The Integration between Fuzzy Logic and Geographic Information Systems for Urban Planning Evaluation of Entertainment Land Use in Basrah City: a Model

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Abstract

Entertainment services is one of the main features of any city and is an important part of the population's needs. It is described as the place where people spend their leisure time and holidays, and the importance of this service increases as the population grows.

The current study aims to evaluate the use of land for recreational services in the city of Basrah using the Geographic Information System (GIS) techniques and fuzzy logic (FL) based on the adoption of planning criteria. The results of the study classified the districts of the city to three levels, the first level is poor, the second level is poor medium, the third level is good (20.6%, 73.93% and 5.45%), respectively, indicating that districts of the first level suffer from a very severe shortage of services because they do not meet the standards , while there is a weakness in the second level because they meet part of the standards. As for the third level, it has got a complete match to the standards, which indicates that the service is good.

The research recommends the adoption of modern techniques in the urban planning , as they optimize the results and help the relevant parties in the process of good decision-making and avoid randomness and bad organization of the population's life.

Keywords

GIS, Geo DB , FL , fuzzification , Rule , Difuzzification , fuzzy sets, Model

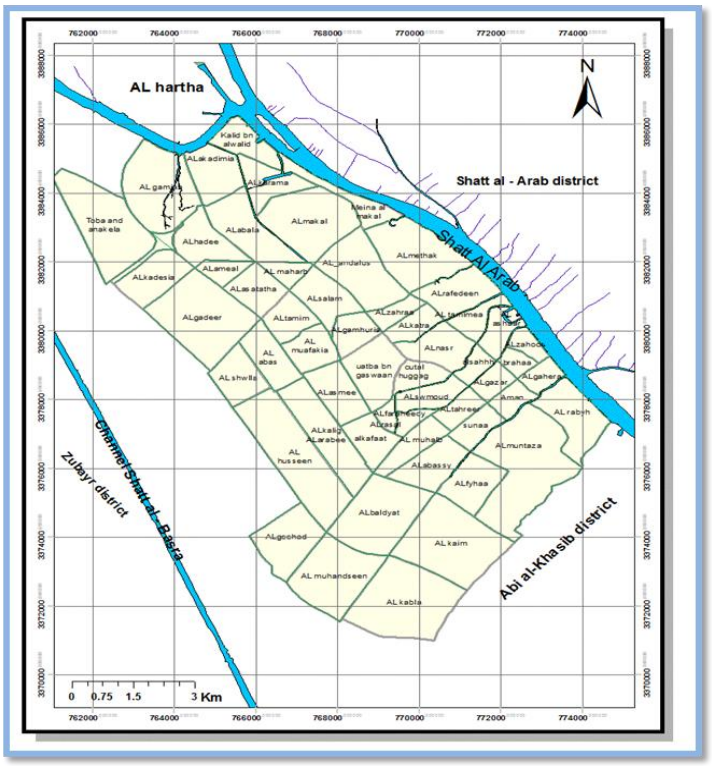
1.Introduction

The increase in income and the rise in the individual's standards of living has led to increasing demand on recreational services. Therefore, the provision of these services can be an indicator of the development of these cities, moreover, the level of modernity in any city is measured by the availability of recreational places. The importance of this research lies in adopting the integrated approach between fuzzy logic technology(one of the techniques of artificial intelligence) and the technique of geographic information systems to process spatial data used to evaluate the uses of recreational land at the level of the city of Basra to identify the problems of the planning process and offer proposals to the relevant authorities to take the necessary decisions.

2.Study Area [1,11]

The city of Basra is located at the south of Iraq on the two longitudes (47 ° 44 '47 47 ° 52' 6) east and the two latitudes (30 ° 26 '2″30 ° 34' 46′)) north with a total area of (107) Km^2. Its population is (1377104) people according to the estimates of 2016 and the city is divided into 55 districts divided into 6 administrative sectors and Figure (1) illustrates its residential areas.

Figure (1): Residential Areas in the city of Basra



3. Planning Standards for Recreational Services [11]

For the purpose of evaluating the recreational uses in the city of Basra, two planning criteria were adopted which can be clarified as follows:

1 - Area: means the area allocated to each entertainment attraction, which varies depending on the type of attraction, for example, parks need an area of no less than 5000 m 2.

