



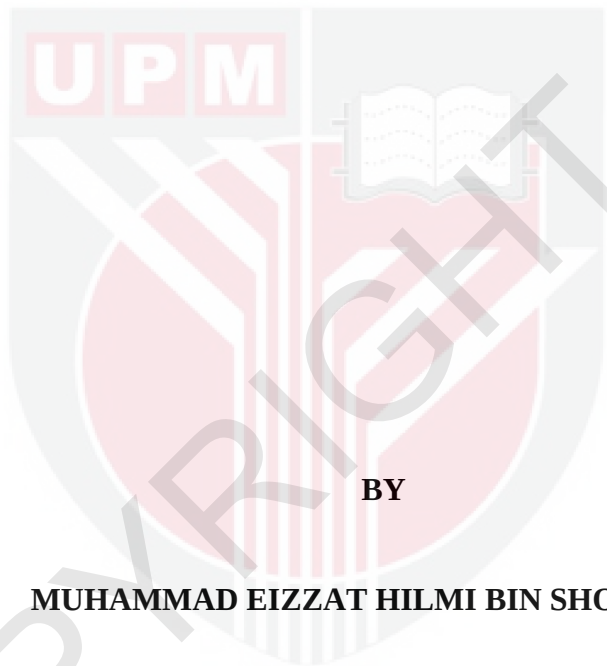
UNIVERSITI PUTRA MALAYSIA

***USABILITY OF A SAFETY & HEALTH APP-BASED EDUCATIONAL
AND HAZARDS REPORTING TOOL FOR STUDENTS IN UNIVERSITI
PUTRA MALAYSIA***

MUHAMMAD EIZZAT HILMI BIN SHOLIKHIN

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AND HAZARDS REPORTING TOOL FOR STUDENTS IN UNIVERSITI
PUTRA MALAYSIA**



BY

MUHAMMAD EIZZAT HILMI BIN SHOLIKHIN

**Thesis submitted in fulfillment of the requirement for the degree of Bachelor
Science (Environmental and Occupational Health) from the Faculty of
Medicine and Health Sciences, Universiti Putra Malaysia.**

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ABSTRACT

USABILITY OF A SAFETY & HEALTH APP-BASED EDUCATIONAL AND HAZARDS REPORTING TOOL FOR STUDENTS IN UNIVERSITI PUTRA MALAYSIA

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Introduction: In the Higher Educational Institutional setting, effective delivery of safety and health information by the university directly influences student awareness, knowledge, attitude and practices. Even if the students can identify or assess the risk, to a certain extent, they mostly do not know how to make a report or whom to report to. **Objective:** To determine the usability of a mobile application which serves as an educational tool for safety and health for the students and concurrently provide a platform for reporting hazards to the management of the university. **Methodology:** A cross-sectional study was conducted between May to June 2020, where convenience sampling was applied. A total of 151 respondents from five different faculties in UPM voluntarily participated in this study. A custom-built mobile app was developed to provide the respondents on the foundation of knowledge in safety and health and reporting hazards. It also serves as an instrument to collect socio-demographic information and usability via questionnaire embedded within the app. Socio-demographic information was collected during the registration process. The adapted PSSUQ are presented after respondents have completed and submitted at least one report of hazards within the mobile app. **Result & Discussion:** The results showed the majority of respondents were, female (54.3%), 23 years old (45.7%), Malay (90.1%) and students from the Faculty of Medicine and Health Sciences (42.4%). In terms of the usability, majority of the respondents (62.46%) strongly agreed that the app is easy to use, the information is well organised and, has an attractive interface. There was no association between all socio-demographic factors and the usability of the app, except for gender with interface quality ($r = -0.222, p < 0.05$). Significant association were also found between faculty and information quality ($r = 0.185, p < 0.05$), interface quality ($r = 0.374, p < 0.05$), and overall usability ($r = 0.202, p < 0.05$) respectively. **Conclusion:** In conclusion, the safety and health educational tool and hazard reporting tool has the potential to deliver the intended objective of educating students on basic safety and health knowledge and ease students in reporting hazards around campus. The app was shown to possess a good usability. However, there always have a room for improvement in this study.

Keywords: Usability, safety and health, mobile application, reporting

ABSTRAK

KEBOLEHGUNAAN ALAT PENDIDIKAN & PELAPORAN HAZAD BERASASKAN APLIKASI KESIHATAN & KESELAMATAN UNTUK PELAJAR DI UNIVERSITI PUTRA MALAYSIA

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Pengenalan: Dalam persekitaran institusi pendidikan tinggi, penyampaian maklumat keselamatan dan kesihatan yang berkesan oleh pihak universiti secara langsung mempengaruhi kesedaran pelajar, pengetahuan, sikap dan amalan. Walaupun pelajar boleh mengenal pasti atau menilai hazard, secara asas, mereka kebanyakannya tidak tahu bagaimana untuk membuat laporan atau siapa yang perlu mereka rujuk. **Objektif:** untuk menentukan kebolehgunaan aplikasi mudah alih yang berfungsi sebagai alat pendidikan untuk keselamatan dan kesihatan untuk pelajar dan pada masa yang sama menyediakan platform untuk melaporkan hazard kepada pengurusan universiti. **Metodologi:** Kajian rentas lintang dijalankan antara Mei hingga Jun 2020, di mana persampelan kemudahan telah digunakan. Seramai 151 responden daripada lima Fakulti yang berbeza di UPM secara sukarela mengambil bahagian dalam kajian ini. Aplikasi mudah alih yang dibina khas telah dibangunkan untuk memberi responden asas pengetahuan dalam keselamatan dan kesihatan dan melaporkan hazard. Ia juga berfungsi sebagai instrumen untuk mengumpul maklumat dan kebolehgunaan sosio-demografi melalui soal selidik yang terdapat di dalam aplikasi. Maklumat sosio-demografi dikumpulkan semasa proses pendaftaran. PSSUQ yang diguna pakai telah ditunjukkan selepas responden telah menyempurnakan dan mengemukakan sekurang-kurangnya satu laporan hazard dalam aplikasi mudah alih. **Keputusan & Perbincangan:** Keputusan menunjukkan majoriti responden adalah, perempuan (54.3%), 23 tahun (45.7%), Melayu (90.1%) dan pelajar dari FPSK (42.4%). Dari segi kebolehgunaan, majoriti responden (62.46%) sangat bersetuju bahawa aplikasi mudah untuk digunakan, maklumat itu diatur dengan baik dan, mempunyai antara muka yang menarik. Tiada hubungan di antara semua faktor sosio-demografi dan kebolehgunaan aplikasi, kecuali bagi jantina dengan kualiti antara muka ($r = -0.222$, $p < 0.05$). Hubungan penting juga didapati di antara fakulti dan kualiti maklumat ($r = 0.185$, $p < 0.05$), kualiti antara muka ($r = 0.374$, $p < 0.05$), dan kebolehgunaan keseluruhan ($r = 0.202$, $p < 0.05$). **Kesimpulan:** Kesimpulannya, alat pendidikan keselamatan dan kesihatan dan alat pelaporan hazard mempunyai potensi untuk merealisasikan objektifnya iaitu mendidik pelajar tentang asas keselamatan dan kesihatan dan memudahkan pelajar dalam melaporkan hazard di sekitar kampus. Aplikasi ini ditunjukkan untuk memiliki kebolehgunaan yang baik.

Kata Kunci: Kegunaan aplikasi, Keselamatan dan Kesihatan, aplikasi mudah alih, laporan hazard.

TABLE OF CONTENTS

DECLARATION.....	i
ACKNOWLEDGMENTS	iii
ABSTRACT	iv
ABSTRAK	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF ABBREVIATIONS	xii
CHAPTER 1:INTRODUCTION.....	1
1.1 Background	1
1.2 Problem Statement	4
1.3 Research Justification.....	7
1.4 Objectives.....	8
1.4.1 General Objectives.....	8
1.4.2 Specific Objectives	8
1.5 Hypothesis	7
1.6 Conceptual Framework	9
1.7 Definition of Term.....	13
1.7.1 Conceptual Definition.....	13
1.7.2 Operational Definition	14
CHAPTER 2:LITERATURE REVIEW	15
2.1 Definition of Hazard, Exposure and Risk.....	15
2.2 Safety and Health	15
2.2.1 Legislative Provision	17
2.3 Safety and Health in Higher Educational Institution.....	18
2.3.1 Accidents, Injuries in Higher Educational Institution	18

2.3.2 Current Knowledge Level of Safety and Health among University Students	18
2.3.3 The Importance of Knowledge and Awareness.....	18
2.5 Mobile Applications	21
2.5.1 Important of Mobile Applications in Education	21
2.5.2 Mobile Learning	22
2.5.3 Developing of Mobile Applications	24
2.5.4 User Interface (UI).....	25
2.5.6 User Experience (UX)	26
2.5.7 Usability.....	26
CHAPTER 3:METHODOLOGY.....	30
3.1 Study Design	30
3.2 Study Location	30
3.3 Sampling Method	30
3.3.1 Sampling Strategy.....	30
3.3.2 Sampling Population.....	31
3.3.3 Sampling Frame.....	31
3.3.4 Sampling Unit.....	31
3.4 Sampling Size.....	32
3.5 Instrumentation.....	34
3.5.1 Questionnaire	34
3.5.2 Mobile App.....	35
3.6 Data Collection Procedure.....	39
3.7 Quality Control and Quality Assurance	47
3.8 Data Analysis	48
3.9 Ethical Consideration	49
CHAPTER 4:RESULT	50
4.1 Demographic Information of Respondents	50

4.2 Usability Testing	51
4.2.1 Usability Questionnaire Results	51
4.3 Association between Usability and Socio-demography	55
CHAPTER 5:DISCUSSION	56
CHAPTER 6:CONCLUSION.....	63
6.1 Summary	63
6.2 Recommendation.....	63
6.2.1 Functionalities.....	64
6.2.2 Interface	64
6.2.3 Safety and Health Experts	64
6.2.4 Stakeholders.....	64
6.2.5 Study Improvement	64
6.3 Limitations.....	65
6.3.1 Covid-19 and Movement Control Order (MCO).....	65
6.3.2 Stable internet connection.....	66
6.3.3 Sample Size	66
REFERENCES.....	67
APPENDICES	74

LIST OF TABLES

	Page
Table 3.1 Stratification of students based on faculties	30
Table 3.2 Summary of Statistical Analysis	41
Table 4.1 Socio-demographic background of respondents	43-44
Table 4.2 Usability score percentage on Q1 to Q17 (N=151)	46
Table 4.3: Association between Usability and Socio-demographic	48

