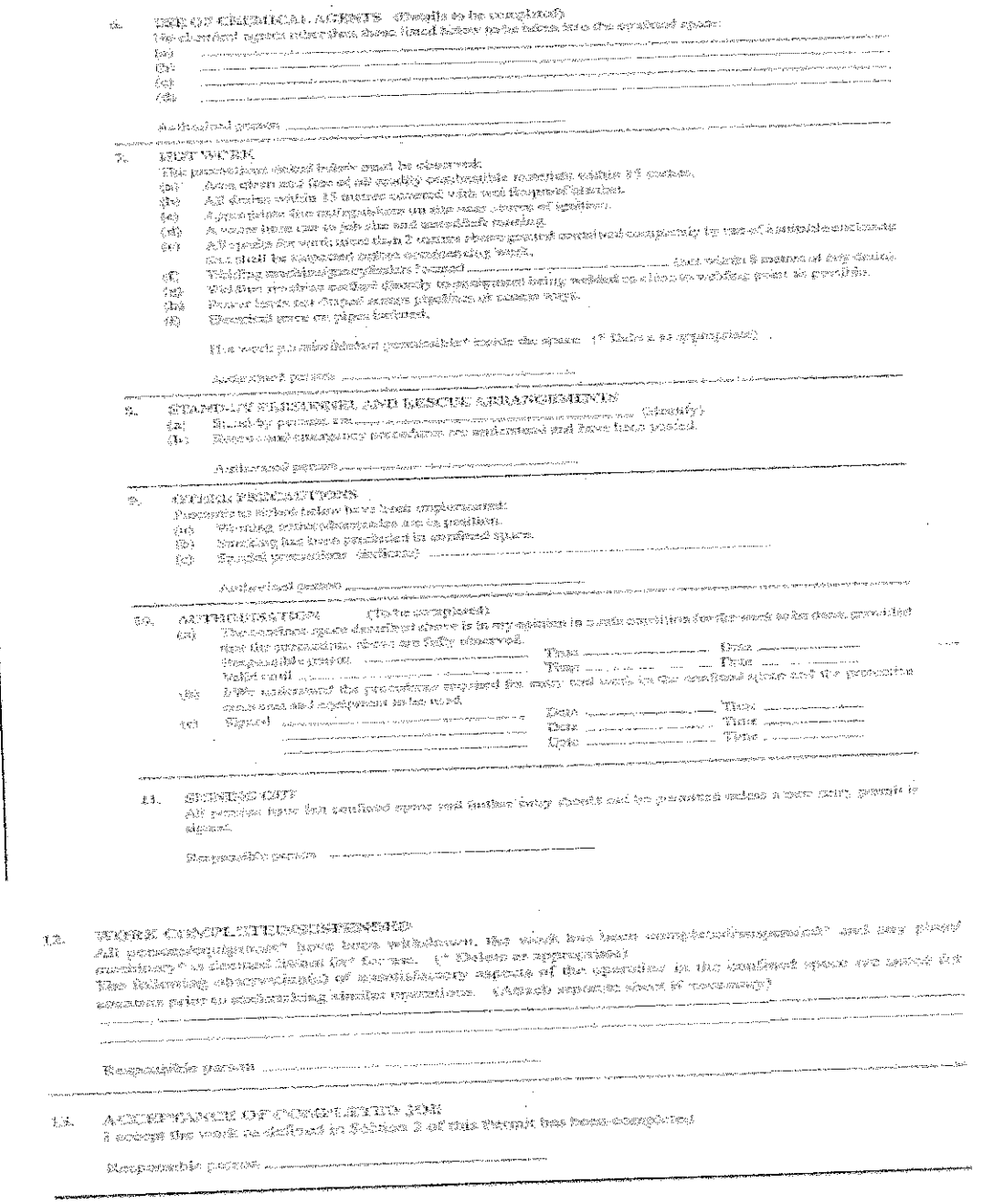


Figure 11: DOSH Guidelines and Checklist

The figures above are the checklist prepared by DOSH in **Code of Practice for Safe Working in a Confined Space** (2001).From the figures above, author will transfer the data needed into mobile system and users can use the mobile to do the checklist instead of using paper-based.