2. Population size: for each number of people, there is a specified number of these attractions (depending on the approved recreational planning standards) . Table 1:

These criteria will be applied to three geographical attractions in the study area:

1- Sport clubs

2 – Parks

3 - Sport Stadiums

Table (1): Local Planning Standards applied in the Study Area[11]

code	Type of service	Local Planning Standards	
		Distance/m^2	**population**
1	**Sport clubs**	**15000**	**60000**
2	**parks**	**5000**	**10000**
3	**sport stadiums**	**15000**	**40000**

4.Fuzzy Logic(FL) [8,9,10]

This is one of the techniques of artificial intelligence. The expression 'fuzzy logic' refers to the study of human thinking methods and provides approximate logical bases using inaccurate propositions. While conventional logic deals with questions that are either true or false, which is insufficient to solve complex problems, the fuzzy logic provides the approximate logical bases because it uses accurate proposals based on the theory of fuzzy groups depending on the way of human thinking, for example in our daily language we use many terms to express inaccuracy or ambiguity, for example the person's weight and height.

Fuzzy logic deals with the degrees of membership that can be expressed by using numbers ranging from zero to one. Many logical operations can be performed such as abstraction, union, and complement. The abstraction process is defined in the fuzzy logic as minimum (min) while union is represented by maximum (max).

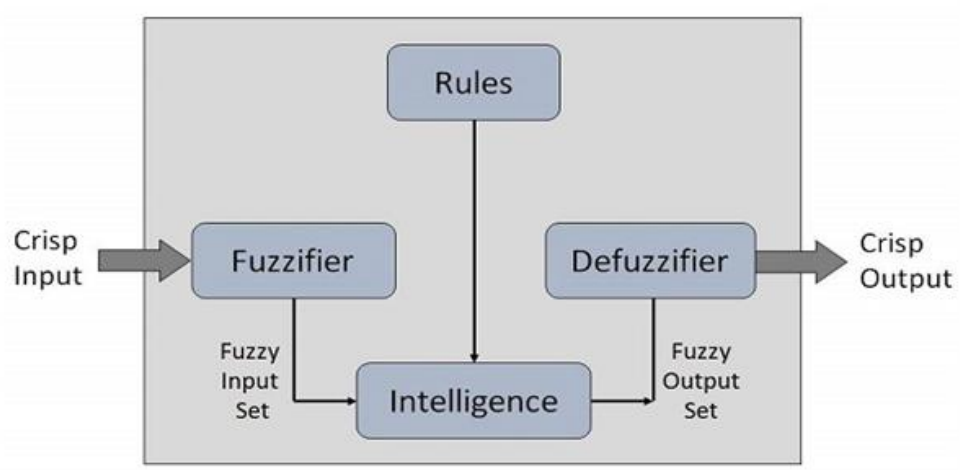
The processing of fuzzy logic is characterized by three main steps:

1- Fuzzification

2. Rules

3. Difuzzification . Figure (2) illustrates the inference engine in the fuzzy logic

Figure (2) : The Inference Engine



Fuzzification is used to convert crisp sets into fuzzy sets, while the rules are used to describe human thought, they are composed of two important parts: the part that evaluates the rule, i.e. the part of the 'if 'conditional process which is called 'antecedent', and the second part is the inclusion and the application of the result and is called 'the consequent'. The decoding process is a process of converting fuzzy sets into crisp sets.

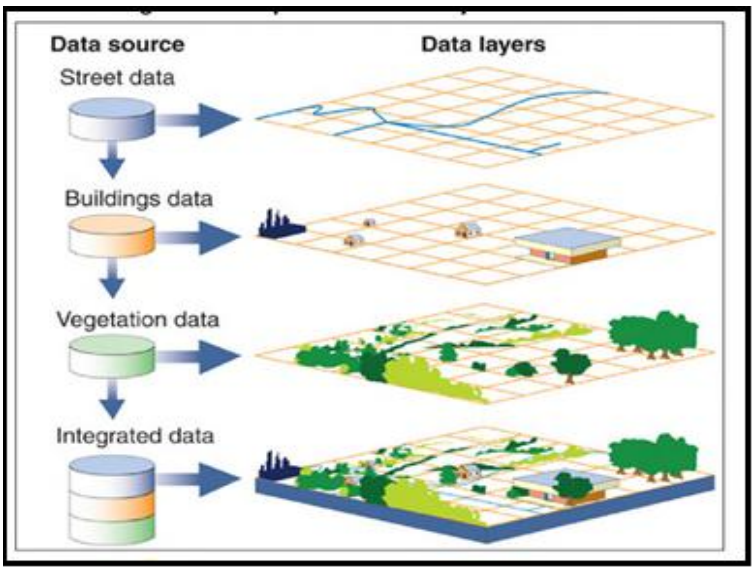
There are several ways to convert fuzzy groups to fragile values such as total position, mean value, weighted average, and other ways of defuzzification. Fuzzy logic uses a set of functions in the process of fuzzification and defuzzification (e.g. trigonometric functions, exponential functions, trapezoidal functions, etc.) and one is chosen based on the nature of the data studied.

