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Using Geographic Information System Technique In Identifying The Suitability Of Mosque Sites And Its Locations In Erbil City

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Abstract
The distribution of the mosques needs to be organized to help to choose the appropriate location according to the regulations for the new mosques proposals. The distribution and the area of mosques is a big problem in the Islamic cities. This paper aimed to find the mosque location and evaluate the distribution of the mosques to find a selection criterion for mosques locations and capacity. A district number three in Erbil city covered as a study area . Geographic information systems (GIS) used to identify existing mosques locations . Two types of buffers applied to the mosques according to general Islamic roles and local ministry roles then the intersection of the mosques identified . The finding was the total worshiping area is more than the needed area for the total worshiper and even if all the mosques used only one floor area for worshiping and neglect the second floors it will be also more than enough for this sector inhabitants but Mosque distribution need to be rearranged . Although the built mosques cannot removed but many of this mosques do not do its function as well as it was built for due to its wrong location . huge areas and a high amount of population need mosques in their areas because the existing mosques are too far from their houses and concentrated in other places .

Keywords: *mosques, mosques location, GIS, mosques distributions, Erbil.*

1 – INTRODUCTION

Islam, as a universal and complete religion responding all the spirituals and materials needs of people, have a close relation with problem of the city and the urban from the beginning. During the Islam emerging and development, Muslim people founded a new towns and big cities with buildings and mosques built on the spirit of Islamic thought were the headquarter and the main bases of Muslim in the vast territory of that time (SHOJAEE and PAEEZEH, 2015) .

Mosques is one of the important place of worship for Muslim around the world. It is used by Muslim to perform religious activities and also as the place for social gathering in the city . Besides being used as a place for the spiritual activities, it also have an other functions some of the mosque provided space for learning activities in order to allow it to function as an education centre . The guideline on selecting a suitable site for a mosque focused on three important criteria which included the settlement hierarchy, population catchment and suitability of a site. the population catchment for the area will determine the number of mosque required for that particular area. The population catchment will also determine the size of mosque and the supporting facilities provided in the mosque. The guideline also explained on the selection of a suitable site for mosque (Abdullah et al., 2013) .

Due to the increase of urban population and the growth of the number of mosques , mosques are among the places that residents refer to repetitiously. The transportation and movements of worshipers is mainly done by foot , thus, the number of the mosques remained inadequate in some places and more than the required in some other places , which was effected in the creation of mosques in the province .

1.1 - types of mosques

Mosque is a muslims place for worship it provides a spiritual, social, educational, judicial, medical, and military messages. Mosque is classify according to its size and area and capacity in to (Hassan, 2002) :

1. Small mosque or (Mosalla): have a capacity for 40 person , it used in an institutions , factories or schools .

2. Mosque (Masjed): it is located in the core of community with a distance of walking about (150- 200m) and its capacity more than 200 person .

3. Grand mosque (Jame'a): The largest among all the types , it also called Friday mosque , and the walking distance isn't exceeding (500m).

1.2 - mosques location

In the Islamic city each element of the community can used equally the religious and public spaces, and every person have the right to use these spaces . This type of spaces is traditional, the mosque in the center of the city and the market (bazaar) is adjacent to it , and the residential areas surrounding them, from the time of the Medina and other Muslim cities also followed the same method (Ayhan and Cubukcu, 2010) .