4.2 Experimentation/ Modeling Prototype

- **Proposed Interface:**

Interfaces

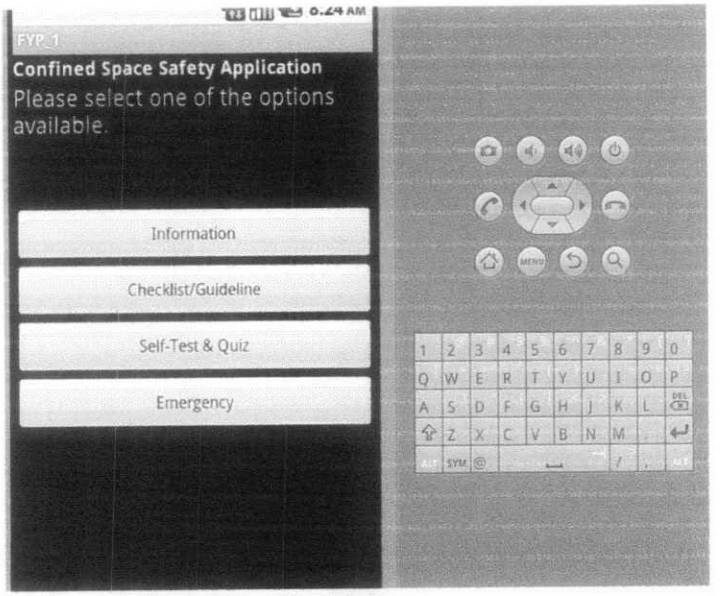


Figure 12: Main Page

Figure 11 above shows the login page of the system. Once user logged into the system, they will automatically be directed to the default or the main page of the system. Next, the user need to select the modules from the main page which consists of: Information, guidelines & checklist, self-test and also emergency.

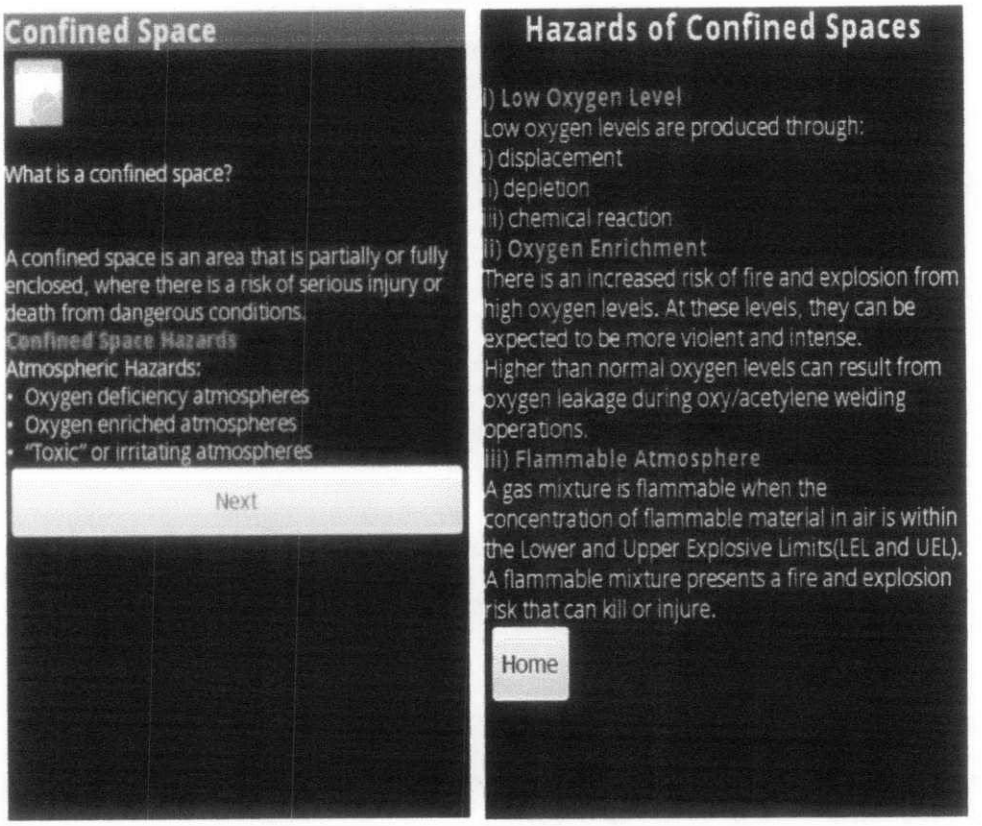


Figure 13: Background Information page

For this introduction page, users will be able to view learning materials according to the chapters that will be included in the system. It will include chapters such as definition of confined spaces, hazards in confined spaces, statistic of incidents happened in confined space from NIOSH and more.

