Sudan University of Science and Technology

College of Graduate Studies

A Design Of Smart Hajj Guide System For Piligrim Identifaction And Location Services

تصميم نظام دليل ذكي للحج للخدمات المكانية والتعرف على الحاج

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by

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ايه

وَأَذِّن فِي النَّاسِ بِالْحَجِّ يَأْتُوكَ رِجَالًا وَعَلَى كُلِّ ضَامِرٍ يَأْتِينَ مِن كُلِّ فَجٍّ عَمِيقٍ

(27)لِيَشْهَدُوا مَنَافِعَ لَهُمْ وَيَذْكُرُوا اسْمَ اللَّهِ فِي أَيَّامٍ مَّعْلُومَاتٍ عَلَى مَا رَزَقَهُم مِّن بَهِيمَةِ

الْأَنْعَامِ فَكُلُوا مِنْهَا وَأَطْعِمُوا الْبَائِسَ الْفَقِيرَ (28) ثُمَّ لْيَقْضُوا تَفَثَهُمْ وَلْيُوفُوا نُذُورَهُمْ

وَلْيَطَّوَّفُوا بِالْبَيْتِ الْعَتِيقِ (29) ذَلِكَ وَمَن يُعَظِّمْ حُرُمَاتِ اللَّهِ فَهُوَ خَيْرٌ لَّهُ عِندَ رَبِّهِ وَأُحِلَّتْ لَكُمُ

الْأَنْعَامُ إِلَّا مَا يُتْلَى عَلَيْكُمْ فَاجْتَنِبُوا الرِّجْسَ مِنَ الْأَوْثَانِ وَاجْتَنِبُوا قَوْلَ الزُّورِ(30) **(سورة الحج)**

صدق الله العظيم

Dedication

To soul of my mother, Sida Alhajaz

one of the first educated women in Sudan

whose encouragement helped push me to limits I never thought I would attain.

To my son: Mohamed, let's conquer the world.

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Glossary

Black Stone – Small black stone set into one side of the Ka'bah, which defines the start location for circumambulations pilgrims perform during Tawaf.

Fatwa – Fatwa is an Islamic religious ruling, a scholarly opinion on a matter of Islamic law.

Hajj – Pilgrimage to Makkah prescribed by the Quran, which involves several rites to be performed a specified times and locations.

Umrah – The lesser pilgrimage, including the initial Tawaf and the say's. It may be completed at any time of year and is also a part of Hajj.

Ihram – Simple white garment pilgrims wear during some of the rituals of Hajj.

Jamarat – One of the rites to perform during Hajj, where pilgrims have to symbolically stone the Devil.

Ka'bah – Sacred building in the center of the great mosque at Makkah.

Al-Quibla – Direction Muslims face when praying, which is defined by the location of the Ka'bah in Makkah.

Quran – Holy book of the Muslim faith.

Saai – One of the rites performed during Hajj, where pilgrims walk back and forth seven times between the two hills Safa and Marwa.

Tawaf – One of the pillars to perform during Hajj, where pilgrims have to circumambulate the Ka'bah seven times in counter-clockwise direction.

Rakaat – This is essential part of the prayer (i.e. any prayer consist of a number of Rakaat, e.g. Isha prayer consist of 4 Rakaat.

Zamzem – An object of veneration, built into the eastern wall of the Ka'bah and probably predating Islamic, pilgrims should drink from it and take some for their relatives.

Abstract

This dissertation investigates the issues of guidance for pilgrims and how to make it more suitable for groups of pilgrims who navigate in unfamiliar areas. The dissertation will explore how to provide aid to pilgrims in crowded places by developing a pilgrim tracking and identification system using mobile phones that use NFC technology. The proposed system will provide education to pilgrims to guide them throw the Hajj journey. The proposed system will provide instructions regarding the ritual places such as Arafat a and it provides the correct supplication (Dua'a) and procedure for performing the required ritual. Furthermore, the proposed system will provide a better way to make Hajj journey safer. Also, the pilgrim can use the proposed system for searching for their accommodation, retrieving information about different activities in Makkah city. The results provide evidence that such a system could be easily utilized, may reduce task load, and could improve navigation performance as 81% of pilgrims who have tested the system agreed.

The system which has been presented in this dissertation was designed, implemented and tested all results provided good evidence that would provide considerable help in managing situations with large and heterogeneous crowds such as Hajj season.

المستخلص

التنقل في الأماكن غير المألوفة هو مشكلة مشتركة تواجه الحجاج أثناء الحج، وهناك عدد قليل من التطبيقات والبحوث التي توفر الدعم التقني للحجاج في هذه الإعدادات. أن العديد من هذه الحلول تعمل بشكل جيد على المستوى الفردي، فهي أقل ملائمة تماما في حالات الازدحام ، ولذلك يحقق هذا البحث في نظام يستخدم في إدارة الحشود الكبيرة لتحقيق قضايا التوجيه للحاج ولتحقيق سهوله التنقل في مجموعات في مكة المقدسة كحل لتتبع حركة الحجاج عبر تكنولوجيا مختلفة ونظام تحديد الهوية باستخدام الهواتف النقالة التي تستخدم تقنيةnfc. يوفر النظام المقترح تثقيف لتوجيه الحجاج له اثناء رحلته. يوفر النظام المقترح تعليمات بشأن أماكن الشعائر مثل عرفة ويوفر الدعاء الصحيح لأداء الطقوس المطلوبة. وسيوفر النظام المقترح طريقة أفضل لجعل رحلة الحج أكثر أمانا. كما يمكن للحجاج استخدام النظام المقترح للبحث عن سكنهم، واسترجاع المعلومات حول الأنشطة المختلفة في مكة المكرمة. وتقدم النتائج دليلا على أن هذا النظام سهل الاستخدام، ويمكن أن يقلل من العبء على الحاج، ويمكن أن يحسن أداء الملاحة حيث أن (81٪) من الحجاج الذين اختبروا النظام في المسجد الحرام في مكة المكرمة يوافقون على ذلك.

بشكل عام، قدمت جميع النتائج أدلة جيدة يمكن أن توفر مساعدة كبيرة في اداراه الحشود الكبيرة والغير المتجانسة. قد يتم تطويرها واستخدامها في التنقل بامان داخل مكة والسماح للمستخدمين متعددين لاستخراج المعلومات بشكل فردي

Table of Contents

List of Tables

List of Figures

CHAPTER 1

Introduction

This chapter explores in details the main parts which define and explain the presented information system. This chapter presents the problem statement of the research, hypothesis, philosophy behind the research, and objective of the study Hajj pilgrimage crowed management problem.

1.1The purpose of the research

The Muslim annual pilgrimage to Makkah, which is performed by many Muslims from all over the world, is one of the largest recurring events on the planet. Managing such an event is a very complex and tedious task. Muslims from all over the world with different languages and culture must perform the Islamic pilgrimage, Hajj, to Makkah at least once in their life time if they are able. This amounts to about four to five million visitors every year to the cities of Makkah and Medina in Saudi Arabia. The annual Hajj rituals are performed on an exact specific number of days during the last month of each lunar year. All Hajjis (Hajj observers or pilgrims) must be at the same place and time during the Hajj season. They all move from one site to another throughout the Hajj days. In such a massive gathering, where people are walking shoulder by shoulder, the chance is very high that many people divert from their groups and may get lost. Hazard situations may also arise due to various reasons such as car accidents, overcrowding, human jams, etc. This can create an overwhelming situation making it too difficult to locate pilgrims and help them reconnect with their groups or hosting agencies. Another major concern for the Hajj organizers is the arrival of all the millions of Hajjis within a span of few days to the Muslim Holy land in Saudi Arabia which has been a constant challenge at the airports and other land and sea port entries to the hosting country. Airplanes arrive by the minute to the airport carrying thousands of people who must be processed instantly. Each Hajji's data profile has to be entered into the database system. The Hajjis profile data includes the following:

- Visa trip information,
- Which hosting agency will pick up pilgrims at arrival,
- Which location address pilgrims will be transported to,
- Which hosting agency will handle pilgrims accommodation,

- Pilgrims medical record information, etc.

Therefore, an automated system is needed to handle the arrivals processing information and to allow retrieval of such information whenever it is required throughout the Hajj season in real time. Providing safety, authority control, and guidance to pilgrims are not the only services needed during the Hajj season (Hamhoum and Kray, 2012). There are also other personal services required for Hajjis such as education to alert the Hajjis of what ritual he/she has to perform next and where. Advertisement and directory services are also needed, where Hajjis can find information about shopping and other services.

A new system is needed, capable of performing the following:

- Facilitate Hajjis data processing needs.
- Educate and provide instructional guidance Pilgrims in performing the Hajj rituals.
- Provide advertisement information for shopping, religious sites visits, etc.
- Facilitate Pilgrims arrival and departure to/from Makkah and to/from their countries.
- Pilgrims data profiles.
- Provide mobile translation application for pilgrims with different languages to assist them in performing their Hajj correctly.
- Enable groups to communicate using diverse languages.
- Help pilgrims count or remember the Tawaf rounds while walking around the Ka'bah.

1.2 Problem Background

It is well known that Hajj (Pilgrimage) is the most crowded Muslim gathering event on earth. It is a challenge to Hajj authority to control the crowd and identify the personalities. Due to the great number of pilgrims and their old age, sudden deaths or injury during Hajj season were at a high rate during the 2015 Hajj season. Many of those who died were found alone holding no documents. Authorities have found hundreds of pilgrim bodies that weren't claimed nor identified. Such an issue is not easy to solve. Systems for Pilgrims are currently developed to solve this issue. Hajj

authority is obliged to identify the dead and inform their families of their loved lost ones. In some cases, large gatherings cause people to die because of stampedes, fires, mass fights, and others. Records show that at least 362 pilgrims died in a stampede during the "stoning of the devil" ritual in the 2006 Hajj season and 250 pilgrims died due to similar cause in the 2004 Hajj season. A huge accident has happened in the 2015 Hajj season when at least 2,177 pilgrims were killed during a stampede in a pedestrian tunnel in Mina (Salamati and Rahimi-Movaghar, 2016). Due to massive crowding of pilgrims in small geographic areas (Al Haram, Mina, Arafat, Muzdalifah), many pilgrims are reported every hour during the Hajj season asking for help to return to their camps. It is difficult to locate families or friends when they are separated from each other due to many reasons during the Hajj season. In such a case finding someone who speaks the lost pilgrim's native language is not an easy task. With the absence of any proper identification that indicates their camp location and contact numbers, and with no language shared, it's impossible to help them. This is very stressful for the security officers taking care of pilgrims. Technology can be used to help lost pilgrims.

1.3 Limitations and Open Issues

The investigations of the literature have showed that there are some gaps in previous work in this research area. First of all, the focus of most of studies was in the area of security management. Solutions that have been developed in the navigation systems field were not feasible to apply in the city of Makkah. Therefore, it was necessary to design optimum systems which take the proprieties and constraints of the environment in Makkah into account. Some of the possible research topics that are related to Hajj are listed follows:

A. Pilgrim Health: At the moment, the Saudi authorities provide health facilities for the pilgrims. This makes it difficult for the local population of Makkah and the surrounding regions to get medical help during the Hajj season. Some countries are also bringing their health services for their pilgrims, including medical staff, medical facilities and medicine. Research may look into the possibilities of better organization and management of the Hajj health system, including an option of introducing health insurance for Hajjis and allowing private health organizations to participate in the system.

B. Hajj Communication: With pilgrims coming from a large number of different ethnic backgrounds with hundreds of different languages, research may look into the need for sign language and other means of communication. Formatting issues!

C. Hajj Security: At the moment there seem to be no issues with pilgrims and infrastructure security. However, research may look into the details of technological tools, mechanisms and measures to prevent the occurrence of any future mischievous and harmful acts.

D. Hajj Infrastructure: The Saudi government has continuously been improving the Hajj facilities Research could look into future infrastructure needs, including the needs for expansion of accommodation in Mina, Arafat, and Muzdalifa (these places are in Makkah area and to be visited by Pilgrims during the Hajj season as part of the rituals).

E. Hajj Travel: Movement in and around Makkah is very time consuming. Future research may suggest some better ways of transportation to overcome the long delays and facilitate smooth transition of pilgrims.

F. Local Pilgrims: Hundreds of thousands of people from Makkah and the surrounding regions decide to perform Hajj at the last moment, often without any intimation to the Hajj organizers. This poses serious difficulties in managing the Hajj activities. How could these pilgrims be managed in a better way?

G. Personnel location systems: Personnel location systems are currently an interesting research area. There are many systems that were launched recently using different technologies. Intelligent mechanisms are required to deduce Hajjis actual location.

1.4 Problem Statement

Pilgrims face issues while walking through crowds in unfamiliar environments. There is no system currently used to assist, organize, and manage people.

The following are the problems that will be solved in this dissertation:

1. Lack of pilgrim’s knowledge with the Hajj rituals.
2. Losing the pilgrims' identification documents (missing or losing).

3. Knowing how to re-join with their groups in case of getting lost.

1.5 Questions/Hypothesis/Philosophy

1.5.1 Questions

The research should be able to address many questions. Some of these questions that have been identified are as follows:

1. How to use proposed location models to solve the tracking and identifying pilgrim's problem?
2. Could these proposed location models play role in identifying if a pilgrim is in the right location and at the correct time for the specific Hajj ritual?
3. Can the proposed model improve entering and exiting procedure for national and international pilgrims?
4. Could these proposed location models play role in locating lost pilgrims in a timely manner?

1.5.2 Hypothesis

1. The proposed solutions which are; pilgrim identification problems, tracking the movement of pilgrims as well as location based services for pilgrims will help to enhance the accuracy and tracking time of the Pilgrims.
2. Implementation of integrated Hajj guide system will help increase pleasant, safe and rewarding Hajj experience and also set the agenda for future research in this area.

1.5.3 Philosophy

The main philosophy of our research is based on developing a system that can help pilgrims have a safe, pleasant and rewarding Hajj experience as much as possible.

1.6 Research Objectives

The main objectives of this dissertation are specified as follows:

1. Make Hajj journey easier for pilgrims and reduce the problems that can possibly occur which may save Hajj authorities time and effort in identifying pilgrims.
2. Identify and track pilgrims in case of lost, death, or injury.
3. Improve the effectiveness of teaching Hajj rituals to pilgrims by the following ways:

i. Giving them information in a format that makes Hajj rituals easy to be implemented by Hajjis according to the correct place and time.
ii. Improve the security and convenience of pilgrims during Hajj season through designing an electronic system or device that can be given to pilgrims during the Hajj season.
iii. To provide a complete guideline and procedure to perform Hajj and Umrah based on Sunni principles in order to achieve Hajj Mabrur (correct and acceptable Hajj).

4. Improve on the pilgrim entrance and exit to Saudi Arabia so that it is faster and more convenient to pilgrims.
5. Flow of pilgrims at key points resulting in proper utilization of space.

1.7 Research Scope

The research focuses on pilgrim tracking and identification during Hajj in the Holy areas using a mobile phone to improve crowded situations and assist people in finding their personalized navigation information and reaching their destination without any delays, workload, errors or disorientations.

1.8 Research Significance

The research helps educate pilgrims and/or preachers in performing the Hajj rituals for all their needs during the pilgrim season (where to go, when to go, how to get to a place, etc.). The research also helps minimize pilgrims' need to request help from others. The research also helps provide step-by-step guide for pilgrims until the pilgrimage is completed.

1.9 Dissertation Outline

This section gives the outline of each chapter of the dissertation and illustrates some important aspects of the dissertation chapters.

Chapter 2: Related Work

Chapter 2 gives an outline of the research that has been done on pedestrians' navigation and identification systems and a brief overview of the different prototypes that have been developed over recent years. For Tracking Pilgrims during Hajj Season we provides the basic aspects of tracking people using different technologies and how

people use these technologies as guidance while travelling from one place to another in Heterogeneous Crowds.

Chapter 3: Research Methodology

This chapter first discusses the pilgrimage scenario in the whole world and gives an explanation of the Hajj scenario as case study (pilgrimage to Makkah) which contains definitions and descriptions of the Hajj rituals and places that pilgrims should visit and perform during the Hajj season. The chapter also includes definition of the technology that will be used to control crowded in hajj. The last section of the chapter will describe the methods that were applied to achieve the goal.

Chapter 4: Tracking & Identification of Pilgrims during Hajj Season

Chapter 4 will present a new proposed system for Tracking & Identification of Pilgrims which promotes accessibility by choosing a common platform that is widely used by people. This Chapter describes the development of an integrated system which provides services during Hajj season. Services such as pilgrim identification control of access to the Holy places, providing timely medical information, and guiding lost pilgrims to their camps.

Chapter 5: Implementation for Pilgrims Identification system

This chapter shows the implementation details of Pilgrims Identification system project

.**Chapter 6: Result and Simulation**

shows the running application for identification system

Chapter 7: Testing

This chapter to prove effectiveness of the developed system in providing improved services to the pilgrims and resolving some of the problems faced by Hajj authorities

Chapter 8: Conclusion

This chapter gives a summary and the important aspects of the whole dissertation and presents the significant results of all the studies. The chapter also presents the contributions of the dissertation.

CHAPTER II

LITERATURE REVIEW

The Current State of Intelligent Hajj Guidance Systems

2.1 Introduction

The main goal of this chapter is to identify related work. It includes information on the previous systems which have been done in pedestrians' navigation and identification field and a brief overview of the different prototypes that have been developed over the last few years and the questions that have been the focus of previous researches and topics that have been neglected (Cooper, 1988). Also, the current research tries to specify some methodological problems which have prevented the information of an integrated body of knowledge in the field. We categorized the area of research into two types: Tracking level, and Communication level. Some examples about each category and issues related to them will be presented. Summarize of all approach will be presented in tables at the end of each sections.

2.2 Literature Review Methodology

While investigating the previous work, the focus is mostly on the finding articles and methods used to achieve easy Hajj rituals and efficiency. This review targets Hajj rituals as the main audience and explores theoretical and empirical issues relevant to scientific research. To collect academic literature on how to control the crowd and identify persons (pilgrims), journal, international conferences and university research databases were used to search for the following keywords:

1) Tracking, pilgrims tracking,
2) Crowed management systems,
3) Hajj Rituals, and
4) Pilgrim identification .

We searched in the title, abstract and keywords of the references. As a result, it did lead to 684 papers. We have adopted a specific restriction to choose the suitable papers. First, we filtered this list based on journal names and impact. Second, we evaluated the main objectives of the reference. Third, we reviewed the abstract that would make the HAJJ easy through the use of technology. Fourthly, we investigated

the reference sections of the papers to include more potential articles in the review. The result of the proceeding filtering produced a list of 40 articles. Table 3.1, Table 3.2, Table 3.3 and Table 3.4 provide a summary of the selected papers based on the review process described above.

2.3 Tracking Pilgrims during Hajj Season

There has been quite a number of tracking and monitoring systems being developed. Each system used its own various means and facilities to increase its effectiveness. One of the most widely recognized system is the tracking via RFID chips. Nowadays, a lot of embedded RFID chips are placed in our belongings and because of its small size; it has been used quite extensively. In order to have a system that suits events such as Hajj, Yamin and Ades (2009) proposed to track people using the RFID chip and wireless technologies which have used a database to save data and the entities for each person. Another approach is having an object recognition system where a picture, which usually is an object or structure on land, is taken using a built-in camera in any common mobile phone to identify their location (Luley et al., 2005). As good as the system might get, the system still relies solely on Internet connectivity. People need to register to have their own Internet connection available in their mobile phones. Another approach is implementing a low cost object tracking system using GPS and GPRS (Hasan et al., 2005; Mohandes, 2009). The system allows a user to view the present and the past positions recording for the target object on Google Maps through the Internet. It reads the current position of the object using GPS, the data then is sent via GPRS service from the GSM network towards a web server. Using SMS as the means of communication with the server is expensive. Although it is cheaper to use wireless network technologies when usage is heavy, it is expensive to use if we consider the duration of time it will be used. Another approach is a prototype using passive RFID technology passed through several implementations and discussions with Hajj officials (Mohandes, 2010). The results of the experiment have convinced the Hajj authorities to utilize this technology for all pilgrims in the near future. However, authorities indicated the need for tracking pilgrims in addition to the identification process. Therefore, an active RFID system is developed for tracking pilgrims to work on coordination with the passive RFID system for identification. The tracking and monitoring system consists of portable wireless sensor units carried by the pilgrims and

a fixed Wireless Network (WSN) infrastructure capable of gathering, processing, and routing data on locations and time stamp of sensor units carried by the pilgrims. All the nodes in the fixed WSN are made equivalent to keep the deployment, configuration and reconfiguration process simple. However, in Hajj pilgrimage situation where the pilgrims will only be there for around a month, getting Internet services from ISPs might be troublesome and therefore might result in inability to use the local service. Also it was noticed that an expensive infrastructure would need to be built and the cost of each portable sensor unit will not be significantly cheaper than a mobile phone equipped with a GPS unit. Table 2.1 presents a comparison of the work that has been presented in literature regarding Hajj mobile applications.