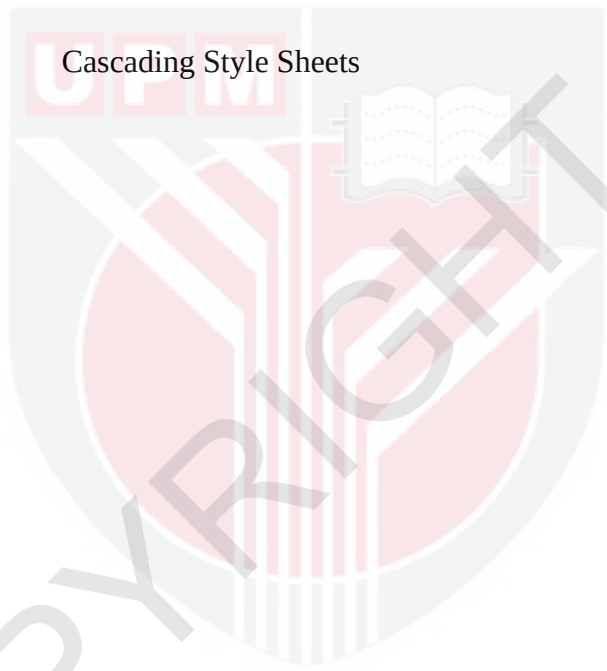
LIST OF FIGURES

		Page
Figure 1.1	Conceptual Framework	11
Figure 2.1	Distributed mobile learning platforms architecture	23
Figure 3.1	Drafted a few designs of interface	36-37
Figure 3.2	Message and link of the app were posted in Whatsapp and Twitter	41
Figure 3.3	Consent form via app	41
Figure 3.4	HazRep app listed in App Store and Google Play Store	42
Figure 3.5	Sign up process	43
Figure 3.6	App Information and Features	44
Figure 3.7	Details need to be fill up for hazard reporting via app	45
Figure 3.8	A completion of PSSUQ reminder popped up once a report was submitted	46

LIST OF ABBREVIATIONS

UPM	Universiti Putra Malaysia
PSSUQ	Post Study Usability Questionnaire
IBM	International Business Machines
OSHA	Occupational Safety and Health Act
OSH	Occupational Safety and Health
OSHUPM	Occupational Safety and Health Universiti Putra Malaysia
HazRep	Hazard Reporting app
SBS	Sick Building Syndrome
SOB	Shortness of Breath
NADOPOD	Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease
HIRARC	Hazard Identification, Risk Assessment and Risk Control
MCMC	Malaysian Communication and Multimedia Commission
FMHS	Faculty of Medical and Health Sciences
FVM	Faculty of Veterinary Medicine
FA	Faculty of Agriculture

FHE	Faculty of Human Ecology
FS	Faculty of Science
UI	Usability Interface
UX	Usability Experience
HTML	Hypertext Markup Language
CSS	Cascading Style Sheets



CHAPTER 1

INTRODUCTION

6.3 Background

Hazard is defined a source or a situation with a potential for harm in terms of human injury or ill health, damage to property, damage to the environment or a combination of these (Guidelines for Hazard Identification, Risk Assessment and Risk Control, 2008). Hazards can be divided into three categories; health, environmental and safety. Risk, on the other hand, is the product of the probability of a dangerous event occurring with a specified time or under specified circumstances and the extent of injury or damage to human health, property, environment or any combination of these induced by the event (Guidelines for Hazard Identification, Risk Assessment and Risk Control, 2008).

According to OSHA (1994), it shall be the duty of every employer and every self- employed person to ensure, so far as is practicable, the safety, health, and welfare at work of all his employees. Being part of the industry regulated by the OSHA (1994), the higher education institution such as universities and colleges are similarly subjected to the responsibility for providing information, instruction, training and/or supervision (where applicable) not just for the employees but extended to the students who are uniquely part and health.

The Occupational Safety and Health (OSH) policy in UPM was announced in 2013 with a commitment to protect the safety and health of all occupants within the campuses and create a conducive working environment. Within the university, the students were engaged in a broad range of activities not limited to the nature of academics or classrooms but also other outdoor involvements such as co-curricular, sports and student movements which exposes them to various hazards leading to accidents. There were lot of activities held by Occupational Safety and Health Management Office, UPM. The management held safety talks, safety week and forums almost each month. They also include participation from the students and the staff itself. The aim of the programs and activities were to increase the knowledge of safety and health among UPM students and staffs. This was a traditional method for learning which was widely used by most of department and management office. Furthermore, safety awareness of undergraduates are the main aspects of organizing safety culture (Gong, 2019). Accidents involving students in campuses are closely related to safety behaviour and safety attitude. Gong (2019) also point out that a consensus exists about the necessity to promote a substantial increase in the relevant safety culture at university. Therefore, understanding safety culture and taking measures to improve safety culture is a pertinent way to prevent accidents at university. In order to increase the flexibility of delivering educational information of safety and health, a conventional method was approached.

Advanced mobile devices like smartphones and tablets are popular with people today, mainly because they allow people to communicate and receive information while on the go. Mobile learning (M-learning) is the intersection

between mobile computing and e-learning. M-learning includes the application of small, portable, and wireless computing and communication devices. At the same time, e-learning used to facilitate and supported learning through the use of information and communications technology (Aker et al., 2014). Mobile learning is becoming a tool for disseminating safety and health information among students and staff in a university because IT development was rapidly growing. M-learning can improve mobility where the student can access the information instantly at any time and anywhere, an environmentally friendly, time-saving, and interactive method by limiting paper printing (N. S. Ismail et al., 2018). Mobile devices have switched from inexpensive leisure applications to more important market uses. While specific “classical” software engineering methods, such as the waterfall method, should be easy to pass to the mobile device sectors, the sector of mobile apps also needs research and development in many other areas, including academic, safety, and health.

Lewis (2006) found that evaluation of usability is regarded as one of the most significant and highly used methods for product design review. It attempted by simulating user interaction to assess the usability in controlled conditions of a product. According to the International Standardisation Organisation (ISO) (1998) usability was defined as “the efficiency, effectiveness and satisfaction in which established users could achieve specific objectives in a given environment”. Effectiveness refers to how successfully a task was accomplished (e.g., The proportion of users who can perform a specific task). Efficiency means the amount of resources a user spends on a task. The discrepancy can be calculated from the desired user behaviour (e.g. time to complete the task, number of user

activities to complete a task). Effectiveness and efficiency are both forms of success indicators. The attitude to the subject may be considered as satisfaction. It is a statistical metric, usually obtained in usability experiments by questionnaires.



1.2 Problem Statement

Hazards were not natural to identify, classify, or assess if the person does not have a foundation in safety and health. To the general untrained public, hazards were perceived as part of the natural environment. As such, the danger would be stayed unnoticed until an accident such as slip, trip, and fall, road accidents, etc. took place (Noorul Huda et al., 2012). The ineffective delivery of safety and health information among students by the university influences students' awareness of safety culture.

In a study that shown poor awareness and perception of health and safety amongst students in the university's residential college, only 29% (37 out of 139) of the respondents knew about the procedure and existence of OSH policy (Arifin et al., 2010). Arifin et al. (2010) claimed that there were insufficient access to information in addition to the lack of educational and promotional activities on safety and health by the university's management. The students were only unaware of the programs or news on safety and health on the campus. They also had a wrong perception about the OSHA 1994 that the Act only protects the workers (Arifin et al., 2010).

In the case of academic institutions specifically in Universiti Putra Malaysia, even if the students can identify or assess the risk, to a certain extent, they mostly do not know how to make a report or whom to report to. A feedback form was generally provided within the campus, such as in the offices or available online; however, filing a report traditionally would be tedious and cumbersome besides being delayed (Turner-McGrievy et al., 2013). The procedures and hotline number for reporting can only be found on the UPM's website or the guide-book provided during students'

orientation week in the first semester of freshman year. However, the hassle of the traditional reporting method discourages the notification and reporting of the hazard around campus. The accident that occurred within the university not only can cause physical injuries reduces productivity besides damaged reputation.



1.3 Research Justification

The higher educational institutions need to comply with the OSHA (1994) Section 15, as the employer, they were responsible to the welfare and safety of the employees. It helps them to fulfill those requirements by the DOSH

The identification of hazards is a critical step to maintaining a place's safety and health. The best approach and topics in the educational process must be discussed, and safety education recommendations that suit college, industrial, and governmental aspects need to be given (Hill, 2007). This research is vital to improve student safety and health awareness in the educational environment. Understanding the culture of safety and taking measures to enhance the perception of safety is, therefore, a proper way to prevent university accidents. Improving awareness and knowledge regarding safety and health is the best way to deliver safety and health information (Chang et al., 2016).

There is an urge to heighten the knowledge and awareness of safety culture, especially to the future generation that will graduate from universities to reduce the accident rate through the mobile-based application (D. H. Shin et al., 2011). This mobile application is intended to ease the process of reporting and notifying the hazards.

1.4 Objectives

1.4.1 General Objectives

To determine the usability of a mobile application which serves as an educational tool for safety and health for the students and concurrently provide a platform for reporting hazards to the management of the university.

1.4.2 Specific Objectives

- i. To determine the socio-demographic background (age, gender, race, faculty, year of study) among respondents.
- ii. To develop an educational safety and health and hazard reporting app for UPM students.
- iii. To determine the usability of the app.
- iv. To determine the association between usability of the app and the socio-demographic background.

1.5 Hypothesis

- i. There is an association between socio-demographic background and the usability of the app.

1.6 Conceptual Framework

Figure 1.1 shows the conceptual framework for this study. There are two hazard categories in which the students were exposed to campus; safety and health hazards. They were exposed to these hazards, mainly in the lecture halls, laboratories, college, etc. The purpose of hazard identification is to highlight the critical operations of tasks, that is, those tasks posing significant risks to the health and safety of employees as well as highlighting those hazards pertaining to certain equipment due to energy sources, working conditions or activities performed. Hazards can be divided into three main groups, safety hazards, health hazards, and environmental hazards.

Safety hazards is any force strong enough to cause injury, or damage to property. An injury caused by a safety hazard is usually obvious. For example, there was an obstruction in the hallway, and one of the students accidentally bump onto it and fall causing injury. Safety hazards cause harm when workplace controls are not adequate. Whereas any agent can cause any person to get ill is a health hazard. An urgent (acute) severe health threat can create or induce (chronic) long-term issues. The body may be affected entirely or partly. World Health Organization (WHO) also note that mold and the microbial agents may increase the risk of bronchial and fungal infections. Someone with a disease may not immediately recognize the symptoms. For example, pulmonary related illnesses often misjudged as a normal coughing or wheezing by the affected individual until it is well advanced. Health hazards include chemicals (such as battery acid and solvents), biological hazards (such as bacteria,

viruses, dusts and molds), physical agents (energy sources strong enough to harm the body, such as electric currents, heat, light, vibration, noise and radiation) and work design (ergonomic) hazards. Lastly, an environmental hazard is a release to the environment that may cause harm or deleterious effects. An environmental release may not be obvious. For example, a lab user who drains a glycol system and releases the liquid to a storm sewer may not be aware, of the effect on the environment. Environmental hazards cause harm when controls and work procedures are not followed.

To complete hazard identification, one can use techniques to identify hazards. Some examples of techniques include, but are not limited to (i) work place inspections, (ii) task safety analysis or job hazard analysis, (iii) preliminary investigations, (iv) potential accident factors, (v) failure analysis and (vi) accident and incident investigations. The degree of possible impact and the probability of its occurrence are defined in a qualitative analysis. Scales that may be modified or tailored to the conditions and with specific threats, different definitions should be used. This approach combines expertise and professional experience to assess the level of likelihood and severity.

There were two ways of reporting method, as shown in the figure. The traditional approach was filling up the hazard reporting form using pen and paper and submit it at administration offices. It was very time consuming and tedious to complete a single report. Hence, it was not sure when the report would be review by the administration. Confusion over the monitoring process and the lack of time for

documentation in a survey of psychiatric nurses have contributed to the lack of recording incidents. (Gifford & Anderson, 2010). The review by hospital personnel found a lack of clarification on what needed to be reported, the length of time necessary to complete processing and the lack of input from recorded accidents. (Evans et al., 2006). Actions and reviews on documentation are critical to fostering a culture of safety.