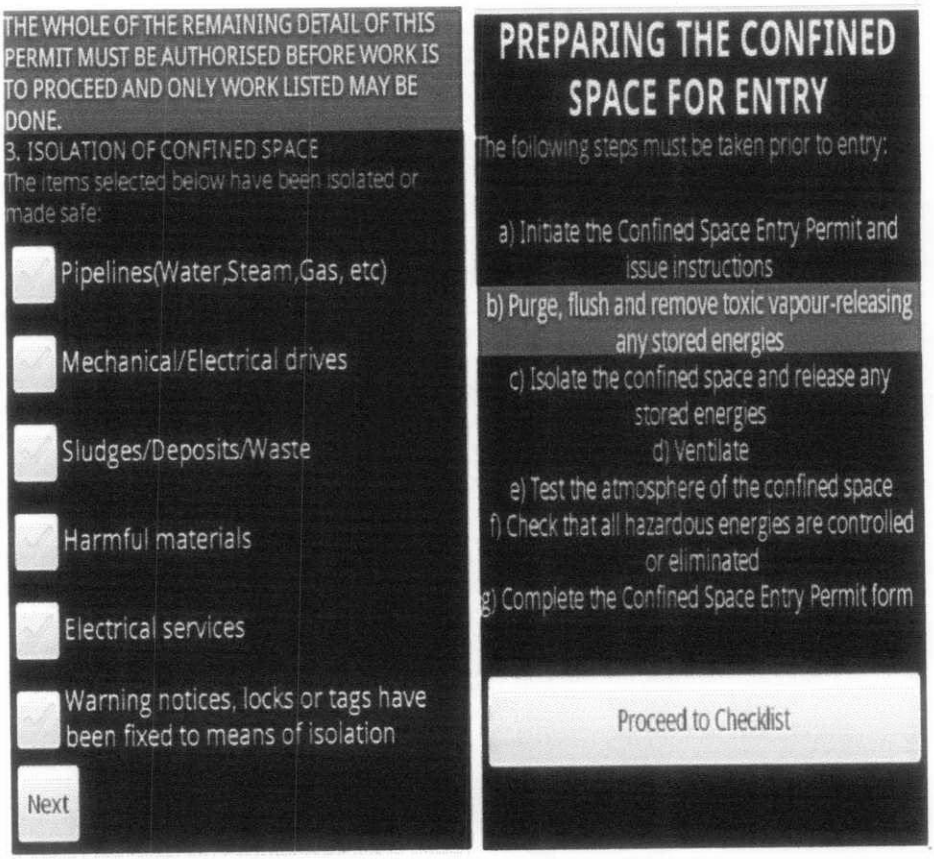


Figure 14: Checklist & Guidelines Page

In the guidelines and checklist page, user can check the right guidelines before, during and after doing work in confined spaces and there are also checklists such as Personal Protective Equipment and tools required before entering confined spaces. After they finish the checklist, the system will send the reports directly to person in charge for record keeping and also verification. After receive verification from the person in charge, only then they can proceed to work in confined spaces.

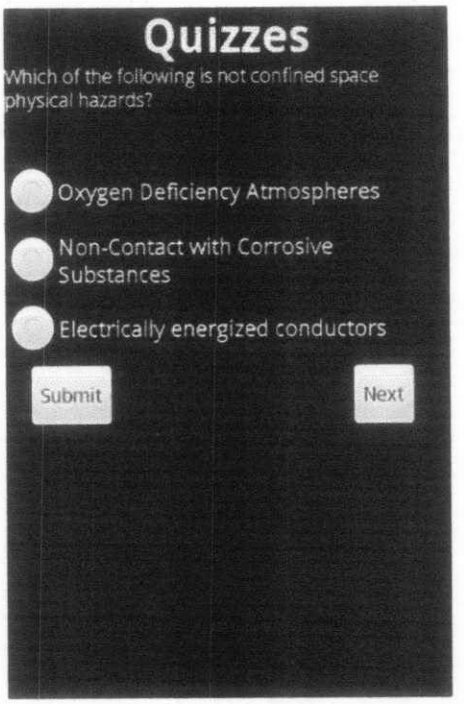


Figure 15: Quizzes Page

For this page, user can test their knowledge regarding safety on confined spaces. They will need to answer some series of questions to test their understanding and they need to exceed some level to pass and if they fail, they need to re-do the quiz again.