5.**Geographic Information Systems Technology (GIS)** [2,3,6]

This technique is based on highly efficient information systems for the management and processing of spatial and non-spatial data by conducting spatial analysis of phenomena on the surface of the Earth. It combines the use of database, information systems, visualization of maps, analysis, spatial analysis, and simulation, where all these processes are called Geo_computation. This technique deals with various spatial data layers as input (Figure 3) and gives different outputs such as digital maps, reports and chart formats, as well as the possibility of exporting digital outputs for handling in other software environments.

Therefore, it provides an explanation for the representation of spatial phenomena in their real locations on the surface of the earth and understanding of planning strategies as it is an important tool in the process of urban land planning and it facilitates the decision-making process, which has been used in many developed countries and contributed to the management of urban planning, especially in land management and use and the set of future predictions.

Figure (3) : Layer Representation in GIS [6]



In spite of the high capacity of artificial intelligence techniques to handle different types of data, it is not able to deal with spatial data, so it was necessary to adopt GIS

technology for its high efficiency in the analysis and spatial processing. But in some cases, it is a limited technique in decision-making processes, especially in urban planning studies that need to provide quick answers and high degree of flexibility, so there is a need to use other techniques to obtain the best and most accurate results in decision making [4,5,10]

6. Application Mechanism : The working mechanism included three stages applied to the study data, as follows:

6-1 Stage 1: Building a Spatial Information System

The first phase included two sub-phases that can be clarified as follows:

6.1.1 Capture Data

Represents the first step in any project and is the basis for the success of any study and it is the adoption of the rest of the stages. It was represented by satellite image of the city of 2012 and the coordinates of entertainment attractions with their descriptive data.

6.1.2 Geographic Database (Geo_DB)

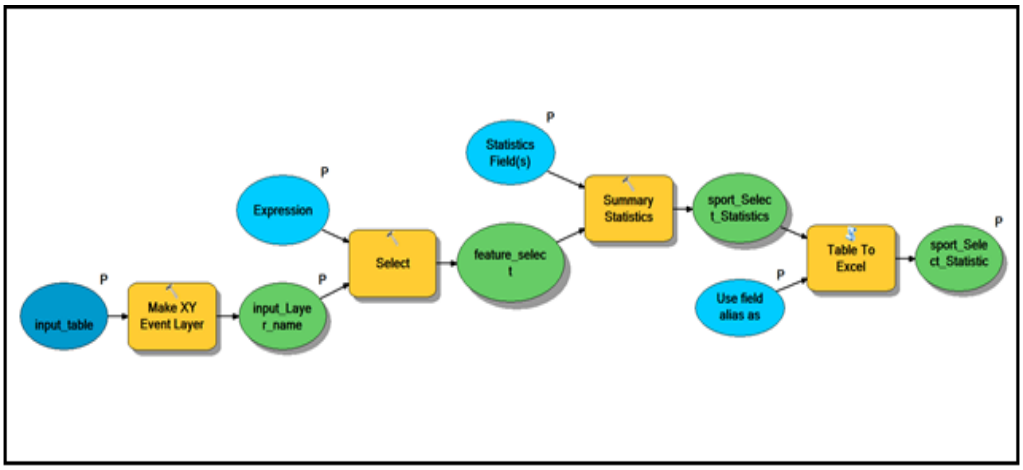
The stages of database construction include:

1. Data Set1: included three categories of feature classes (sports clubs, parks, sports stadiums).
2. The creation of the Dataset 2 dataset comprises four categories of features(districts boundaries, Shatt al-Arab, Shatt al-Basra canal , and the city boundaries).

6.1.3 Spatial Analysis Model [7]

ArcGIS10.4 allows the addition of tools for analysis and modeling, resulting in the construction of models to simulate the work of phenomena. This feature is ideal for analysis and provides a shortcut to the time and effort in the implementation of analysis processes where the model is represented as a series of tools connected to each other to facilitate the implementation process and Figure 4 clarifies the structure of the model that was adopted in the spatial analysis of the current study.

Figure (4) : The Proposed Analytical Model in the Spatial Analysis Process



The approved tools for building the model are as follows:

1**. Make Feature Layer Tool**: This tool is used to convert the coordinate tables of the entertainment attractions into separate layers of the point type.