According to Islamic law , two principles in site selection for mosques should be take in consideration first is distribution of balanced and suitable access . Islam has emphasize that the mosques in the city must be distributed equally depending on the ratio of the inhabitants. The Prophet Mohammed (PBUH) has emphasized that the mosque should built inside the area that the people can be coming on feet to the mosque. It also ensure that people can easily hear the call of pray by Muezzin. The voice of Muezzin is in the scale of the mosque building (human scale) (Mortada, 2003)

"In the traditional Islamic cities, mosques have function and hierarchy, and they are placed in a constant and standard distance from each other." (Mortada, 2003)

Selecting the mosque location simultaneously with the appropriate capacity sufficient for the number of the worshiper is a big problem in the Islamic cities , in additional to nonobservance of the planning standard in the area of the mosques to handle with the population growth and also urban expansion. Site selection is one of the most important activity aimed for producing the optimal mosque location in the city . Site selection for mosque is involve of combine a large amount of information (Elhag et al., 2017) . The designer should take into his account most of the major planning consideration that raise the strength of the mosques site in the heart of Muslims city . The researchers summarize the most important considerations for mosque planning according to (Ibrahim, 1979) .

1) The mosque location must be far from the noise, smoke , pollution and other environmental risks .

2) Mosque site should be integrate with the build environment that surround it and also the urban fabric, and if possible in the center of public service.

3) The location should be found in a allowable location in the Islamic role (Sharia) , cannot be in unclean, graves, occupied, or public location .

4) The chosen site to built a new mosque should not be adjacent to another old one , it will cause a dispersion of worshipers .

5) It should be supported by good access road and also pedestrian way with possible trees and shades .

6) The utilization of the mosque as focal point based on the visual aspect, and use its the minaret as the distinctive signs (El Jamassi et al., 2013)

7) The mosque location should avoid high noise activities for instance as traffic and industrial development project (Bukhari et al., 2010)

1.3 - criteria to select suitable site for mosque

Since the beginning of Islam, the mosque was the center of attention of the Muslim community. At the beginning of the establishment of the Islamic state represented by the migration of the Prophet , his first ordered was the construction of the mosque, the mosque was the starting point of the first Islamic city, and with the expansion of the nation was the first to start in Each new village and city is the building of the mosque, which has become the nucleus of architectural planning in all Islamic times. With the increase of the Islamic State and its geographical area and the progress of the ages, the architecture of the mosques has become diversified according to the environment in which they are built, And there has been a large disparity in need and use from one mosque to another , here is some of the criteria of selecting suitable mosque site :

1 - The mosque orientation must be facing the direction of Al- Qibla .

2 - It must located at the strategic location so it will be close to the settlement centre and also it should have good accessibility to the motor vehicle users and pedestrian.

3 - The mosque must not be near unsuitable site for instance garbage disposal site , oxidation pond and electrical transmission line.

4 - The mosque is better to not located on the hilly and steep land.

5 - The mosque can be used to serve as a land mark in the area.

6 - The site is better to have enough space around it to reduce disturbance for example the loud noise from outside activities.

7 - New towns should have enough sites for mosque to serve the population in the future.

8 - It should located near the public transportation, retail facilities, residential area and civic and education institution.

9 - Sharing of adjacent facilities such as parking when there is inadequate of land.

10 - The site must be located in some place that can be expanded in the future.

11 - The entrance should be visible for the pedestrian pathway and parking areas from the street .

12 - It should have adequate space for educational facilities, administrative facilities, the main prayer hall and social facilities (Kahera et al., 2009) .

2 – PRRVIOUS RELATED RESEARCH STUDIES

Elhag et al.(2017) in their study Arc determined the location of the mosques in the map and in the aerial Photograph; the result indicate that some of the mosques were found to be suitable . and some others need to be extend within the existing location , while the others cannot extended within the existing location so new location must be determine for a new mosque within the buffer area to accommodate the expected number of people (worshipers) .

El Jamassi et al.(2013) utilized many types of statistics and analysis method to know the pattern of mosque location distribution, and also determine the problem, then he suggest some suitable solutions. This study shows the importance of utilizing the GIS in urban design and planning through selecting the best site location to establish a new mosque in the future based on the suitable planning criteria. These standard can applied anywhere in the Gaza Strip to arrive the available best solution .