Figure 16: Emergency Page

This page is for emergency. If an emergency occurs, user can alert directly to rescue team and also BOMBA. Besides that, users also can ask for ideas from several other persons. So, instead of having just few ideas, by having this system, users can have more ideas and to react quickly during emergency.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

As a conclusion, the project entitled Developing Computer-Assisted Safety Systems:A Mobile Safety Support System for Confined Spaces consist of four main functions which are background information that contains information about safety in confined spaces such as the hazards, checklist and guidelines before,during and entering the confined spaces, quizzes to test the users knowledge and lastly, emergency page which helps user to directly contact rescue team, BOMBA and also send distributive request to several others people in the network. It is an intergrated platform for safety support system that has the functions of knowledge portal, communications and also alert system. T he main aim of this project is to reduce fatalities and also incident. So, by having this system, hopefully it can save a lot of live by increasing the response time to rescue and also users will know what to do if emergency occurs when they received feedbacks from other people.

5.1 Relevancy to the Objectives

At the end of the project, the author had met the objectives been set for this project. This can conclude that this project is successful because it had met the objectives.

As the scope of study, the system's objectives are:

i. To create a mobile safety support system, specifically for use by persons supervising workers who are carrying out tasks in confined spaces.

ii. To improve worker safety behavior by making information, crisis alarms and collaborative problem solving networks available in a mobile format.

iii. To reduce the frequency of accidents, lost-time injuries and fatalities.

It is say that the author had met the objective because firstly, the system already been developed and the functionalities is specially for persons who is supervising their workers that work in confined spaces. Besides that, the system provides information

to the users, crisis alarms to alert users and also include a network that helps users to solve problems if incident occur.

5.2 Suggested Future Work for Expansion and Continuation

As for the future work, the author plan to extend and add more functions for the systems. The contents of the system also will be added and extra functions such as statistics and reports from DOSH also will be included in the system.The interface also will be modify according to market and users demand to make it more interesting to use. Besides that, the author will try to seek other mobile operating system such as Apple and Blackberry and convert this system to that operating system so that it is compatible with any mobile devices.

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APPENDIX

Coding

i) Main Page

```
package com.application;


import android.app.Activity;
import android.app.AlertDialog;
import android.content.DialogInterface;
import android.content.Intent;
import android.os.Bundle;
import android.view.Menu;
import android.view.MenuItem;
import android.view.View;
import android.widget.Toast;


public class main extends Activity{



   /** Called when the activity is first created. */
   @Override
   public void onCreate(Bundle savedInstanceState) {
      super.onCreate(savedInstanceState);
      setContentView(R.layout.main);
   }


   public void information (View view){

            Intent intent = new Intent(this, Information.class);
            startActivity(intent);
}
    public void guidelines (View view){


            Intent intent = new Intent(this, guidelines.class);
            startActivity(intent);
}
  public void quiz (View view){
```

```
        Intent intent = new Intent(this, Quiz.class);
        startActivity(intent);
}
public void emergency (View view){

                Intent intent = new Intent(this, Emergency.class);
                startActivity(intent);
        }

  @Override
  public boolean onCreateOptionsMenu(Menu menu){
        menu.add(0,0,0, "About").setIcon(android.R.drawable.ic_menu_info_details);
        menu.add(0,1,0, "Email").setIcon(android.R.drawable.ic_dialog_email);
        menu.add(0,2,0, "Call").setIcon(android.R.drawable.ic_menu_call);
        menu.add(0,3,0, "SMS").setIcon(android.R.drawable.ic_menu_gallery);

                return true;
                }

  @Override
  public boolean onOptionsItemSelected(MenuItem item) {
        switch (item.getItemId()){
        case 0:
                AlertDialog.Builder alert = new AlertDialog.Builder(this);

                alert.setTitle("");
                alert.setMessage("Mobile Safety Support System for Confined Spaces 1.0 \n Developed at
UTP").setCancelable(true).setNegativeButton("Dismiss",new DialogInterface.OnClickListener(){

                        @Override
                        public void onClick (DialogInterface dialog, int id){
                                //
                                dialog.cancel();
                        }
                });
                //compile
```

```
                alert.create();
                //display
                alert.show();
                return true;

            case 1: //for email
                Intent msg = new Intent(Intent.ACTION_SEND);
                msg.setType("type/plain");
                msg.putExtra(Intent.EXTRA_SUBJECT, "Mobile Safety Support System for Confined Spaces");
                //msg.putExtra(Intent.EXTRA_TEXT, "Check this android app for free");
                msg.setType("vnd.android.cursor.dir/email");

                startActivity(Intent.createChooser(msg, "Send email..."));

                //some missing, that why email doesn't work!
                return true;

            case 2:
                Toast.makeText(this,"Call Selected", Toast.LENGTH_SHORT).show();
                return true;

            case 3:
                Toast.makeText(this,"SMS Selected", Toast.LENGTH_SHORT).show();
                return true;

            }
            return false;
    }

}
```

