Secure and Healthy Hajj Management: A Technological Overview

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Abstract. A systemic approach for the effective management of crowded events such as the pilgrimages of Hajj and Omrah in Saudi Arabia continues to remain a challenge mainly due to uncontrollable crowds and slow adaptation of the modern technology and tools. Despite many catastrophes such as stampedes and fires, there are no international binding standards for controlling and managing large crowds. Undoubtedly, use of advanced technology such as tracking and monitoring tools, and sensor and biometric identification methods can result in better management of crowds. However, technology alone cannot be a solution to overcrowding. Overcrowding also causes significant delays in cleaning and sanitation of the crowded venues, which results in breading bacteria causing respiratory and other diseases. With the outbreak of EBOLA in West Africa and ongoing spread of the Middle Eastern Respiratory Syndrome (MERS) in Saudi Arabia and the other neighboring countries, Hajj becomes an event venerable for spread of these dangerous diseases at a catastrophic scale. This article discusses some factors which are critically important, and provide a systemic approach, for a management of secure and healthy Hajj.

Keywords: Crowd, Hajj, Kumbh, Stampedes, RFID, Sensor Networks, Biometric, Pilgrims, Tawaf.

1 INTRODUCTION

Thousands of people have perished in stampedes, fires and other incidents resulting from overcrowding or mismanagement of large gatherings of people around the world. Ironically most of the large crowded events are religious in nature. An account of the people killed in various crowded events in the world can be found in (Yamin & Albugami, 2014) and (Wikipedia, http://en.wikipedia.org/wiki/List_of_human_stampedes).

The Hajj is a pilgrimage to Makkah (Mecca) in Saudi Arabia that takes place every year during 8th-12th Dhulhijja, a month in the Islamic (lunar) calendar. Every year about three millions pilgrims converge to the ancient city of Makkah from more than one hundred and eighty countries (Yamin & Albugami, 2014) and (Ziad, Stephens, Steff and Ahmed 2012) to perform hajj. The hajj is a religious obligation for Islamic communities if they can afford it. The core hajj rituals are performed during four days but, due to limitation of transportation, many of the pilgrims stay for over a month in Saudi Arabia. During this extended period of stay almost all pilgrims also visit the prophet's mosque, built by Mohammed - the prophet of Islam in Madinah, the second most sacred mosque, at a distance of about four hundred kilometers from Makkah. The Hajj is highly complex, having very intense rituals posing many management challenges to the organizers. The most difficult hajj operation the transportation over three million people to and from tent city of Mina and Mount Arafat, lying some 20 kilometers away from each other. Some of the problems and aspects of Hajj can be found in (Yamin & Albugami, 2014), (Yamin & Ades, 2009), (Yamin, Huang and Sharma 2009), (Yamin, Mohammadian, Huang and Sharma, 2008) and (Yamin, 2008). In this paper we shall analyze and describe the problems of overcrowding in Hajj. In particular, we shall

review the management issues of the hajj of the last three years. We have chosen the case of Hajj, which is an annual event involving a gathering of more than three million with very intense activities

The most critical factor for managers is the size of the crowd. An efficient management of crowd must have a manageable size of crowd. The number of permits issued every year for performing hajj is about two million. However, sometime the number of unauthorized people in the hajj crosses the limits as it happened in 2012 when more than 3.65 million people performed hajj (Yamin & Albugami, 2014). Indeed, to minimize the chances of stampedes and other catastrophes, the crowding must be limited to acceptable levels. Unfortunately, there are no binding international standards for limiting the number of people which should be permitted to gather in a specified space or area. Organization of events, in particular those having millions of participants like in hajj and Kumbh would become relatively easier to administer if such standards were agreed upon and implemented. In the last decade or so, many technological advances have produced tools and gadgets which can be utilized to improve the crowd management. In particular sensor and biometric technology, tools and gadgets can be immensely helpful in improving the crowd management. Some of the intensely crowded events like the Hajj often involve simultaneous movement of the entire congregation, which creates problems of transportation and uncontrollable build-up of crowd. In such situations, tracking, accessibility and identification of pilgrims becomes very difficult. Many of the sensor and wireless devices available today, including Radio Frequency Identification (RFID), e.g. (Finkenzeller, 2010) and (FOTOSEARCH, 2015), can be used for controlling and monitoring the movement of crowds. These technologies are now being widely used for improving management and administration of many business functions. However, these technologies are still going through a transitional phase (Talevski, Wu and Chang, 2009) and one would hope to see significant refinement of them to become usable and effective for managing very large and dense crowds. Nevertheless, these technologies in their present form could have been used in saving thousands of precious lives in many of the past incidents of stampedes and fires. A description of ubiquitous technologies including RFID, sensor networks, biometric and scanning devices can be found in (Yao, 2010).