Kumar and Bansal,(2016) study a questionnaire survey was adapted to identify different aspect that construction professional consider critical for suitable site selection . This study explored the using of geographic information systems (GIS) in modeling the site location and topographical aspect to categorize the areas of suitability , AGIS based methodology for finding a safe site that satisfies a range of spatial safety aspects that was developed.

Chehreghan et al.,(2013) in thier study integrated both GIS, Fuzzy Reasoning Systems (FRS) and also the Genetic algorithm (GA) to come up with a new approach for the optimum site selection of fire station . The results of this research show that by using the proposed methodology the service area of the fire stations can be extended from 69% up to 95.2%. Results represent that the ability of the proposed methods to solve the optimum site selection problem for the buildings .

While Abadi and Masoudi (2015) used GIS to analyze and classify the location of the mosque as it's the most important element of the Islamic city society and the introduction of the actual position being obsolete and its expression in the physical disappearance of Tehran (as sample case , zone 5) it deal with at the end of the priority measures for example the application of Islamic schools logistics, to improve the problem of the physical , the centrality of faith, social, too.

Ayhan and Cubukcu (2010) was based on the results of the GIS/spatial analyses using the 3 basic measure of spatial statistics the spatial distribution of the mosques is a close proxy of urban development. Thus, the location data for the places of worship(prayer),it is often accessible and available , can be utilized to derive historical urban development over a given period.

Abazari et al. (2012) by positioning the location with GIS includes the following stages: determination of positioning criteria , valuation of informational layers and modulation of informational layer and finally extract of final map for region layering . According to the considered criteria found that there are better opportunities for library constructions in the highlighted areas by the GIS , With the construction of libraries in these locations, deficiencies can be compensated .

Spatial analysis done by Rikalovic et al. (2014) with scientific data in term of single aim decision making with optimized numbers of criteria , without the conflict and subjective

criteria, utilizing MCDM in GIS environment . Focus of the research was that whether the MCDM method can be efficiently use in GIS as support tool for the industrial site selection . the result presents a successful solution for the spatial support decision in the case of the spatial analysis of Vojvodina (is an autonomous province of Serbia, located in the northern part of the country) which is a region of interest for the industrial site selection.

Another study done by Al-Enazi et al. (2016) used Several GIS tools using ArcGIS 10.2 to evaluate the school distribution planning . The results were utilized in evaluate spatial distribution of schools, which can help designer and planner in managing of the distribution of the future school at Jeddah city.

Ahmed and Asmael(2009) in their study used ARCGIS 9.2 as a tool for the spatial analysis has been utilized to achieve the research strategy . The goal of this paper was to develop the (GIS) model to determine suitable routes , the case studies verified that GIS based on multi criteria approach was known to be used as a tool for the optimum route selection but only by considering the factor affecting on the decision maker of route selection and also saving of money and effort and time .

A study done by (Mahmood et al.) A nearest neighbor analysis method was applied to analyzing the spatial distributions of the fuel stations . This study and its analysis leads to most important result about the distribution pattern for the fuel station in each district of Baghdad city. The finding was that the distribution of fuel stations is irregular.

Ismail et al. (2007) used the GIS software and Remote Sensing such as ArcGIS 9.0 and Erdas Imagine 8.5 to achieving research goals . Various GIS analyses like buffering analysis , modeling analysis and overlay analysis are carried out in order to finally produce a spatial product of suitable criterion. As the result of the model analysis the study was more focused on the most suitable mosque area. Through union operations and buffering operations mosques were separated for the purpose to get suitable location .

A Conflict Resolution Framework was proposed by Zhang et al. (2012) based on GIS software and Multi criteria decision Analysis technique . A unique feature of the GIS model was that the consensus building was designed to help the participant promote mutual understanding and improve group agreement . Besides , participant were suggest to compromise from the particular level and generate mutual solutions.

The study is conducted in Ranau district in Malaysia by Rendana et al.(2014) to find out the available and suitable areas for development of the rubber crop by using the GIS technique . The process involve the spatial matching methods between the land characteristics qualities and the crop requirements . The overlay process was applied to set of stratums of land quality to produce suitability of land in the map.