2 . **Select Tool** : This tool is used to select the attractions according to their location in the districts, that is, it distributes the entered geographical attractions on the districts they are found in.

3. **The Statistical Summary Tool** : contains a number of fields (Sum, count, mean, min, max, STD). The 'mean' function has been adopted to extract the average area of the recreational attractions for the requirements of the evaluation of districts.

4. **Export Tool**: This tool is used to export the results of the analysis to an external file for adoption in the process of classification by the fuzzification program.

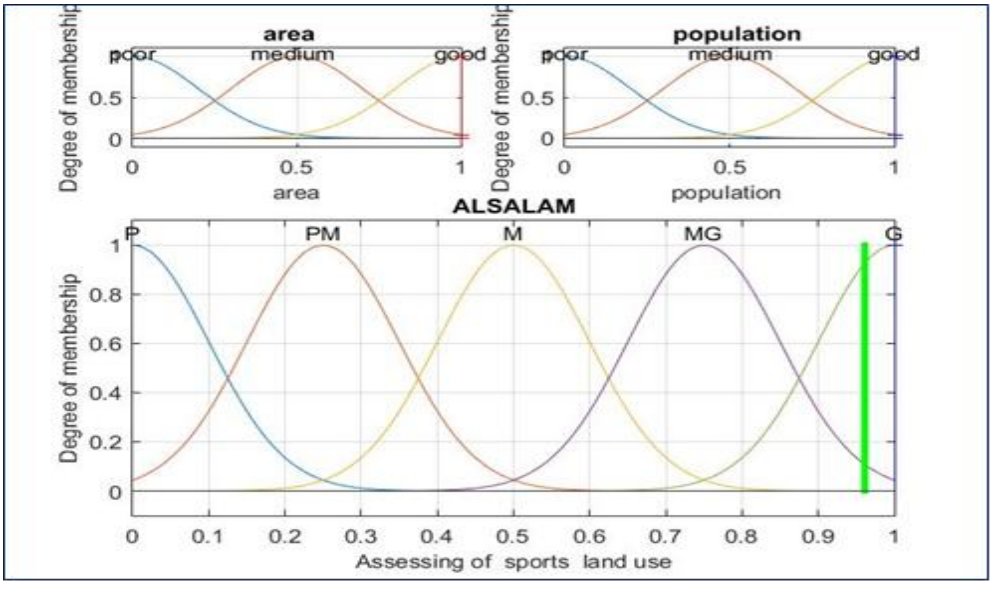
6.2 Stage 2: Design of Evaluation Fuzzification Program

The fuzzification program was designed using the Mat lab 2015 environment depending on five degrees of district evaluation. In our present study, the fuzzification program consists of two main inputs (area, population size). The work in the program involves the adoption of the Gaussian function to illustrate and draw inputs and outputs as well as determine the degree of belonging of each districts. Three groups were identified to represent inputs: (**Poor , Medium , Good**) . Five sets of outputs were also identified:

1. P: represents poor
2. PM: represents Poor Medium
3. M: represents Medium
4. MG: - represents Medium Good
5. G: represents Good

The results of the spatial analysis model of the study were passed to fuzzification program to determine the degree of belonging of each district to these groups. The center of gravity was then used I defuzzification. Figure 5 shows the inputs and results of fuzzification of one of the districts (Hay Al Salam)

Figure (5) Inputs and outputs of Fuzzification of one of the Districts of Basrah (Al-Salam District)



7. Presentation and Discussion of the Results

After the implementation of each of the model adopted for spatial analysis and fuzzification program on the study data, it was found that there are different degrees of belonging according to the recreational service on which the districts of Basrah were classified , Table (2) so they can be discussed according to the service as follows:

7.1.Sports Clubs

Results of fuzzification showed that only (1) of the districts obtained an evaluation of (0.03) with a score of (0), that is, it did not meet any planning criterion, so that it was within the Poor category (1.81%) while 50 districts obtained (0.5) with a matching score (1) that is, it meets half of the standards and is therefore within the Medium category (90.901%). In addition, (4) of the districts obtained an evaluation of (0.961) with a degree of matching (2), that is, they met all the criteria and therefore fall within the category Good category (7.272%) of the total number of districts. Appendix (1) and Appendix 2 , Figure (1).