In recent times, some serious health risks have emerged. Most deadly of all is the spread of EBOLA in West Africa which has different strains of flu viruses have discouraged many people from participating in crowded events like hajj and Kumbh. Details can be found in (Centers for Disease Control and Prevention (2014), World Health Organisation (2014). and New York Times (2014), In particular, the Middle Eastern Respiratory Syndrome (MERS) have taken hundreds of lives in the Middle East. However, there are no reports of MERS spreading amongst hajj pilgrims. There are other serious health issues for crowded events with a span of three or more days, mainly because of lack of cleaning and detoxing the environment regularly. Lack of cleaning may give rise to the growth of dangerous bacteria, which has been witnessed in some cases (McConnell (2012). Another serious health risk is from the mismanagement of the pilgrims carrying communicable and contagious viruses, bacteria and diseases. Due to inability to control entry, many pilgrims may carry deadly bacteria such as HIV Aids and Hepatitis. Many of these infected pilgrims may not be known to the management and hence cannot be isolated. Indeed the infected pilgrims must be isolated from the rest of the pilgrims. For managing the health and wellbeing of the pilgrims, including those infected with contagious bacteria, the RFID technology can play a very significant role (Yao, 2010).

In this paper we present and analyze a number of problems of hajj management, and offer some solutions including architecture for improving the management. These solutions can indeed be applied in many other and similar crowded events such as Kumbh.

2 AN OVERVIEW OF HAJJ MANAGEMENT ISSUES

Unlike many other large crowded events, the Hajj is a well-defined, articulated, precise but very tedious event to manage. The problems lie in the simultaneous and frequent movements of millions of people with in tight time limits, sometimes hours only, see Fig 1. The core activities of four days of the hajj see Fig 2, require all pilgrims to move back and forth from one place to another. The linguistic and health issues add to the complexities of this event. Researchers face problems in accessing authentic and credible information of hajj statistics,

Fig. 1 Hajj Assemblies

and management issues. Hence, despite being a regular event involving billions of dollars, and creating many avenues for research in many areas of social, medical, environment sciences and engineering, we see very little research emerging in the academic journals. Let us look at some of the entities of the hajj research in detail. For more details, see (Yamin & Albugami, 2014).

Every year the demand for hajj permits is overwhelming and more than half of the requests are rejected due to limited facilities. Many pilgrims have to wait for years for their turn to make this sacred journey to Makkah. In order to manage this situation, there is a system of rationing. Accordingly, people (including the Saudi citizens) are allowed to perform Hajj once in five years. However, it is very difficult to implement this moratorium all the time and in all situations (Yamin & Albugami, 2014). One of the main problems for the Hajj mangers is to deal with a large number of illegal pilgrims. Makkah region, which has a population of about two million, largely contributes to the illegal pilgrims. According to the governor of Makkah (Yamin & Albugami, 2014), in 2012, up to 3.65 million pilgrims performed hajj, which nearly doubled the maximum accommodation capacity. Unauthorized pilgrims, especially the illegal migrants living in Saudi Arabia, can pose law and order and health risks. Particularly since the hajj managers do not have their personal and health data.

Grant of hajj visa by the hajj management authority namely, the Ministry of Interior of the government of Saudi Arabia requires intending pilgrims to undergo a medical examination. If found having contagious or dangerous diseases, the request for pilgrimage is rejected. However this health check in some cases can be forged; hence posing the risk to other pilgrims (Yamin & Albugami, 2014).