ELSamen and Hiyasat (2017) calculated the distance by using the term of minutes to access to each shopping mall using GIS techniques . The area under the study, which was cover multiple sub district , suffers from excessive oversupply, due to the lack of established planning criteria and the regulations , which in turn it has resulted in high population ratio in the retail area. This result was further supported by the referring to other evaluation criteria, also including the planning criteria that were used in the other countries like UAE and Saudi Arabia also .

The study by Yang et al. (2015) presented a contemporary approach to assess potential site for proposed hotel properties by designing the automated GIS application , Hotel Location Selection and Analyzing Toolset (HoLSAT) . The application used a group of machine learning

algorithm to calculate various business success indicator associated with the location of the sites . The approach illustrate considerable potential effectiveness in the field of the hotel location assessment by GIS .

Abdullah et al. (2013) study used structured questionnaire to investigate the transport choice of the resident to the mosques . Many important variable that were highlighted in previous studies was measured in the structured questionnaire ; the mode was choice of travel among the respondents , distance between house and mosque, socio demographic and reasons choosing to go to the selected mosque . A comparison between all the 3 different kinds of districts showed that most of the people tend to walk to the mosque in Seksyen 8. Since Seksyen 8 had the highest residential density compared to the other two districts kinds . The study suggested that the urban form might influence the people to walk although the relationship is very weak since most of the people prefer to use the motor vehicle to went to the mosque.

Hamid et al. (2012) conducted that the personal decision, geographical and social factors affect the selection of the site for the mosque and its extends , normally connected with the growth of the Islam and the Muslim population growth as the chain of the geographical phenomenon in the large part of the surface.

The techniques of GIS were used in different application and analysis at the level of urban and architecture design and planning . It used in studies of mosques and other buildings

2.1 - Research problem

The distribution of the mosques is considered one of the problems suffered by residents in the province of Erbil , and the distribution of the mosques within the city is inconsistent.

The planners have the problem of the distribution of the mosques which is non-compliance with the planning standards that led to the planning problems which negatively affect the role of the mosques in the provision of service to the citizen.

2.2 - Aims and objectives

The research aims to find the appropriate planning criteria for the selection of the best sites for mosques in the future through a case study of the distribution of the mosques in Erbil neighborhoods, using Geographic Information System (GIS). GIS can enhance the accessibility and flexibility of information and improve the linkages and the understanding of relationship between different types of information (Baniya, 2008) . So the objectives of the study are :

1- To study site and location of the existing mosque in Erbil city .

2- To identify the existing mosque site and location suitability .

3 – RESEARCH METHODOLOGY

3.1 - Study area

The position of the study area in Erbil state the capital of Kurdistan region located between [44° 0' 38 E) and [36° 11' 33 N] . Its governorate had a permanent population of 2,009,367 . Erbil city center is divided to six sectors , one of these sectors were chosen which is sector number three because of the variety that can be found in this sector from (history , culture , land use , etc) .

3.2 - Geographic information systems

Geographic information systems (GIS) is a powerful tool designed for the spatial analysis which provide functionality to store, capture, query, analyze, display the output geographic information. As it have big influence in the spatial decision making process . the development in the field of the decision making leads to the dramatic improvement in the capability of GIS in site location analysis. These improvement were reviewed through the analysis of the attribute data especially procedures for the Multi Criteria and also Multi Objective site location analysis in GIS. Special importance is given to the problems of incorporating individual influence in the context of the decision making the appearance of uncertainty in the establishing the relationship between the decision that make and the evidence . Procedure for the aggregation of evidence in the attendance of varying degrees of trade off between the procedures and the criteria for conflict resolution and conflict avoidance in case of multiple objective decision problems (Eastman et al., 1998) . The distribution of mosques in residential areas must take into consideration their distance from each other and the number of mosques must be compatible with the number of houses around them , and to use ArcGis software with spatial analysis support system for mosque planning that can be used as a tool to select the optimum mosque location based on multi-criteria approach. The GIS software is flexible to accept different data sets, accommodate different suitability criteria, work with different criteria weight, and define different land use types. GIS can help to improve the quality of decision making through increasing the capacity of analysis, display and management of data.