Table (2) : Percentages of fuzzification Classification by Number of Districts and Matching Scores with the Approved Planning Standards

Service	Number of Districts	Value	Percentage	Class	Matching Score
Sport Clubs	1	0.038831	%1.81	POOR	0
	50	0.5	%90.90	MEDIUM	1
	4	0.961169	%7.29	GOOD	2
Parks	30	0.038831	%54.55	POOR	0
	21	0.5	%38.18	MEDIUM	1
	4	0.961169	%7.27	GOOD	2
Sport Stadiums	3	0.038831	%5.46	POOR	0
	51	0.5	%92.73	MEDIUM	1
	1	0.961169	%1.81	GOOD	2

7.2 Parks

The results of fuzzification program showed that (30) of districts obtained an evaluation of (0.03) with a matching score of (0) , that is, it did not meet any criterion, therefore, it was within the Poor category (54.5%). In addition, (21) districts received a rating of (0.5) with a matching score of (1), that is, they met half of the standards and were classified as Medium (38.18%). Only (4) of the districts obtained a rating of (0.961) with a matching score of (2) so they meet all the criteria and were in the Good category (7.27%). Appendix (1) and Appendix 2, Figure 2.

7.3 Sports Stadiums

The results of the fuzzification program showed that (3) of the districts obtained a rating of (0.03) with a matching score of (0) for non-conformity with the criteria, so it was within the Poor category (5.45%). In addition, 51 districts received a score of 0.5

with a matching score of (1), that is, they meet half of the standards and were classified as Medium (92.72 %) . While only (1) of the districts obtained a rating of (0.961) with a matching score of (2), so they meet all the criteria and were in the Good category (1.81 %). Appendix (1) and Appendix 2, Figure 3.

8. Conclusions

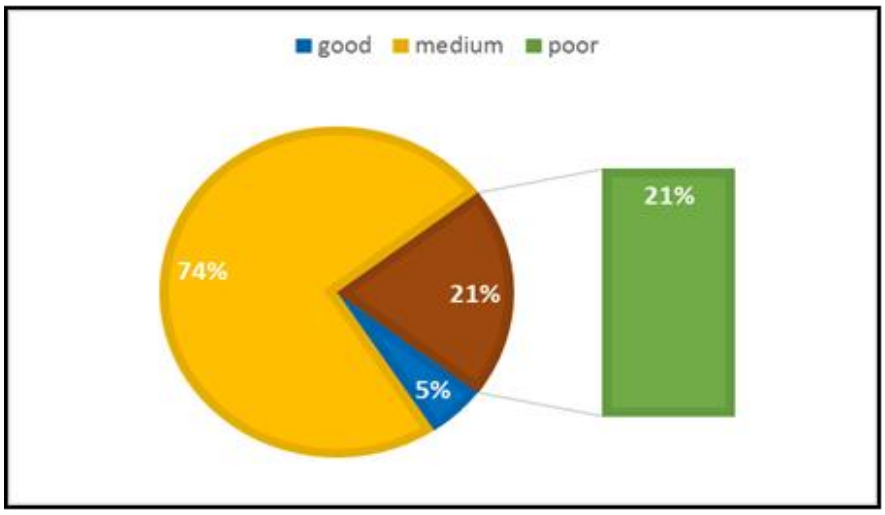
Based on the above, we conclude the following:

1. The degree of matching to the approved planning criteria varies, indicating that recreational services are not ideally available in most districts of the city.
2. The percentages of membership in fuzzification program vary, resulting in different percentages of the classification of districts according to the type of recreational service available. So we can find poor category represents (20.60%), medium represents (73.93%). The lowest of the good category was (5.45%), which indicates poor recreational services in the districts of Basra. Table (3) and Figure (6).

Table (3): Percentages of Classification of Districts in Basrah according to the Results of the Fuzzification Program

Type of Service	Classification					
	poor	Percentage	medium	Percentage	good	Percentage
Sport Clubs	1	%1.81	50	%90.90	4	%7.29
Parks	30	%54.55	21	%38.18	4	%7.29
Sport Stadiums	3	%5.46	51	%92.73	1	%1.81
Total Percentage	20.60606%		73.93939%		5.454545%	

Figure (6): Percentage of the Classification of Districts in Basrah according to the Results of the Fuzzification Program



3. There is a clear variation in the classification of districts in terms of sports clubs service for the medium category represents (90.9%) while the good category (7.27%), which means that only (4) of the districts came up with perfect match (Al-Salam, Al-Maaqal, Al-Zahra, Kut Al-Hajjaj). While the poor category (1.81%) is

represented in Al Hussein district and this indicates that most of the city's districts suffer from a lack of availability of this recreational service.