The conventional approach is by the electronic devices (mobile phones and websites). It can improve mobility where the student can report the hazards instantly at any time and anywhere, an environmentally friendly, time-saving, and interactive method by limiting paper printing.

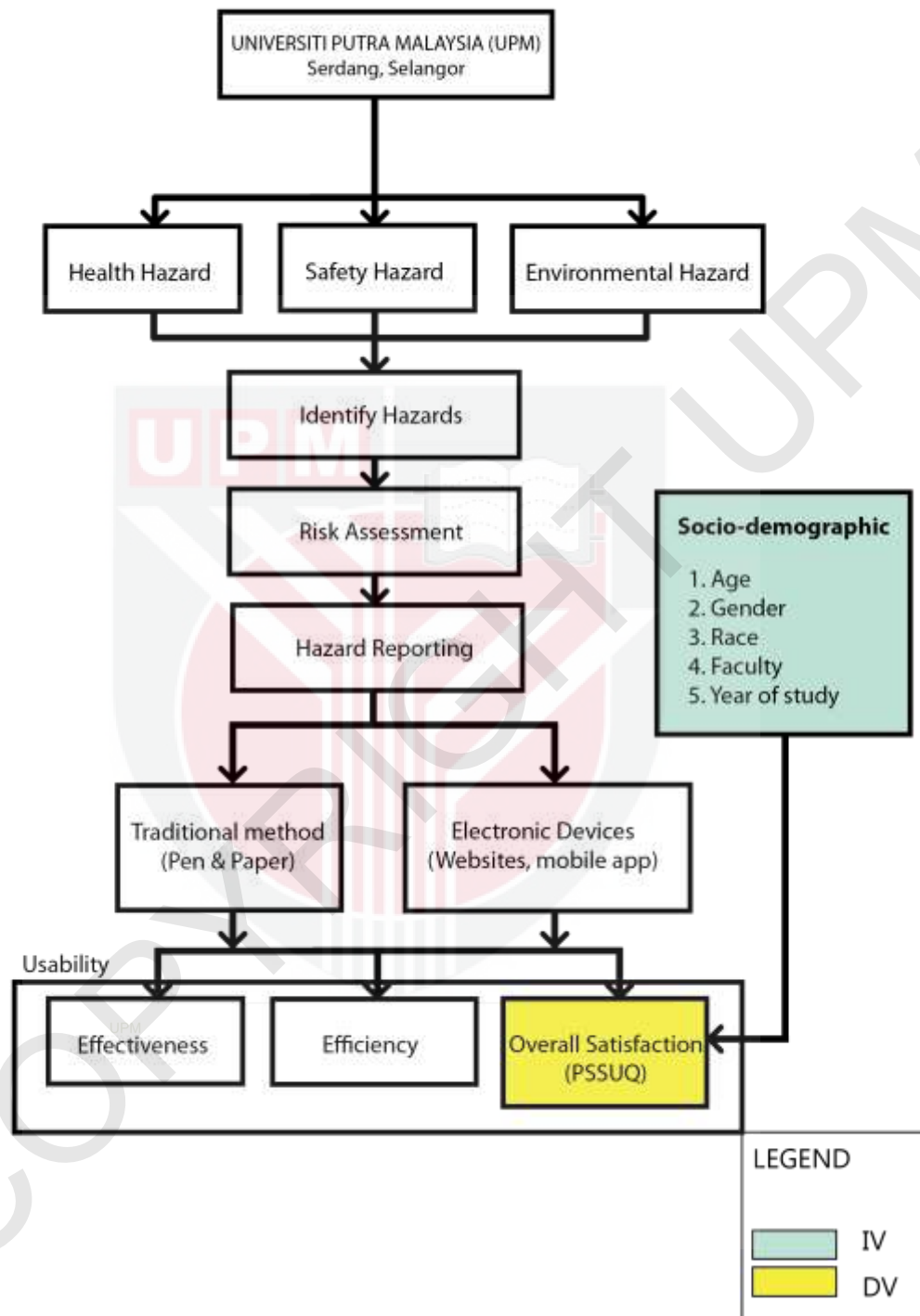


Figure 1.1: Conceptual Framework

1.6 Definition of Term

1.6.1 Conceptual Definition

- Socio-demographic

The characteristics of a population. Generally, components such as age, gender, ethnicity, education level, income, type of client, years of experience, location, etc. (Hitlin & Andersson, 2015)

- Mobile App

Software that is running on a small handheld mobile device which is moveable, easy to use and accessible from anywhere and any place (Islam & Mazumder, 2010).

- Usability

The point to which product or software can easily be used and learned without restriction, satisfy users expectation, and help users reach their own goals (Rubin & Chisnell, 2008).

1.6.2 Operational Definition

- Socio-demographic

The socio-demographic background of participants being studied including gender, race, age, years of study, and faculty of respondents by using the app where the respondents key in their information when they register as a user to use the app.

- Mobile App

Android Studio, Ionic, Visual Studio Code, Xcode and Adobe Photoshop and Adobe Illustration were used to develop the interface and functions of the mobile app. Respondents were required to use their mobile devices (handphones, tablets) to download and use the app.

- Usability Test

The usability of the app from the perspective of the respondents was being determined using the post-questionnaire adapted from IBM's Post-Study System Usability Questionnaire (PSSUQ) which embedded in the app.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of Hazard, Exposure and Risk

Hazard means a source or a situation with a potential for harm in terms of human injury or ill health, damage to property, damage to the environment, or a combination of these (Guidelines for Hazard Identification, Risk Assessment and Risk Control, 2008). A health hazard is any agent that may cause a person's illness.

Exposure is the probability that a worker is or has been affected by any job hazards that can lead to employment poisoning or work-related disease (Guidelines on Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations (NADOPOD), 2004).

Risk means the combination of the likelihood and seriousness of the accident or threat to the human health, the properties, the environment or any combination thereof incurred by the accident with the time or circumstances stated (Guidelines for Hazard Identification, Risk Assessment and Risk Control, 2008).

2.2 Safety and Health

The science of the detection, assessment, calculation, and avoidance of hazards that can affect the health and well-being in or out of workplaces is usually defined as occupational safety and health, taking into consideration the potential impact on the environment and community.

In the past five years the workplace environment has experienced major shifts in terms of working hours, years of jobs, organisation of work, form of job contracts and working conditions. Changes may include, for example, a rise in retirement age, a rise in regular and weekly working hours, "deregulation" of working hours, contractual and part-time jobs, labor contracting, outsourcing, subcontracting, self-employment, business downsizing, expanded workload and staff time demand (Papadopoulos et al., 2010). Dramatic changes continue to affect health and safety in the workforce. Occupational and environmental health concerns have a significant effect on the safety and welfare of each person (Slovak, 2012). Therefore, we all have a responsibility to address the issues that affect an organization's individual, family and community members (Levy et al., 2006).

Health and safety involve avoiding persistent and severe illnesses and eliminating threats from the workplace and environmental concerns involving external agents, chemical agents, biological agents, and stressors (Levy et al., 2006). The signs may not be recognised immediately by someone with an occupational disease. A safety hazard is a situation or force which were capable of causing injury or property damage which generally evident. For example, a worker could be severely cut where blood losses or any complication in-connection thereof may present life-threatening situation. If the control measures in an organisation were not appropriate.

Health and safety can influence people, organisations, and countries' economic costs. Low awareness of safety and health would cause a high rate of loss of employment, missed working hours, interruption to manufacturing, schooling, retraining, and medical costs.

2.2.1 Legislative Provision

According to Law of Malaysia Act 514 Occupational Safety and Health Act (OSHA) (1994), Section 15 (1) state that every employer and self-employed person to ensure as far as practicable the safety health and welfare of all his employees. Within the scope of this study, the OSHA 1994 includes setting in the higher educational institution where the administration of the university needs to take care of the safety and health and welfare of all the employees, including students. On the same note, the legislation also stipulate that every employee needs to take reasonable care for the safety and health of himself and other persons who may be affected by his acts (OSHA, 1994). However, the same cannot be applied to students. Students are not employees as per definition underlined by the Malaysia Employment Act, 1955 as they were not tied to a specific contract which the services provided is remunerated for the services rendered. In relation to that, provision of the Section 17 and 18 of OSHA 1994 specify that it is the responsibility of the employer and occupier to ensure safety and health.

Besides that, the Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC) (2008) was created to guide the employers comply with the

legislation. This guideline has guided the methodology of conducting HIRARC in workplaces. The legislation provides a standardised systematic method so that findings were accurate. The risk evaluation method should be constant and not use as a single exercise. Thus, this application was compliment towards the requirement of the HIRARC itself.

2.3 Safety and Health in Higher Educational Institution

2.3.1 Incidents and Injuries in Higher Educational Institution

Higher education institutions are often considered as shelters, secured areas, in which younger folks pursue amazing ideas and create life-long friendships in the college setting. In multiple laboratory accidents proof of poor safety awareness was found: measured at 2.5 lab accidents in university settings weekly (Stuart & Toreki, 2014) (media-reported incidents only, so actual rates are much higher). The Centers for Disease Control and Prevention (CDC) reported that the industry of Educational Services (ES) came in second among top industries with chemical accidents, and two-thirds of the ES accidents recorded were among the students (Anderson, 2015). These high levels represent an unsatisfactory condition for safety education.

2.3.2 Current Knowledge Level of Safety and Health among University Students

In our society, students or young adults were lacking awareness in terms of safety and health. They were exposed to various types of hazards every day without

knowing the risk of it. Existing risks were neglected, and they are clueless on how to tackle this issue because of the absence of safety and health knowledge towards their settings (Tureková & Bagalová, 2018). During the education process, students were in contact with potentially hazardous materials of chemical, physical, or biological nature (Blair et al., 2004). The foundation of effective prevention is by the first acknowledgement of these materials and determine the sequel steps to mitigate injuries (Auyong et al., 2016).

Research on undergraduates' safety culture in the educational setting in Malaysia is inadequate compared to research on industrial workers. Nevertheless, there were differences between the safety culture of undergraduates and an employee because of their background and different work content. (Petitta et al., 2017). To better understand and prevent occupational accidents and work-related illnesses among young workers, there is a need to target specific groups of young workers that were particularly vulnerable (Gong, 2019). Human development is marked by learning, discovering, and differentiating right from wrong. These habits were usually acquired through the family environment and school education.

Therefore, it is necessary to implement OSH into education in such a way to enable the students to avoid hazard (Tureková & Bagalová, 2018). If safety and health awareness have been introduced in the campus yet the level of knowledge among undergraduate students were alarming, then, the current methods used to deliver the occupational safety and health information were not adequate or effective enough (Ismail et al., 2018).

2.3.3 The Importance of Knowledge and Awareness

Knowledge is a critical resource in preserving, preserving, solving issues, building core skills, and introducing new situations to individuals and organisations (Farouk et al., 2011). According to Lugah et al. (2010), safety and health awareness were vital for organisations' injury prevention. Education can help to develop and apply strategies and practices which were better and more environmentally friendly for everyone (Goel et al., 2010).