Through the definitions above, the geographic information system is designed to find appropriate location that accomplishes some goals depending on specific conditions and criteria, such as finding the best location for a new mosque, or any other services.

4 – ANALYSIS AND RESULTS

The study area is 12,289,443 square meters , after searching and surveying the researcher found that there are 23 mosques in the study area as shown in table 1 . Location of each mosque was identified by GPS (Global Positioning System) and after that the data entered to GIS to identify the mosques location on the map as shown in Fig 1.

Table 1. The mosques names and its area and the number of worshipers.

No.	Mosques name	Area	No. of worshipers according to floor area
1	Abo bakr alsdeq	1651	1651
2	Mohammed fawzy	2824	5648
3	Dream city	12740	12740
4	Rostam rasol	2831	4246.5
5	Shahed najmaden	1626	1626
6	Haje younis	4360	8720
7	A'auzayry	3450	3450
8	Sahaba	2364	3546
9	Haje mohammed salh	1500	1500
10	Haje azez	2815	5630
11	Xarabarot	3846	3846
12	Spy	3130	6260
13	Haje hashm	1201	1201
14	Haje bahjat salh	338	338

15	Shahed sabah	1802	1802
16	Haje sania	382	764
17	Bokhara	3475	5212.5
18	Salahaden ayobi	1129	1129
19	Haydar agha	2932	4398
20	Shekh mohammed	6044	12088
21	Qazi mohammed	2162	2162
22	Haje zaki	3397	6794
23	Ga'aetl	2135	2135
Total		68134	96887

An area of each worshiper at the mosque is equal to 1 square meter (1.25 x 0.80 cm) so the number of the worshipers in each mosque will be the mosque area divided by one square meter.