ii) Checklist/Guidelines Page

```
package com.application;


import android.app.Activity;

import android.app.AlertDialog;

import android.content.DialogInterface;

import android.content.Intent;

import android.os.Bundle;

import android.view.Menu;

import android.view.MenuItem;

import android.view.View;

import android.widget.Toast;


public class Checklist_last extends Activity {


        /** Called when the activity is first created. */

        @Override

        public void onCreate(Bundle savedInstanceState) {

          super.onCreate(savedInstanceState);

          setContentView(R.layout.checklist_layoutlast);


          // TODO Auto-generated method stub

        }
public void submit(View view){


         AlertDialog.Builder alert = new AlertDialog.Builder(this);


         alert.setTitle("");

         alert.setMessage("Congratulations.You have completed the checklist and the record will be send to HSE
Department. You may proceed with your work now.").setCancelable(true).setNegativeButton("Proceed",new
DialogInterface.OnClickListener(){


                  @Override

                  public void onClick (DialogInterface dialog, int id){
```

```
                        //
                        dialog.cancel();
                }
        });
        //compile
        alert.create();
        //display
        alert.show();
        return;

}
public void Home (View view){

        Intent intent = new Intent(this, main.class);
        startActivity(intent);
}
@Override
public boolean onCreateOptionsMenu(Menu menu){
        menu.add(0,0,0, "About").setIcon(android.R.drawable.ic_menu_info_details);
        menu.add(0,1,0, "Email").setIcon(android.R.drawable.ic_dialog_email);
        menu.add(0,2,0, "Call").setIcon(android.R.drawable.ic_menu_call);
        menu.add(0,3,0, "SMS").setIcon(android.R.drawable.ic_menu_gallery);

        return true;
        }

@Override
public boolean onOptionsItemSelected(MenuItem item) {
        switch (item.getItemId()){
        case 0:
                AlertDialog.Builder alert = new AlertDialog.Builder(this);

        alert.setTitle("");
        alert.setMessage("Mobile Safety Support System for Confined Spaces 1.0 \n Developed at
UTP").setCancelable(true).setNegativeButton("OK",new DialogInterface.OnClickListener(){
```

```
            @Override
            public void onClick (DialogInterface dialog, int id){
                        //
                        dialog.cancel();
            }
});
//compile
alert.create();
//display
alert.show();
            return true;

case 1: //for email
            Intent msg = new Intent(Intent.ACTION_SEND);
            msg.setType("type/plain");
            msg.putExtra(Intent.EXTRA_SUBJECT, "Mobile Safety Support System for Confined Spaces");
            //msg.putExtra(Intent.EXTRA_TEXT, "Check this android app for free");
msg.setType("vnd.android.cursor.dir/email");

startActivity(Intent.createChooser(msg, "Send email..."));

//some missing, that why email doesn't work!
return true;
case 2:
             Toast.makeText(this,"Call Selected", Toast.LENGTH_SHORT).show();
             return true;
case 3:
             Toast.makeText(this,"SMS Selected", Toast.LENGTH_SHORT).show();
             return true;
             }
 return false;
}
```