The hajj starts on the 8th day of Islamic calendar, based on the motion of moon, when all pilgrims gather in the tent city of Mina (Wikipedia, Mina, 2014) for the next four days. The core activities of the hajj include gathering of all pilgrims in Mina travel to Arafat next morning, arriving and spending the night in Muzdalifah. The day of 10th Dhulhijja requires travel from Muzdalifah to the tent city of Mina, walking to a few kilometers to place called Jamaraat for symbolic stoning of Satan, offering a sacrifice of an animal, shaving the head, visiting Makkah and coming back to Mina. These journeys are intensely crowded and in the past have caused several stampedes. The next two days have repeat of some the activities of 10th Dhulhijja. Details can be found in (Yamin & Albugami, 2014).
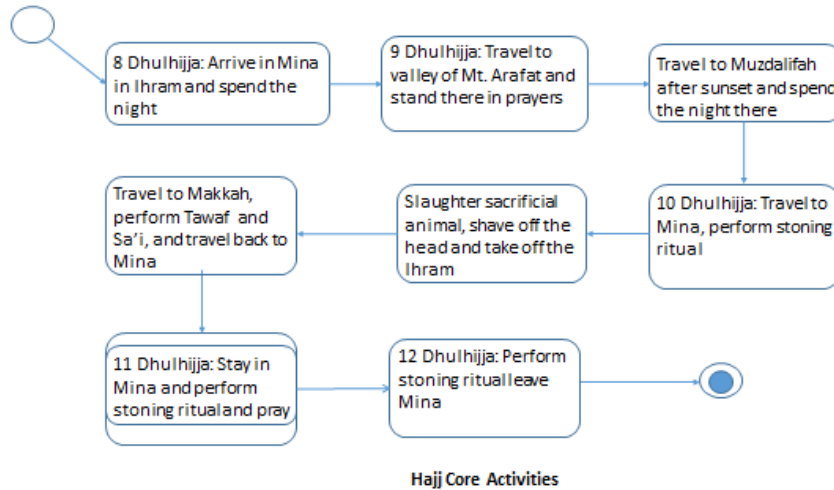

Hajj Core Activities

Fig. 2 Core Hajj activity Diagram

One of the aims of this article is to provide an overview of architecture which could be used as a basis for organizing management activities of Hajj. Fig 2 demonstrates a diagram of the core activities of the hajj as described above.

Currently hajj permissions cannot be granted for people suffering from serious and life threatening illnesses like HIV AIDS, Middle Easter Respiratory syndrome (MERS), SARS, and Hepatitis or other life threatening and contagious diseases. Hajj being a sacred religious duty for believers, these restrictions are undesirable. In cases when medical records can be forged, it becomes very dangerous to have people carrying dangerous viruses, infections and diseases, unknown to and unnoticed by the management. Therefore, it is better to allow sick people to perform hajj under medical supervision.

3 TOWARDS A SECURE AND HEALTHY MANAGEMENT

One would find it very difficult to complain about the adequacy of Hajj and Omrah facilities provided by the Saudi Arabian government. Despite state of art facilities, some problems of congestion, resulting in stampedes and spread of diseases still exist. Some people may think that extra lane to an existing road may ease the congestion. But to the contrary, an extra lane sometimes may cause indiscipline on the road. In particular, adding more infrastructures just increases the usage and doesn't reduce congestion (Duranton & Turner, 2011). Thus a large infrastructure may not always solve the crowding problems. We present architecture in Fig. 2 of hajj management functions which may be helpful in solving some of the problems during the hajj seasons.