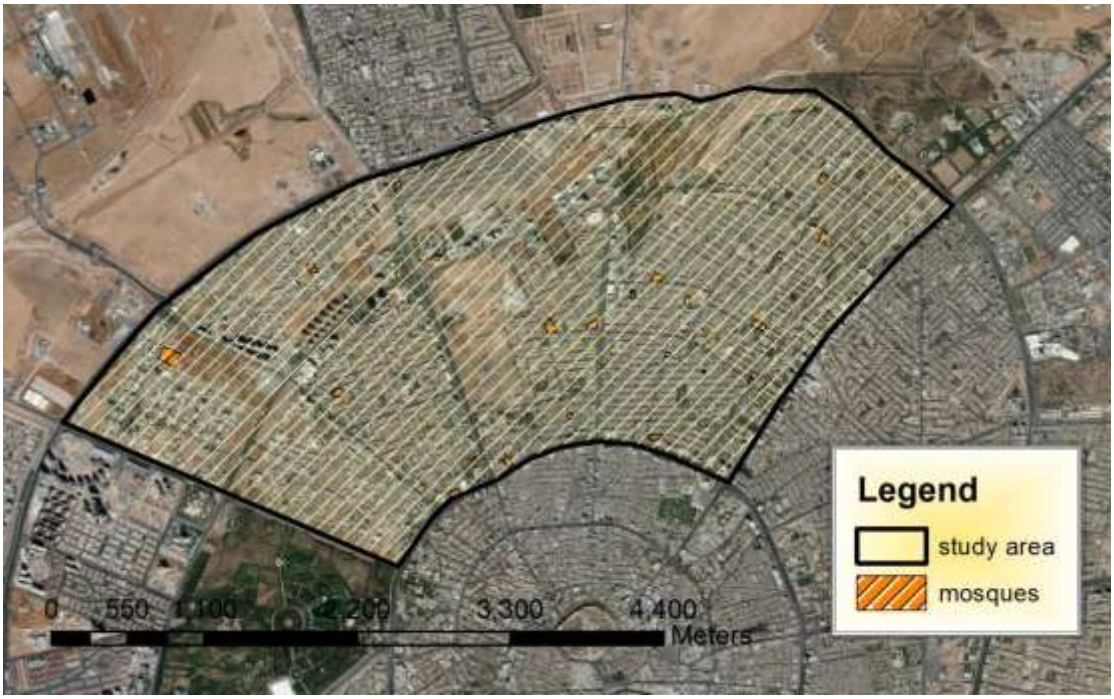

Figure 1. Study area and the mosques location .

The population density is 143 person per hectare in the study area according to the ministry of planning , that mean the total population in the study area is about 175,739 inhabitant and the family members number average is 6 person , by dividing the population on the family members number the result will be 29,289 family in the study area . If we assume the number of worshipers is two person in every family the total number of worshiper will be 58,578 person.

A buffer (GIS tool) of 300 meters applied around each mosque according to the Islamic thinking and the optimal distance for worshipers to access the mosque by walking within 10 minutes because the sufficient time for the worshiper to reach the mosque after prayer call time and prayer starting time as assumed by about 10 minutes . The buffer area used around each mosque to identify the suitability of the mosque location as shown in Fig 2. After

the buffer of 300 m applying another GIS tool applied to find the intersection between the buffer zone of the mosques as shown in Fig 3.

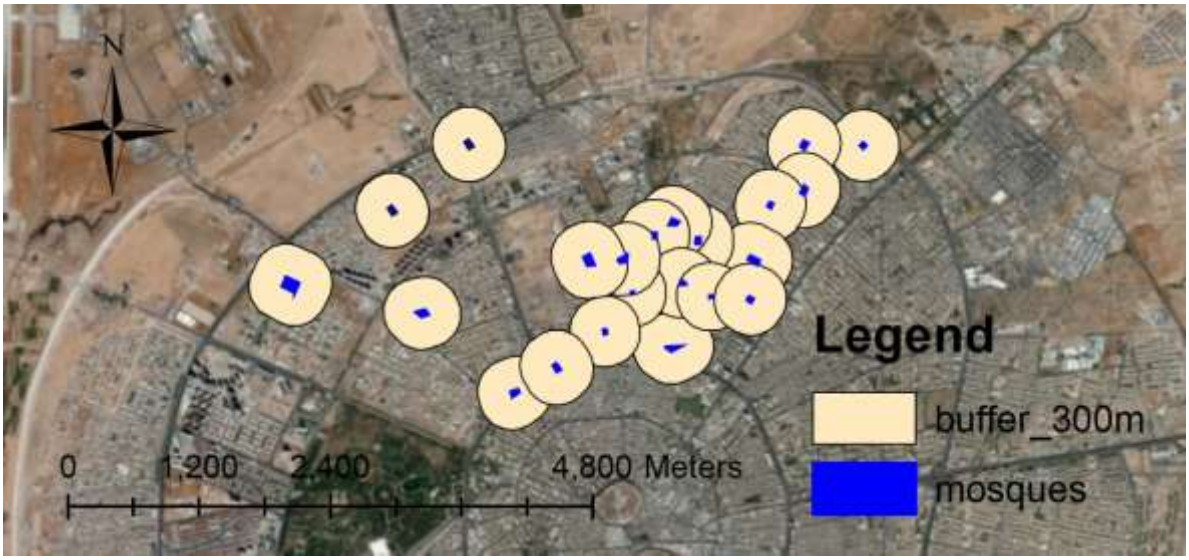

Figure 2. 300 meter buffer around each mosque in the study area .