iii) Quizzes Page

```
package com.application;


import android.app.Activity;

import android.app.AlertDialog;

import android.content.DialogInterface;

import android.content.Intent;

import android.os.Bundle;

import android.view.View;


public class Quiz extends Activity {


        /** Called when the activity is first created. */

        @Override

        public void onCreate(Bundle savedInstanceState) {

          super.onCreate(savedInstanceState);

          setContentView(R.layout.quiz_layout);


          // TODO Auto-generated method stub

        }


public void submit(View view){


        AlertDialog.Builder alert = new AlertDialog.Builder(this);


        alert.setTitle("");

        alert.setMessage("Your answer is right.You may proceed to next
question.").setCancelable(true).setNegativeButton("Dismiss",new DialogInterface.OnClickListener(){


                @Override

                public void onClick (DialogInterface dialog, int id){

                        //

                        dialog.cancel();

                }
```

```
            });
            //compile
            alert.create();
            //display
            alert.show();
            return;
    }
public void quiz_layout2(View view){

            Intent intent = new Intent(this, quiz_layout2.class);
            startActivity(intent);
}
}
```

iv) Emergency Page

```
package com.application;


import android.app.Activity;

import android.app.AlertDialog;

import android.content.DialogInterface;

import android.content.Intent;

import android.os.Bundle;

import android.view.Menu;

import android.view.MenuItem;

import android.view.View;

import android.widget.Toast;


public class Emergency extends Activity {


        /** Called when the activity is first created. */

        @Override

        public void onCreate(Bundle savedInstanceState) {

          super.onCreate(savedInstanceState);

          setContentView(R.layout.emergency);


          // TODO Auto-generated method stub

        }


         public void rescue (View view){

                  AlertDialog.Builder alert = new AlertDialog.Builder(this);


                  alert.setTitle("");

                  alert.setMessage("You have already alert the Rescue Team.They will arrive
shortly.").setCancelable(true).setNegativeButton("OK",new DialogInterface.OnClickListener(){


                           @Override

                           public void onClick (DialogInterface dialog, int id){

                                    //
```

```
                                dialog.cancel();

                        }

                });

                //compile

                alert.create();

                //display

                alert.show();

                return;


}

        @Override

          public boolean onCreateOptionsMenu(Menu menu){

                menu.add(0,0,0, "About").setIcon(android.R.drawable.ic_menu_info_details);

                menu.add(0,1,0, "Email").setIcon(android.R.drawable.ic_dialog_email);

                menu.add(0,2,0, "Call").setIcon(android.R.drawable.ic_menu_call);

                menu.add(0,3,0, "SMS").setIcon(android.R.drawable.ic_menu_gallery);


                        return true;

                        }


          @Override

          public boolean onOptionsItemSelected(MenuItem item) {

                switch (item.getItemId()){

                case 0:

                        AlertDialog.Builder alert = new AlertDialog.Builder(this);


                        alert.setTitle("");

                        alert.setMessage("Mobile Safety Support System for Confined Spaces 1.0 \n Developed
at UTP").setCancelable(true).setNegativeButton("OK",new DialogInterface.OnClickListener(){


                                @Override

                                public void onClick (DialogInterface dialog, int id){

                                        //

                                        dialog.cancel();

                                }
```

```
                });
                //compile
                alert.create();
                //display
                alert.show();
                return true;

            case 1: //for email
                Intent msg = new Intent(Intent.ACTION_SEND);
                msg.setType("type/plain");
                msg.putExtra(Intent.EXTRA_SUBJECT, "Mobile Safety Support System for Confined
Spaces");
                //msg.putExtra(Intent.EXTRA_TEXT, "Check this android app for free");
                msg.setType("vnd.android.cursor.dir/email");

                startActivity(Intent.createChooser(msg, "Send email..."));

                //some missing, that why email doesn't work!
                return true;

            case 2:
                Toast.makeText(this,"Call Selected", Toast.LENGTH_SHORT).show();
                return true;

            case 3:
                Toast.makeText(this,"SMS Selected", Toast.LENGTH_SHORT).show();
                return true;

            }
            return false;
        }

        public void bomba (View view){
            AlertDialog.Builder alert = new AlertDialog.Builder(this);
```

```
                alert.setTitle("");

                alert.setMessage("You have already alert the BOMBA.They will arrive
shortly.").setCancelable(true).setNegativeButton("OK",new DialogInterface.OnClickListener(){


                        @Override

                        public void onClick (DialogInterface dialog, int id){

                                //

                                dialog.cancel();

                        }

                });

                //compile

                alert.create();

                //display

                alert.show();

                return;


}


}
```