4 - There is a clear variation in the classification of districts in terms of parks service. It was found that more than half of the districts, i.e. (54.55%) fall within the poor category and medium represents (38.18%), while good category represents (7.27%) which is a very low percentage. This indicates that most districts of Basra suffer from the lack of parks and that only four of the districts (Al-Muharbeen, the Arabian Gulf, Oman, Algeria) showed full match.

5- There is a clear variation in terms of sport stadiums. The medium class represented (92.73%), followed by the poor category which forms(5.46%) represented in three districts (Utbah Ben Ghazwan, Andalus, Qibla). The good category was (1.81%) represented by only one district which is Al - Salam. This indicates a deficit in this recreational service in most districts of the city.

In the light of the results, the research recommends the following:

1. The need to activate the role of artificial intelligence techniques in urban planning studies for their ability to optimize decision-making.
2. The need to adopt technical models for spatial analysis in planning and urban growth studies.
3. The need to adopt planning criteria to improve the efficiency of recreational services in Basra to meet the needs of the population and their wishes.

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Appendix (1) : Results of Spatial Analysis and Fuzzification Program According to the Type of Service

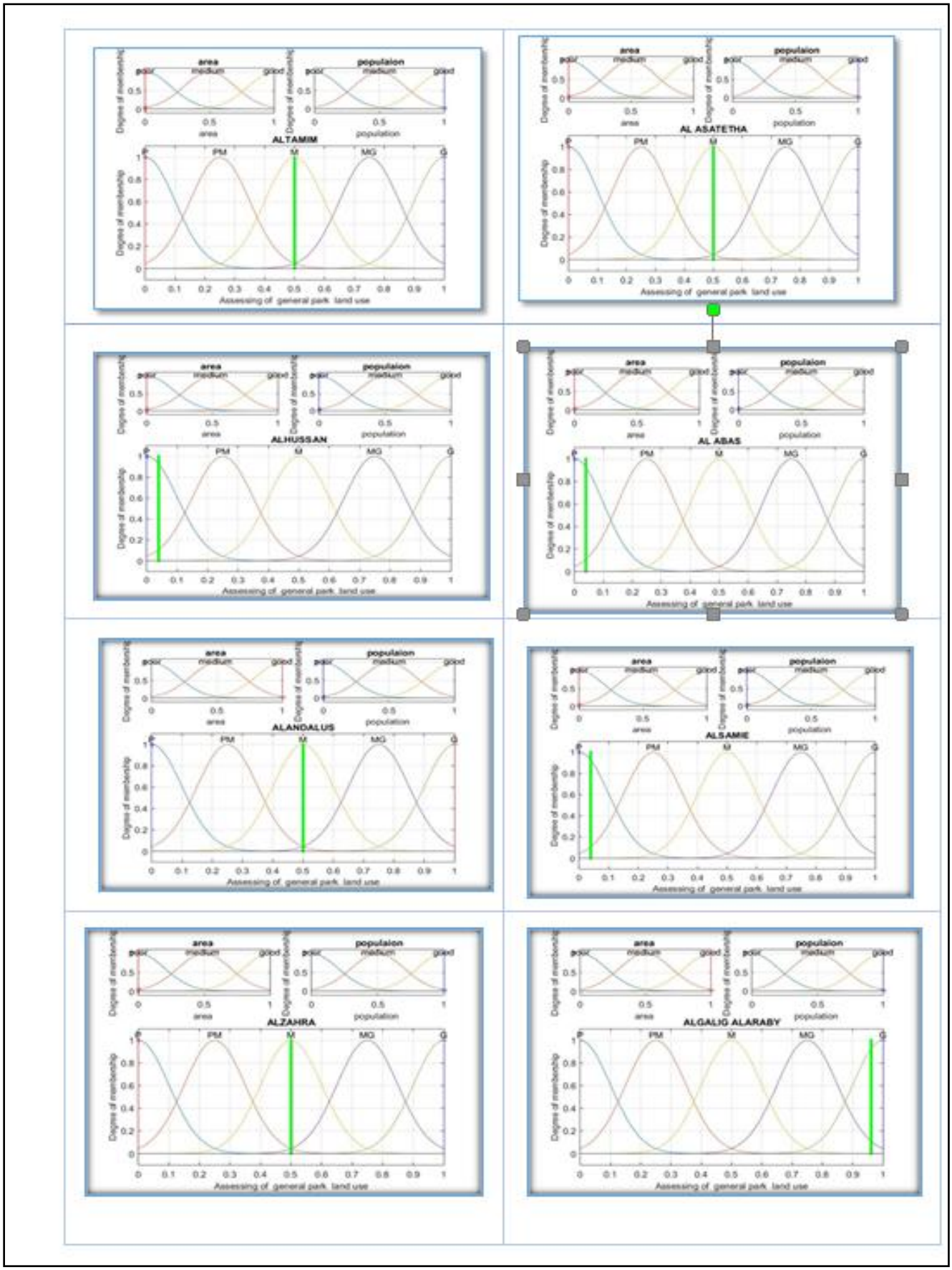
Code	District	Population	No. Of Parks	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Clubs	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Stadiums	Average Distance	Degree of Fuffification Evaluation
1	Toba & Nakhela	7609	0	0	0.5	0	0	0.5	0	0	0.5
2	Alkadesia	16813	0	0	0.038831	0	0	0.5	0	0	0.5
3	Alhadee	37185	0	0	0.038831	0	0	0.5	0	0	0.5
4	Alabala	57803	1	4000	0.038831	0	0	0.5	1	1248	0.5
5	Alameal	13745	0	0	0.038831	0	0	0.5	0	0	0.5
6	Algadeer	4786	2	4617.5	0.5	0	0	0.5	0	0	0.5
7	Alasatitha	6995	0	0	0.5	0	0	0.5	0	0	0.5
8	Almuharib	12763	1	16000	0.961169	0	0	0.5	1	1222	0.5
9	Alkarama	8836	0	0	0.5	0	0	0.5	0	0	0.5
10	Khalid bin alwaleed	7118	0	0	0.5	0	0	0.5	0	0	0.5
11	Maqal	37553	2	1926	0.038831	1	116000	0.961169	2	3126	0.5
12	Altamim	6995	0	0	0.5	0	0	0.5	0	0	0.5
13	Alsalam	18899	1	12000	0.5	1	57500	0.961169	1	22000	0.961169
14	Aljamhuria	36940	0	0	0.038831	0	0	0.5	0	0	0.5
15	Almuwafikia	30435	0	0	0.038831	0	0	0.5	2	992	0.5