3.1. Reduction in Crowding

Large and dense crowds can pose serious threats to security, safely and health if the crowding pushes the available space beyond limits and blocks amenities and passage as usually is the case with some rituals of the Hajj. For an effective management of an event in general and the hajj in particular, it is absolutely necessary to limit the number of pilgrims to an acceptable level. In case of the Hajj and Omrah, overcrowding occurs because of a large number of unauthorized pilgrims. The Hajj in the year 2012 witnessed a swelling crowd posing many problems (Yamin & Albugami, 2014).It is vital to prevent illegal pilgrims, which may be the source for spreading diseases, and create security and safety concerns. Learning from the problems encountered in 2012, the hajj management introduced very harsh penalties for illegal pilgrims in 2013 and 2014, resulting in largely incident free and healthy Hajj. Although

Fig. 3 Figure RFID

these measures did succeed in limiting the number of pilgrims but still there were no effective measures to prevent unauthorized pilgrims from Makkah region. To minimize the chances of unauthorized local pilgrims from Makkah region contributing to the catastrophes, it is highly desirable to organize information and training programs for people of the region to educate them of dangers of overcrowding.

3.2. Technology for Pilgrim Tracking and Identification

Malaysia was the first country of the world to use the RFID chips in the passports of their citizens for accessing and retrieving information. This was followed by the Unites States of America, European countries, Australia and other countries. Currently many organizations and businesses are using RFID chips with a sensor or a WiFi network to track and monitor people and products. Some RFID tags such as shown in Fig. 2 can be used to replace traditional wristbands. The RFID tags can carry vital data and can be supported with a sensor, GPS or a 3G network to relay data to the data center. More details can be found in (Yamin & Albugami, 2014). The Hajj management provided by the Kingdom of Saudi Arabia, during the Hajj 2014 has started using an RFID enabled card for reading data with the help of a card reader. As cards can be easily lost, it would be better to use RFID in the wrist bands of the pilgrims. To be able to control the movement of crowds and to identify the pilgrims accurately and timely, the Hajj management should consider introducing a full RFID enabled sensor network covering important points and locations of hajj sites. In some intensely crowded places like the grand mosques, where congestion is optimum, the RFID technology may not work accurately (Yamin & Albugami, 2014).As the technology evolves, there may be more tools and devices available in future which should be employed, especially for Hajj, without delay.

3.3. Prevention of Spread of EBOLA and MERS and other diseases

Prerequisites for preventing the spread of diseases include prevention of illegal pilgrims and ensuring the availability of data of every pilgrim's health including the diseases they carry which can affect others. By preventing illegal pilgrims, the management can limit the number of pilgrims, ensure the availability of pilgrims' health data and can effectively prevent the outbreaks of bacteria that normally develop due to uncleanliness and unhygienic conditions.

Instead of preventing pilgrims with diseases like HIV Aids, tuberculosis and Hepatitis, hajj management should create a secluded isolation area for the isolation of the infected pilgrims. From a social and religious point of view, it would be very hard to deny pilgrimage to people on their deathbeds. More importantly, medical reports can be tempered and compromised in some countries in some cases, and hence cannot always be relied upon due to involvement of so many countries. Therefore, in some cases people carrying these diseases would get into hajj without the management knowing about them. Such pilgrims would be a serious threat to the health of other pilgrims and may sometime cause an epidemic. So if infected pilgrims cannot be stopped, they should be properly managed. However, the case of EBOLA is quite different; people infected with this virus must be prevented from entering the hajj, otherwise there would be catastrophic consequences. In case of the people suspected of carrying the virus, must go through a waiting period.
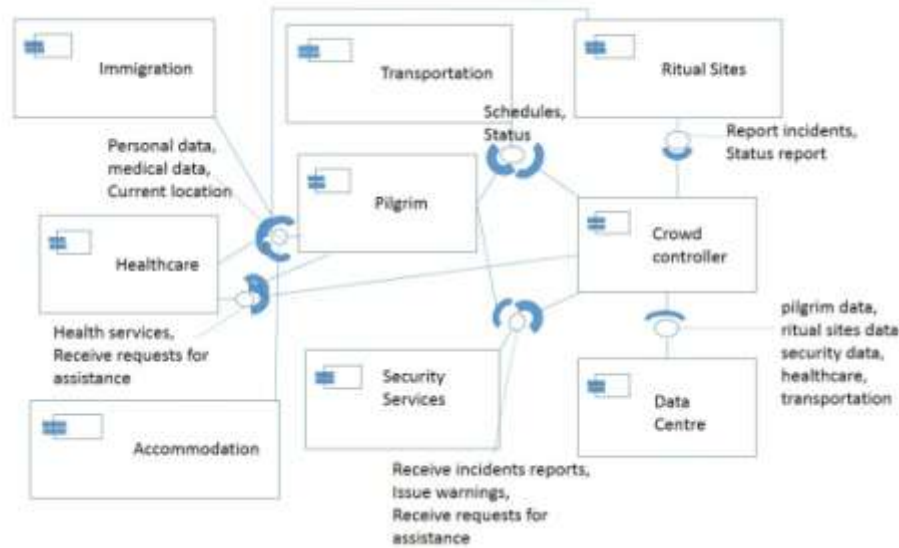