Table 2.1: Hajj mobile applications and techniques

Author	Year	Approach	Adv+	Limitation
Yamin et al	2009	Using the RFID chip and wireless technologies	Track people.	People need to register. Have some serious economic considerations.
Luley et al	2005	Having an object recognition system where identify their location according to the picture taken.	The system relies solely on Internet connectivity.	People need to register to have their own Internet connection.
Hasan, K.S	2009	The system allows a user to view the present and the past positions recorded of a target object on Google Maps through the Internet.	Low cost object tracking system using GPS and GPRS.	Using SMS as the means of communication with the server is expensive.
Mohandes	2009	Using passive RFID technology passed through several implementations.	Tracking pilgrims in addition to the identification process.	The system faced several difficulties and proved to be impractical, particularly with the crowd.

There are operational challenges in Hajj including controlling the crowd, accurately identifying individuals as and when needed, communicating with pilgrims as they speak more than 120 different languages. It has also been observed over the years that a large percentage of pilgrims are senior citizens and are prone to sickness and may require special attention and advanced medical services. More challenges that pilgrims should perform the same rituals at the same time and the same place. Technology can mitigate most of the challenges of this event and improve the quality of services. Several attempts have been made in the past using technologies to alleviate problems faced in this event as mention in table 3.1. One of these attempts was the development of a tracking system using a wireless sensor network in (Mohandes, 2012) and later using a Global Positioning System (GPS) in a mobile phone and a separate RFID tag for identification and other services (Mohandes, 2010). However all previous approaches suffer from high cost for the object tracking system and difficulty in using them. We are proposing a solution for a personal location system which is low cost and easy to use. A proof of concept was implemented to use Near Field Communication and (NFC) together with GPS in a smartphone as an integrated service for identification and tracking of pilgrims.

All the details about the design, implementation and testing of a system for improved Hajj services using the features of NFC in a smartphone will be covered in chapter 4. Several stages of assessment and evaluation of these services are presented in chapter 4 which include validation of Hajj permits, medical records, Mutawif services etc.

2.3.1*Track & Educate Pilgrims*

Many pilgrims lack the knowledge in performing pilgrim's rituals. Many mobile applications for Hajj are proposed to assist the pilgrims in performing their Hajj easily and safely.

The time and information availability may lead paper based information to disappear and the way in which information published and formed has been changed and dynamically updated (Osman M and Shaout, 2015 b). Experienced people with mobile devices can be at an advantage in terms of education and how to get help in English (Osman M and Shaout, 2014). The mobile experience has encouraged

researchers utilizing mobile computing in different fields such as educating Pilgrimage by providing Pilgrimage's practice terminology as well as guidance and educational material (Osman M and Shaout, 2015a). There is almost no future for printed version of the educational material (Osman M and Shaout, 2016). Voice recognition technology has been used in mobile phones since early days to provide quick call using voice tags. Voice recognition is an adaptive technology to use microphone instead of keyboard to help disable people or to implement special purpose operation in human computer interaction (Osman M and Shaout, 2015b; Osman M and Shaout, 2015c). Voice recognition technologies are currently employed effectively in Smartphones to do other functions than just quick calls. The purpose here is to develop a mobile application that can provide customers with many options to reduce input errors as well as to provide fast interactions with the user. The following are some of existing Hajj mobile systems;

A) Panduan Umrah bergambar (Android rich) was developed in Bahasa Malaya language (Google Play Store, n. d, a). The application provided to Pilgrims text for performing Hajj rituals using a Map for guidance. Figure 3.1 shows some of the interfaces of the application.

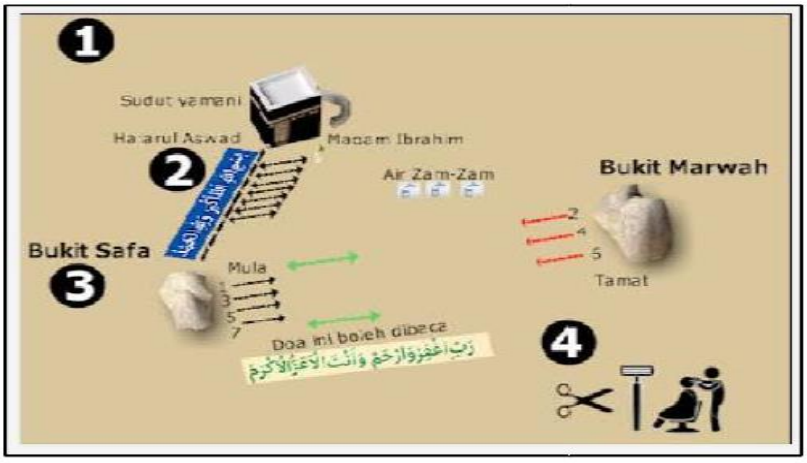

Figure 2.1: Umrah guidenss application with images

B) Mutawef-4th edition, has been published in 2014 BY **AndroidRic**h which includes a mobile application to provide and facilitate the pilgrims with information about Hajj. The system uses the J2ME Mobile application and Java MIDP 2.0 (Google Play Store, n. d). The system also uses 3D graphs to provide the users with the

geographical information for Hajj rituals and places. The system has been developed in 14 different languages. Figure 2.2 shows the Mutawef interface.

Figure 2.2: Mutawef user interface (Google Play Store, n. d)

C) The Hajj &Umrah Guide (Google Play Store, n. d) has been published in 2008 by yuumedia which provides audio and video lectures as well as a manual to perform Hajj and Umrah. It provides a one page summary of the whole performance as a guide, nevertheless, to get the full details the user has to refer to the full Hajj and Umrah manual. This system supports four different languages which are English, Arabic, French and Urdu to provide information about Hajj. The guide consists of some simple movements that synchronized with the narration by voice describing Hajj information. The information inside this system is very efficient and helpful for the newer Hajj. This system assists a lot of pilgrims while doing their Hajj. Figure 2.3 shows the Hajj guide line system interface.

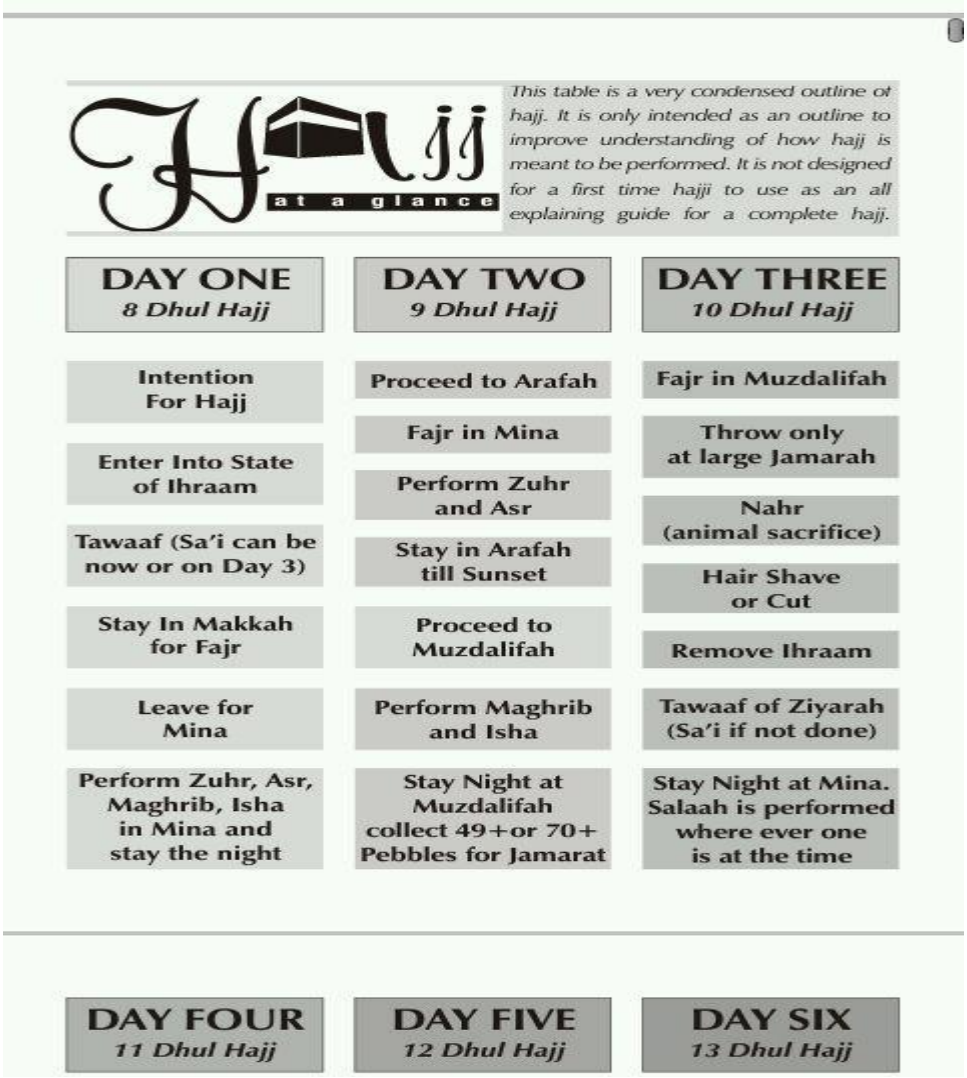

Figure 2.3: Hajj and Umrah Guide (Google Play Store, n. d).

D) The Rituals of Hajj and UmraTork has been published in 2008 by Nokia is a mobile guide for both Hajj and Umrah journeys with multimedia content in addition to the most famous places to visit during the Hajj season (Mobile Ground, n. d 2017). The features of the application are shown in Figure 2.4.

Figure 2.4: Hajj and Umrah Application (Mobile Ground, n. d2017)

E) Knowledge-based expert systems (KBES) (Sulaiman, S,2009) known as Hajj-QAES to support Hajj pilgrims in any stages of Hajj (pre-, during and post-Hajj). The main goal of the KBES system is to support Hajj pilgrims in learning and decision making processes. It can capture experts' knowledge and organize it in a database. The approach requires an inference engine that can draw conclusions or solutions to the given problem based on the facts given by the users. KBES has been used to support queries in many areas or problem domains including power system petrography or study of rock samples and search engines. Knowledge of experts retained extensively in the system to solve all possible queries. KBES involves three types of Hajj: ifrad, tamatuk, and qiran. The problems can be further categorized based on gender (female and male) and Muslim groups (mazhab or maslak) including Hanafi, Shafai, Maliki and Hambali. The KBES for Hajj domain allow filtering of queries based on the above classifications. KBES will be useful to Hajj pilgrims in three stages: pre-Hajj, during Hajj and post-Hajj. Such expert system can also be beneficial during the Hajj training (pre-Hajj stage) in their respective countries. Trainers can use KBES to test their knowledge by asking questions and predict the answers or solutions. Results have shown that the model has reduced searching time as well. Figure 2.5 shows the main windows KBES interface.

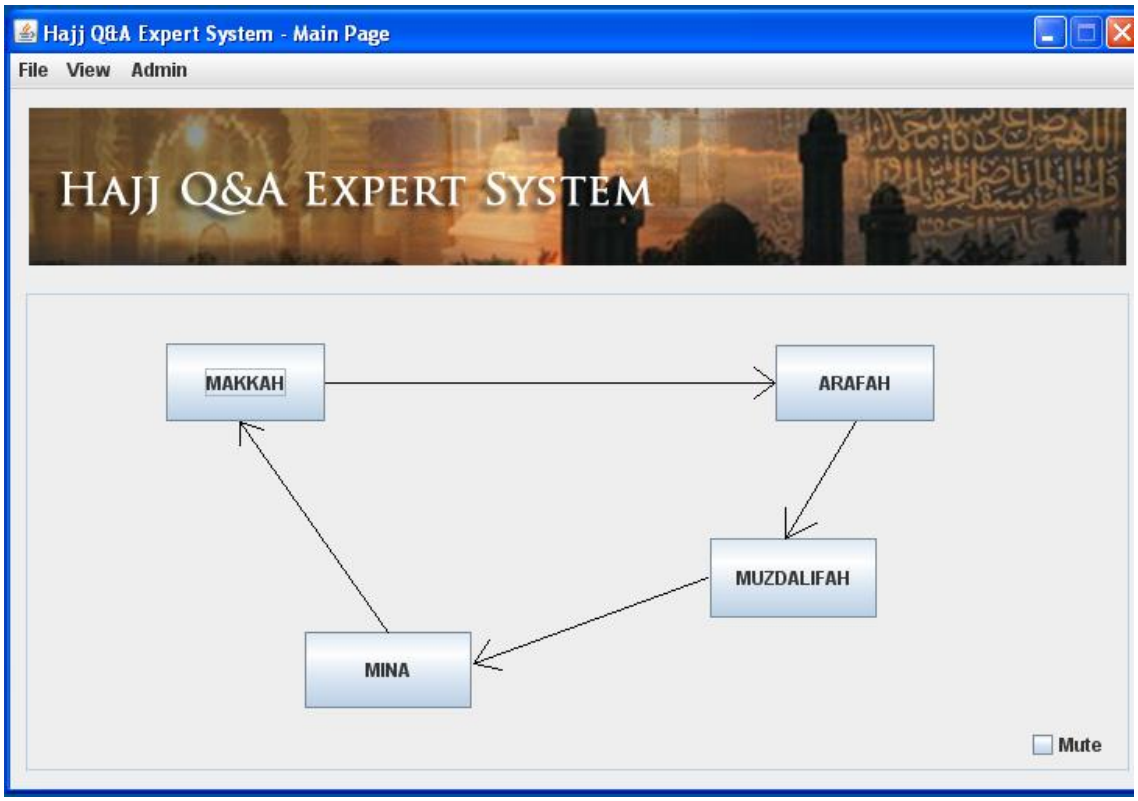

Figure 2.5 The main window of Hajj-QAES (Sulaiman, S 2009)

F) The M–Umrah provides a guide to performing Umrah; from the beginning of preparation at home up until the pilgrimage is completed. After the development of the application on the Android platform, the first version of the application has been released to the market (Google Play Store, n. d, d 2014). The main goal of the system is to minimize pilgrims' need to ask help from others. The challenge is how to provide portable, tri-language, easy to use rich multimedia that illustrates the practices to pilgrims and facilitates their interaction with local people, Arabic native and others around. M-Umrah uses three languages: Arabic, English and pilgrims native language. English is used because it is the most common spoken language in the world, while Arabic is the language that supposed to be used during pilgrimage practices as well as it is the language of the place and the rituals. M-Umrah was developed using the Android platform and Java programming. M-Umrah consists of the following modules: overview, step-by-step Umrah procedure, interactive Dua'a, interactive check-list function and GPS location tracking. Figure 2.6 shows the Rituals of Hajj interface.

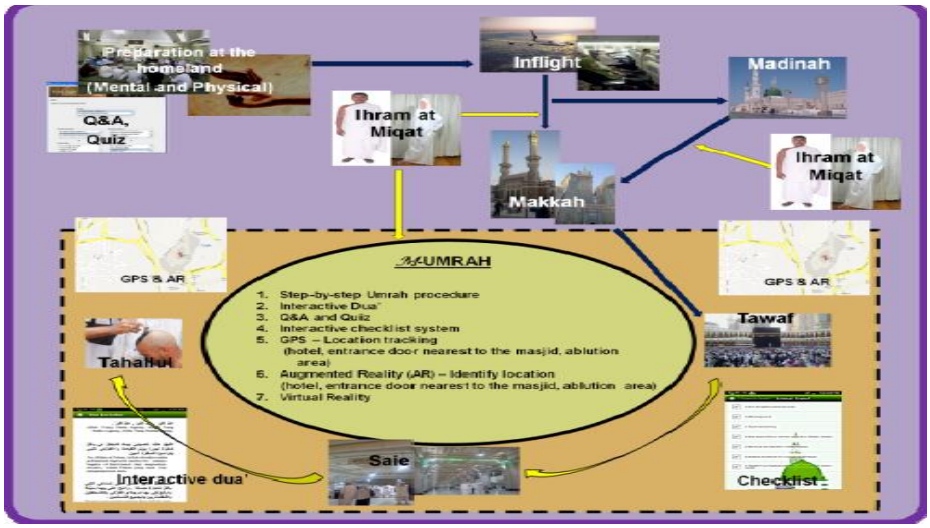

Figure 2.6 M–Umrah application (Google Play Store, n. .d,2015)

G) Islamic E-health was proposed by Househ (Househ, M) which defines and discusses various applications of E-health. The results have shown that some Islamic E-health applications focus primarily on the Hajj spiritual health; followed by Hajj applications for guidance and monitoring and the use of Electronic Medical records to monitor the blood glucose levels of Pilgrim patients who fast during the month of Ramadan.

H) Hajj Locator framework was proposed by Teddy (Teddy, M), for cases of missing Hajj pilgrims during Hajj season to track Hajj Pilgrims based on mobile phone environments since it is reasonably affordable and is extensively used by people.

I) Shaout and Shahzeb (Shaout, A., and Shahzeb, K) introduced AL-Hajj app for iOS which is an interactive guide to Hajj, allowing users to walk through the process of the Hajj to develop a better understanding of the obligations, locations, dates and sequence they need to perform. It covers both pre and post Hajj activities. It has a very simple User Interface (UI) and current version of the system has not been tested in a real world scenario. Table 2.2 presents a summary of related works in tracking and educating Pilgrims.

Table 2.2: Summary of related works in Track & Educate Pilgrims

Author/app name	Year	Advantages	Limitations
Panduan Umrah bergambar	2014	Presented a solution for pilgrim educate.	Developed just in Bahasa Malaya language.
Madar/Mutawef	2016	Easy to deal with maps and the possibility of movement and easily browse through the arrow buttons. Ease of download and installation on the device. The program is compatible with all Java Enabled Mobiles, such as Nokia and Sony Ericson and others. Developed in 14 different languages.	Inability to use the localization service.
yuumedia / The Hajj &Umrah Guide	2008	Contains multimedia features such as flash. Consisting of some simple movements that synchronized with the narration by voice describing Hajj information. The information very efficient for the newer Hajj. Usable and comfortable user interface give Arabic and Islamic look.	Little bit selection of supplications and prays for the Holy trip "Arafat prayer Mena etc.".
NOKIA/ The Rituals of Hajj and UmraTork	2014	Mobile guide for both Hajj and Umrah journeys with support multimedia. The most famous places to visit during the Hajj season.	Static data.
Shahida Sulaiman et al Hajj-QAES	2009	Support Hajj pilgrims in learning and decision making processes. Providing different questions and learn from the possible answers inferred by	Requires a friendly inference engine that can get solutions to the given problem

		the inference engine. Suitable in pre-Hajj stage to allow pilgrims learning by examples of scenarios that involve decision making. Support Hajj pilgrims in any stages of Hajj (pre-, during and post-Hajj).	based on the facts by the users.
M–Umrah	2013	Provides a guide to performing Umrah application. Minimize pilgrims' need to ask help from others.	Available in the just two languages Malay and English.
MHouseh /Islamic E-health	2012	Defines various applications of E-health. Focus primarily on the Hajj spiritual health BY use of Electronic Medical records to monitor the blood glucose levels of Pilgrim patients who fast during the month of Ramadan.	System have been shown to work well on an individual level (e.g. a single user) in areas that are very crowded, several problems arise.
Teddy/HajjLocator	2011	Reasonably affordable and is extensively used by people. Track Hajj Pilgrims In cases of missing based on mobile phone environments.	If a large number of people try to access a wireless network frequently results in errors, low bandwidth or loss of connection.
Shaout et al AL-Hajj app	2012	Gives a process to better understand the Hajj rituals and obligations.	The system has not been tested in a real world scenario.

2.3.2 ***RFID Usage in Tracking***

The RFID technology is a solution to track large numbers of objects effectively. It is widely used in tracking applications, military equipment tracking and large shipping containers books, market stores and libraries. Table 2.3 shows some examples of RFID usage in large numbers for large scale events.

Table 2.3: Examples of RIFD in large scale events

Event	Event Descriptions
Germany world cup 2006	Had 3.5 million tickets with RFIDs covering 12 different locations (FIFA World Cup, n. d).
The 2008 Olympics in Beijing	Was the biggest opening with 7 million spectators, all identified with tickets using RFID anti-counterfeit technology (FIFA World Cup, n. d; Chhabra, 2008).
The 2010 World Expo in Shanghai (May to October)	Where nearly 70 million RFID tags where used again to help identify, track, and trace visitors, assets, and foodstuffs. The event took place along the banks of the Huangpu River in downtown Shanghai, between the Nanpu and Lupu bridges, an area comprising 5.53 square kilometers (MC Press, n. d, PR Web, n. d).
The railway system in China	Carries around three billion passengers every year has moved to RFID technology since October 2006 and is using about 125 Million tags (PR Web, n. d).

2.4 Chapter summary

Through this chapter we have introduced some types of pedestrian navigation systems. The chapter discussed tracking and monitoring pilgrim during hajj season and determined their location and information using technology such as 'mobile guides'. Then mentioned some examples of mobile guide applications and how mobile devices can be used to help people navigate in different situations and described some examples. However, these approaches include some disadvantages which were summarize in table 3.1: Hajj mobile applications and techniques, then we described examples about Track & Educate Pilgrims (e.g. paper maps, guidebooks) which were summarize in table 2.2. On the other hand, we described the Situated Navigation Support for Heterogeneous Large Crowds such as RFID Usage in tracking which was summarized in table 2.3.