Code	District	Population	No. Of Parks	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Clubs	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Stadiums	Average Distance	Degree of Fuffification Evaluation
16	Utba bin Gaswaan	46758	0	0	0.038831	0	0	0.5	0	0	0.038831
17	Alasmaee	38903	2	3033	0.038831	0	0	0.5	1	1813	0.5
18	AlAbass	24054	0	0	0.038831	0	0	0.5	5	7104	0.5
19	Alshulla	23686	0	0	0.038831	1	10544	0.5	0	0	0.5
20	AlHussein	188504	0	0	0.038831	0	0	0.038831	10	2633.3	0.5
21	Alkhaleeg Alarabi	35835	10	5618.182	0.961169	0	0	0.5	0	0	0.5
22	Aljihad	28717	1	3600	0.038831	0	0	0.5	0	0	0.5
23	AlAndulus	42831	2	22000	0.5	0	0	0.5	0	0	0.038831
24	AlMethaq	24177	0	0	0.038831	1	7500	0.5	0	0	0.5
25	AlZahra'	5031	0	0	0.5	1	25000	0.961169	0	0	0.5
26	AlKhadra'	13254	1	4100	0.038831	0	0	0.5	0	0	0.5
27	Alrafedein	15340	0	0	0.038831	0	0	0.5	0	0	0.5
28	Altememia	15095	0	0	0.038831	0	0	0.5	0	0	0.5
29	AlNasar	25158	1	2000	0.038831	0	0	0.5	1	1200	0.5
30	Alzuhoor	4909	0	0	0.5	0	0	0.5	0	0	0.5
31	AlAshar	9204	0	0	0.5	0	0	0.5	0	0	0.5
32	Buraha	8713	0	0	0.5	0	0	0.5	0	0	0.5