Recent graduates have inadequate health and safety skills, but they do not realize that they are incapable of safety until they confront the safety obligations of their new activities, which allow them to recognize and use safety knowledge and to have solid safety ethics. A respected university professor probably best explained this: "New chemistry Ph.D. graduate has been said to represent the greatest hazard in an industrial laboratory" (Shreeve, 2015). Mason (2014) stated that industry is often a strong advocate of safety and aligned with study by Banholzer et.al (2013) and Marvel (2015) which stated industry has long been complaining of inadequate safety education, and has even dedicated its own resources to help academic institutions improve their academic laboratories safety measures. Students with better health and safety management practices are likely to be seen as better career candidates in business and government.

Since most students do not know where they will come in the future, it is important to clarify basic safety and health in the broadest sense. (Hill & Finster, 2016; National Research Council, 2011). This education should be principle-based safety—RAMP: Recognize hazards; Assess the risks of hazards; Minimize the risks

of hazards; Prepare for emergencies (Hill & Finster, 2016). Safety training might concentrate on hazard awareness in terms of chemical and science concepts such as: formulae, reaction equations and profiles; thermodynamics; structure-activity relationships; hazard risk assessment; safe practice in mitigating hazard risks; and emergency preparedness.

2.4 Mobile Applications

2.4.1 Important of Mobile Applications in Education

The most concerned and rapidly developing areas in the current era were mobile applications (Islam & Mazumder, 2010). It can be supported by Statista (2018), the number of mobile phone users in the world is expected to pass the five billion and forecasted to continue to grow, rounding up to 67 per cent by 2019.

According to the Malaysian Communication and Multimedia Commission (MCMC) (2014), the number of smartphone users among the young age group of 20-24 in 2014 was the highest compared to other age groups (24.5%). It shows that 1 in 2 Malaysians were smartphone users. This number was increased from 14% in 2010 to 53.4% in 2014, where 90.1% of smartphone users access the internet via a smartphone.

The mobile technology has been identified as a potential delivery alternative since it can provide services anywhere anytime (Ellis, 2015). As mobile applications widely typical to a younger generation, therefore, they were the leading group to be

in this study. Mobile apps do not apply to games, photography, or videography only. It could help in increasing knowledge, especially in education.

Based on the study by Botzer & Yerushalmy (2007), a pilot case study has been done intended to examine how socio-cultural and situated learning aspects were reflected in learning experiences within an innovative mobile learning environment.

It shows that mobile applications as a tool of learning were becoming popular (Bidin & Ziden, 2013), and this app was more than just an information app. It offers a report and notifying features for any possible hazards spotted on the campus. Furthermore, mobile apps require only a phone and a stable internet connection to be accessed anytime and anywhere.

2.4.2 Mobile Learning

Due to the increased popularity of mobile devices, the development of mobile learning applications and their usage in class have been widely adopted all over the world. One of the most comprehensive example of a mobile learning application would be Mobile Moodle (MoMo) (Yingling, 2006) and Mobile Blackboard (Kinash et al., 2012). However, mobile learning is a term that is yet to be explicitly defined. Sharples (2000), described it as “learning that happens without being limited at a fixed location” and “learning that takes advantage of mobile technologies”, while Traxler (2009), defined it as an exploitation of both handheld computers and mobile telephones and other devices that draw on the same set of functionalities. Mobile learning using handheld computers is relatively immature in terms of both its

technologies and its pedagogies but is developing rapidly. It draws on the theory and practice of pedagogies used in technology-enhanced learning and others used in the classroom and the community.

Several researchers carried out more discrete analyses with a emphasis on higher education. Such reports, however, have also reduced the emphasis to include only some areas of higher education. Alrasheedi et al. (2015) explored important factors affecting the implementation of mobile learning. Based on Rogers et al. (2019) diffusion of innovations theory, From 2005 to 2013, Alrasheedi et al. (2015) reviewed 30 studies. Their study found 14 important variables that have a significant impact on the introduction of mobile learning. Researchers showed that whether or not students thought their efficiency increased by mobile learning was the most important factor in performance. They have also found that students are fairly happy with the use of mobile learning and are looking forward to using mobile learning in the future.

From 2000 to 2013, Pimmer et al. (2016) has reviewed 36 research to figure out how virtual schooling in comparison to current models of learning is used in higher education. Their finding implies that the most influential learning model was instructionism, rooted in the philosophy of behavioralism. Instructionism is the theory that says, "We have to improve instruction to get better education and when we are going to use computers, then we have the computers doing the instruction". A research exploring disparate characteristics such as system form, teacher expectations and student philosophy constructs was undertaken by Kaliisa & Picard (2017). The research was selective as only experiments carried out in Africa were

included. All of these studies are useful, but only minimal mobile learning dimensions of higher education are shown. Pimmer et al. (2016) reported that there is no institutional information about the use of mobile learning in higher education environments. This systemic review aims at a comprehensive, modern (2010-2016) review of higher education mobile learning from various countries with this acknowledged gap in academic comprehension.

2.4.3 Developing of Mobile Applications

In the creation of mobile applications for educational material, there have been many approaches. Pemberton, Marcus, & Fallahkhair (2009), developed a web-based mobile app to help users with language learning to incorporate user content paradigm into mobile learning. The software provides information by using entities as a reflection of the system's data. Usage simulations were built with these people that illustrate the future use of the program in different contexts such as personal, educational, and recreational activities to support the engineering and design team build the software and express the vision with potential investors.

Mobile application development has been gaining popularity in Malaysia over the past three years. An app usually refers to a specific function of software applications or programed (Wong et al., 2012). Users' engagement (users' attraction and retention) with mobile applications becomes extremely important (Fang et al., 2017). It is hard to gather all information on how an optimum mobile apps interface looks like. The usability of mobile applications was critical for their adoption

because of the relatively small screen and awkward (sometimes virtual) keyboard, despite the recent advances of smartphones (Ma et al., 2013)

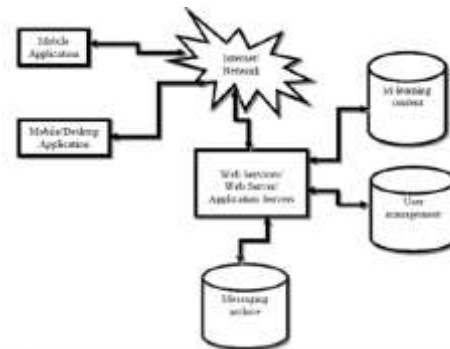


Figure 2.1: Distributed mobile learning platforms architecture

2.4.4 User Interface (UI)

In the 1970s, computers emerged in places including home, and the relationship people with computer systems were brought to the attention. Thus the field of Human-Computer Interaction (HCI) began to emerge. (Churchill et al., 2013). HCI covers a vast area, as well as the design of an efficient UI, has always been emphasised because the use of effective interfaces can improve system performance overall. (Mani et al., 2015). The creation of a successful UI is a significant challenge as it involves understanding the various disciplines such as the physical and cognitive capacities of users, the sociological backgrounds, informatics and architecture, web design and work areas (Mani et al., 2015; Brodić & Amelio, 2020). A valid user interface will be developed based on functional perspectives.

In response to technical advances, HCI evolves continuously. In the first step, HCI focussed on how a single person would access a computer, such as laptop machines, on a fixed board. HCI was not limited to stationary computers at the second level. In the late 1990s, mobile computing began. A lot of small screen actions and feedback and a few buttons became the focus of the HCI community (Y. Shin et al., 2017). Several firms, like Samsung, Apple, and HTC, launched mobile app models in 2007. The new versions have been replaced by touchscreens and are no longer fitted with keyboards. This has since caused a significant change in research attention (Lee & Zhai, 2009; Perry & Hourcade, 2008).

Globally, over a billion mobile users have a significant number of non-generic users. Mobile platforms were an essential part of everyday life, but there are no real requirements for mobile user interface design. Many projects appear to be based on the model on the desktop (Nathan & Scobell, 2012). There may be a laptop model, but there are significant differences between handheld apps and desktops, such as a lack of touch support, small screen space and high demands for visual focus. There are different reasons to use between desktop and mobile computers, aside from physical quality discrepancies. Desktop machines are stationary, while handheld apps can be used anywhere and wherever people walk, hold or move.

2.4.6 User Experience (UX)

User Experience (UX) has been described as “The cumulative perception of what a user feels and perceives, considers and responds through the use of a product and service” (ISO, 2010). The process through which users gain experience from the

first meeting with the product and from the time that the product is used is an essential concept in UX (Pucillo & Cascini, 2014). Three characteristics may clarify UX. The first is UX's fundamental existence. The holistic term UX requires a wide variety of features, not only visual, touch, auditory elements of the system but also how the device functions in an appropriate area of use or meaning (Kim, 2015). The second aspect is that the UX focus is highly directed to the consumer. UX and UI are often confused because their abbreviations are identical. UI seems to lean to a computer side, and performance checking or predictive analysis is also performed in UI tests. UX, on the other hand, addresses the way people behave, believe and act (Kim, 2015). The third aspect is that when designing a product or service for the client, UX has competitive importance. UX has recently become a popular focus for top management (Kim, 2015).

The aim is to foster good feelings in UX (for example, rewarding, pleasurable, thrilling, inspiring, fun) and to reduce negative emotions concerning this commodity (e.g. dull, irritating, unpleasant). In comparison to usability goals, UX expectations are intangible characteristics and how a system looks to a consumer. Quantitative analysis attempts were made to measure the feeling of people (Lazar et al., 2017). However, it remains uncertain regarding its significance in assessing user experience. Although they are distinct in usability and UX, they are not entirely segregated. Usability is also part of the experience of consumers. An example is the favourable impression of the first touch with a visually friendly product, but if the user interface is unsatisfactory, it can affect the whole user experience. Many main UX components include valuable and attractive products, functionality, integrity, eye pleasure, and entertainment in addition to usability (Simonsen, 2017).

2.4.7 Usability

The usability evaluation is considered one of the most significant and used tools for evaluating product design (Lewis, 2006). It attempted by simulating user experience to test the usability under controlled conditions of a product. Usability has been described as “the efficiency, effectiveness and satisfaction with which specified users in a particular setting can achieve particular objectives” according to the International Standardization Organization (ISO) (1998). Effectiveness refers to how a task has been successfully completed (for example, a percentage of the users who can execute a specific task). Efficiency refers to the amount of time the user uses on a job. Difference can be calculated from optimum user activity (e.g. completion of the task, number of user activities to complete a task). Effectiveness and efficiency reflect various types of measurements of output.

Satisfaction may be called an attitude to the product. It is a subjective measure typically obtained in usability tests through questionnaires (PSSUQ or CSUQ). In the late 1980's, as part of the early-user interface testing project on IBM, Jim Lewis created the Post-Study Usability System Questionnaire (PSSUQ) and the Computer System Usability Questionnaire (CSUQ). The questionnaires are common for assessing the perceived applicability and are later published in 1995. Like the SUS, PSSUQ is an agnostic technology that can be applied to any

interface – hardware, software or mobile apps. The PSSUQ language is appropriate to be used at the completion of a typical task-based usability report, and the things were written in the past tense to identify the tasks that were previously performed (e.g., I was able use this system). The CSUQ wording, on the other hand, is appropriate for surveys and field research and objects and usually written in present tense (e.g., the system is simple to use).