CHAPTER III

Research Methodology

3.1 Introduction

This chapter aims to explain how we use different technologies for crowded management systems. We take Makkah as a case study and how can we manage Hajj - which is has the biggest crowd that occurs annually. The chapter is divided into five main sections to achieve the desired goals and each section is divided into subsections. The first section presents all Mega Pilgrim Events in the world. Table 2.1 shows a summary of all the Mega Pilgrim Events in the world. The second section is about Pilgrimage to Makkah as a case study. The section gives a brief discussion about Makkah, the Holy city, rules, places, Hajj pillars then several terms that are related to the Hajj event in the Islamic religion will be presented like Ihram, Saai and so on. The final subsection discusses Hajj Pilgrim Characteristics. The third section is about the technology that is used and has two subsections; Mobile Device Enabled NFC and Electronic Identity Card section. The fourth section covers the methodology. This section provides full details about the methods that we applied to obtain information about the pilgrimage situation and places of congestion during Hajj. The chapter also provides information about the main goal of the dissertation which is how to make hajj easier through the Easy Hajj application for pilgrims. Easy Hajj application is an intelligent system that is able to track pilgrims at any specified time and date. It is also capable of sending automatically SMS notifications and alerts to pilgrims so that they are at the right time and the right place during the Hajj season (Arafat, Muzdalifah, or Mena). The waterfall methodology is used. It is quite possible that a man loses his wife, friend or group inside Makkah or in other places around that area. Second subsection is the Analysis and Evaluation of Easy Hajj Solution, which explains what methods used to overcome those problems as well as who should perform Hajj.

Furthermore, the final section will discuss ethics of human tracking then summarize the significant points of the whole chapter and briefly introduce the next chapter.

3.2 Mega Pilgrim Events

Kumbh is the largest pilgrim gathering anywhere in the world (Osman and Shaout, 2014). It takes place every 12 years at the Holy River in Allahabad in India. There are other smaller Kumbh events such as half or ArdhKumbh organized at different locations in India. Unlike Hajj, Kumbh pilgrims mostly come from within the country and therefore do not require a visa and hence do not furnish information to the Kumbh organizers. The Kumbh pilgrims are required to undergo some immunization before they can enter the Kumbh precinct (Jha, 1991). Immunization enforcement is very difficult due to the huge influx and infiltration of pilgrims. The Kumbh, like the Hajj, also involves many rituals in which dense crowds move simultaneously.

The Badrinath Yatra takes place every year involving brisk crowds climbing to the sacred sites in the foothills of Himalayas in India (Badrinath, 2014). Like Kumbh, there are no arrangements for collecting data about the pilgrims of BadrinathYatra.

There are many similar crowded religious gatherings at different temples and shrines in the world like those of Vaishno Devi and Kamakhya temple (Vaishno Devi, 2014).

Crowd management during the intense crowded travel and rituals, as described in the Hajj and Kumbh cases, is a critical issue since many pilgrims go on missing whereas others require urgent medical attention during these mega events. Overcrowding often results in stampedes, not all of which are reported in the press due to safety and political reasons. The occurrence of high traffic, human jams and hazards are frequent during such events. Similarly, the possibility of the spread of communicable viruses such as swine flu, bird flu, and hepatitis are also very high during pilgrim seasons. There are security issues as well that need to be taken care of. In order to provide an effective management framework for such mega events, we need to be realistic as to what is critical, useful, manageable, feasible and economical for large and dense crowd management system. Table 3.1 presents a summary of the most major mega events in the world.

Table 3.1: Mega Pilgrim Events

Event Name	Frequency of the Event	Event Place	Event Site
Kumbh	Every 12 years	Within the country	The Holy River in Allahabad in India
Badrinath Yatra	Annual	Within the country	Himalayas-India
Vaishno Devi	Annual	Within the country	India
Kamakhya temple	Annual	Within the country	India
Hajj	Annual	International	Makkah

3.2 Pilgrimages to Makkah

There are five pillars in the Muslim faith, which prescribe how believers should behave. One of them is Hajj, the pilgrimage to Makkah that every adult able-bodied Muslim who can afford it should undertake once in their lifetime. It involves performing a series of rituals, which are related to events in the life of Mohammed (peace be upon him) the last and final messenger sent to mankind, the prophet of Islam. These rituals include, for example, climbing the Mount Arafat, symbolically stoning the Devil, and spending the night at a location near Makkah. They have to be performed during a particular week of the year, which is when millions of pilgrims travel to Makkah and engage in various rituals activities (Asharq Alawsat, 2015). Pillars of pilgrimage are called (in the Arabic language) 'Arkaan', if one of the pillars is not performed then everything should be redone. If the obligatory actions are not done, the pilgrim has to offer an animal sacrifice as a ransom or fast for ten days if he or she cannot afford to provide an offering. There are also actions, which are forbidden called 'al-Mahdhoorat'; if done they can spoil the duties of Hajj or render the Hajj void. The following are the Arkaan of Hajj (Abdalziz, 1999):

3.2.1 Ihram

During the Hajj, male pilgrims are required to dress only in the ihram which is made of two sheets of cloth (preferably white color), with the top draped over the torso and the bottom secured by a white sash; plus a pair of sandals. There is no difference in ihram between rich and poor. Women are simply required to continue wearing their normal dress, which does not cover the face or hands (Abdalziz, 1999).

3.2.2 Tawaf

Tawaf is one of the rituals performed during Hajj. It involves circumambulating the Ka'bah located within the walls of the Great Mosque in Makkah. Figure 2.1 shows the Tawaf around Ka'bah. There are two levels, which can be used for this purpose: the ground level and the roof of the mosque enclosing the Ka'bah. Pilgrims have to walk seven rounds starting from a particular point defined by the Black Stone, which is set into one corner of the Ka'bah building. Until recently, there was a line drawn on the floor extending outwards from the Black Stone to indicate the starting location of Tawaf, and a blinking light mounted on a column to help people spot the starting line. Both of these have now been removed due to safety concern that were largely related to people looking down in search of the line and then tripping or making others trip, a significant danger in a crowded place. Pilgrims circumambulate the Ka'bah counterclockwise, and the seven rounds can take one to two hours to complete. During Tawaf, pilgrims wear Ihram, a white two-piece garment (Mahmud and Mansur, 2003).

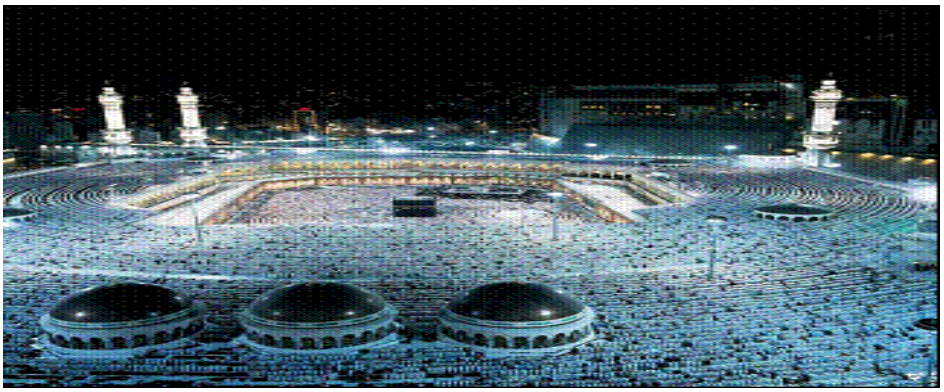

Figure 3.1: Around Ka'bah (Tawaf ritual)

*3.*2.3 Saai

After the Tawaf pillar is complete, on the same day, the pilgrims have to perform the Saai ritual, walking seven times between the hills of Safa and Marwa. Pilgrims should start walking from the Safa hill. When a pilgrim starts from Safa and reaches Marwa this is one round. The return back to Safa again is the second round and so on until the rounds are completed seven times (Ministry of Hajj, n. d)

*3.*2.4 Arafat Day

The pilgrims arrive to Mina on the eighth day of Dhu-al-Hijjah morning. On the ninth day, they leave Mina for Arafat where they stand for prayer and Qur'an recitation. Pilgrims must spend the whole day within a defined area on the plain of Arafat until after sunset. No specific rituals or prayers are required during the stay at Arafat. A pilgrim's Hajj is considered unacceptable if they do not spend part of the day (the ninth of Dhu-al-Hijjah) in Arafat (Ministry of Hajj, n. d).

*3.*2.5 Hajj Characteristics

The most distinguishing characteristic about the Hajj season is the spiritual atmosphere that the pilgrims live and practice. The government authority on the other hand faces great responsibilities of facilitating Hajj rituals and safety. Some of factors that complicate the government authority responsibilities are stated as follows (Osman, Shaout and Mohandes, 2015):

1. **Age of pilgrims**

Most of pilgrims are of old age since their countries allow only seniors to perform pilgrims where many of them fall sick or die during the Hajj season.

2. **Language barrier**

As pilgrims come from various countries and speak different languages, educating them to perform Hajj is a very challenging task.

3. **Dress Code**

Males during the Hajj season dress two pieces of cloths, one is for covering the upper part of the body while the other is covering the lower part of the body. Pilgrim’s

dress has no pockets. A pilgrim may wear a belt that has small pockets where he can guard his personal things.

4. **Identification of pilgrims**

Due to the great number of pilgrims and their old age, sudden death or injuries during Hajj season are at a high rate. Many of those who die are found alone holding no documents. Every year authorities find tens of bodies belonging to pilgrims that aren't claimed nor identified. Such an issue is not easily solved. RFID-based System for Pilgrims is being considered to solve this issue in this dissertation. Hajj authorities are obliged to identify the dead and inform families of their lost ones.

5. **Guiding Lost Pilgrims to their camps**

Many pilgrims are reported lost every hour during the Hajj season asking to be helped to return to their camps. In such a case finding someone who speaks the lost pilgrim's native language is not an easy task. With the absence of any proper identification that indicate their camp location and contact numbers and with no language shared makes it impossible to help them. This is very stressful for the security officers taking care of pilgrims.

3.3 Technologies used to develop Easy Hajj application

It is the collection of techniques, skills, methods, and processes used in the production of services or in the accomplishment of objectives GPS navigation device, an embedded web browser and instant messaging client, and a technology used for cellular communication. The following technologies will be used in this dissertation:

3.3.1 Mobile Device Enabled NFC

Smartphone are entering the market with technology such as NFC (Near Field Communication). NFC will allow the Smartphone to wirelessly interact with physical object which will enable the phone to simplify the daily life of its users. NFC can seamlessly receive and transfer information which would otherwise be tedious work for the user to input. Currently the majority of the education institutions in the world relay on student identification cards for identification purposes (Osman M , Shaout and Mohandes, 2015).

3.3.2 Electronic Identity Card

The electronic identity (EID) is used in many nations such as Denmark, Germany, Spain and Turkey (D.Hühnlein et al., 2012; Heichlinger and Gallego; 2010; Mutlugün, 2009). The electronic identity card is a physical card with smart capabilities, used to authenticate users electronically. The majority of EID cards have a contact based interface (ISO 7816-3) similar to a secure element. However, some utilize a contactless interface (ISO14443). The smart card contains sensitive information. For authentication, the EID card can be used with or without biometric data depending on the authentication policy of the given service. However for high level security all three authentication factors are used, biometric templates, pin-code and the card itself. The card is compatible with most smart card readers; however, it requires a specialized device known as a Card Access Device (CAD) to use the biometric authentication. The three levels of authentication achieve very high level of security and are difficult to compromise, since the authentication process itself is done online with an authentication server (Poller et al., 2011). The EID has great potential and is definitely very secure which is naturally a requirement for a device that is supposed to be used with e-Government applications.

3.4 Research Methodology

The research uses the waterfall model which is simple and easy to use. It is document driven where each phase yields a set of documents. Each phase must be completed before starting in the following phase. At the end of each phase, phase review takes place to ensure that the research is moving in the right path. The research is divided into three main phases to achieve the desired objectives. Figure 3.3 shows the three phases of the methodology that used in research. There are a lot of models such as Build and Fix, Incremental Models, Rational Unified Process, Spiral, and Agile and each model has different characteristics.

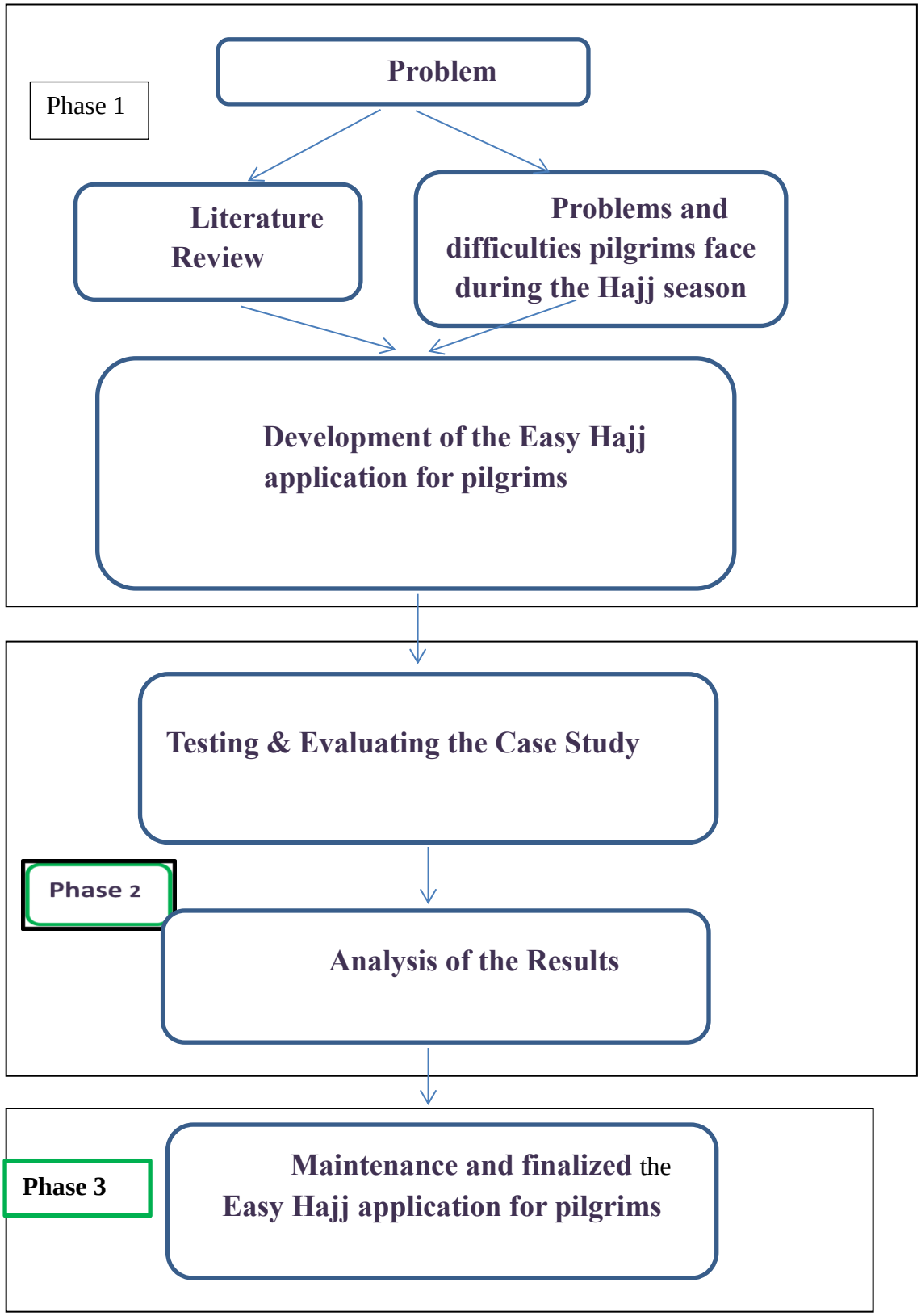

Figure 3.2: The three phase methodology used in research

*3.*4.1 Phase1: Problems Pilgrims Face and the Developed Solution

There are several problems raised by the pilgrims we interviewed when investigating this scenario that pilgrims face during Hajj. Dehydration and exhaustion can be a grave problem due to the heat and the potentially long duration of a ritual. A further danger is being pushed due to the large number of pilgrims present at any time during Hajj. This is particularly bad near the Black Stone corner of the Ka'bah as pilgrims are encouraged to kiss/touch it. It is also easy to get separated from one's group due to the crowdedness and the resulting density of people. Therefore, losing other people is another problem facing pilgrims. One interviewee had personally experienced this problem, and reported having lost his group during Tawaf and then been unable to find them (or his hotel) for three days. Another key problem: finding various places in and around Makkah. There are a number of static signs installed throughout the city. However, they found the signs of limited use (even with interviewees that were capable of reading and speaking Arabic).

In this dissertation we focused on main issues which face pilgrims while performing their rituals inside Makkah's Haram. The first is how to control the crowd and identify the personalities and track them. The second is how to assist people in finding each other after becoming separated in the Haram. People finding each other' will be covered in Chapter 4 and the 'Tawaf study' will be covered in Chapter 6.

*3.*4.2 Phase 2: Analysis and Evaluation of Easy Hajj Solution

In this phase the proposed Easy Hajj solution was analyzed and evaluated to determine its real effect and if it makes the event pleasant and safe for pilgrims. The solution was as follows:

Reciting zikir and Dua'a when performing pilgrimage becomes easier with the assistance of audio facilities provided by the solution Easy Hajj. The Tawaf count facility also overcomes the forgetfulness of Tawaf count. Getting lost, which is very problematic for most pilgrims, is addressed and the solution is able to track and locate pilgrims. The facility is beneficiary to individuals who perform pilgrimage and to agencies that directly involve with managing pilgrims. The time to find the right direction and to find missing people is reduced by using this solution.

*3.*4.3 Phase 3: Maintenance

Maintenance is a set of procedures that should be considered throughout the research. Maintain databases will be according to the history of pilgrim-reported problems, feedback from pilgrims, and action taken. By tracking the history of pilgrim problem reports, programmers can target maintenance procedures for validation that have the greatest potential impact on safety and/or economics. This information is used to keep track of which problems need to be corrected and as a simple way to measure manual quality (i.e., year-to-year comparisons of the number of problems). The programmer perform limited testing of documentation to ensure that maintenance procedures are satisfactory from the user's perspective not necessarily an attempt to hide problems, but rather fixing errors. In this phase, documents are released, problems are identified, revisions are made to the document based on those problems, and then re-released. Technical documents will improve with more use of the system. However, because of the current limited depth of data, it is not possible to track trends over time. By tracking the number and type of user responses, trends can be identified that can guide efforts to improve manuals and serve as useful metrics of manual quality. Authority could save resources by identifying and validating procedures that have historically been problematic. Operators could also benefit by identifying the personnel, equipment, and environmental variables that contribute to usability problems and respond accordingly.

3.5 Ethics of Pilgrims Tracking

Tracking and monitoring others may be tainted easily and it is similar to spying into people's private lives (Poller et al, 2011). Michael et al. (K. Michael P, 2006) have investigated the ethics of human-centric GPS tracking. The authors have raised a series of questions that need answers such as 'who owns the information?' and 'who is authorized to access the information? Authors have a set of questions related to accuracy of collected data (e.g., 'who is responsible for the authenticity of the data?') and questions related to the ownership of accessing the data (Osman et al., 2015). Also questions about the individual private data (such as his/her current location). These ethical questions should be carefully considered so that the service can be integrated into the society. To ensure that private data is not revealed to unauthorized parties,

collected private data is often anonymized. Such anonymization can be achieved by inserting fake data into the source data or by removing potential identity revealing data selectively. Another technique to restrict drilling into private data is to block data queries that may result in identifying individuals. For example, the result of the query "number of people who come to HAJJ from y country that work in x company", could be blocked if this number turns out to be a small value (e.g., 3), since it can potentially identify individuals. Gkoulalas et al. (Gkoulalas, 2008) have used such query restrictions to build a privacy-aware trajectory tracking query engine. Hoh et al. (2007) have defined a privacy metric called 'time to confusion', which is the time an adversary could correctly follow an individual's trace. Tracking uncertainty exists when the 'time to confusion' is small. Maximizing tracking uncertainty increases privacy that applies to the collected GPS data; by pruning data while maintaining the overall statistical properties.

3.6 Chapter Summary

Through this chapter we have introduced Mega Pilgrim Events in the world and take Makkah as case study by introduce several terms that are related to the Hajj event in the Islamic religion and Hajj Pilgrim Characteristics and the technology that is used finally the methodology used which provides full details about the methods that was applied to obtain information about the pilgrimage situation and places of congestion during also provided a brief description for each method we applied in the research.