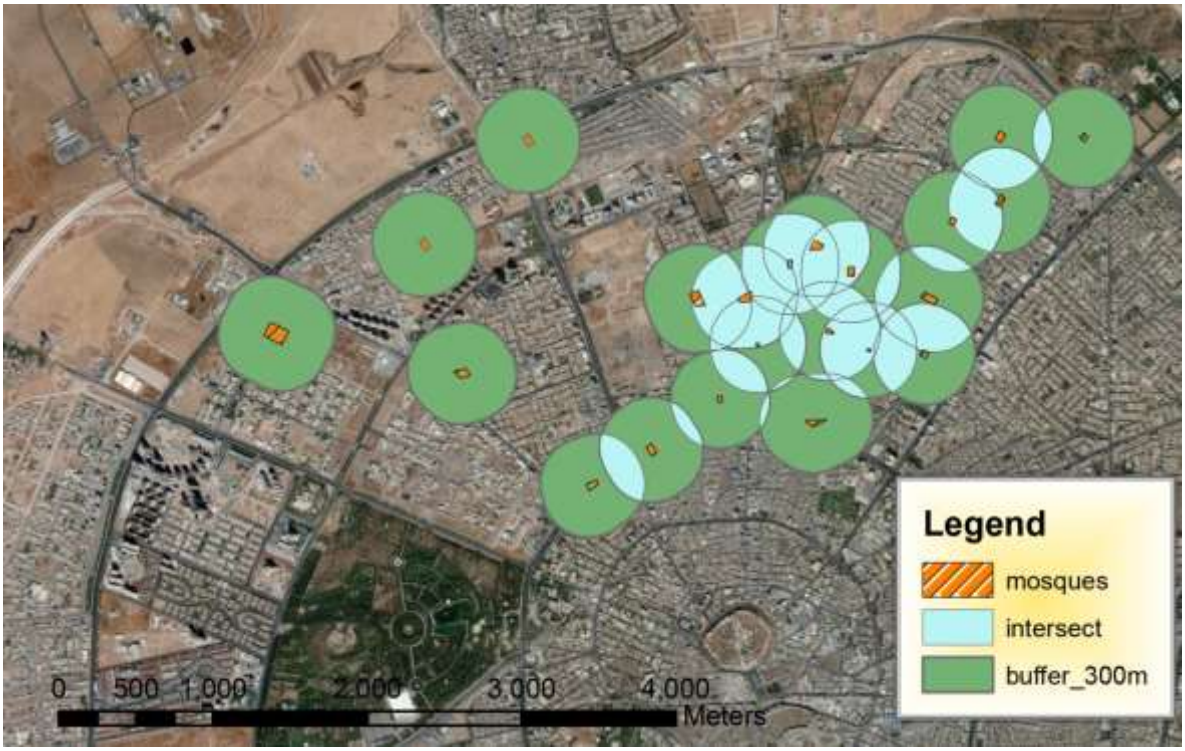

Figure 3. Intersection between the buffer zone of the mosques.

Another buffer in GIS applied around all the mosques by 500 meters according to the regularity of the ministry of Endowments (Awqaf) as shown in Fig 4. and then the intersection tool applied to present the intersect area between the mosques as shown in Fig 5.

Figure 4. 500 meter buffer around each mosque in the study area .