CHAPTER 3

METHODOLOGY

3.1 Study Design

A cross-sectional study was carried out over two months among local undergraduate students starting from May until June 2020 throughout the five faculties in UPM Serdang Campus.

3.2 Study Location

This study was conducted at the main campus of Universiti Putra Malaysia, which was located at Serdang, Selangor.

3.3 Sampling Method

3.3.1 Sampling Strategy

The convenience sampling was used in this study. The study population was grouped according to the location of the faculties in consideration of cost-effectiveness in this study. The respondents were chosen based on the criteria detailed in sub-chapter **3.3.4.1**

3.3.2 Sampling Population

The sampling population in this study were all the undergraduate students who were studying in the Serdang campus of UPM.

3.3.3 Sampling Frame

The sampling frame was the list of all currently active students in each of the faculties' administrative offices.

3.3.4 Sampling Unit

3.3.4.1 Inclusion Criteria

The sampling unit was the undergraduate students who fulfil the following inclusion and criteria:

- i. Students who own smartphone
- ii. Have a stable internet connection

3.3.4.2 Exclusion Criteria

- i. Postgraduate student.
- ii. Disabled student (blind, not sensitive to touch)

3.4 Sampling Size

The Krejcie & Morgan (1970) formula was used to calculate the sample size estimation as follow;

$$s = \frac{X^2(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Where;

s = required sample

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level

$$(1.96 \times 1.96 = 3.8416)$$

N = the population size (5090 undergraduate students from five faculties in UPM Serdang Campus)

P = an estimate of students' basic knowledge of occupational law proportion (0.224) based on Arifin et al., (2010).

d = the degree of accuracy expressed as a proportion (0.05)

Therefore;

$$s = 1.96^2(5090) (0.224) (1-0.224) \div 0.05^2(5090-1) + 1.96^2 (0.224) (1-0.224)$$

$$s = 1.96^2 \times 5090 \times 0.224 (1-0.224) \div (0.05)^2 (5090-1) + 1.96^2 \times 0.224(1-0.224)$$

$$= 259 \text{ respondents.}$$

Based on the formula, 259 respondents were needed. The sample for the strength of analysis of the study and the non-responsive respondents, missing data, and errors were considered by adding 10% of respondents. Hence, the total number of respondents in this study were 288 respondents. The respondents required were stratified based on the cluster of faculties selected for this study with examples as follow:

The formula for stratification the percentage of the student based on the program:

$$(No \text{ of students} / Total \text{ student of Health Sciences Program} \times 100)$$

The formula for calculating the number of respondents based on the program:

$$(Percentage / 100 \times Sample \text{ size})$$

Table 3.1: Stratification of students based on faculties

Faculties (N)	Percentage of students based on the program (%)	Number of respondents (s)
Faculty of Science (1473)	$\frac{1473}{5090} \times 100 = 28.93$	$\frac{28.93}{100} \times 288 = 83$

Faculty of Medical and Health Sciences (1138)	$\frac{1138}{5090} \times 100 = 22.36$	$\frac{22.36}{100} \times 288 = 64$
Faculty of Veterinary Medicine (563)	$\frac{563}{5090} \times 100 = 11.06$	$\frac{11.06}{100} \times 288 = 32$
Faculty of Human Ecology (916)	$\frac{916}{5090} \times 100 = 18.00$	$\frac{18.00}{100} \times 288 = 52$
Faculty of Agriculture (1000)	$\frac{1000}{5090} \times 100 = 19.64$	$\frac{19.64}{100} \times 288 = 57$

3.5 Instrumentation

3.5.1 Questionnaire

There were two sections of questionnaires used in this study. Section A is the socio-demographic background (which include gender, race, age, faculty and years of study), and section B is the usability questionnaire. It was adapted from the Post-Study System Usability Questionnaire (PSSUQ) (Lewis, 2002). A series of 17 questions answered by the respondents was used to evaluate users' experiences throughout the usage of the app. It was developed by IBM, which has been used extensively in measuring the usability of a system. The questionnaire uses Likert-scale from 1 (Strongly Disagree), 2 (Fairly Disagree), 3 (Neutral), 4 (Fairly Agree), and 5 (Strongly Agree) to determine the respondents' agreement with the different elements of usability.

Besides the overall score, the 17 questions of PSSUQ can be further grouped as follows: usefulness of the app (Q1 – Q7), information quality (Q8 – Q13), interface quality (Q14 – Q16), and overall usability (Q1 – Q17) (Teodorescu, Watada & Jain, 2009). The usability questionnaire was designed to be triggered upon the first reporting of hazard via the in-app function. A recurring reminder was sent to users once every two days in order to remind participants to complete using the app – to report hazards observed within their environment.

3.5.2 Mobile App

There were various tools used to build this mobile app. It helps in making the best UI and the top-notch of UX for all users.

3.5.2.1 App development framework

Ionic Creator was used to develop the app framework. It is an open-source programming package for the development of high-quality web technologies (HTML, CSS, and JavaScript) smartphone and desktop applications. The Ionic system was based around an app's immersive user interface (controls, interfaces, movements, animations). It was conveniently combined with other libraries and objects or used separately with a basic script without a software structure. The Ionic Creator already has approved Angular integrations. It runs on various formats, including native iOS,

Android, mobile, and the internet-all from a single code base. Write once; use anywhere. Ionic System was designed to function and display both channels entirely out of the package. Start with pre-designed elements, typography, and immersive paradigms and a marvellous (and yet expandable) style.

3.5.2.1 Programming Languages and Techniques

The TypeScript was intended for large-scale frameworks and JavaScript transcompiles. Because TypeScript was a JavaScript preprocessor, current programs in JavaScript were also valid programs in TypeScript. The typeScript was used to build a framework for JavaScript, both on the client and the server-side.

3.5.2.2 Database

The software uses Firebase (supplied by Google) for the data component. It was a platform for databases to support data, storage, and user authentication. It was the Application Manager, the Database, and the datastore, written in such a general way that we can adjust it for most requirements. Occasionally, with specialised apps, it needs to include other Google cloud parts. As soon as it has modified, Firebase sends updated data. If a user saves the info, the updates were obtained almost instantly by all related users. It offers a convenient way to store binary files, mostly images were used directly from user to Google Cloud Storage and comes with its protection regulations to secure Google Cloud bucket from crowds. It was thus supplying authorised customers with comprehensive write rights.

3.5.2.3 Debugging and Code Editing

Visual Studio Code combines the simplicity of a source code editor with powerful developer tooling. It supports Windows, macOS, and Linux. This tool provides debugging support, syntax highlighting, smart code completion, samples, and Git embedded application refactoring. This can be used to modify the topic, keyboard shortcuts, preferences and enable additional features. This helps to access one or more files instead of a project framework, which can be stored in working space to be reused in the future. This allows it to function with every language as a language-diagnostic computer editor. It supports several languages of programming and a number of functions that vary according to language. The project tree will delete unsolicited files and directories via the settings. Many Visual Studio Code features may be accessed via a command palette, not through menus or through the user interface.

Extensions, accessible from a single repository, would extend the Visual Studio Code. This includes editor and language support additional information. The ability of making plugins that provide support for new languages, themes and debuggers, static code search and the use of the Language Server Protocol is a remarkable benefit. Visual Studio Code contains multiple FTP extensions that enable the software to be used as a free web development alternative. By importing any external program, the file can be synced between the editor and server. Visual Studio Code helps users to configure the application page where the active document is stored, the

newline character and the active document programming language. This can be used on any computer, locally and with any programming language.

3.5.2.4 Further Development of the App on iOS and Android Platform

XCode provides source code for a range of programming styles like Cocoa, Carbon and Java, for programming languages like C, C+, Objective-C, Objective-C++, Java, AppleScript, Python and ResEdit (Rez), as well as for Swift. Xcode could build fat binary files with Mach-O executable format containing code for different architectures. The program can be managed with PowerPC and Intel-based (x86) platforms and both 32-bits and 64-bit codes can contain these universal binary data. Xcode can also be used for compiling and debugging iOS programs operating on ARM architecture processors via the iOS SDK. Xcode contains a GUI application, DTrace, developed by Sun Microsystems and published as part of OpenSolaris, operating on a dynamic monitoring architecture.

Android Studio provides Gradle-based build support, Android-specific refactoring and fast fixes, the Lint tools for recording results, usabilities, version compatibility and other issues, ProGuard combining and device signing features, template-based wizards for popular Android designs and components. A rich interface editor that helps users to drag and drop UI elements, pre-view templates on multiple device setups, support for creating Android Wear devices, Google Cloud Platform built-in functionality, integration with the Google App Engine and Android

Virtual System (Emulator) for running and debugging applications with Firebase Cloud Messaging. (Google Cloud Messaging).

3.6 Data Collection Procedure

Step 1: Obtaining Ethics Committee Approval

A proposal was submitted to UPM Ethics Committee alongside three forms; Checklist for Applicants, JKEUPM Application Form, and Respondent's Information Sheet and Informed Consent for approval.

Step 2: Development of the app

The mobile app was developed using Ionic Creator (subchapter 3.5.2.1) Visual Studio Code (subchapter 3.5.2.3) To test the app, Android Studio was used for Android-based and Xcode for iOS-based devices detailed in subchapter 3.5.2.4.

In the initial draft design, a simple graphical user interface concept was designed (see Figure 3.1) to ensure that the mobile device functionality was well built for its representation layer. The app was built such that the data collected for the project would be registered into a cloud database according to the specifications for the app layout after ensuring seamless flow between pages.



Figure 3.1: Drafted a few designs of interface

Towards the final output of the app, the app coding process undergoes rigorous testing and software enhancements when all iterations have been made in each step. Each module was tested to allow the use of the latest version of iOS or Android. The final version of the app contains five primary tabs which display different contents; reported hazards map, videos and infographics of safety and health, the provision on Occupational Safety and Health legislation, UPM Safety and Health Policy, emergency notification numbers, and account personalisation. The language of the app was in English in order to fulfil the expedited requirement for app publication in both Google Play Store and iOS.

Step 3: Recruiting Respondents

The study begins with establishing the pool of respondents' databases from five faculties (Faculty of Medicine and Health Sciences (FMHS), Faculty of Veterinary of Medicine (FVM), Faculty of Science (FS), Faculty of Agriculture (FA), and Faculty of Human Ecology (FHE)).

All of the respondents were filtered based on the inclusive criteria in accordance to the sub-chapter 3.3.4.1. The recruitment was via invitation link posted in various social media and messaging platform, which includes WhatsApp, and Twitter. Each of 30th respondents participated, a token of RM30 was given to the person.

Step 4: Respondents' Briefing

The respondents were virtually briefed using a text messages via social media and messaging platform, which includes WhatsApp, and Twitter (see Figure 3.2). The purpose of this study and how their participation can help in improving safety and health in Serdang campus, UPM were displayed as Respondents Consent Form in app (see figure 3.3). This process displayed a checkbox, and they checked it to proceed. This both app were used as the medium of communication between the researcher and the respondents throughout the study.