CHAPTER IV

Tracking & Identification Of Pilgrims During Hajj Season

4.1 Introduction

Several million pilgrims from all over the world perform Hajj every year. This number is projected to grow up to 5 million by the year 2020. The Hajj authorities face several problems in managing the growing huge number of pilgrims and providing them the essential services on timely basis. This chapter describes the development of a system for solving some of the major problems faced by Hajj authorities and pilgrims each year. The developed system uses technologies to provide services such as pilgrim identification, controlling access to the holy places, providing timely medical information and helping lost pilgrims. The identification, health support, and security modules were designed and developed in the form of an App for NFC compliant Android smartphones and NFC tags. In addition, web-based information system was also designed and developed to host the data related to pilgrims, such as personal identification information, health related information, groups getting separated and being unable to find each other, or having difficulty finding their way around the Holley area and their addresses of accommodation in the holy sites such as Mina, Arafat and Muzdalifa . The objective of this chapter is to look into these problems and develop solutions that are usable by very large numbers of pilgrims from different cultural backgrounds and with varying abilities. The proposed system will allow pilgrims to extract information using their relative position with respect to date and time.

The chapter has tow parts, one for identification and tracking pilgrims, and the other is Case Study : **To detect pilgrim location if out of Arafat** . The flowchart diagram that shows the architecture tracking and educate system during Arafat (Osman et al., 2015) will be shown in the section on educating pilgrims.

The end of each section contains the theorem which was extracted based of the tests and survey results.

4.2 Identification System for pilgrims based on NFC

There is need to identify pilgrims in case of lost, death, or injury. Moreover for safety and security of pilgrim’s reliable and affordable solutions are required to help in

crowd control by allowing the authorities to estimate the number of people at a specific location when there is a risk of accidents. The proposed system eases the flow of pilgrims at key points resulting in proper utilization of space and is proposed to use NFC (near filed communication).

4.2.1 Pilgrims card

Every Pilgrims gets an NFC capable card for Identification. Although there are many types of NFC cards from a number of different vendors available on the market (Osman M and Shaout, 2014); the Mifare DesFire card was chosen due to its excellent safety features. In addition, the Mifare DesFire card (see figure 4.1) provides services for managing multiple NFC applications independently on one card. The latter feature may come in handy if additional NFC based services are implemented in the future. The Pilgrim card contains a Pilgrim identifier which is used when needed during the Hajj season. The card contains personal information like name, nationality, age, health history and fingerprints. The chosen card has 4k memory that is far enough for storing the Pilgrim identifier and his/her fingerprints. The administrator verifies the identity of the Pilgrim based on the ID card. The administrator requires Pilgrims to be equipped with a small wearable NFC tag which is identifiable by authority using NFC enabled smartphones.

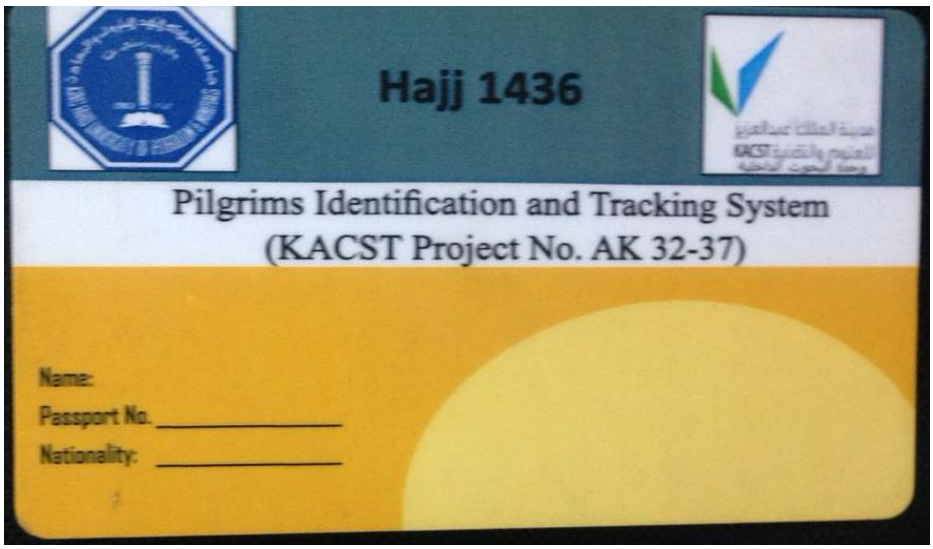

Figure 4.1: A sample identification card for pilgrims (Osman and Shaout, 2014)

4.*2.2* Advantages of NFC Tags

The main advantage for NFC tags and the reason why this technology was chosen is that NFC does not require a pairing of devices. Technicians do not have to perform additional steps than just placing the NFC reader next to the tag. The short distance of about 0-20 centimeters of the NFC based communication and the fact that NFC readers can only read one tag at a time lead to a secure communication. Further advantages are the size of tags (0.5mm²) and the memory capacity as well as the low prices ranging around one Euro for a tag with more than a kilobyte. These advantages make it easy to place NFC tags in small and wearable wristbands, identified with and handed to the Pilgrims at the time of arrival to Saudi Arabia (Osman and Shaout, 2014).

4.2.3 Framework for Pilgrims Identification System

The proposed architecture for NFC based identification system is illustrated in Figure 4.2. The detailed description is given as follows:

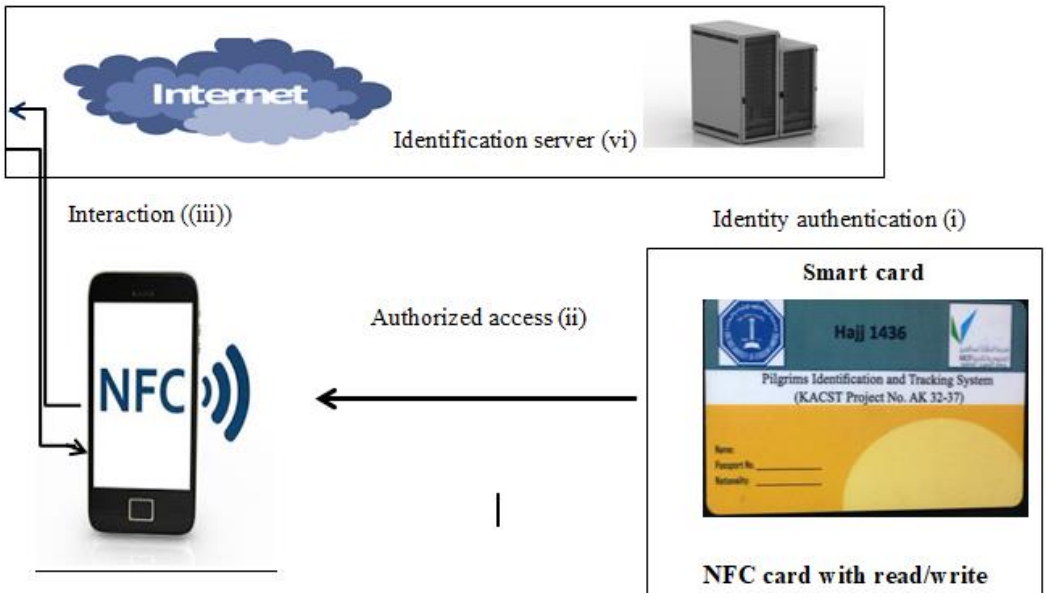

Figure 4.2: NFC based identification system architecture

(i) Identity authentication uses NFC recognition technology. NFC recognition reads card ID and personal data.

(ii) In the architecture, NFC card is read by a mobile device using a Java application. The application can read and access the card's data. NFC is mainly used to get the unknown people's identity.

(iii) To manage the system easily, Admin Mobile and server communicate data by using GPRS/ WIFI. Admin Mobile can upload identity verification information and permission change request. Identity verification information includes personal information in the card ID.

Figure 4.3 shows the flow chart for the NFC writer and reader.

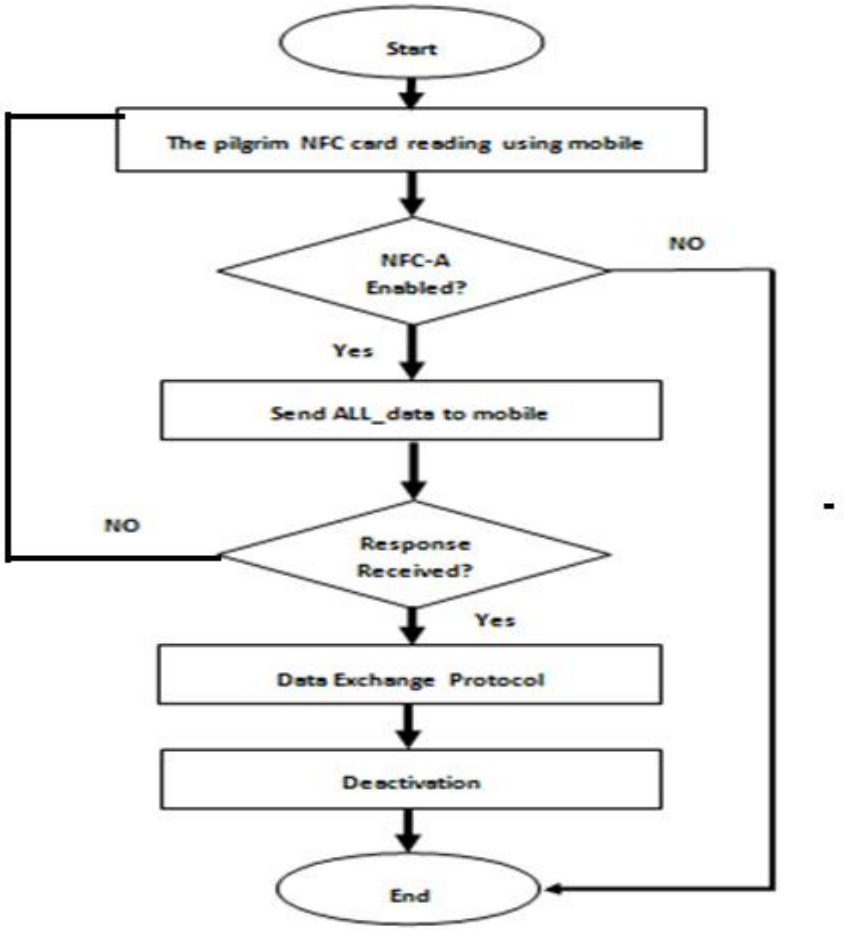

Figure 4. 3: NFC Reader/Writer Flow Diagram

4.3 Tracking System using GPS

Our objective is to build a framework using GPS to track pilgrims in the Holy areas during Hajj (Pilgrimage) with the following requirements:

1) The location reported should be demand driven.

2. Privacy of the pilgrims needs to be respected. Location information should only reveal the location to those who are authorized.

3) It is desirable that the framework is technology independent as much as practically possible to be able to report pilgrims' location and have communication capabilities with them.

The following are some of the information that the proposed module will be able to provide:

1. Is the person at a specific grid area?
2. Is the person moving?
3. Is the person at the right location at the right time?
4. How fare is the person from a certain service (ritual site, medical location, food location, etc.)?
5. Has the person exceeded his/her stay in a certain Hajj ritual area?

4.3.1 The Tracking System Architecture

Figure 4.4 shows the proposed tracking system networked architecture. It consists of the following software components:

1. GPS location module,
2. GSM delivery module, and
3. Backend system that collects and displays the requested information.

Figure 4.4: The Proposed Tracking System Architecture

After creating and activating the GPRS connection, data will be requested from GPS, and then analyzed before sending it to the server. The difference in time and distance between the current GPS data request and the last GPS data sent can also be calculated. The proposed system will also decide wither to send the data or not based on the calculated time and distance. The controller in the system checks to see which satellite is in view, and checks for the transmission intervals to trigger the time and distance intervals to see if there is a GPS data or not. If GPS data is ready, it will resume the socket connection, and then send the data to the server through the GPRS network. Normally the tracking device waits until the GPS module is locked on the signal of at least four satellites to calculate the 3D position. The position is defined based on three values; longitude, latitude, and altitude which are called the coordinates of the tracked position. The tracking device sends those coordinates with other information to a fixed IP address at a fixed port for specific server. The transmission of the coordinate data is done by establishing a GPRS connection using the GSM modem. The wireless carrier network provides wireless Internet service through the GPRS connection. A TCP packet with all the essential information is sent to the monitoring server. The server has TCP packet listener application installed and running on the server. The packet listener opens a local TCP port that is specific for the GPRS packets

and keeps listening until a TCP packet is received. After receiving the data, the application analyses the data format which is checked against the supposed tracker data format, and then inserted into the database based on its tracker device ID.

The proposed tracking system consists of two clients, namely mobile application and monitoring & controlling the web site and two servers namely web service and database as back end as shown in figure 4.5.

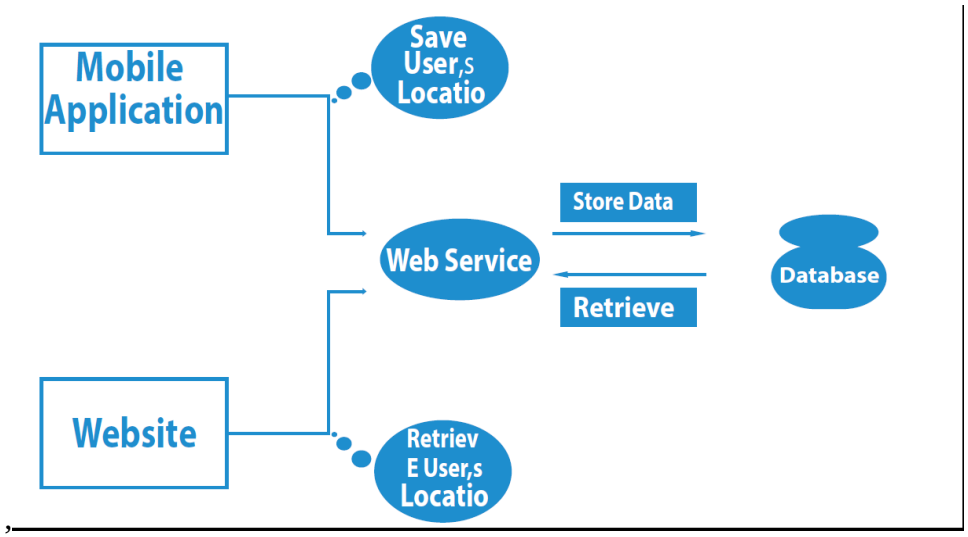

Figure 4.5: Data flow diagram that shows the architecture tracking system (Osman, M et al., 2015)

The first client used is the mobile application which is used to obtain the location information and sends it to the web service. The web service saves the received data in a database server using a secure channel and then the website connects to the web service to retrieve a specific user location and show his/her location on a Google map. In next section we will explain each component in figure 4.5 in details.

4.3.1. 1Mobile application

The mobile application is the software that can be downloaded to the mobiles of the participants to be tracked. This software extracts the latitude and longitude data from the GPS system installed in the mobile phone and sends them along with the time stamp periodically to the web server based on pre-set parameters for the user as per the tracking requirements.

The system consists of three underlying technologies: Global Positioning System (GPS), Global System for Mobile communication (GSM), and General Packet Radio Service (GPRS) (Garmin, 2015; US Air Force Fact Sheet, 2015; Birsan and Iubu, 2010; Hapsari et al., 2005; GSMWorld, 2005; El-Medany et al., 2010; El-Medany, 2014). To design an affordable, fast and intelligent personnel location system the GM862 cellular quad band module is used. GM862 has GPS and GPRS integrated together to track and identify pilgrim moves and places which will provide a safe and comfortable environment for the pilgrims during the Hajj season. GPS is a 24-hour worldwide service which can provide accurate, three-dimensional information of the location as well as precision velocity and timing services (Hapsari et al., 2005). Google Map is used for mapping the location and tracks pilgrims. GPRS is a low-cost wireless data communication system provided by smart phone operators (Birsan and Iubu, 2010). The system provides the ability to track Pilgrims current position or their position at any specified time and date.

For the tracking system, the mobile application is developed and its tasks are defined as the following:

1. Retrieve the current user's location and location time, then shows it on the application main screen,
2. Enable user to edit settings which are the user ID that is used as a reference for the user and also the time update range which is the number of minutes between locations update,
3. Then user can select to start location update, which can start sending the current location and time of that user to the web service which will save it to the database. In case of unavailable internet connection then the application may save locations on the mobile phone until the internet becomes available and then all stored location information is sent to the server with their time stamp. The application continues sending the location data periodically until the user stop the process or close the application. The application uses different GPS that exists in the mobile itself to get the location and time. The application sends the location data using either wireless network or using GPRS over HTTP protocol and using SOAP protocol.

4.3.1.2Web service

Web service is used as an interface for both the mobile application and the website. It connects to a backend database so it is used to store the received data in a database server and it provides the following functions:

1. Web method to save the current user's location using the mobile application and any other client implemented for future work,
2. Web method to retrieve locations for a specific user using the user id, and
3. Web method to retrieve all locations for all users on the system.

Through the web application, administrative or authorized personnel will be able to view the live position of the tracked user, together with the past positions and the route they have chosen. By monitoring this information in real-time, authorities can have fully updated information regarding Pilgrims movement. This gives the authorities the option of using this information to locate missing or lost pilgrims. A web application is responsible for accepting data that has been sent by the mobile device via GPRS or GSM, using GET method of the HTTP protocol. This data consists of SIM number of the device, latitude, longitude, time, date, update mode, and distance between two consecutive coordinates based on their updating mode. SIM number is used to authenticate the device. For the real-time aspect, we have used the technique of checking the database periodically. Once real-time mode is activated, the current time will be stamped and then the database will be checked, as shown in Figure 4.16. If new data was found, the marker will be added to the map. Checking the database in a specific interval will automatically animate the marker on the map. We use the publicly accessible Google Maps API for some part of the code (Birsan and Iubu, 2010).

```
function realTimeUpdate()
{
GDownloadUrl(sqlXmlUrl, function(data){
var xml = GXml.parse(data);
markers =
xml.documentElement.getElementsByTagName(
"marker");
var databaselatestdate =
markers[0].getAttribute("date");

var latestdate =
changeToDate(databaselatestdate);
if( latestdate >= currentTime)
{
   currentTime= new Date();
   addMarkerToMap(0);
}
});
}
```

Figure 4.6: The code for the function for real-time update calculations.

4.3.1.3 Database for Tracking System

The database is used to store and retrieve the user's data, and it is accessed only from the web service or mobile application securely by authentication using system administrator name and password. The database consists of a table that contains longitude, latitude, time stamp and user ID. This table contains all the saved locations from the web service which previously sent by the mobile device(s) and it is accessed to retrieve data using user ID as the primary Key of this table. The database is created using MYSQL which is made of three tables as shown in the entity relational diagram (ERD) in Figure 4.7. The three tables are as follows (MYSQL Reference Guide, 2015):

1. The devices table where each table has its ID. The devices table contains a list of tracking devices, the device name, and the user ID.
2. The users table which contains the devices users, and its password.
3. GPS logs table which contains the device ID, the UTC (Universal Time Coordinates) time and date, the position records for the tracking device (longitude, latitude, and altitude), time in, and date.Table 5.2 show the Database fields used in the implementation.

Table 4.1: Database fields used in the implementation.

Column Name	Date Type	Length
user_name	nvarchar	200
tag_id (primary key)	nvarchar	100
user_pic	varbinary	8000
user_id_no	nvarchar	100
user_birth_date	datetime	8
user_gender	nvarchar	8
user_perm_address	ntext	16
user_local_address	ntext	16
user_med_info	ntext	16
user_nationality	nvarchar	100
user_inter_ph	nvarchar	20
user_local_ph	nvarchar	20

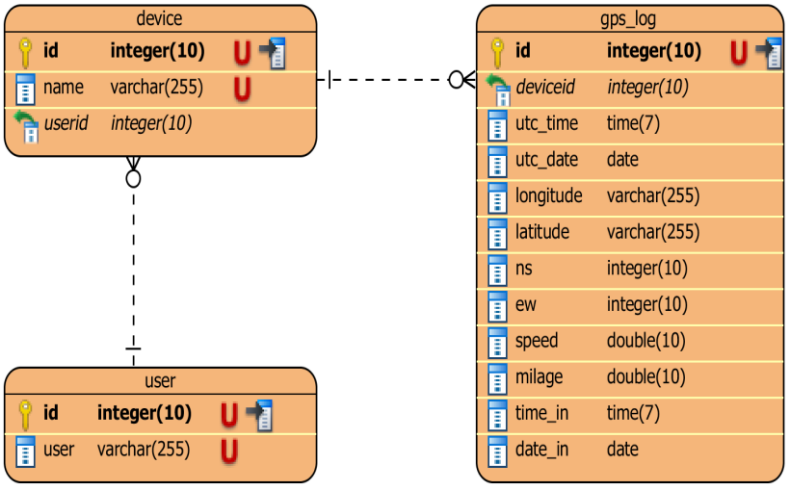

Figure 4.7: Entity Relational diagram.

There were some requirements and external tools, libraries and services used for this implementation such as Google *Places*, *Google API Key* and *Services LibraryRequirements* together with different web services which were called (Google Places API, n. d, Place Types, n. d, Google APIs Console, n. d). Figure 4.8 shows Arafat finder architecture.

