Abstract—Piazzas are designed within the urban textile to practice certain activities according to their location, and mosques are buildings that have been allocated surrounding piazzas. The Western Piazza of the Holy Mosque in Makkah is one of the most important piazzas surrounding it, where it connects the building of the Holy Mosque with a large number of residential neighborhoods in the central region of Makkah. This piazza has witnessed some developments affecting the activities practiced there.

This Piazza, like other piazzas surrounding the Holy Mosque, witnessed a number of different activities that are related to the Holy Mosque. This paper presents a mechanism to analyze large spaces that experience various activities as well as analyzing activities that is engaged in this piazza in details and determine their location and frequency rate.

This study found a concentration of congestion in specific locations, which will appoint decision makers to adjust the operational plans for the management of the crowds in order to ensure the break up of clusters and mitigate congestion, also found the focus of sleeping/resting people in other locations which will enable operators to place measures to limit this phenomenon.

This study recommends redistributing prayer zones and identifying pathways; in addition, identifying concentration sites of observers to address the bad manifestations and minimize unwanted activities in piazzas surrounding the Holy Mosque.

Index Terms—Activities, analysis, mechanism, piazza.

I. INTRODUCTION

The Western Piazza of the Holy Mosque is considered to be one of the most important piazzas surrounding it; its importance comes from the geographical location in Makkah and its association with most of the main roads for pedestrians and vehicles coming to the Holy Mosque, from both the southern and western sides. M. Nofal [1]-H. Ibrahim [2]. Since its association with King Abdulaziz road leading through Mabass Aljinn tunnels to Alazizyah district and then to Mina, and Ajyad Almassafi street which leads to Kudday and then to Taif city Dar Qabes [3]. In addition to its association Almsial (Alhijrah) street and Abraham Alkhalil street which both leads to the southern district of Makkah and then to Laith. And through Souq Alsagheer tunnels linked with Um Alqura street leading to the western district of Makkah and then to Jeddah city. As well as linking Kudday tunnels that contains King Abdulaziz gate station for buses as shown in Fig. 1 shows the Western Piazza of the Holy Mosque and its surrounding projects and connected main streets.

This Piazza covers an area of estimated 42,844 m², and it is linked directly to two main gates of the Holy Mosque; King Abdulaziz gate and King Fahd gate, these two gates recorded the highest flows in and out of the Holy Mosque according to statistics studies of Ministry of Higher Education. In addition, some of the most important mega-projects surrounding the Holy Mosque opens directly to the Western Piazza M. Aba Al-Khail [4]-H. Abbas [5], also King Abdulaziz Endowment is located southwest side of the Piazza, Makkah construction company and Dar Altawhid Hotel are located west side the Piazza Saudi Bin Laden Group [6].

II. OBJECTIVE OF STUDY

This paper aims to analyze activities practice in large spaces and provide an analytical method by transferring the qualitative results to quantitative, to enable numerical comparisons to facilitate numerical readings and decision.
making. This paper reviews two of the most important activities of interest to operators by highlighting on sleeping/resting in the Piazza and overcrowding as a sample research GK. Still [7].

III. ACTIVITIES AND ANALYSIS MECHANISM

Frequent visitors of the Holy Mosque practiced number of activities while they are at the Holy Mosque W. Halabi [8]. Piazzas surrounding it come as complementary to the Holy Mosque building to accommodate demand on prayer areas. Piazzas surrounding the Holy Mosque provide an area of about 42,844 m², which accommodate about 35,700 worshipers and to approximately 52,250 prayers in peak hours A. Fouda [9]. Visitors practice a number of activities in the piazzas which is different from that in the Holy Mosque, since piazzas considered areas outside the main building of the Holy Mosque. The number of these activities and the relationship of religious background make it one of the rituals and worship performed by Muslims The Holy Koran [10]. Some are related to the devotional aspects such as prayer, and others are related to the organizational and administrative aspects such as placing partitions and distribution of prayer areas. Activities practiced in the surrounding areas of the Holy Mosque have been classified as follows:

- Adding partitions.
- Increasing the prayers outside partitions.
- Passing of a funeral.
- Cleaning piazzas.
- Starting of the pray.
- The area is full of prayers.
- Overcrowding.
- Sleeping/Resting people.
- Smooth flow of pedestrian movement.
- Semi-Stopping in the pathways between the partitions.
- Opining the partitions.
- Prayers sitting within the pedestrian’s bridge.
- Prayers been rejected to enter the Holy Mosque.
- Entry of prayers to the Holy Mosque.
- Prayer in the pathways.
- Vacant places.
- Free of Prayers.
- Starting of Iftar.
- Finishing of Iftar.
- Completion of the prayer.

IV. MONITORING AND ANALYSIS MECHANISM

Western Piazza of the Holy Mosque is divided into 31 interior zones as shown in Fig. 3 shows the division of the Western Piazza into a number of zones to facilitate the process of analysis and study. The division has taken into account the use of movement pathways as main borders of the divided zones to be drawn. Then activities within these zones were analyzed. Monitoring work has been done on specific times and days of the month of Ramadan 1433G in order to clarify what is witnessed in the Holy month of Ramadan of differences in the overcrowding between off-peak and peak times. Off-peak is represented on 16th and 18th of Ramadan, whereas on the 14th is the middle peak since it encountered on Thursday which usually is a high intensity of pilgrims and worshipers (since it’s a weekend), while on 21 and 23 of Ramadan is the peak of the holy month of Ramadan whereas 21st encountered on Thursday as well.

Table 1: Shows the recording times during the month of Ramadan 1433 G, representing different peak times during this month. The recording time has been chosen during the day such that it covers the daily maximum peak; it starts from 17:00 and continues until 23:00 to cover the Maghrib and Ishaas prayers as well as Tarawieh prayer and the time period in between, also it includes recording mechanism of Iftar in the Piazza. Recording work has been done according to a specific mechanism as shown in Fig. 4 shows the mechanism for gathering field data through analysis. Where six digital video cameras was used to record activities that are practiced in a certain zone of the Western Piazza, and when combining the output of the cameras, the vision for the entire Western Piazza and the Holy Mosque will be complete.

Fig. 3. Shows the division of the Western Piazza into a number of zones to facilitate the process of analysis and study.

Fig. 4. Shows the mechanism for gathering field data through analysis.

<table>
<thead>
<tr>
<th>DAY</th>
<th>RECORDING TIMES</th>
</tr>
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<tbody>
<tr>
<td>14</td>
<td>1:00</td>
</tr>
<tr>
<td>16</td>
<td>1:00</td>
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<tr>
<td>18</td>
<td>1:00</td>
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<tr>
<td>21</td>
<td>1:00</td>
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<tr>
<td>23</td>
<td>1:00</td>
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</tbody>
</table>

Transferring mechanism of the activities into quantitative information was adopted to be able to make comparisons through analytical study for each of the 31 zones. This is to know the most important activities which seized control of each time period; that is through the conversion of the recording time into equal intervals, each with duration of
fifteen minutes, to enable researchers to obtain information and to make digital comparisons between activities in the Western Piazza spaces of the Holy Mosque R. Larsen, M. Marx [11].