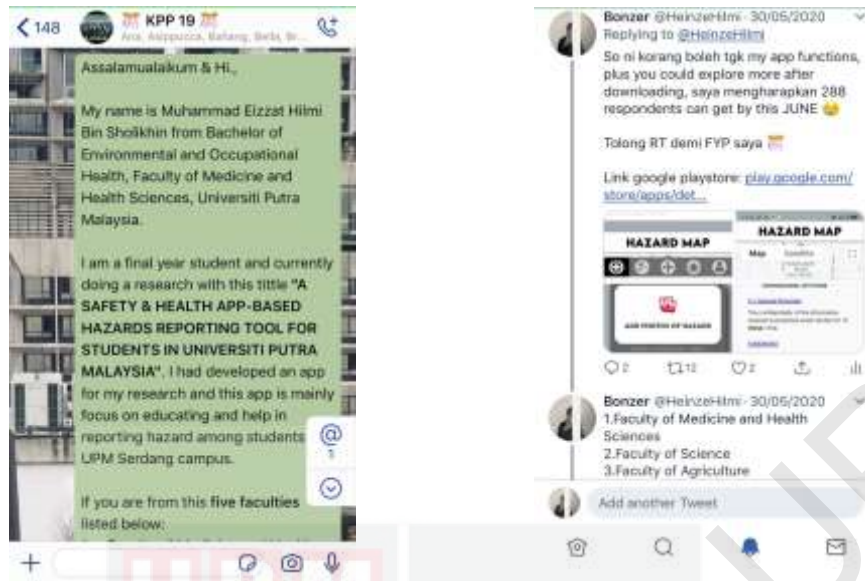


Figure 3.2: Message and link of the app were posted in Whatsapp and Twitter

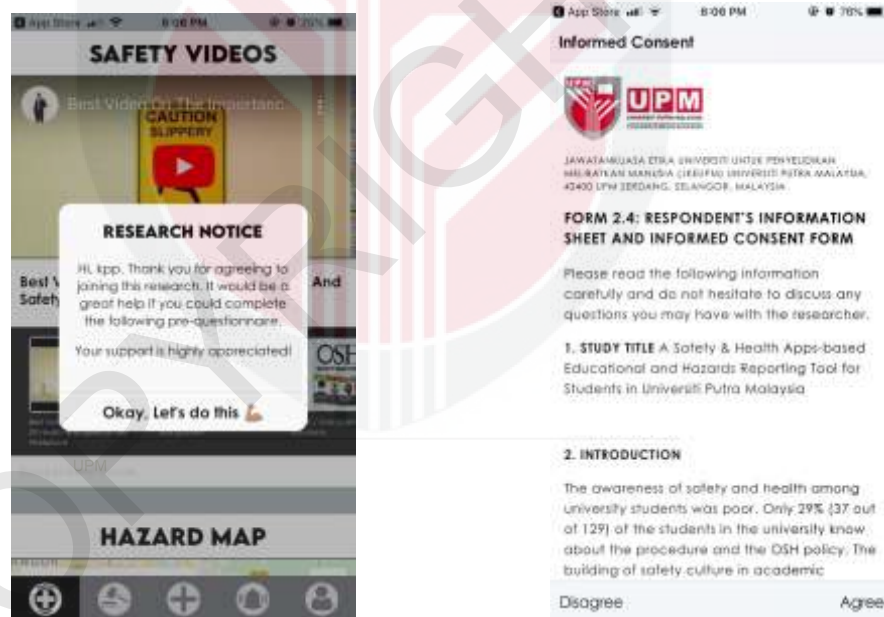


Figure 3.3: Consent form via app

Step 5: Downloading the App

All respondents were required to access their mobile application store (Google Play Store or App Store) and download the app. The app which runs on Android-based device is available for download in Google Play Store at <https://play.google.com/store/apps/details?id=com.alaswerapps.hazrep> while the iOS version is available for download in AppStore at <https://apps.apple.com/app/hazrep/id1510647708> (see figure 3.4).

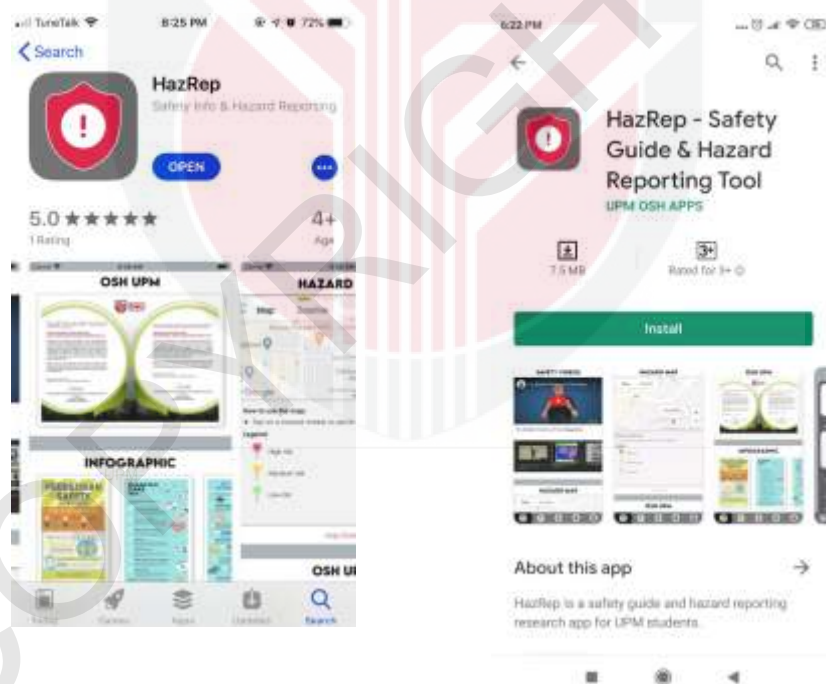


Figure 3.4: HazRep app listed in App Store and Google Play Store

Step 6: Sign up or log in into the App

The app requires respondents to sign up in which the details provided (matrics number, full name, phone number and faculty (optional), email address, and password) for login. It serves as a database for further data analysis. Following login, the respondents agreed to give their consent for the researchers to use their data for study purposes.

The figure displays two screenshots of the HAZREP mobile application interface. The left screenshot shows the 'Create your account' screen, which includes a 'CONTACT INFORMATION' section with fields for 'First Name', 'Last Name', and 'Phone No. (optional)', and a 'STUDENT INFORMATION' section with fields for 'Student Matric ID' and 'Faculty (optional)'. The right screenshot shows the 'Login' screen, which includes a 'STUDENT INFORMATION' section with a 'Student Matric ID' field and a 'LOGIN INFORMATION' section with fields for 'Email', 'Password', and 'Confirm Password'. A 'JOIN NOW!' button is visible at the bottom of the login screen, along with a link to 'Have Account Already? Log In Here'.

Figure 3.5: Sign up process

Step 7: App Layout and Information

They went through all of the content in each tab in the app. Within the app, the hazards map shows the users the location of hazards which has been reported. The videos and infographic tab serves as an educational tool on concepts, definition and application of safety and health (see Figure 3.5). At the same time, the legislative provision on OSH was provided via linked external resources (ProAtoZ) for the users (see Figure 3.5). Specific information on OSH Policy and emergency notification contact number were also provided within the app (see Figure 3.5).



Figure 3.6: App Information and Features

Step 8: Make a Report

In order to report hazards observed, respondents were required to take a picture(s) of hazards or situation (up to 4 photos) which is attached to the report. The

report requires users to further furnishes the detail of their observation which includes (see Figure 3.6):

- i. the classification of the type of hazards (Biological, Chemical, Physical, Ergonomic, or Psychological),
- ii. the urgency (high, medium, low) which portray the exposure probability,
- iii. provide the location of hazards in writing or via auto-detection using Global Positioning Satellite (GPS), and
- iv. other supplementary detail or information

The reported hazards were designed to appear on hazard maps immediately.

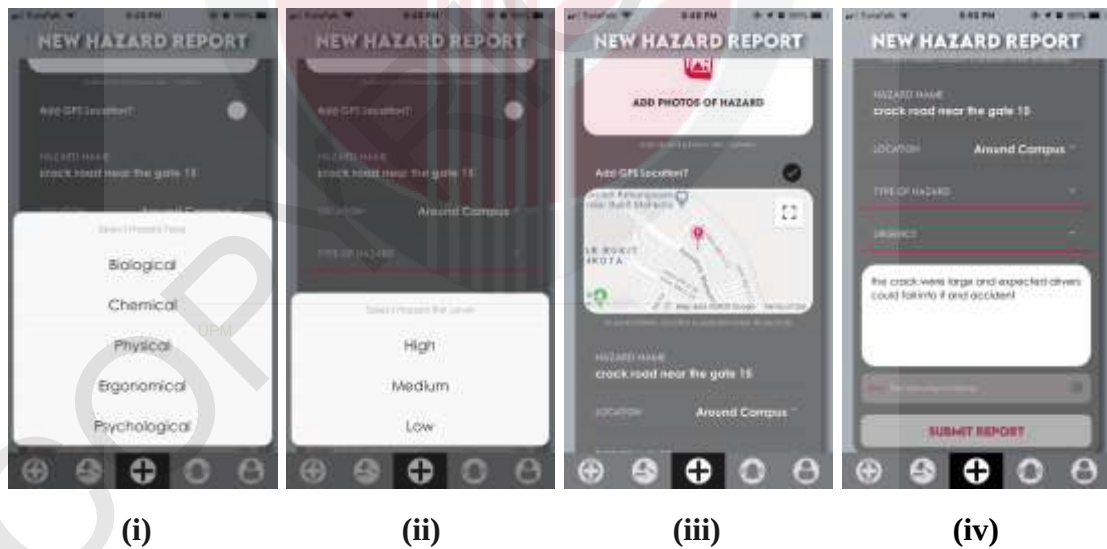


Figure 3.7: Details need to be fill up for hazard reporting via app

Step 9: Completing Post-App Usage Questionnaire

Finally, they need to complete the PSSUQ after first reporting of hazard via the in-app function. A recurring reminder was sent to users once every two days in order to remind participants to complete using the app – to notify hazard observed within their environment.



Figure 3.8: A completion PSSUQ reminder popped up once a report was submitted

3.7 Quality Control and Quality Assurance

Quality assurance was concentrated on assuring that quality requirements were fulfilled, whereas quality control was focused on meeting quality requirements (Manghani, 2011). The app was run for initial testing during the development phase to ensure that the app functions meet the requirements of this study. Before the usage of the app, the respondents were briefed about the objectives of the study and the task to be carried out in the study.

3.8 Data Analysis

Data that obtain from this study were analysed by using the software Statistical Package for Social Science (SPSS) Version 25. The summary of the data analysis that was used in this study was as in Table 3.2.

Table 3.2: Summary of Statistical Analysis

Objectives	Hypothesis	Statistical Analysis
To develop an educational safety and health and hazard reporting app for UPM students.	No hypothesis	Not Applicable
To determine the socio-demographic background (age, gender, race, faculty, year of study) among respondents.	No hypothesis	Descriptive statistic (frequency and percentage)
To determine the usability of the app	No hypothesis	Descriptive statistic (frequency and percentage)
To determine the association of the usability of the app and socio-demographic background students	There is an association between socio-demographic background and the usability of the	Spearman Correlation

3.9 Ethical Consideration

Ethical approval was obtained prior to data collection from the Ethics Committee for Research involving Human Subjects University Putra Malaysia (JKEUPM). Written consent forms from the parents and respondents were obtained prior to the study. Short briefing to the study subjects was carried out to ensure they understand the procedure and instruction before the data collection process. All the collected data from this study were confidential. A RM30 token was given to each 30th respondents of this study.