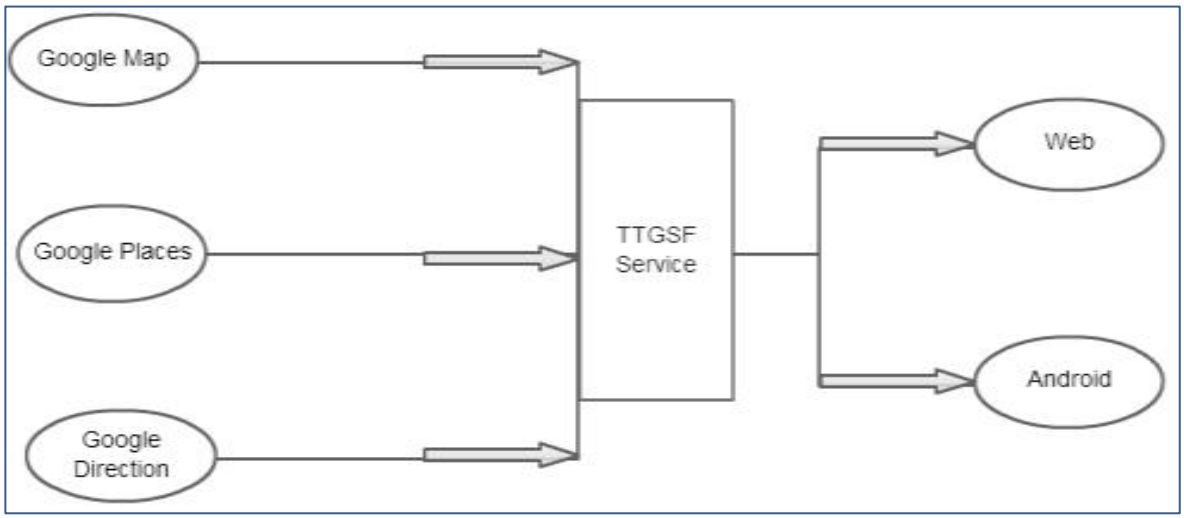

Figure 4.8: Arafat finder architecture.

The unit will establish a GPRS connection with the server, and then establishes a TCP/IP socket connection with the data that is sent as IP data packets over this connection. In the event that there is no GPRS available, the GPS data is stored in the memory unit and will be sent to the server along with the real time and location details as soon as GPRS becomes available again. Figure 4.9 shows a block diagram for the architectural Operation for tracing system (Osman, M., and Shaout, A., 2015).

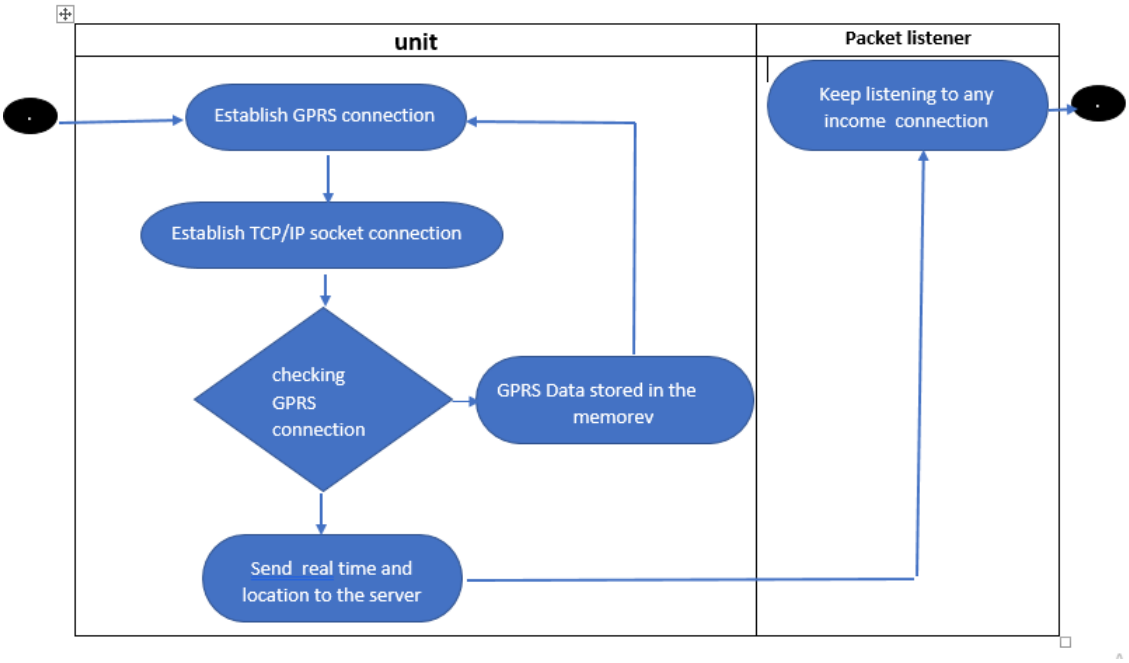

Figure 4.9: Architectural Operation for tracing system

The main software components of the system are the socket communication among the monitoring server, the web server, and the GIS map server as shown in figure 4.10.

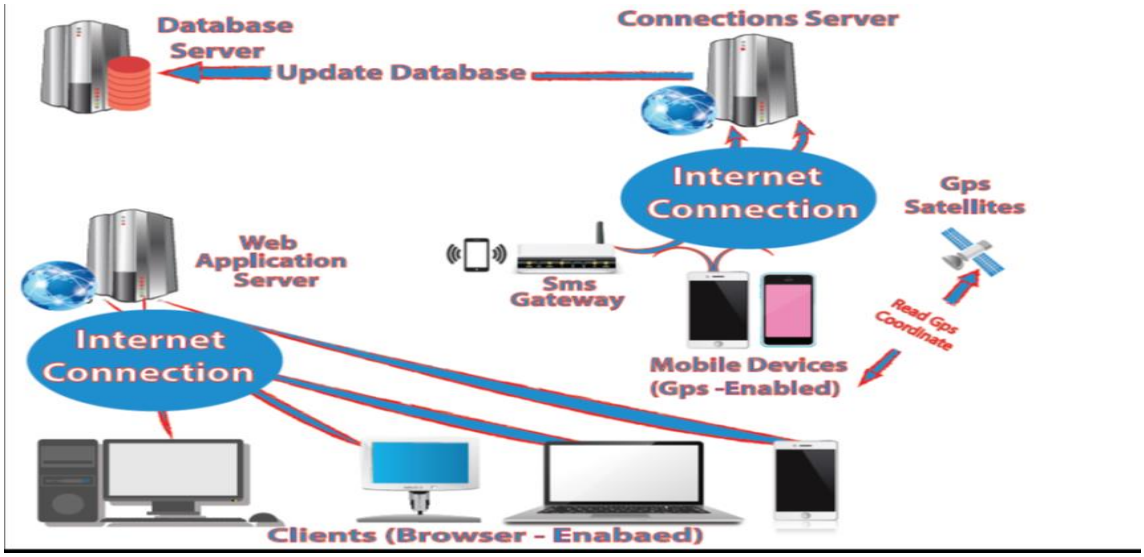

Figure 4.10: The proposed tracking system using the database server& mobile device

The monitoring server is the central server component that communicates with the tracking unit's remote hardware. It is capable of communicating with multiple client units using multiple threads. The server will create a TCP socket and will bind the application to the relevant port. The packet listener opens a local TCP port and keeps listening to any incoming connections. When a client connects, the server will check the data format against the tracker data format, and then it's inserted into the database based on its tracker device ID. The proposed architecture is for a mobile framework that implements a pilgrims tracking system. The system provides the ability to track current position of the pilgrims at any specific time and date by analyzing the data from the GPS receiver (Osman et al., 2015).

4.4Case Study: To detect pilgrim location if out of Arafat

The GPS-enabled mobile phone is connected with the user and with the coordinates and update mode to the server and stores it into the database then sends the data with the Subscriber Identity Module (SIM) card number as its identifier, together with other data. The server which only provides reliable indoor and outdoor user location is divided into three parts; server side, processing side and connection side. Dissolution of servers is needed to handle the huge clients' updates.

For connectivity, two different services offered by any GSM mobile phone will be dealt with. Any wireless network infrastructures available can be used, together with SMS as the means of data communication between the client and server. The main precedence will be given to updates using any available Internet connection such as Wi-Fi, GPRS and 3G were it will then make use of the connection to update the server with pilgrim's GPS coordinates. In addition to that, SMS is also used as the other alternative connection to update the server. If Internet connections are not available, the device will then automatically use SMS as another option. This works as a solution for the availability issue especially in a situation such as alerting for a missing pilgrim. Security is also considered for this proposed tracking system. Regarding security, it is considered as control privacy, thus we will authenticate any user who wants to access the data. For server update, a client application has been designed in parallel with the server process. It reads the latitude and longitude of the location and process it based on the specifications defined by the user. The main specifications are through the distance-

based and time-based parameters. The choice of distance-based and time-based parameter is designed to offer flexibility to the user in updating the server calculation. For the distance calculation of coordinates, the Cosine-Have sine formula technique based has been used (Juang et al., 2002). It results in a great-circle distance between two points on a sphere given the latitudes and longitudes. However, other parameters can also be used manually according to the user request such as the "Mark My Location" and the "panic alert." "Mark My Location" is a special button designed for users who intended to update the server about their current location. It uses only the chosen connectivity method to communicate with the server. This data of latitude and longitude will help the system to store reference points. The panic button is designed to alert the system in emergency situations. It uses all of the available resources, i.e. Wi-Fi, GPRS and SMS, to update current location of the user. Figure 4.11 shows the flow diagram of the distance-based and time-based latitude and longitude calculation updates in the server.

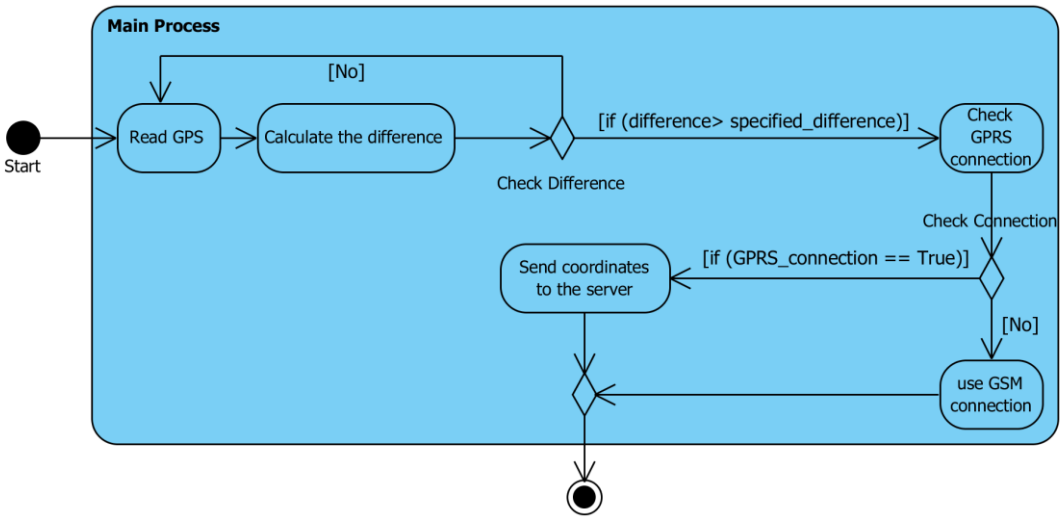

Figure 4.11: The flow diagram of the distance-based and time-based

In order to compensate the real-time update, we have decided to use the dynamic update triggering to the server. This means that the pilgrim will be assumed to be in a circular area with a defined radius and the system will only send an update to the server. For this reason, to gain popularity and widespread usage, our proposed system is developed. To provide the ability to facilitate real time we decided to use a PHP file and parse it into an XML format. These XMLs will then be processed by the application processing server.

4.4.1 Receive SMS Text Messages

In the case that a pilgrim is being late in a stage of a pilgrimage ritual, the system compares pilgrim location with the time and gives stimulatory signals with messages of guidance to the pilgrim. For example, if a Hajj is delayed in standing in Arafat, then he will receive the following message (as shown in figure 4.12):

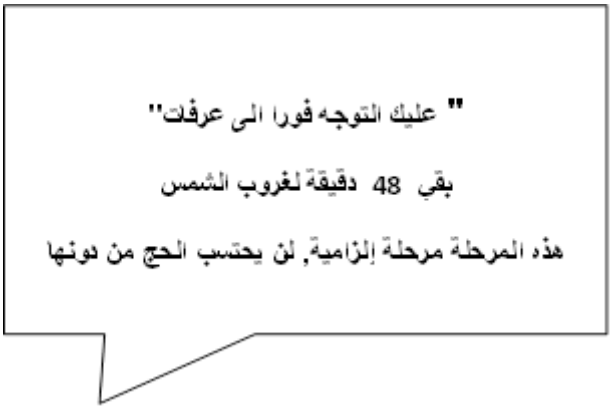

Figure 4.12: The message received when a pilgrim is late being in Arafat

Also the system includes an optional feature that would enable a pilgrim to get messages with prayers for each Hajj ritual. It is worth mentioning here that the Hajj can cancel this property any time. This feature provides the pilgrim to carry brochures and religious supplication publications that are issued by the Ministry of Hajj. All supplications will be linked to the place and time of the ritual, and there will be a variety of prayers that can be played by Hajj.

The followings are the main points to be considered when developing an SMS educate pilgrim system:

1. The system shall be able to provide the pilgrims with the information, in specific time and place when needed or required.
2. The system shall be able to detect the pilgrims if s/he is in the coverage area.
3. The system shall contain a graphical user interface that will allow the pilgrims to monitor the covered area.
4. Users might not be available to respond to SMS all the time. Therefore, a start SMS should be sent to ask whether a user is ready to start receiving SMS. The user can either send a YES or NO response to this initial message. If the user is not ready, then s/he will not respond to this initial message. When the YES response is received from a user, the system then starts sending. If NO response is

received within the time limit specified, then the system does not send any to that user.

5. The location should be learnt before the text message is received.
6. SMS should start at specific time and date as identified by the administrator.
7. There is more than one SMS message sent a day.

In the next section we will divided how to educate pilgrims through the Hajj process stages and build the software programs and applications to the sequential stages that fits the sequence of the stages based on the pilgrimage type. We will take IFRAD as an example and show all of pilgrimage steps so that the pilgrim is in the right place at the right time. Table 4.1 shows the Hajj rituals with time and place before the 8^{th}day of the Hajj (the 8^{th} day of Hajj is called the Tarwyah Day). Table 4.2 shows the Hajj rituals on the 8^{th} day. Table 4.3 shows the Hajj rituals with time and place from Arafat (the 9^{th} day) to Muzdalifah then Mena.

Table 4.2: Hajj rituals with time and place (before the 8thday TARWYAH DAY).

Date	Event	Dua'a Sample
The eight day of Thulhajjah before (TARWYAH DAY)	Message alerts appear on the screen and explain to pilgrim that the pilgrims heading to the area of Ihram. Display a map showing the nearest point to the place of Ihram (Miqat) and the shortest route to it and the time required to reach it. Calculates the Hajj site every 15 seconds, and in the event of the arrival of Hajj to the place of Ihram (Miqat) the program then starts by giving tips and guidance to the Hajj on how perform the Ihram. When the Hajj is out of the Ihram area then the message to the pilgrims will show that "now you go to Makkah and enter the Grand Mosque and start with TAWAF." When pilgrim completes the TAWAF then the following message "TAWAF has been completed" will be sent and another message will be sent to pilgrim to perform two rakaat "Rkaata circumnavigation". After that another message will be sent to the pilgrim instructing him to go to the area of Safa and Marwa to preform SAEE.	

Table 4.3: Hajj rituals with time and place (the Tarwyah Day)

Date	**Event**	**Dua'a Sample**
The eight day of ThulHajjah (Tarwyah Day)	Graphic SMS "Go to Mena" "*عليك التوجه لمنى*" A map would appear showing the shortest route to Mena. Expected time to get there from the pilgrim place.	

Table 4.4: Shows Hajj rituals with time & place (Arafat to Muzdalifah to Mena)

Date	Event	Dua'a Sample
Tenth day	Graphic SMS 1. Go to Muzdalifah from Arafat immediately after sunset. 2. After the middle of the night go to Mena for the special need pilgrims. For others, wait until you perform Fajer prayer. 3. Throwing Cinder Aqaba 4. Slater sacrifice, then perform Ifaadah 5. SAEE (If pilgrim did not perform the entering Tawaf). 6. Maps showing the shortest way to help Hajj for all the areas for the various Hajj rituals. **7.** Supplications and invocations are sent throughout Hajj stay in Mena.	

4.4.2 Send SMS Text Messages

To ensure that the location is sent only to those who are authorized, the received text message is checked for location. The location can be learnt quite easily if the mobile device has a GPS receiver. In this case, upon receiving the location querying text message, the device should turn on the GPS, get the location, turn off the GPS, and then send the location to the requester. The reason to turn on the GPS on demand is to conserve power. GPS receivers are quite power-hungry, and thus keeping them on all the time will drain the battery fast. For the same reason, the GPS should be turned off once the location is determined. However, the cold start-up time for the GPS is significant, and this will contribute to a significant delay before the device is located. A tracking architecture based on the mobile device having a GPS receiver is shown in Figure 4.13.

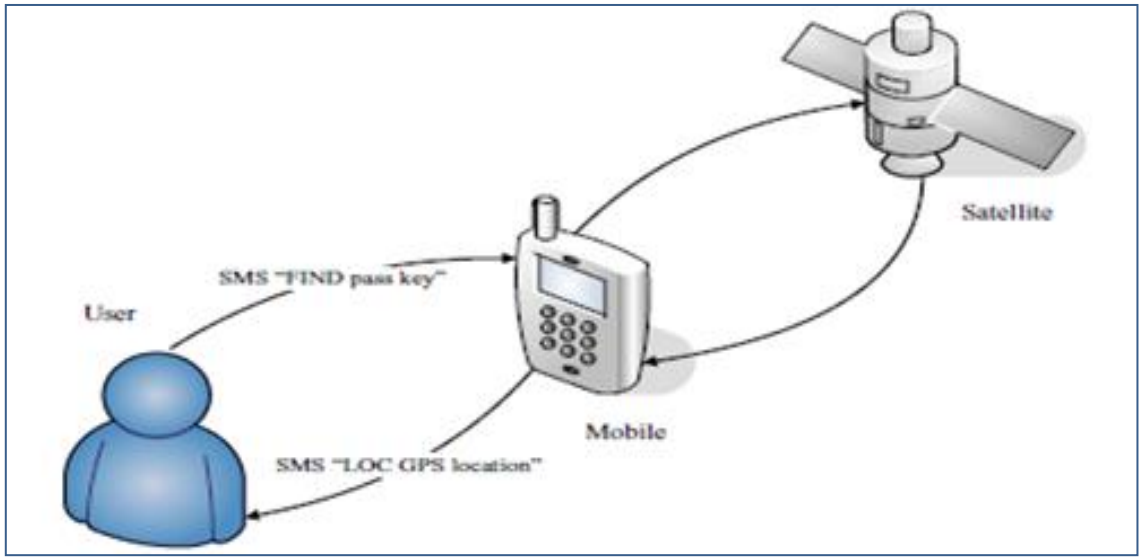

Figure 4. 13: Tracking architecture base on GPS

Not all devices may be equipped with a GPS receiver. Those that do not have access to a GPS receiver may calculate their location based on the location of (at least) three base stations. This technique is known as multilateration (Busic et al., 2005) SMS Notifications algorithm for this technique is shown in Figure 4.14 A tracking architecture based on multilateration is shown in Figure 4.15

```
if the text message has a specific pattern (e.g., FIND 'pass key')
    check to see whether there is an accessible GPS or not
    if there exists an accessible GPS
        get location from GPS
    else
        get location through multilateration
    endif
    send text with location information and ritual instructions
else if there is no identified pattern in the message
    leave the message in the inbox
endif
```

Figure 4. 14: SMS Notifications algorithm.

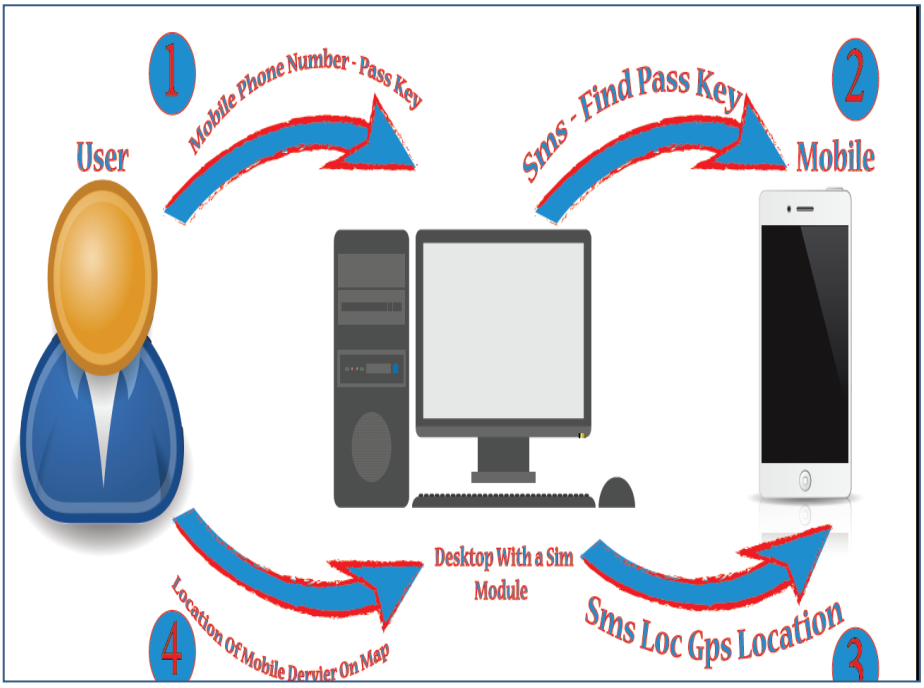

Figure 4. 15: Tracking architecture based on multilateration.