V. ANALYSIS RESULTS

The output of this study showed variation in the frequency of activities in the zones within the Western Piazza of the Holy Mosque, which confirmed that the fullness of these zones by prayers was demonstrated by the results to be the highest frequent activity practiced there. This interprets the occurrence of these periods during prayers peak periods of Ramadan as in Fig. 5 shows frequency of activities in the Western Piazza of Ramadan season 1432G. The sleeping/resting in the prayer zones observed to be second highest activity in the Western Piazza, zones and peak times of this activity will be reviewed. The results reflected the smooth flow of the movement of pedestrians as shown in Fig. 6 shows frequency of smoothness of the flow in the zones of Western Piazza, repeated more than four hundred times, which describes the mechanism exercised by entities operating in the management of the crowds and traffic of Western Piazza by facilitating the movement of worshipers. Fig. 7 shows recording times of smoothness of the flow during the season of Ramadan 1433G in the Western Piazza of the Holy Mosque where it showed the peak of this activity at 19:45 which is after Maghrib prayer. While the results showed frequency of overcrowding for more than two hundred times to illustrate the size of the demand for zones in Western Piazza and its associated surrounding projects and streets of major movement of the central area of Makkah. The frequency of cleaning Western Piazza activity, as shown in Fig. 8 shows frequency of cleaning in the zones of Western Piazza, was nearly a hundred time, which shows operators keenness on providing a clean environment for the practice of worship. Fig. 9 shows recording times of cleaning during the season of Ramadan 1433G in the Western Piazza of the Holy Mosque where it showed the peak of this activity at 19:30 which is after Maghrib prayer.

Focusing on the analysis of the two activities; overcrowding and sleeping/resting as a sample for analysis, the results showed congestion overcrowding in some zones than others. Zone 31 located east of the piazza recorded the highest overcrowding rate as shown in Fig. 10 shows frequency of overcrowding in the zones of Western Piazza. The interpretation of this high frequency is that this zone is the entry point to the Western Piazza and the Holy Mosque for those coming from King Abdulaziz road and Ajyad Almasafi street. The zones 18, 23, 9, and 4 has a high frequency of the phenomenon of overcrowding and this can be interpreted by the relationship between these zones and its association with a number of the main gates of the Holy Mosque or the escalators leading to the roof of the Holy Mosque. While the zones 11, 6, and 3, located in front of the Dar Altawheed Hotel in west of the piazza, didn’t recorded any overcrowding cases, which can be explained by the movement of pedestrians in these zones around the clock, to enable the movement of crossing the pedestrians to the piazza and its surrounding areas. Fig. 11 shows recording times of overcrowding during the season of Ramadan 1433G in the Western Piazza of the Holy Mosque where it showed the peak of this activity at 19:15 which is during the period between Maghrib and Isha prayers.

In Fig. 12 shows the frequency of sleeping/resting in Western Piazza, zone 16 then 1 and 19, located in the middle of the Western Piazza, shown as the most frequent for sleeping/resting which can be interpreted by its far distance from the movement areas and its linking the Holy Mosque or projects and the streets surrounding the piazza. The zones 3, 6, and 11 located in front of the Dar Altawheid Hotel, are the least in the recording of this activity, which can be interpreted by the well-management of the hotel by preventing sleeping/resting in front of the building. In Fig. 13 shows recording times of sleeping/resting activity during Ramadan season 1433G in Western Piazza of the Holy Mosque, which confirms that the peak for this activity were recorded in the period between Maghrib and Isha prayers and this can be interpreted by the desire of prayers to stay near the Holy Mosque to wait for Isha and Taraweeh prayers after their performance for Maghrib prayer.
VI. RECOMMENDATIONS

We reached a number of recommendations as follows:

1) The management of the crowds in the Western Piazza of the Holy Mosque succeeded in maintaining the pathways free from prayers to facilitate the movement of pedestrians.

2) The management of prayer sites is subjected to changes through moving partitions during peak hours based on the number of prayers due to the use of moveable partitions.

3) The importance of careful review of sleeping/resting sites, and the allocation of the zones in the center of the Western Piazza, such as the zones 26, 19, 16, 10, 8, and 5 for organized sleeping/resting, and the emphasis on creating pathways for movement on the outskirts of the Western Piazza.

4) The emphasize of the importance of focusing on the outer areas of the Western Piazza which connects to the projects and to the surrounding streets to plan for management of crowds in addition to the correlated areas with the gates of the Holy Mosque.

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