Fig. 4 Hajj Management Functions Component Diagram

The causes of crowding in Mina, Arafat and Muzdalifah are usually due to large number of unauthorized pilgrims, religious interpretations and congestions due to insufficient transport infrastructure. According to prophetic tradition, every pilgrim should spend the night of 9th Dhulhijja in Muzdalifah. Muzdalifah has an area of twenty square kilometers, as can be found in (Wikipedia, Mina, 2014), most of which is occupied with building and roads leading to Arafat, it is simply impossible to accommodate two million people in Muzdalifah. Some traffic congestion problems may ease in coming years once the rail links (under construction) between Jeddah, Makkah, Mina, and Madinah become operational. Residential capacity of Mina is being increased by constructing many residential towers under construction in Mina to meet the increasing demand of accommodation.

3.4. Overview of Control of Hajj Operations

While there are a lot of issues associated with the Hajj, the most important is the need to managing the crowd and facilities during the Hajj period. The component diagram in Fig 4 shows an overview of the proposed operations architecture. As shown in Fig 4, the crowd controller will be responsible for monitoring and managing, transportation, health care services, security services and ritual sites. The transportation is managed by scheduling, based on the number of people in a ritual site at given time. In case of emergency, the controller will inform and request help from health care and security services. The controller will liaise with

the security services in a two ways communication, where they can report and receive reports about security issues. The controller receives information about the situation and status in the various ritual sites. The ritual sites would be monitored and receive instructions or request help from the controller. The controller, with the help of tracking devices such as RFID, could also monitor the movements of individuals and crowd for security, health and traffic reason. The architecture and other solutions proposed in this paper can be useful in managing many other crowded events such as Kumbh (Reuters, 2013).

4 CONCLUSIONS REMARKS

Crowd and event management should ensure security, safely and well-being of the people involved. Overcrowding must be prevented at all costs. Adequate infrastructure should be provided for the events. Management of crowd must take advantage of modern technology, tools and devices. There should a proactive management of crowds. Hajj and Omrah in particular are prone to overcrowding, which must be controlled. The hajj rituals are based on Abrahamic traditions mentioned in the holy Quran which were followed and demonstrated by Mohammed, the prophet of Islam in his only Hajj in the year 1410H. As such some desirable changes like easing the overnight stay in Muzdalifa would require decrees by competent religious authorities.

Technology can assist to an extent but it cannot overcome ignorance and overcrowding, which prevails in almost all religious gatherings. Unfortunately, there is a lot of ignorance in religious gatherings like the Hajj and Omrah as the participants come from different backgrounds, ethnicities and geographical regions, which make it very difficult to adapt to a uniform code of conduct which is desirable in most gatherings, particularly the religious ones. Educational programs at national and international levels are desirable to educate the indiscipline and ignorant people. Last but not the least is the need for an international standard for crowd management.

5 DISCUSSION QUESTIONS

There are many questions which arise from the case of Hajj. Some of them are as follows:

1. Should there be an international binding standard for crwd capaiciity per square meter
2. If a stampede occurs in a crowd, where shold the responsibiliyty lie
3. Is RFID technology mature enough to be used in dene crowds
4. Why should or shouldn't Hajj manajement make the use of RFID band manadatory for every pilgrim
5. If used, what kind of data shold RFID band contain
6. How can the health management be improved for pilgrims

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