To be tracked, a mobile device is installed with a service that is set to activate upon receiving a text message. In order for the tracking to work, the tracked mobile device should be powered. Devices that are switched off or otherwise powerless cannot be located. Generally, the mobile phone is located by sending the device a text message. The location will then have to be mapped by the user to be useful. Figure 4.16 shows the working mechanism of the proposed system or device. Figure 4.17 explains Hajj rituals with time and place (before the 8thday TARWYAH DAY).

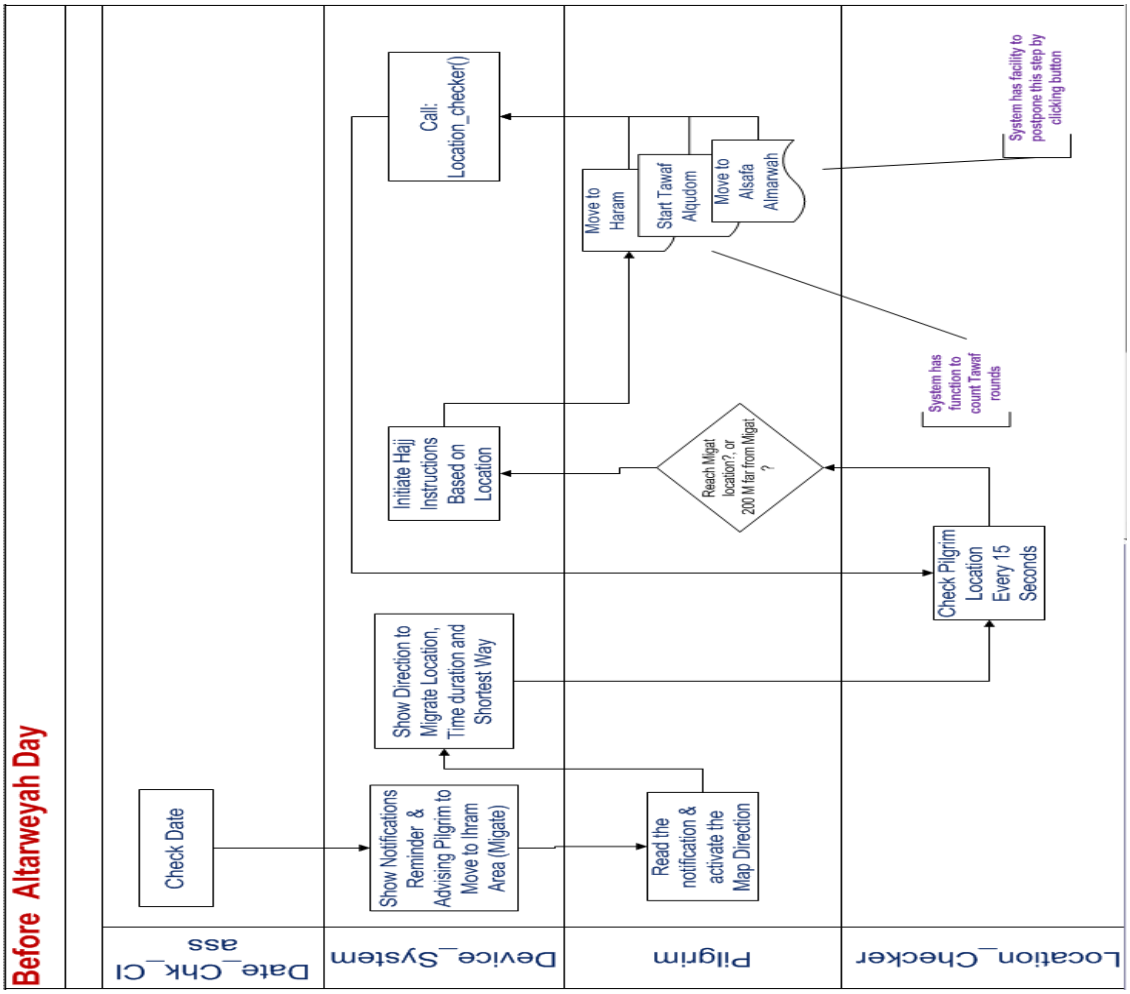

Figure 4. 12: Explain Hajj rituals with time and place before the 8th day (Tarwyah Day). You still need to Fix the flow chart!

Figure 4.17describes the conditions of the pilgrims during the day of TARWYAH on the 8^{h} day of Thulhajjah.

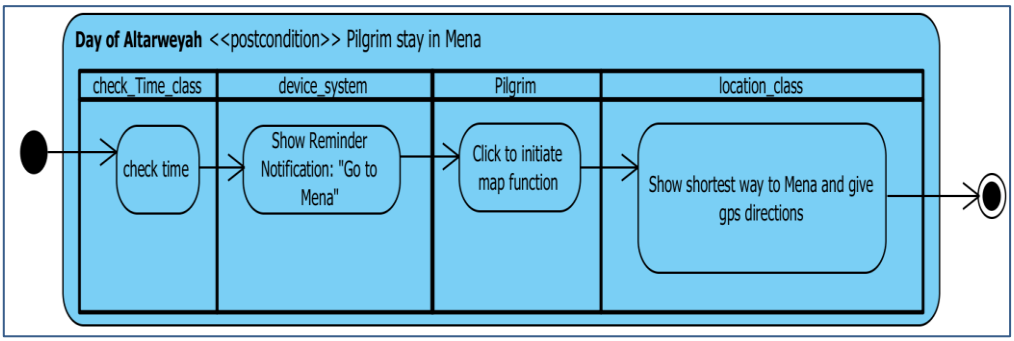

Figure 4.13: Explain the work model on TARWYAH DAY (the 8h day of Thulhajjah).

Figure 4.18 shows the working mechanism of the proposed system. The figure explains the spatial and temporal conditions of the pilgrims while in the region of Arafat.

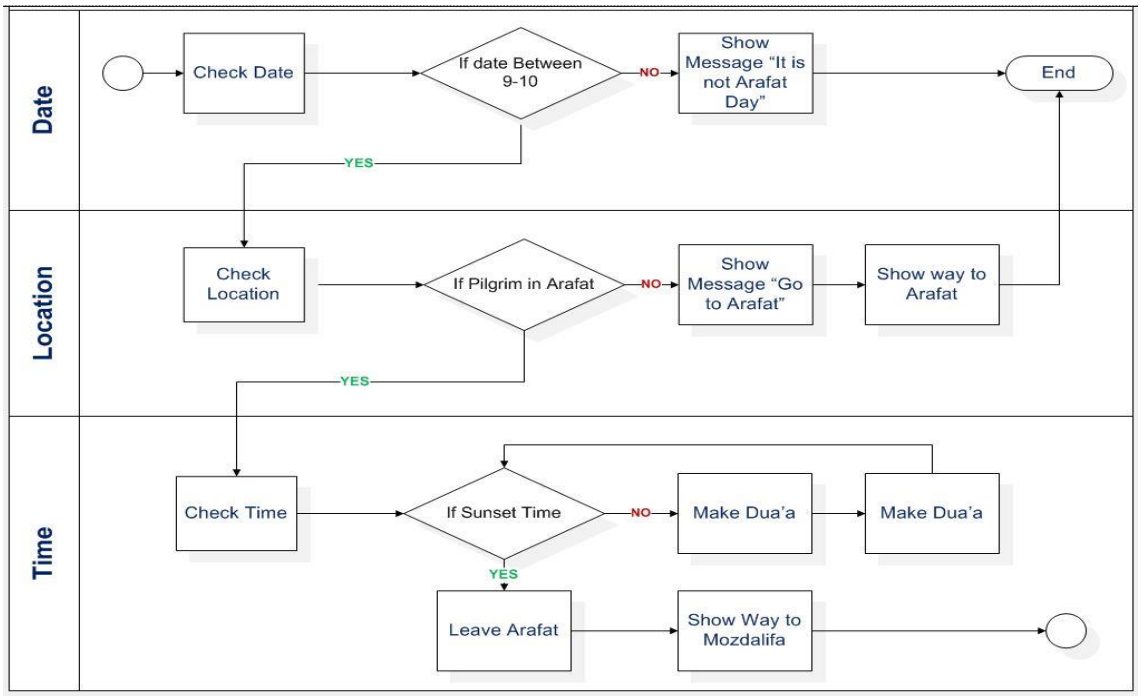

Figure 4. 18: The working model of the proposed system according to time and place while at Arafat.

4.5 Chapter Summary

The majority of pilgrims have their own mobile phones and a large percentage of their phones are already equipped with GPS. This led to developing a pilgrim tracking & Identification system using mobile phones. The chapter demonstrated the effectiveness of the developed Pilgrim Identification System for providing improved services to pilgrims. Pilgrims benefit from the significantly reduced waiting time at checkpoints, easier access to transportation services between different areas during the Hajj, and elimination of communication barrier with the medical staff and other service providers. Also reduces the immense pressure on Hajj authorities to provide efficient and timely services to the pilgrims and also prevent overcrowding by stopping pilgrims from accessing the Hajj areas without Hajj permits. The proposed system also provides educating a pilgrim to guide him throw his journey. The proposed system provides

instructions regarding the ritual places such as Arafat and Mena and it provides the correct supplication (Dua'a) and procedure for performing the required ritual.

CHAPTER V

Implementation for Pilgrims identification system

5.1 Introduction

This chapter shows the implementation details of Pilgrims Identification system project. It also shows the steps required to achieve the complete system process.. It also introduces a GUI we implement to facilitate interaction with the system and make it very comfortable

5.2 Software & Hardware Requirements

The proposed system was implemented using web services consists of a web and android application. The web application was developed using PHP (server side) scripting language and the Android application have Java Programming and XML. The basic web services platform is XML and HTTP for the services. These were implemented using Window Communication Foundation (WFC). However, any language could have been selected for implementation as long as the web services platform can be accessed. Table 5.1 show Software and hardware requirements

Table *5*.1: Software and hardware requirements

Operating Systems	Windows 7 SP1, Windows 8.1, and Windows 10 version 1507 or advanced.
Hardware	At least 1.8 GHz or rapid processor 2 GB of RAM; Hard disk space: consists of up to 130 GB space, The video card that stake a basic resolution of 720p (1280 of 720);
Supported Languages	It can be accessed in the following languages: Arabic, English are supported beside most of known languages.
An Additional Provisions	For Mobile Development Android SDK version 4.0 (API level 14) with Java, php and XML by Power Shell 3.0 required Apatche server and MYSQL as database

5.3 Reading NFC Tags

NFC can enable safe and useful uses for pilgrims during Hajj season. NFC enabled device was developed that can be connected to an existing web service enabled infrastructure using standard technologies. Mobile devices are ubiquitous in our daily life and have a high acceptance rate. The application was developed for the Android platform using the Android SDK version 4.0 (API level 14) ensuring upward compatibility and therefore can be executed on all Android based smartphones and tablets where NFC is available. The application uses the NFC technology to identify Pilgrims information. Placing the mobile device next to an NFC tag, which comprises of the ID and other Android/NFC related information, leads to an automatic startup of the mobile system and opens up when Pilgrims arrive. The kind of data can be defined

by specialists (authority) and can be edited and customized for each institution (country) making the system very flexible and adaptable to local needs.

To get access to the NFC hardware, you have to apply for permission. Using uses-permission the app can't be installed on devices without NFC and Google Play will only display application to users who own an NFC device. Figure 4.4 explains how to apply for a permission.

```
<TextView
    android:id="@+id/textView_explanation"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="@string/explanation" />
```

Figure 5.1: To get access to the NFC hardware

The Main Activity class consist of the onCreate() method which interacts with the hardware via the NfcAdapter class. It is important to find out whether the NfcAdapter is null. In this case, the Android device does not support NFC. Figure 5.2 the Main Activity class.

```
public class MainActivity extends Activity {

    public static final String TAG = "NfcDemo";

    private TextView mTextView;
    private NfcAdapter mNfcAdapter;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        mTextView = (TextView) findViewById(R.id.textView_explanation);

        mNfcAdapter = NfcAdapter.getDefaultAdapter(this);

        if (mNfcAdapter == null) {
            // Stop here,              need NFC
            Toast.makeText(this, "This device doesn't support NFC.", Toast.
            finish();
            return;

        }

        if (!mNfcAdapter.isEnabled()) {
            mTextView.setText("NFC is disabled.");
        } else {
            mTextView.setText(R.string.explanation);
        }

        handleIntent(getIntent());
    }
```

Figure 5.2: Activity for reading data from an NFC Tag.

The NdefReaderTask is a private inner class which can read the data from the tag. Figure 5.3 explains the NdefReaderTask class and figure 5.4 reads the content.

```
private class NdefReaderTask extends AsyncTask<Tag, Void, String> {

    @Override
    protected String doInBackground(Tag... params) {
        Tag tag = params[0];

        Ndef ndef = Ndef.get(tag);
        if (ndef == null) {
            // NDEF is not supported by this Tag.
            return null;
        }

        NdefMessage ndefMessage = ndef.getCachedNdefMessage();

        NdefRecord[] records = ndefMessage.getRecords();
        for (NdefRecord ndefRecord : records) {
            if (ndefRecord.getTnf() == NdefRecord.TNF_WELL_KNOWN && Arrays.
                try {
                    return readText(ndefRecord);
                } catch (UnsupportedEncodingException e) {
                    Log.e(TAG, "Unsupported Encoding", e);
                }
            }
        }
```

Figure 5.3: Task For Reading The Data

```
private String readText(NdefRecord record) throws UnsupportedEncodingEx
    /*
     * See NFC forum specification for "Text Record Type Definition" at
     *
     * http://www.nfc-forum.org/specs/
     *
     * bit_7 defines encoding
     * bit_6 reserved for future use, must be 0
     * bit_5..0 length of IANA language code
     */

    byte[] payload = record.getPayload();

    // Get the Text Encoding
    String textEncoding = ((payload[0] & 128) == 0) ? "UTF-8" : "UTF-16

    // Get the Language Code
    int languageCodeLength = payload[0] & 0063;

    // String languageCode = new String(payload, 1, languageCodeLength,
    // e.g. "en"

    // Get the Text
    return new String(payload, languageCodeLength + 1, payload.length -
}

@Override
protected void onPostExecute(String result) {
    if (result != null) {
        mTextView.setText("Read content: " + result);
    }
```

Figure 5.4: NFC ReaderTask

```
public class RouteActivity extends FragmentActivity {

    GoogleMap map;
    ArrayList<LatLng> markerPoints;

    @Override
    protected void onCreate(Bundle savedInstanceState) {

        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_route);
        // Initializing
        markerPoints = new ArrayList<LatLng>();
        // Getting reference to SupportMapFragment of the activity_main
        SupportMapFragment fm = (SupportMapFragment) getSupportFragmentManager().findFragmentById(R.id.map);
        // Getting Map for the SupportMapFragment
        map = fm.getMap();
        if (map != null) {
            LatLng origin = new LatLng(21.3549849,39.9831968);
           // Bundle extras = getIntent().getExtras();
            Intent receiveIntent = this.getIntent();
            double ori_lat = receiveIntent.getDoubleExtra("lati",0.0);
            double ori_lng = receiveIntent.getDoubleExtra("lngi",0.0);
            LatLng dest = new LatLng(ori_lat,ori_lng);
          // LatLng dest = new LatLng(21.1549849,39.4831968);
            System.out.println("??????????????????????????????????????????????????????????"  + origin);
           //LatLng origin = new LatLng(28.41852133,71.14562323);
            // Getting URL to the Google Directions APi
            String url = getDirectionsUrl(origin, dest);
            DownloadTask downloadTask = new DownloadTask();
            // Start downloading json data from Google Directions API
            downloadTask.execute(url);
            map.addMarker(new MarkerOptions().position(origin));
```

Figure 5.5: Sample code for RouteActivity (see Appendix 5-A-1 for the full code)

```
public class ShowRoute extends Activity {
    WebView webview;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.show_route);

        webview = (WebView)findViewById(R.id.webView1);
        GPSTracker gpsTracker = new GPSTracker(this);

        if (gpsTracker.canGetLocation())
        {
            Log.d("gps track location vijay", ""+gpsTracker.latitude);
            //markerPoints.add(new LatLng(gpsTracker.latitude,gpsTracker.longitude));

            double lat = gpsTracker.latitude;
            double lon = gpsTracker.longitude;

            double dlat = getIntent().getExtras().getDouble("latitude");
            double dlon = getIntent().getExtras().getDouble("longitude");

            String url = "http://maps.google.com/maps?saddr=@"+dlat+","+dlon+"&daddr=@"+lat+","+lon;
            webview.loadUrl(url);

        }
    }
```

Figure 5.6: Sample Code for Show Route (see Appendix 5-A-2 for the full code)

This part of the code enables responsible to view the present and past positions recorded of the pilgrim on Google Map through purpose designed web site.

```
smsBtn.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        String number = getIntent().getStringExtra("user_mobile");
        double lat = getIntent().getDoubleExtra("lat", 0.0);
        double lng = getIntent().getDoubleExtra("lng", 0.0);
        Intent smsIntent = new Intent(Intent.ACTION_VIEW);
        smsIntent.setData(Uri.parse("smsto:"));
        smsIntent.setType("vnd.android-dir/mms-sms");
        smsIntent.putExtra("address", new String(number));
        smsIntent.putExtra("sms_body", "http://maps.google.com/maps?saddr=21.3549849,39.9831968&daddr
        try {
            startActivity(smsIntent);
            finish();
            Log.i("Finished sending SMS...", "");
        } catch (android.content.ActivityNotFoundException ex) {
            Toast.makeText(UserDetail.this,
                    "SMS faild, please try again later.", Toast.LENGTH_SHORT).show();
        }
        //startActivity(new Intent(Intent.ACTION_VIEW, Uri.fromParts("sms", number, null)));
    }
});
```

Figure 5.7: SMS For Piligrim Sample Code (see Appendix 4-D)

5.3 Chapter Summary

Many programming languages are available, each one has its own strong and powerful capabilities like Java, C++, C#, F#, PHP, Perl and many other languages used by different developers to build different applications and functionality.

For various reasons, the PHP and Java has been selected for building the system. A Java is a powerful language that has a huge support over technologies required for building such application, compatible with MYSQL as Database, and finally have a really huge classes libraries support like the google libraries that has been used in this project.

CHAPTER IV

Result and Simulation

6.1 Introduction

The previous chapter described the implementation of the system, which is simulated using OPNET Modeler software. This chapter will present the simulation scenarios, results of the system

6.2 identification information Simulation

Figure 6.1 shows the running application for identification displaying the data in English. The default language is English in the mobile device system. The user however can always change this setting manually selecting the desired language from the dropdown menu.

A B C

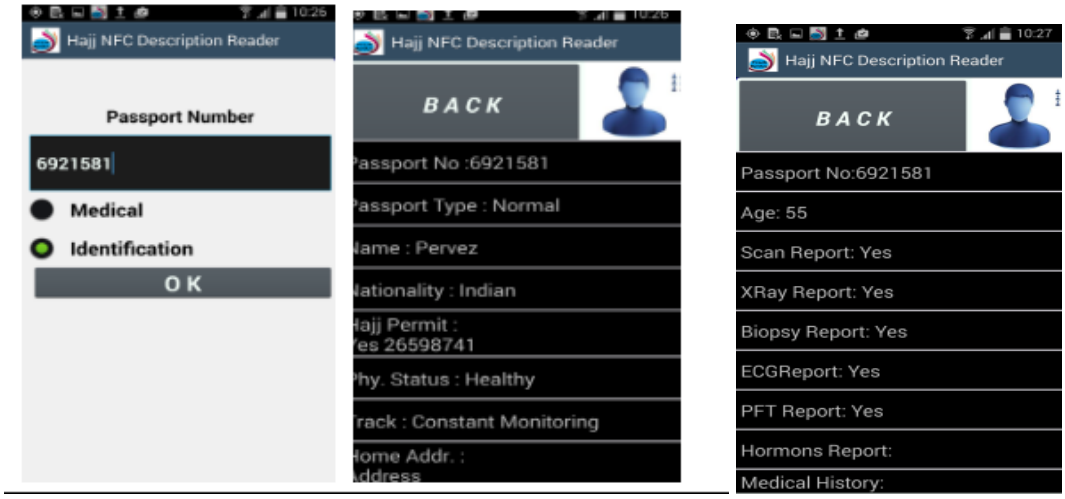

Figure 6.1: The running application for identification;

(A) Shows pilgrim's name and picture (B) Shows pilgrim's gender, nationality etc... (C) Shows the medical information of the pilgrim.