CHAPTER 4

RESULT

4.1 Demographic Information of Respondents

From the result in table 4.1, it shows that the highest number of the respondent was 23 years old, with a total of 69 (45.7%) from 151 total respondents. The respondent was mainly Malay (90.1%), followed by Bumiputera (Sabah and Sarawak) (6.6%). Most of the respondents participated were female (54.3%). Out of five faculties, Faculty Medicine and Health Sciences, where most respondents (42.4%) participated in this study, followed by the Faculty of Agriculture (31.1%). Fourth-year students dominated in this study with (47.7%) followed by the second-year student with (35.1%).

Table 4.1: Socio-demographic background

		N	%
Gender	Male	69	45.7
	Female	82	54.3
Race	Malay	136	90.1
	Chinese	4	2.6
	Indian	1	0.7
	Bumiputera	10	6.6
Age	20	4	2.6

	21	49	32.5
	22	26	172
	23	69	45.7
	25	3	2.0
Faculty	FMHS	64	42.4
	FVM	32	21.2
	FA	47	31.1
	FS	6	4.0
	FHE	2	1.3
Years of Study	First Year	5	3.3
	Second Year	53	35.1
	Third Year	21	13.9
	Fourth Year	72	47.7

4.2 Usability Testing

4.2.1 Usability Questionnaire Results

Based on Table 3.2, on Q1 “Overall, I’m satisfied with how easy it is to use the app”, majority of the respondents (54.9 %) were satisfied with how easy it is to use the app. A total of 76.2% of respondents strongly agreed on that it is easy to use the app (Q2). Plus, the majority of respondents strongly agreed that they could effectively solve tasks and scenarios using this application (51.7%) (Q3). More than half of the respondents feel comfortable using this application (53.6%) (Q5). Most of the respondents (68.9%) were strongly agreed that they easy to learn using this app

(Q6) and they also strongly agreed this system gives a clear message error telling them how to fix the problem (68.2%) (Q7). However, on only 55% of the respondents fairly agree that the apps could complete the tasks and scenario quickly using this application (Q4).

Furthermore, the respondents can quickly and easily recover when they make a mistake using this application (51.6%) (Q8). Majority of respondents strongly agreed on Q9 “Information (such as online, help, messages on screens and other documentation) provided with this system are clear” (74.2%), Q10 “It is easy to find the information I need” (55.6%), Q11 “The information provided for this system is easy to understand” (80.8%), Q12 “This information is effective in helping me solve tasks and scenarios” (72.8%). Though, on Q13 “The organization information displayed on the system screen is clear” majority of the respondents (60.9%) were fairly agreed on it. On the last four questions, majority of the respondents (78.1%) were strongly agreed on Q14 “The user interface of this app is fun”, and on Q15 “I like using the interface system” the majority of respondents (75.2) were strongly agreed too. However, on Q16 “The system has all the functions and capabilities I expected” the respondents were almost equally distributed to fairly agreed (46.4%) and strongly agreed (47%). On Q17 “In conclusion, I am satisfied with this system”, majority of the respondents (60.3%) were strongly agreed. The whole range of usability scales has not been shown since no users scored the app for Likert-scale of 1 (Strongly Disagree) and 2 (Fairly Disagree).

Table 4.2 Usability score percentage on Q1 to Q17 (N=151)

PSSUQ (17 QUESTIONS)	n (%)		
	Neutral	Fairly Agree	Strongly Agree
Overall Usability			
The usefulness of the app			
<i>Q1. Overall, I'm satisfied with how easy it is to use the app.</i>	6 (4.0)	62 (41.1)	83 (54.9)
<i>Q2. The app is easy to use.</i>	7 (4.6)	29 (19.2)	115 (76.2)
<i>Q3. I can effectively solve tasks and scenarios using this application.</i>	17 (11.3)	56 (37.0)	78 (51.7)
<i>Q4. I could complete the task and scenario quickly using this application.</i>	5 (3.3)	83 (55.0)	63 (41.7)
<i>Q5. I feel comfortable using this application.</i>	5 (3.3)	65 (43.1)	81 (53.6)
<i>Q6. It is easy to learn using this app.</i>	7 (4.6)	40 (26.5)	104 (68.9)
<i>Q7. This system gives a clear message error telling me how to fix the problem.</i>	15 (9.9)	33 (21.9)	103 (68.2)
Information quality			

Q8. When I make a mistake using this application, I can quickly and easily recover.	19 (12.6)	54 (35.8)	78 (51.6)
Q9. Information (such as online, help, messages on screens and other documentation) provided with this system are clear.	7 (4.6)	32 (21.2)	112 (74.2)
Q10. It is easy to find the information I need.	9 (6.0)	58 (38.4)	84 (55.6)
Q11. The information provided for this system is easy to understand.	6 (4.0)	23 (15.2)	122 (80.8)
Q12. This information is effective in helping me solve tasks and scenarios.	9 (6.0)	32 (21.2)	110 (72.8)
Q13. The organisation information displayed on the system screen is clear.	5 (3.3)	92 (60.9)	54 (35.8)
Interface quality			
Q14. The user interface of this app is fun.	7 (4.6)	26 (17.2)	118 (78.2)
Q15. I like using the interface system.	7 (4.6)	29 (19.2)	107 (75.2)
Q16. The system has all the functions and capabilities I expected.	9 (6.0)	70 (46.4)	72 (47.0)
Q17. In conclusion, I am satisfied with this system.	4 (2.6)	56 (37.1)	91 (60.3)
No value for 2 (Fairly Disagree) & 1 (Strongly Disagree) in the Likert-scale			

4.3 Association between Usability and Socio-demography

Table 4.3 presents, each of the PSSUQ subscales and the socio-demographic were poorly to fairly correlated. The significant correlation between gender and interface quality was negative and poor, ($r = -0.222$, $p < 0.05$). Faculty was significantly correlated with information quality ($r = 0.185$, $p < 0.05$), interface quality ($r = 0.374$, $p < 0.05$), and overall usability ($r = 0.202$, $p < 0.05$) respectively. However, none of the correlations was greater than 0.50 or has good correlation.

Table 4.3: Association between Usability and Socio-demographic

	Correlation Coefficient (<i>p-value</i>)			
	The usefulness of the app	Information Quality	Interface Quality	Overall Usability
Gender	-0.062 (0.448)	-0.030 (0.715)	-0.222 (0.006)*	-0.101 (0.217)
Race	0.037 (0.656)	0.143 (0.081)	0.003 (0.974)	0.075 (0.360)
Age	-0.090 (0.273)	-0.123 (0.133)	-0.143 (0.080)	-0.134 (0.101)
Faculty	0.150 (0.065)	0.185 (0.023)*	0.374 (0.000)*	0.202 (0.013)*
Years of Study	-0.003 (0.974)	-0.006 (0.942)	0.011 (0.889)	-0.015 (0.852)

N=151

* *p-value* <0.05 indicate correlation

CHAPTER 5

DISCUSSION

Usability testing is one of the most important and commonly used techniques for assessing product prototypes (Lewis, 2006). This aims at determining the usability of a system by simulating the relationship between consumer and device under managed conditions. In this study, we only focus on the satisfaction of the respondents. Satisfaction can, therefore, be seen as an attitude towards the object. It is a subjective measure, usually gathered by questionnaires in usability tests (Sonderegger & Sauer, 2010).

Nevertheless a study by Norman (2007) viewed that product usability should not be the only main factor in user satisfaction and that the other design features do play a significant role. This has contributed to a gradual change in design ergonomics in past years, shifting from a practical view of usability problems to an experiential viewpoint that takes account of the overall user experience (Forlizzi & Battarbee, 2004; Brave & Nass, 2009). User experience includes the whole series of consequences resulting from the use of an item, including emotional experience, context experience and aesthetic experience. (Desmet & Hekkert, 2007). That implies that aesthetics can play a significant role in the design of app and systems (Sonderegger & Sauer, 2010).

Based on the results on the usefulness of the app (Q1-Q7) in this study, the app is easy to use due to the app was designed with five icon tabs, ensuring that the user can access all of the functions efficiently. According to Nathan & Scobell (2012) the icon is a graphic guide that helps users to navigate a destination or task. Three specific roles fulfilled by icons were, (1) access to a task or destination, (2) system status indication, and (3) system behaviour change. The app in this study was develop these fact in mind to help the respondents complete and solve the task and scenario quickly. As an example, when the respondents wanted to take picture(s) of hazards, the app only has access to the camera feature but not their mobile phone's photo library. Instead of finding the right pictures in the photo library, the respondents can quickly hold up their phone camera and snap the pictures instantly. This action was straightforward and simple.

Aligned with the study by Schnall et al. (2014), it is critical that less screen were made for access to information. In fact, it is important to avoid information overload where user interface and the displayed content should be kept "simple and straightforward". The app was designed such that, no report could be submitted if the respondents failed to complete the requirements. A clear message on the error guides the respondents to fix the problem. This correspond study by Mohan et al. (2015) which emphasized that the error message should be layman and easily understood. This was to prevent incomplete reports from being submitted.

In term of app was designed with grey, white backgrounds and white, black, red icons. Huang (2012) who investigated the degree of consensus for the different

variations of iconic background colour with individual visual tastes uses of 3306 colours proposed that only certain colour combinations be used to achieve better aesthetics. Besides aesthetic values, colours are also used to convey messages (Huang, 2012). Ju et al. (2014) found that participants could perceive the different conveyed messages and the change of colours. However, Punchoojit & Hongwarittorn (2017) in their research found that it can be difficult to objectively evaluate choice for colours and colour variations. It is regretted that despite good practice to carry out a preliminary research to determine the users preferences on the aesthetic factors such as color, font type, font size, background color, spacing, etc., it wasn't being carried out due to severe limitations which is further explain in the limitation sections (subchapter 6.3).

From the aspect of usability, the information (such as online, help, messages on screens and other documentation) provided with this system are clear. In this app, a confirmation box popped up on the screen if an action was taken (e.g. logging out the app). Based on Neil (2014) it is important that if an action was taken, it is ensued it with box on the screen. Next, an infographic could have a lot of information in a single image on the screen, making it difficult to read. This app supports pinch-to-zoom feature for the images in the app (infographics and the UPM's policy) as suggested in study by Neil (2014). It helps the respondents to clearly interpret the information provided. Moreover, the respondents able to interact with the video button to have a view on certain topics of safety and health information in the app. Studies have also shown that touchscreen devices are important in efficiency and customer interaction by the scale of the buttons and other interface functions (Lee &

Zhai, 2009; Jin et al., 2007).

On the interface quality, aesthetics questions were first posed in the field of psychology by Fechner whose have a purpose of defining the relationships between various structural dimensions and perceived attraction through systemic use of visual cues such as ellipses and rectangles (Liu, 2003). Therefore, the design inside the app was mostly rectangles with curved ends. The contents in each tab were differently organised in order to trigger the curiosity of the respondents. Inconsistent with Neil (2014), the study indicated that an app should be designed to have a smaller number of different screens in displaying information. Moreover, the variety in the way of organising the content makes the interface of the app more attractive. Consistent with the study by (Liu, 2003; Hekkert & Leder, 2008) specific approaches have been taken to define characteristics that affect the appeal of the material (for example the form, colour, intensity, order, and rhythm). The term concept aesthetics is used in the research literature in two ways: the objective features of a stimulus (for example the colour of a surface) or the subjective approach to particular product characteristics may be used. In the present research, aesthetics refers to empirical design features of a product such as a form, colour, and texture to differentiate between the two concepts (Postrel, 2003). Conversely, the attractiveness refers to the consumer 's reaction to these product features, which is the degree to which an individual feels the product is appealing (Sonderegger & Sauer, 2010).