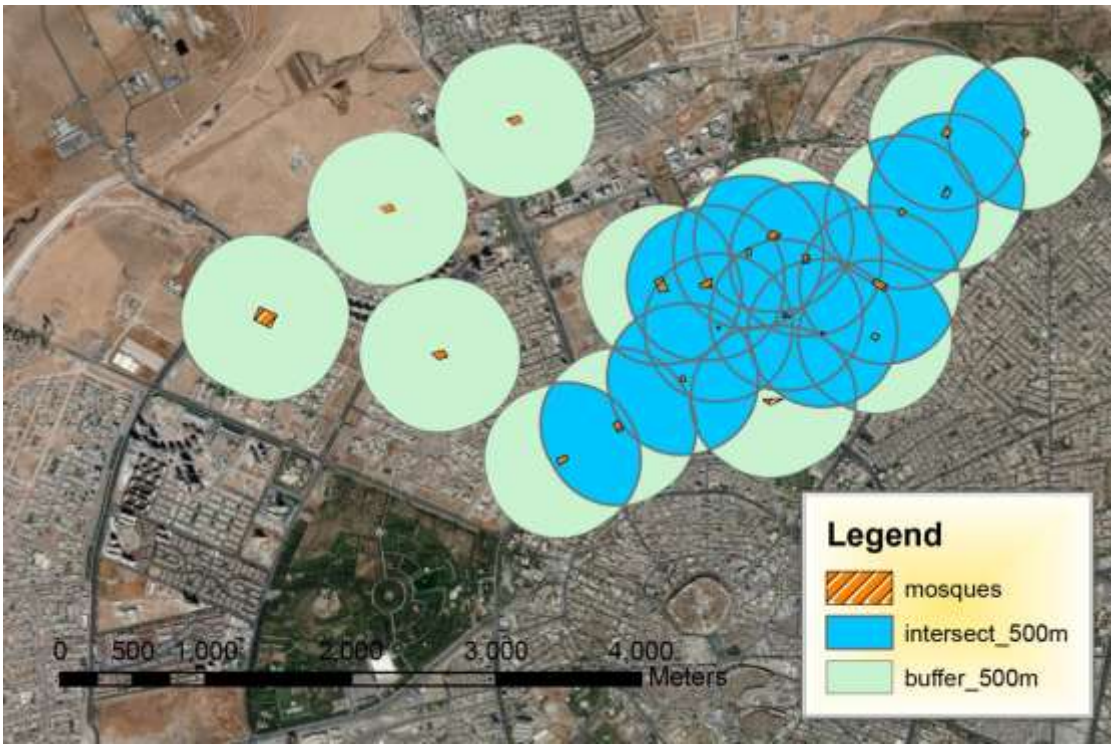

Figure 5. Intersection between the buffer zone of the mosques.

As a result of the study and according to tables and graphs that shown previously the total worshiping area is more than the needed area for the total worshiper and even if all the mosques used only one floor area for worshiping and neglect the second floors it will be also more than enough for this sectors inhabitants .

The 300 m buffer shows the big amount of intersection in a part of the study area and a huge areas were shown not reachable place for any mosques .

According to the regularity's the 500m buffer also show very huge intersection area in some places of the study area and still another areas not reachable to the mosques .

Mosque distribution need to be rearranged , although the built mosques cannot removed but many of this mosques do not do its function well because it's wrong location that cause a huge area and a big amount of population need mosques in their area because the existing mosques are so far from their houses and concentrated in other places .

Some of the people cannot hear the prayer call while other mosques make a noise in the adjacent mosques due to its wrong locations .

5 – CONCLUSIONS

Mosque is an important place in the Islamic city for Muslims worship all over the world. It is used by Muslims to perform religious activities and also as a place for the social gathering in city . Due to the increase of urban population and the growth of the number of mosques , mosques are among the places that residents refer to repetitiously. the number of the mosques remained inadequate in some places and more than the required in some other places . Selecting of mosques location together with the appropriate capacity sufficient for the number of worshipers is a serious problem in Islamic towns added to nonobservance of planning standards in the areas of mosques to cope with population growth and urban expansion. Site selection is a very important activity aimed at producing optimal mosques locations . Geographic information systems (GIS) used to identify mosques location in this study area in Erbil city and it found that mosque distribution need to be rearranged , although the built mosques cannot removed but many of this mosques do not do its function due to its wrong location which cause that big amount of population need mosques in their area . The existing mosques are too far from some houses and concentrated in other places and also some of the people cannot hear the prayer call (Muazin) while other mosques make a noise in the adjacent mosques.

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