The system let the users view the identification information and medical details for pilgrims. The first screen in figure 6.1 A is seen when the application starts. It shows the pilgrim ID when it is scanned as well as the pilgrim's name and picture. At

the bottom of the screen there are four tabs; each one shows different information regarding the pilgrim. The second screen in figure 6.1 B shows the pilgrim's gender, nationality, passport/ID number, local and international phone numbers and blood type. The last screen which can be displayed by clicking the Medical tab shows the medical information of the pilgrim.

6.2 real time tracking of the pilgrim

Viewing the pilgrim current position information on Google maps provide a web interface through website as shown in Figures 6.2

It can also monitor the pilgrim status at specific time and date, or during a period of time as shown in Figures 6.3. This will give a real time tracking of the pilgrim on Google maps.

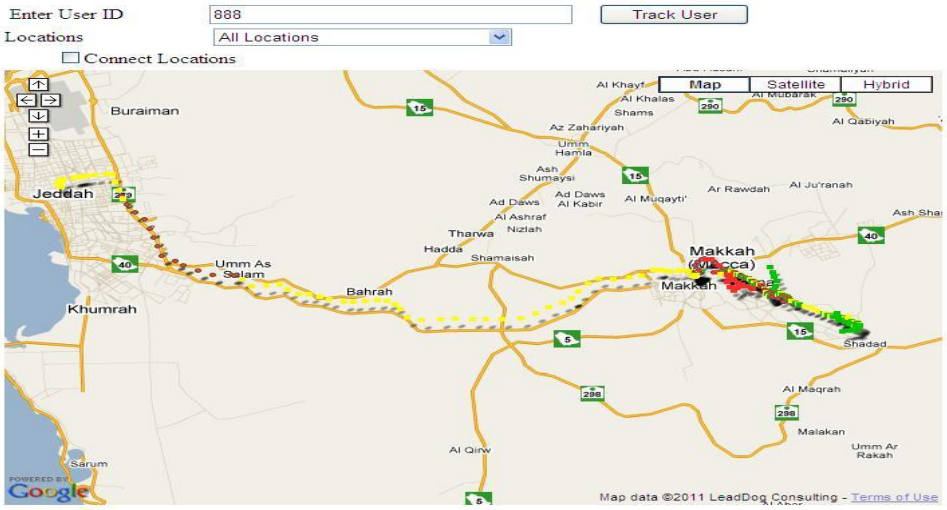

Figure 6.2: A snap shot of viewing the pilgrim current position info on Google maps

For example, in case the administrative or authorized personnel want to trace pilgrims, they need to log into the web server and get the position of the pilgrim using Google Maps view and tabular view.

No.	Latitude	Longitude	Update Mode	Distance
1	3.25170277	101.73437378	Panic Button	-
2	3.25164828	101.73458595	Time Based	-
3	3.25142664	101.73451386	Time Based	16.0979737023
4	3.25142664	101.73451386	Time Based	0
5	3.25101623	101.73467884	Distance Based	-
6	3.25044245	101.73570052	Time Based	106.398278735
7	3.25001524	101.73548629	Time Based	33.0037760104
8	3.24995384	101.73553789	Distance Based	94.3207371134
9	3.24986253	101.73570932	Time Based	18.652000544
10	3.24945986	101.7363134	Distance Based	63.4447262032

Figure 6.3: A snapshot of the operation of the tracking system

6.3 Case Study: To detect pilgrim location if out of Arafat

To detect pilgrim location during Arafat Day we apply the scenario as follows:

1- Know the date and time of Arafat date according to system calendar.

2- Allow the user to send periodic location updates.We use the (ACCESS_FINE_LOCATION) and use Google Play services (Google ApiCl ent).

3- Compare pilgrim with Arafat location with respect to date and before sunset of the day of Arafat.

4- If a pilgrim is out of Arafat, then an alert will appear. All this stage is shown in figure 6.4 (all codes are shown in Appendix 6-D).

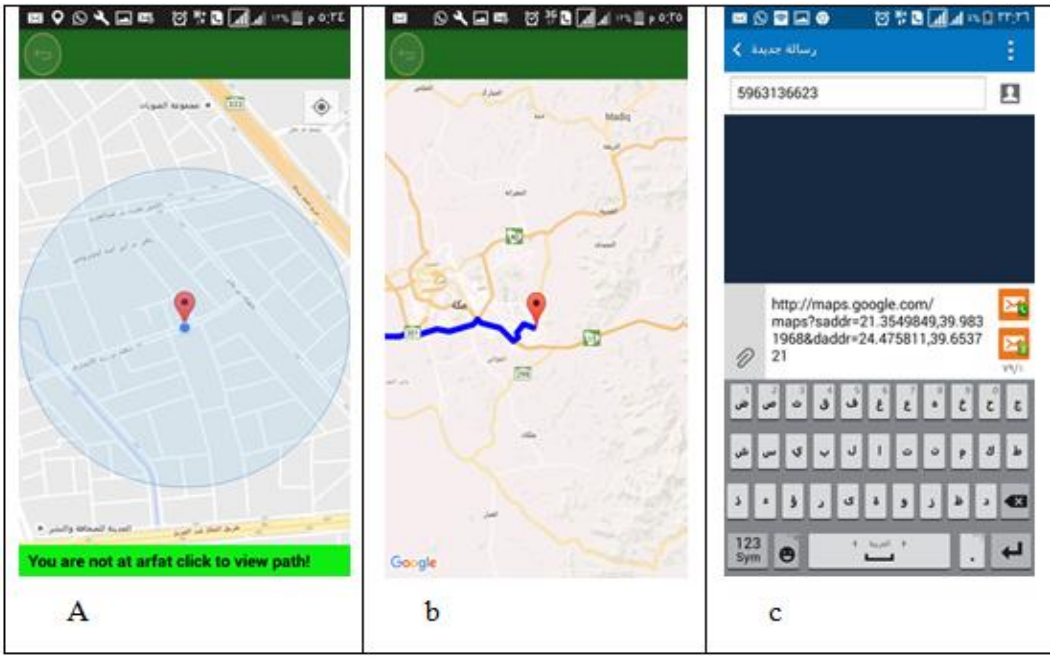

Figure 6.4: **Sample to detect pilgrim location if out of Arafat (a) pilgrim location (b) route path to Arafat (c) sample SMS (see Appendix 6-D**)

Figure 6.5 shows the pilgrim movements throughout a route that is usually used by pilgrims during the Hajj season. It is interesting to see how the system was able to record the exact locations of pilgrims.

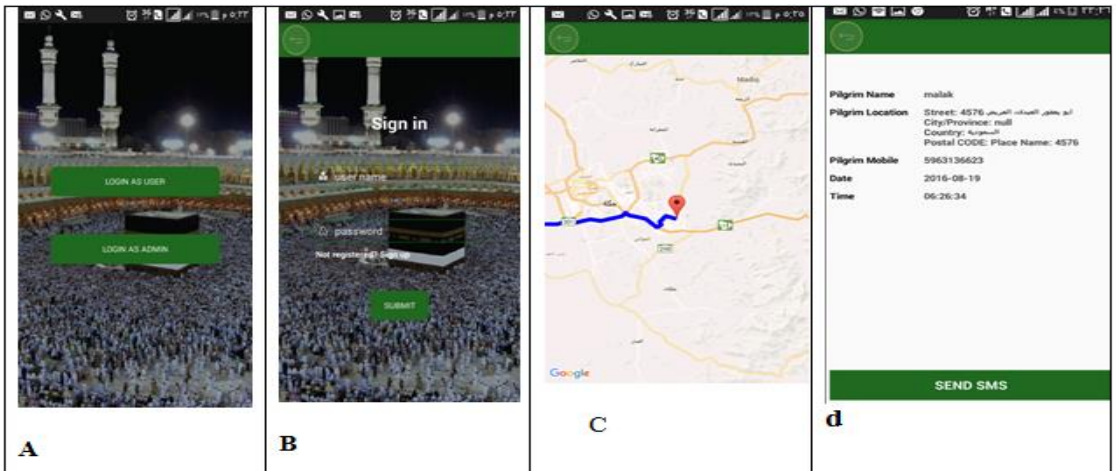

Figure 6.14: Mobile Application screens sample: (a) login type (b) a login screen (c) current location of the pilgrim on the map (d) pilgrim details (see Appendix 6-A-3 for full code)

The next screen was a login screen that immediately takes the user to the main screen which presents the pilgrim's current location on the map and for provide him the means of seeing points of interest and friends'/family's location which. However, the notification screen will provide a list of alerts the user received from the control center and if the alert has GIS information tapping the cell will take the user to that location on the map.

6. Chapter Summary

the application followed the most required standard criteria in mobile applications, using java, MySQL which are considered the most used software and environment for building such application, additionally during the project there has been enforcing the standard methodologies for building web application including the project phases and OOP standards, beside clear and organized documentation which makes it easy for any developer to modify, update or maintain the application.

The application is highly portable within the requirements availability, originally, and could be published to any other platforms with the required specifications, beside it could be transferred to any other computer that runs windows While the application could be considered as high quality, still some limitations were noticed during testing period, these limitations due to technology limitations or environment limitations and could be summarized as follows:

The application is not fully supporting another language, limits the efficiency of working with health information for example , while we succeeded in the test it is still shows some issues regarding reading Arabic content forms.

CHAPTER VII

Testing

7.1 Introduction

This test to prove effectiveness of the developed system in providing improved services to the pilgrims and resolving some of the problems faced by Hajj authorities. some testing about scalability and so on. positive feedback from both the pilgrims who used this application and the Hajj authority

7.2 Identification and Personal Information System Test

The Identification and Personal Information System was tested for the following services (Osman, M et al., 2017):

7.2.1 Hajj Permit verification

The system allows security personnel to check and verify the Hajj permit for a pilgrim. The Hajj permit is stored in the NFC enabled smartphone (or NFC tag) of a pilgrim at the time the system application is installed on it.

7.2.2 Medical emergencies

Physicians often experience difficulties in communicating with a patient due to language problems or due to the medical condition of the patient. As a result of this, physicians do not know much about the medical history of a patient which could help them in diagnosing the patient and suggesting proper treatment.

The App was tested at a clinic in Mina were 15 physicians where shown how to read a patient's medical file from his phone and how to update the file. The medical file of each pilgrim was pre-stored on his NFC enabled phone in the English language. The physician who did not understand the pilgrim patient's spoken language was able to access the patient's medical records stored on patient's phone. The medical details of the patient were displayed on the physician's phone. All Physicians appreciated the usefulness of this function as it helped them to know the medical history of the patient before a doctor could prescribe a treatment. Later, the physician updated the patient's medical file with information about the current case and the treatment received by the patient which may be needed for future (Osman, M et al., 2017). Table 7.1 Shows the Physicians' group comments.

Table 7.1: Shows the Physicians group comments (15 physicians)

Physicians Participants	Description
All Physicians (100%) said that	Easy to read a patient's medical file using phone and update the file about the current case.
(83%) Physicians mentioned that	It helped to know the medical history of the patient before he could prescribe a treatment.
(94%) Physicians argued that	Difficulties in communicating with a patient due to language problems or due to the medical condition of the patient.

7.2.3 Mutawif services

This application was used by the Mutawif for pilgrims' access to accommodation in Mina, daily meals service, and train service between Mina and Arafat. The identification of subscribed pilgrims in his group was done instantly resulting in improved services at lower cost. Pilgrims not belonging to his group could be easily detected with this system. The App was tested in Mina were 15 Mutawif shown how to read/write a pilgrims file from his phone, pilgrims file contains pilgrims accommodation in Mina Positive feedback was received from both the Mutawif and the pilgrims under his care. Table 7.2 Shows the Mutawif group comments.

Table **7.2**: Shows the Mutawifs group comments (15 Mutawif)

Mutawifs Participants	Description
All Mutawif (100%) said that	Pilgrims can easy access theirs accommodation in Mina.
(94%) Mutawif argued that	Pilgrims can access Daily meals service.
(93%) Mutawif mentioned that	Pilgrims can access Train service between Mina and Arafat.
(98%) Mutawif mentioned that	Easily detected Pilgrims not belong to group with this system.

7.2.4 Helping lost pilgrims

Using the system, officers with their NFC phone can retrieve the pilgrim's accommodation locations in Mina, Arafat and Makkah, from the pilgrim's NFC phone or tag and guide him to his accommodation.

1. Tracking a pilgrim and displaying the tracks on another mobile phone. It is used to track the location of pilgrim when they go for Tawaf. The best characteristic of the proposed system is that if the mobile itself is lost or stolen, it is possible to locate it as what is really tracked is the mobile phone itself not the holder.
2. Tracking the pilgrim campus as pilgrim always complain that busses do not follow the specified schedule and find it difficult to locate their busses.
3. Tracking pilgrim's group. The guide (Mutawif) can track all members of his group (who have mobile phone with GPS) and solve their problems and answer all their needs.

7.3 Pilgrims Participants

Fifty participants of the Muslim Faith in Makkah were recruited before and after using the system. Each participant had to first fill in a brief questionnaire, which contained questions about the background and basic demographic of each user such as the participants' age, nationality, etc. Appendix A shows a sample of the questionnaire. Participants were male and female aged between 20 and 60 years old. Figure 7.1 shows the average age of participants. Their cultural background also varied with participants originating from East Africa, East Asia and others as shown in figure 7.2.

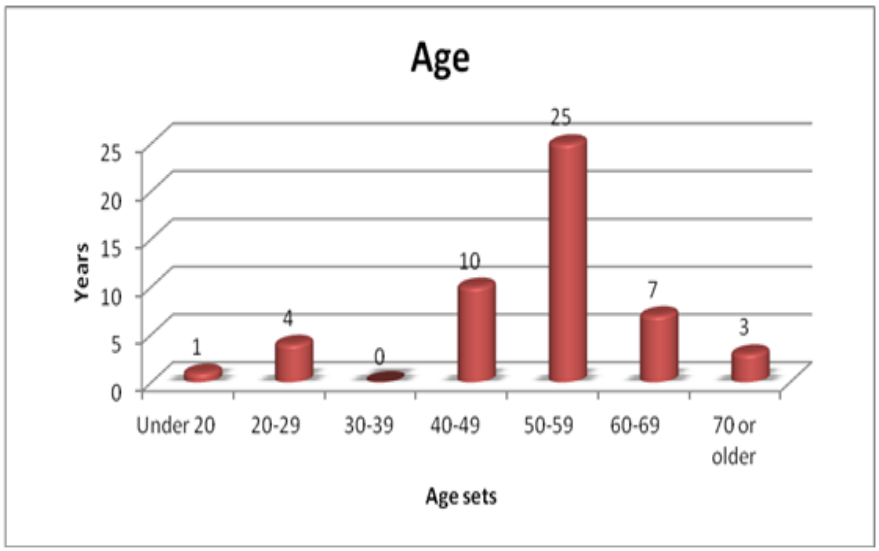

Figure 7. 1: Basic demographic user's age

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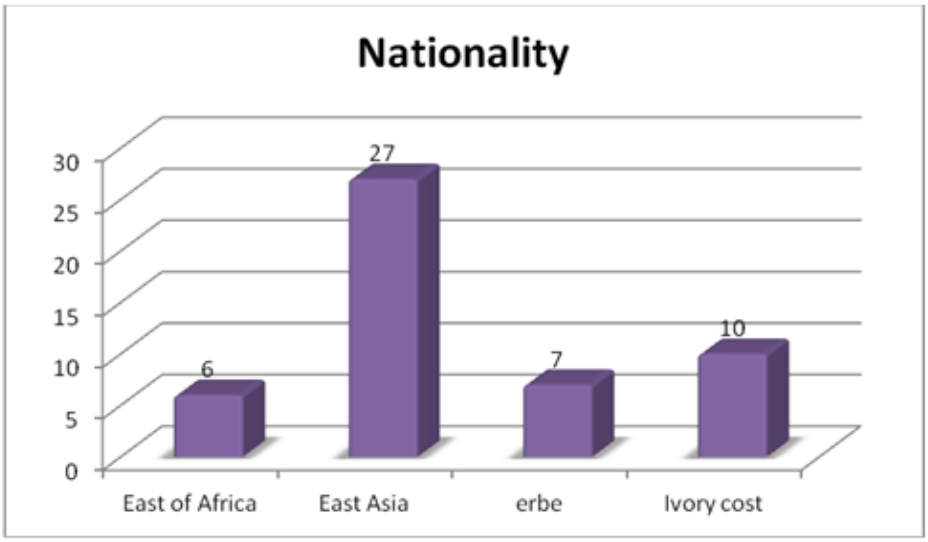

Figure 7. 2: Basic demographic of user's nationality.

Information that was collected from the interviewed pilgrims is as follows ""Do you think the identification application may help in improving services to pilgrims?", "Do you have concerns about pilgrims' privacy using the identification application?" and so on. The system operates by initially having pilgrim's details such as name, age, phone number and health information at the port of entry to Saudi Arabia. The pilgrim's information is entered into the database and the pilgrim is given an E_card to wear through-out his stay at the Holy areas. The security officer also enters the E_card pilgrim's number in the pilgrim's profile that is stored in the system database. Once a

pilgrim is lost or in an emergency situation, then the port would be filed to any security station within the Holy area. The number corresponding to the pilgrim is retrieved from the database and their address or health information is retrieve to locate the lost pilgrim or to treat him. The NFC readers are continuously transmitting the locations of all pilgrims. The developed system tested with the following scenarios:

1- Identification of pilgrims in case of lost using E_card.
2- Identification of pilgrims in case of emergencies like medical using NFC tags which will be read by the authorities using reader present in the NFC enabled mobiles.

7.3.1Suggestions and comments from pilgrims

Comments from pilgrims have been conducted and summarized as shown in Table 7.3.

Table 7.3: Shows the Focus group comments

Participants	**Description**
All participants (100%) said that	Different nationalities, languages and cultures let pilgrims find it hard to deal with available means such as police, other people, hotels, etc.
42 out of 50 participants (84%) mentioned that	All the places around Ka'bah look alike, so pilgrims found it hard to find their way.
38 out of 50 participants (76%) argued that	It is difficult to stay with your relative (wife, friend, or others) throughout the days during pilgrims. This left them worried and consequently impacted their Hajj ritual performance. Some example stories mentioned above illustrated how pilgrims feel when they have lost a relative or a group member.

Participants were asked to indicate whether they agree or disagree with some questions. A five point scale was used where five corresponded to "strongly agree" and one to "strongly disagree". Figure 7.3 shows the participants response to the first question which was "Do you think the identification application may help in improving services to pilgrims?". Figure 7.3 shows that 21 of 50 out of participants strongly agreed and 1 out of 50 strongly disagreed, etc.

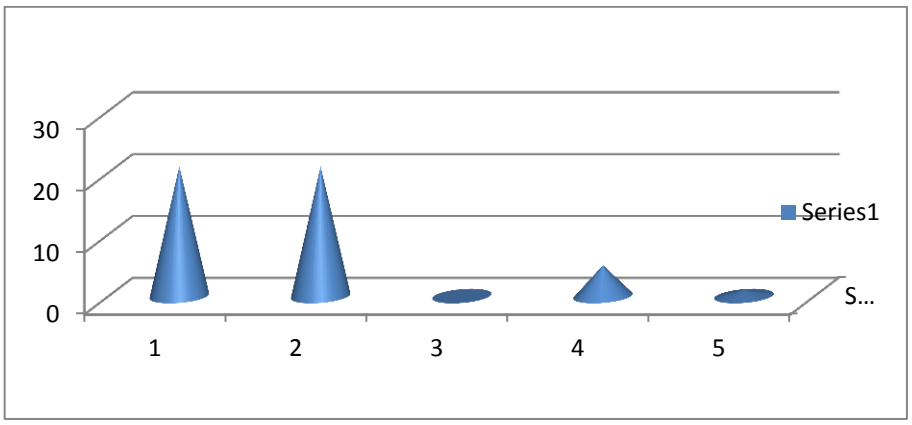

Figure 7.3: Results regarding pilgrims answer to:

"Do you think the identification application may help in improving services to pilgrims? (Scale:1- Strongly Agree, 2 – Agree, 3 - Neutral, 4 – Disagree, 5 – Strongly Agre

Figure 7.4 shows the pilgrim answers to the question "Do you have concerns about pilgrims' privacy by using the identification application?". The figure shows that 7 out of 50 participants strongly agreed and 7 out of 50 strongly disagreed, etc.

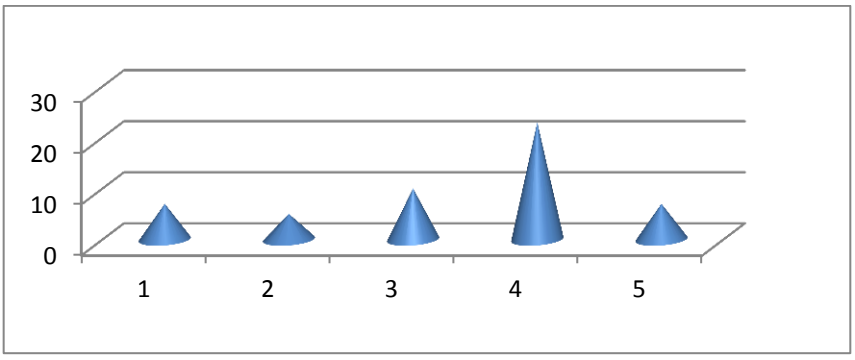

Figure 7.4: Results regarding pilgrims' privacy by using the identification device (scale: 1 – strongly agree, 2 – agree, 3 Neutral, 4 – disagree, 5 – strongly disagree)

Figure 7.5 shows the pilgrim answers to the question "Would you think pilgrims would be willing to compromise some personal and location information privacy issues

only for Hajj days in return for the improved services?". The figure shows that 10 out of 50 participants strongly agreed and 0 out of 50 strongly disagreed, etc.