Not only is the response to esthetic design affected by standard design parameters (such as form or surface attributes), it may also be changed by socio-

demographic background, such as age (Crilly et al., 2004). All of the respondents in this study were on the same group age of 20-25 years old. A study by Mentés & Turan (2012) found that age was not one of the factors affect the usability of an app. as they knew how to operate a smartphone and familiar with its primary function. The reason postulated by the authors was due to pre-existing knowledge of operating a smartphone and relative familiarity with its primary function. Similarly, García-Peñalvo et al. (2019) further indicated that age was not associated with perceived usability since the use of social networks is more pronounced in younger people, it could be attributed to the familiarity of younger participants of this study. According to the Malaysian Communication and Multimedia Commission (MCMC) (2014), the number of smartphone users among the young age group of 20-24 in 2014 was the highest compared to other age groups (24.5%).

Based on the previous literature, among other socio-demographic background which could significantly affect the usability of the app are gender and ethnicity. Although race or ethnicity were found to not influence usability of the app (which was consistent with findings by Nathan & Yeow (2009), gender gaps in adoption in the adoption of technologies may be a significant factor impacting perceived usability (Chinyamurindi & Louw, 2010). According to the results in this study, gender was not associated with overall usability yet associated with interface quality. This result is in agreement with the previous studies evaluating the perceived usability of a similar variable (Orfanou et al., 2015);(Gefen & Straub, 2018) which study suggested that women and men vary in their perspectives but not in using technology whilst examining gender disparities that could be linked to computer-

based media acceptance, beliefs and its usage. Besides that, Venkatesh & Morris (2000) noted that men find their perception of usefulness to a higher degree than women, considering the usability or productivity-related factors of modern technology. Men are more motivated by instrumental considerations than women, but still, there is no gap found in technology adoption and its usage in their study. Venkatesh & Morris (2000) further indicated that, relative to women, men put greater importance on perceived usability in deciding behavioural intention while women weighted perceived ease of use more strongly in deciding behavioural intention than men did. However, this finding was contrary to the research result of Mentis & Turan (2012) that gender difference was significant in the usability of the app among students' of Namik Kemal University.

The association between gender and interface quality was further supported by the research of Oyibo et al. (2016) which has shown that differences between men and women occur in mobile app evaluation. The authors find that in testing applications females are more critical than males. Females were usually referred to as specific information identifiers who pay attention to specifics, while males are referred to as vague information identifiers who ignore subtle clues (Tsichla et al., 2016).

Consistent with the prior findings Emiroğlu (2019), faculty were also found associated with the interface quality, information quality and the usability of the app. As the aim of this app relates to safety and health, the fundamental knowledge of the students which is tied to the background program or courses they were enrolled into

can affect the score usability of the app by the students (Crane et al., 2017). It was postulated that students from any faculty who had not taken safety and health subject would affect the data obtained in this research. This was the reason why it was essential to incorporate aspects of safety and health as key elements of students' education (Ayi & Hon, 2018). Hill (2016) indicated that safety and health subject was not necessary for most colleges and universities' undergraduate. The altered behaviors, including deciding that teaching safety to students is not significant, giving priority to safety education well beyond other chemistry aspects and viewing the training in safety as an appropriate substitute for safety education, seem to have been accepted. There have been only a few reported related research on the inclusion in universities of safety education as a preferential course, a lecture plan, or by incorporation into established curriculums. (Nie et al., 2011). Perrin et al. (2018) claim that safety curriculum was a challenging job and delicate, a difficulty in the present condition was added up due to significant effort was needed on university departments which lead to overburden. Consequently, university decision-makers must find the best way to incorporate safety modules in the curriculum.

Different years of study do not influence the usability of the app in this study. In this case, the association between years of study and the usability of the app were considered to be similar to the association between age and the usability of the app. It found that 95.8% of the respondents from 4th year students were at the age of 23 years old and only three respondents of 4th year were not in the same age.

CHAPTER 6

CONCLUSION

6.1 Summary

This study provides a mobile app design for learning content in safety and health and hazard reporting. The main objectives have been reached, which is to develop, test and determine factors affecting the usability of a mobile app based-tool for educating and reporting hazard among students in UPM Serdang campus, to determine the socio-demographic background (age, gender, race, faculty, year of study) among respondents and principles, to determine the usability of the app through the PSSUQ questionnaire and to determine the association of the usability of the app and socio-demographic. Results from the testing showed positive feedback from the potential users of the app, approving the effectiveness of the app design in providing a smooth interface, packed with safety and health content, and the ability to do hazard reporting. An association was found between the faculty and the usability of the app. However, there are rooms for improvement app despite the high score given by the respondents for the app.

6.2 Recommendation

6.2.1 Functionalities

Some improvements can be added to improve the application. Such as pop-up notification on a new reported hazard. So that all users will be alert with their surroundings and be more cautious. They can plan their journey throughout the campus by avoiding the newly reported hazards. There are endless possibilities to be explored with the mobile application.

6.2.2 Interface

The interface of this app was built with a focused concept of minimalism. There are still various interface frameworks available for both Android and iOS. When it comes to the colours, fonts, and layouts, there is much improvement that can be made, which help in ease reporting hazard and learning.

6.2.3 Safety and Health Experts

The communication between safety and health experts and app developer needs to be established. Despite the app content based on the literature review, an expert view would be very helpful in designing an optimal safety and health app.

6.2.4 Stakeholders

This app can be improved with the full support from UPM. There is potential in the focus of implementing a collaborative environment between students and university. Further research is most definitely needed to further validate this instrument in other study populations. Given the dearth of modern instruments for usability assessments, we believe that the findings from this study provide an essential contribution to the literature and an opportunity for future study of this instrument with additional study populations. As an example, conduct a study of an experimental study between knowledge of safety and health and the usability of the app.

6.2.5 Study Improvement

In the future, there is potential to expand the work to research on the experimental study between knowledge of safety and health and the usability of the app. As the socio-cultural context of the use of technology changes, our studies will need to consider the importance of the usage of digital differences and the presence of mobile users. Further work focused on existing results is important through the incorporation of a broader variety of consumer experiences.

6.3 Limitations

6.3.1 Covid-19 and Movement Control Order (MCO)

World Health Organisation (WHO) recognised the spread of COVID-19 as a pandemic on 11 March 2020 and Malaysia had begun to implement MCO on 18 March 2020. This action affected the progress of the app development and recruiting respondents and the initial plan of the app designs. It needs to be adjusted suits with the current event. A minor setback which impact the outcome and the findings of this study.

6.3.2 Stable internet connection

The students may or not have mobile data while outside the campus, even though it is normal for any universities to have a wireless connection. Moreover, an unstable internet connection led to the buffering of content and productivity of the hazard reporting activities.

6.3.3 Sample Size

The projected sample size should be a total of 288 respondents; however, the total current sample size achieved, 151 respondents. The power of the study has been calculated ($P=0.999$), and it is adequate to carry out the research with the current sample size. The results obtained may not be generalisable due to convenience sampling.

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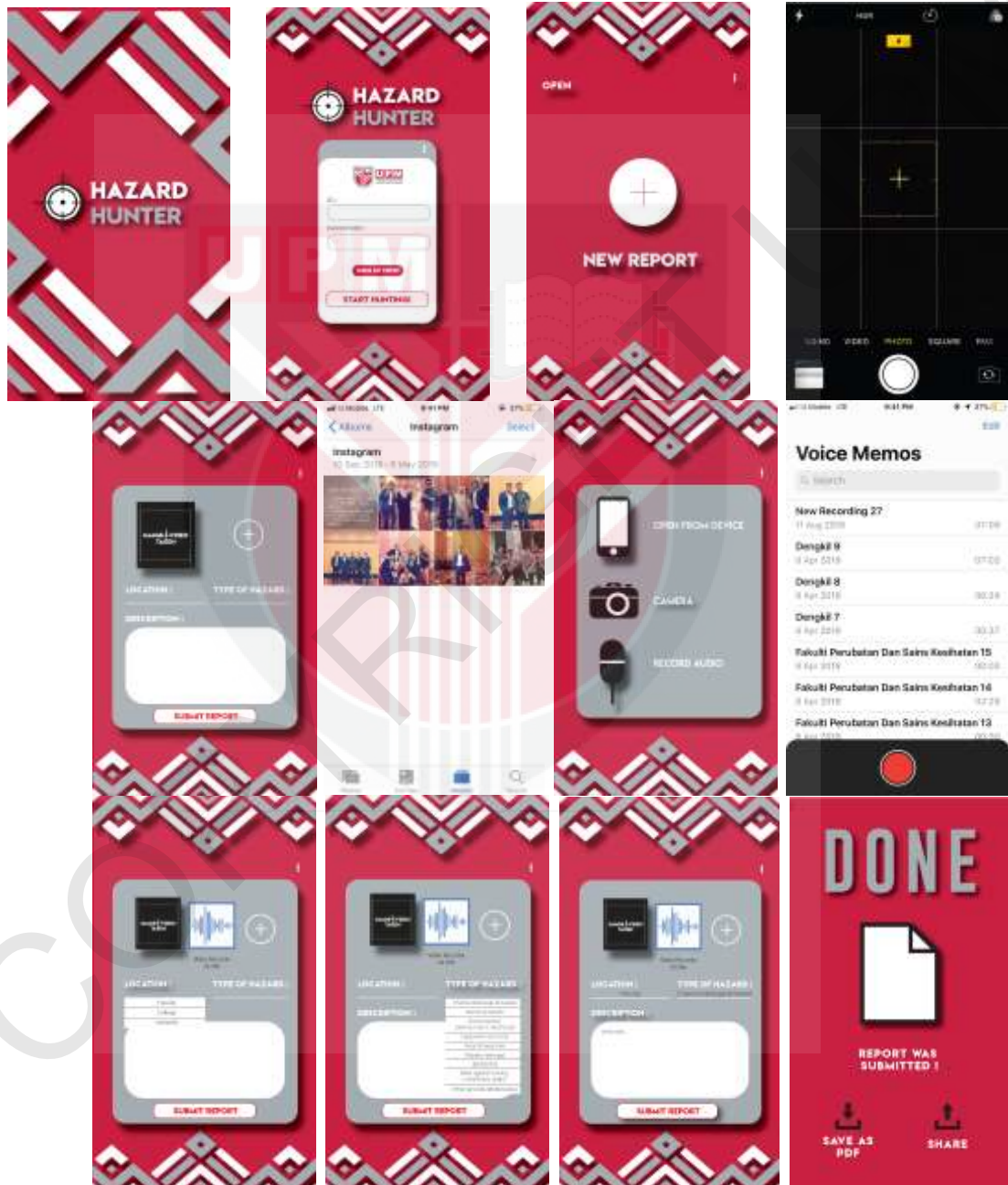
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APPENDICES

DRAFT 1 APP





DRAFT 2 APP