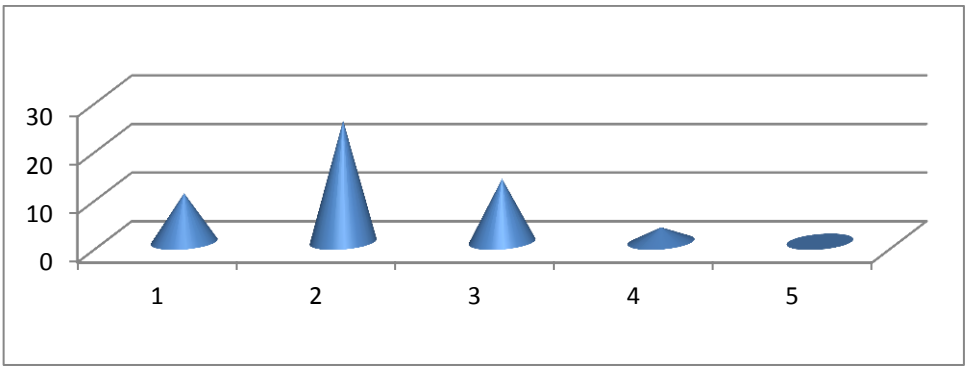

Figure 7.5: 7.3Results Regarding pilgrim identification

(Scale: 1 – Strongly Agree, 2 –Agree, 3 Neutral, 4 – Disagree, 5 – Strongly Disagree).

Checking the pilgrim wristband NFC tag takes a little bit more than 1 second according to the experiment 49% of pilgrims think that identification system will help to improve service at check points (see figure 7.6). The same was at the entrance to the camp in Mina which results in the following theorem:

A survey was carried to get feedback from volunteers who have helped in finding lost pilgrims and with participating pilgrims (4 pilgrims) who get lost from their accommodation in Madina Almnora around Al-Masjid an-Nabawi during Ramadan 2018. The survey about the services offered by the developed system have helped the lost pilgrims. The survey indicates that 100% of surveyed pilgrims have agreed that the application improved services to pilgrims. Also volunteers have mentioned that it took up to 90 seconds before locating a lost pilgrim. In one case, connection had to be re-established for reasons unknown and there were few misunderstandings between participating pilgrims and volunteers.

Table 7.4 shows the response of volunteers and Table 7.5 shows the response of participating pilgrims.

Table 7.4Volunteers (4) responses to the questionnaire

Question	**Response**		
How easy was it to get in touch with the pilgrim ?	negative: 0	neutral: 1	positive: 3
How do you rate the pilgrim's understandability?	poor: 0	neutral: 0	good: 4
At first contact, were you able to get the correct location quickly?	no: 1	neutral: 3	yes: 0
How do you rate the accuracy of the pilgrim's location on the map?	poor: 0	neutral: 0	good: 4
Is the system sufficiently easy to use?	poor: 0	neutral: 0	good: 4
Did the client properly understand your instructions?	no: 1	neutral: 3	yes: 0
Was the pilgrims able to give you sufficient information about his/her whereabouts?	no: 1	neutral: 3	yes: 0
Did you properly understand everything the pilgrims told you?	no: 1	neutral: 3	yes: 0

Table 7.5. Participants' responses to the interview questionnaire.

Statement	Response		
	no:	neutral:	yes:
Found it awkward to use the device around my arm.	4	0	0
The instructions I got by phone were clear.	0	0	4
Carrying this device I felt more secure outside.	0	3	1
Carrying this device I felt safer outside.	0	0	4
Like to be carrying this device again tomorrow	0	0	4

7.4 Chapter Summary

Evaluation of the proposed system on a selected group of pilgrims was carried out to establish the usefulness and efficiency of this system. These pilgrims were impressed with the idea of using a smartphone in providing improved Hajj services. Feedback from the Mutawif as well as Hajj officers involved in the system evaluation was very positive and encouraging. The majority of the pilgrims reported that the proposed system may help in improving services during Hajj.

CHAPTER VIII

Conclusion and Contributions

8.1.Introduction

This chapter is an overview of the overall research that was done in this dissertation. It presents the contributions, which was discussed in the previous chapters. As a result of this research a comprehensive critical investigation of the literature review relating to how to make Hajj easy and safe was performed by using scientific methods and procedures to achieve the desired goals of study.

8.2.Conclusion

In order to provide support for large and heterogeneous crowds in Makkah during Hajj, the research tried to suggest solutions, as well as develop and evaluate some approaches. Majority of pilgrims (65%) agree that currently there are no systems that are used at Makkah to help them perform their rituals inside the Haram. Currently pilgrims usually use traditional methods, for example to ensure that they meet each other, pilgrims agreed and set a particular place to regroup after the event. However, they often find that they are unable to meet again as all places look the same to them. The proposed system might solve issues such the inability of finding each other when they become separated in the Haram or places around it. On the other hand, the easy Hajj system will help pilgrims navigate in crowded environments regardless of their cultures and languages and will assist pilgrims performing their rituals in Makkah and give them the right information at the right time by developing a centralized Hajj guide system. For instance, developing systems for Identification in case of lost, dead, or injury that is reliable and affordable can help in crowd control and well enable authorities to estimate the number of people at specific locations where there is a risk of accidents. The system uses NFC technology which includes all the necessary information about the holly city, and provides different features/services to pilgrims which would be essential for them to plan their Hajj trip.

The proposed system was implemented successfully, that encourages the system to be implemented for commercial use. The system achieved its main goal through a

flexible architecture using real time data and operation. The architecture is very efficient and secure. The web and Android application was developed to show how the architecture works and has a lot of important features for pilgrims such as maps and places, and many others feature which are summarized in table 8.1 that was already discussed in this dissertation. A proof of concept experiment was implemented in the Holy area during the 2015 pilgrimage season. Table 8.1 show the acceptance of the suggested solutions.

Table 8. 1: A**cceptance of the suggest solutions**

Suggest solution	**Pilgrims acceptance**
Pilgrim Identification	96% accepted to be use
Pilgrim tracking and educate	52% accepted to be use

Such a system will be all what a pilgrim needs for his Hajj journey so that he can have a safe and comfortable Hajj. The results of all studies provide clear evidence that could be useful for the provision of navigation information in different situations. In addition, the proposed solutions might solve the issues that pilgrims are suffering from, such as losing others when becoming separated in the Haram, count of Tawaf rounds and the inability of finding places round the Holy city.

8.3.Research Contribution

The main contribution of this research was to improve the safety of pilgrims while they are performing their rituals and to give complete guideline and procedure to perform Hajj and Umrah based on Sunni principles in order to achieve Hajj Mabrur as well as to support pilgrims navigate around Makkah.

The content of Chapters 3, 4, 5,6 and 7 have been published in proceedings of peer-reviewed international conferences and journals [Osman, M., and Shaout, A., and M. Mohandes (2015), Osman, M., and Shaout, A, Osman, M., and Shaout, A., 2015, Osman, M., and Shaout, A., 2015]. The main contributions to making Hajj efficient and easy journey for pilgrims are as follows:

A. system has the ability to track the location of fellow group/family members, since it is easy to get lost in a crowd of four million pilgrims. Have a more interactive guide to Hajj, like an interactive map allowing users to walk through the process of the

Hajj to develop a better understanding of the obligations, locations, dates and processes that are performed (Malak Osman, Adnan Shaout 2014).

B. system which has ability to identify pilgrims in case of lost, death, or injury (Osman ,M. Mohandes ,2017).

C. Distribution of NFC tags to pilgrim would help identification at check points and furthermore would make the job of immigration officers easier and improves efficiency at the port of entries as information needs only be verified from the NFC tags rather than inputting the information while a pilgrim is waiting. This would also reduce the long waiting queues at the airports.

8.4.Future Directions

Although all positive contributions have been achieved, there are still some limitations of this research for future research.

This conceptual perspective could be of benefit in different settings such as sports stadium, especially those prepared for the Olympics which usually include a large number of people who come from different cultures and backgrounds. Several aspects are common with the Makkah situation. Our solution is intended to work and provide support for several circumstances such as general situations, in crowds on the move, in crowds where mobile phones are not usable, and in crowds where is no common language exists. Also it might help in emergency situations such as in a football stadium. Other issues that needs to be researched on are as follows:

A. Pilgrim Health: It is difficult for the local population of Makkah and the surrounding regions to get medical help during the Hajj season. Research may look into the possibilities of better organization and management of the Hajj health system, including an option of introducing health insurance for Hajjis and allowing private health organizations to participate in the system.

B. Hajj Travel: Movement in and around Makkah is very time consuming. Future research may suggest some better ways of transportation to overcome the long delays and facilitate smooth transition of pilgrims.

C. Hajj Infrastructure: The Saudi government has continuously been improving the Hajj facilities. Research could look into future infrastructure needs, including the needs for expansion of accommodation in Mina, Arafat, and Muzdalifa (these

places are in Makkah area and to be visited by Pilgrims during the Hajj season as part of the rituals).

D. Although 50 pilgrims is a relatively large sample for the current project, it only makes 0.00125% from total pilgrims. Moreover, it is recommended that the experiment be performed on an entire contingent of pilgrims from a country such as Malaysia which has about 14,000 pilgrims this coming every year. This will help in validating the system with a relatively good sample size before deploying the system for more than 2.5 million pilgrims.
E. The future plans for the system is that the architecture can be placed in cloud.

List of Publications

1. Osman, M., and Shaout, A., Hajj Guide Systems - Past, Present and Future International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 8, August 2014).
2. Osman, M., and Shaout, A.,: Pilgrim Tracking And Identification Using Mobile Phones, ICIT 2015 The 7th International Conference on Information Technology, Jordan Amman - published in the International Journal of RFID Security and Cryptography (IJRFIDSC), Volume 4, Issue 2, ISSN 2046-3715.
3. Osman, M., and Shaout, A., Overview of Mobile Help for Performing Hajj Rituals **International Journal of Emerging Technology and Advanced Engineering (ISSN 2250–2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 11, November 2015.**
4. Osman, M., and Shaout, A., A., Easy Hajj applications Track & Educate Pilgrims ,3ndInternational Conference on Islamic Applications in Computer Science And Technology IMAN 2015) 1st-3rd October 2015 Konya, Turkey I**nternational** J**ournal on Islamic** A**pplications in Computer** S**cience** A**nd** T**echnologies –** IJASAT **(English edition) : ISSN 2289-4012.**
5. M. Osman ,M. Mohandes, A. Abul Hussain, , W. AlDossary"Smartphone for improve pilgrim services" The 9th_IEEE-GCC Conference in Bahrain 8-11 May 2017. IEEE catalog number: CFP1729A-USB ISBN: 978-1-5386-2755-6 ISSN: 2473-9391.
6. Osman, M., and Shaout, A., "Crowed Management - An Intelligent HAJJ Guide system ICIT 2015 The 8th International Conference on Information Technology Jordan Amman -published in the Journal of Information and Communication Technology (JICT).

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Appendix 5-A - Track System Implementation

This system is used for the observing of pilgrim on the move and supplying a timely ordered sequence of location data for further processing Pilgrim tracking system relies on the Global Positioning satellites (GPS) and a cellular system. A tracking module picks up the GPS coordinates that indicate the real-time location of the Pilgrim. Using a mobile, the coordinates are immediately transmitted to the tracking computers. Customers log in to the tracking website to see Pilgrim on road maps

the main class as flowing

5-A-1:RouteActivity This part of the code enables responsible to view the present and past positions recorded of the pilgrim on Google Map through purpose designed web site.

```
package com.google.android.gms.location.sample.arafatlocation;
import android.content.Intent;
import android.graphics.Color;
public class RouteActivity extends FragmentActivity {
    GoogleMap map;
    ArrayList<LatLng> markerPoints;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_route);
```

```
String str_origin = "origin=" + origin.latitude + "," + origin.longitude;
        String str_dest = "destination=" + dest.latitude + "," + dest.longitude;
        String sensor = "sensor=false";
        // Building the parameters to the web service
        String parameters = str_origin + "&" + str_dest + "&" + sensor;
        // Output format
        String output = "json";
        // Building the url to the web service
        String url = "https://maps.googleapis.com/maps/api/directions/" + output + "?" + parameters;
        return url;
    }
    private String downloadUrl(String strUrl) throws IOException {
        String data = "";
        InputStream iStream = null;
        HttpURLConnection urlConnection = null;
        try {
            URL url = new URL(strUrl);
      urlConnection = (HttpURLConnection) url.openConnection();
            urlConnection.connect();
            // Reading data from url
            iStream = urlConnection.getInputStream();
            BufferedReader br = new BufferedReader(new InputStreamReader(iStream));
            StringBuffer sb = new StringBuffer();
            String line = "";
            while ((line = br.readLine()) != null) {
                sb.append(line);
```

A-2 ShowRoute:

the code will first read location on Google map and then a route will be drawn from current location to Arafat.

```
package com.way.magictips;
import framework.GPSTracker;
import android.app.Activity;
public class ShowRoute extends Activity {
    WebView webview;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
            super.onCreate(savedInstanceState);
            setContentView(R.layout.show_route);
            webview = (WebView)findViewById(R.id.webView1);
            GPSTracker gpsTracker = new GPSTracker(this);
      if (gpsTracker.canGetLocation() {
            Log.d("gps track location vijay", ""+gpsTracker.latitude);
            //markerPoints.add(new LatLng(gpsTracker.latitude,gpsTracker.longitude));
            double lat = gpsTracker.latitude;
            double lon = gpsTracker.longitude;
           double dlat = getIntent().getExtras().getDouble("latitude");
            double dlon = getIntent().getExtras().getDouble("longitude");
            String url =
"http://maps.google.com/maps?saddr=@"+dlat+","+dlon+"&daddr=@"+lat+","+lon;
webview.loadUrl(url);} @Override
    public boolean onCreateOptionsMenu(Menu menu) {
            present.
```

Appendix 6- A-3 Track System Interface

4- A-3-1 **Pilgrim login** Pilgrim login .php is the procedure used to get access to an application, the Pilgrim have (1) a user ID and (2) a password. Often, the user ID length is eight characters and the password must contain at least one digit and not match a natural language word. Web sites require Pilgrim to register in order to use ; registered users can then enter the site by logging on.

```
<?php
 error_reporting(0);
 include('config.php');
 $response = array();
  if(!empty($_REQUEST["user_email"]) && !empty($_REQUEST["user_password"])){
        $user_email=$_REQUEST['user_email'];
        $user_password=$_REQUEST['user_password'];
         $sqlquery="SELECT * FROM `reg_user` WHERE `user_email` = '".$user_email."' AND
`user_password` = '". $user_password."' ";
                $re=mysql_query($sqlquery);
                if($re==true && mysql_num_rows($re)>0){
                        while($row = mysql_fetch_array($re))
                                {
                                $user_id=$row['user_id'];
                                $email=$row['user_email'];
                                $response[success]=1;
                                $response["message"]
=array('user_id'=>$user_id,'user_email'=>$email);      }        } else {
                        $response["success"]="0";
                        $response["message"]="Login Failed..";} } else{
                        $response['status']="0";
                        $response['message']= "enter values";
               }echo json_encode($response); ?>
```

6- A-3-2 **Admin.php**

This code allow Administrators and Super Users to access all **Administrator** level settings for the system .

```
public class Admin extends AppCompatActivity {
    EditText username, pwd;
    Button signupbtn;
    ProgressBar progress;
    @Override
    protected void onCreate(@Nullable Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.admin);
        progress = (ProgressBar) findViewById(R.id.adminloginprogress);
        progress.setVisibility(View.GONE);
        username = (EditText) findViewById(R.id.adminsignin);
        pwd = (EditText) findViewById(R.id.adminpwdsignin);
        signupbtn = (Button) findViewById(R.id.adminsigninbtn);
        signupbtn.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                progress.setVisibility(View.VISIBLE);
                if (!TextUtils.isEmpty(username.getText().toString()) && !TextUtils.isEmpty(pwd.getText().toString())) {
                    if (username.getText().toString().equalsIgnoreCase("admin") && pwd.getText().toString().equals("admin@123")) {
                        Handler mHandler = new Handler();
                        mHandler.postDelayed(new Runnable() {
                            @Override
                            public void run() {
                                //start your activity here
                                    startActivity(new Intent(Admin.this, UsersList.class));
```

6- A-3-3 **register .java**

This code for A registration form is a list of fields that allow to pilgrim will input data into and submit Registration only happens the first time you access the system. It is a way to check your credentials. Every time after your initial registration, you will log on to the system using the username and password you created.

```
public class RegisterActivity extends AppCompatActivity {
    private EditText username, email, pwd, cnfpwd, phone;
    private Button signupbtn;
    private ProgressBar progress;
    private static final String REGISTER_URL =
"http://demo.mediatrenz.com/ph_services/Arafat_loc_finder/register.php";
    public static final String KEY_USERNAME = "user_name";
    public static final String KEY_EMAIL = "user_email";
    public static final String KEY_MOBILE = "user_mobile";
    public static final String KEY_PASSWORD = "user_password";
    String emailPattern = "[a-zA-Z0-9._-]+@[a-z]+\\.+[a-z]+";
   @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_register);
        // get Instance  of Database Adapter
        progress = (ProgressBar) findViewById(R.id.regprogress);
        progress.setVisibility(View.GONE);
        username = (EditText) findViewById(R.id.usersignup);
        email = (EditText) findViewById(R.id.emailsignup);
        pwd = (EditText) findViewById(R.id.pwdsignup);
        cnfpwd = (EditText) findViewById(R.id.pwdconfirmsignup);
        phone = (EditText) findViewById(R.id.phnsignup);
        signupbtn = (Button) findViewById(R.id.signupbtn);
        signupbtn.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
```

Appendix 6-A-3-4

This part of the code for compare pilgrim place with araft place according to time /date to check if he is in right place at a time

```
package com.google.android.gms.location.sample.arafatlocation;
{ private String user_name;
    private String loc;
    private String mobile;
    private double lat;
    private double lng;
    public double getLat() { return lat; }
    public void setLat(double lat) {
        this.lat = lat;}
    public double getLng() {  return lng;  }
    public void setLng(double lng) {
        this.lng = lng;}
    public String getDate() {
        return date;              }
    public void setDate(String date) {
        this.date = date;}
    public String getTime() {  return time; }

   public void setTime(String time) {
        this.time = time; }
    private String date;
```

Appendix 4-A-3-5 send SMS

Allow authority to send a text message to any pilgrim phones number that They choose. They can edit the message to provide more information before hitting send

```
public class UserDetail extends Activity {
    private TextView name, address, mobile, date, time;
    private Button smsBtn;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.user_detail);
        smsBtn = (Button) findViewById(R.id.smsbtn);
        name = (TextView) findViewById(R.id.username);
        address = (TextView) findViewById(R.id.useradd);
        mobile = (TextView) findViewById(R.id.usermob);
        date = (TextView) findViewById(R.id.date);
        time = (TextView) findViewById(R.id.time);
        name.setText(getIntent().getStringExtra("user_name"));
        address.setText(getIntent().getStringExtra("user_add"));
        mobile.setText(getIntent().getStringExtra("user_mobile"));
        date.setText(getIntent().getStringExtra("date"));
        time.setText(getIntent().getStringExtra("time"));
        smsBtn.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                String number = getIntent().getStringExtra("user_mobile");
                double lat = getIntent().getDoubleExtra("lat", 0.0);
                double lng = getIntent().getDoubleExtra("lng", 0.0);
                Intent smsIntent = new Intent(Intent.ACTION_VIEW);
```

Appendix 4-B – Hajj Survey_Nov-10_52 samples

data is collecting from approximately 52 participants to help us evaluate users

to evaluate users interaction with track and identify pilgrim during Hajj :collecting data from approximately 50 participants The questionnaire consisted of two types' initial questionnaire and final questionnaire. The first questionnaire comprised the identification data related to the participant, such as age, and previous experience with pilgrimage to Makkah. The second questionnaire consisted of five questions related to interface issues and general acceptability, and related to negative and positive aspects of the system. This questionnaire was answered after study completed during season 2015.

Please tell us your age [Please tick only one]

□□Under 20 □□20-29 □□30-39 □□40-49 □□50-59 □□60-69 □□70 or older

2. Please tell us your gender. □□Male □□Female

3. Please tell us your nationality

4. Please tell us your mother language.

5. Please tell us your gender. □□Male □□Female

1- Do you think the identification application may help in improving services to pilgrims?

2- Do you think the tracking application may help in improving services to pilgrims?

3- Do you have concerns about pilgrims' privacy by using the identification application?

4- Do you have concerns about pilgrims' privacy by using the tracking application?

5- Would you think pilgrims would be willing to compromise some personal and location information privacy issues only for Hajj days in return for the improved services?

Strongly disagree **Disagree** **Neutral** **Agree** **Strongly agree**