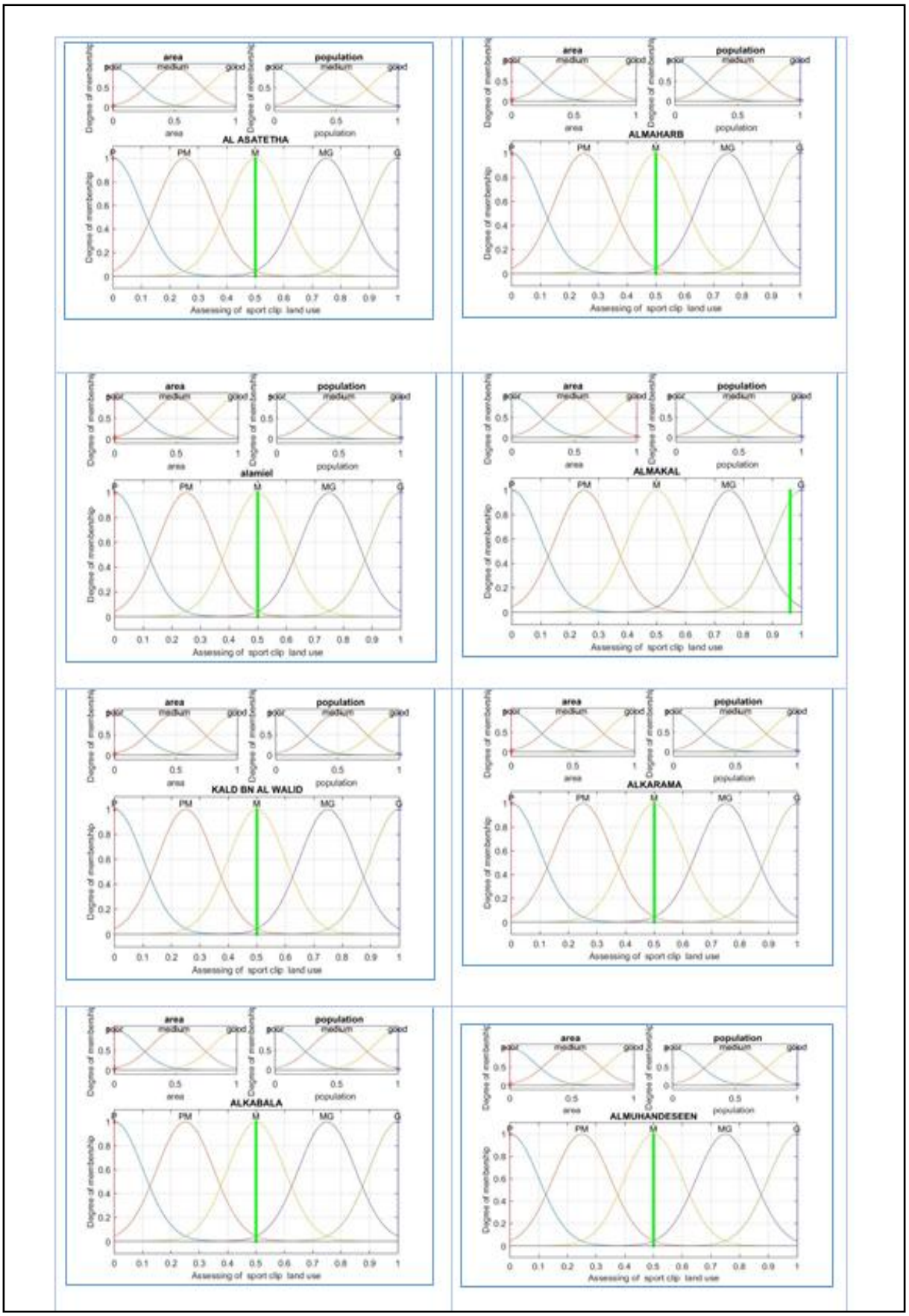
Code	District	Population	No. Of Parks	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Clubs	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Stadiums	Average Distance	Degree of Fuffification Evaluation
33	Alsaee	5400	1	0	0.5	1	3432	0.5	0	0	0.5
34	Aljaza'r	7854	1	13000	0.961169	0	0	0.5	0	0	0.5
35	Kafa'at	4418	0	0	0.5	0	0	0.5	0	0	0.5
36	Alresala	6136	0	0	0.5	0	0	0.5	0	0	0.5
37	AlFraheedy	10309	0	0	0.038831	0	0	0.5	0	0	0.5
38	Kut alhijaj	8222	1	4000	0.5	0	0	0.5	0	0	0.5
39	Alsumood	22458	0	0	0.038831	1	24245	0.961169	0	0	0.5
40	Altahreer	22949	0	0	0.038831	0	0	0.5	0	0	0.5
41	Alqahera	8099	0	0	0.5	0	0	0.5	0	0	0.5
42	Uman	3559	1	8100	0.961169	0	0	0.5	0	0	0.5
43	San'a	13131	0	0	0.038831	0	0	0.5	0	0	0.5
44	AlMuhalab	20618	0	0	0.038831	0	0	0.5	0	0	0.5
45	AlAbassy	24176	0	0	0.038831	0	0	0.5	0	0	0.5
46	Albaladiat	24299	3	4437.5	0.5	0	0	0.5	2	4922	0.5
47	Almuhandseen	22581	1	2500	0.038831	0	0	0.5	0	0	0.5
48	Qebla	40744	0	0	0.038831	1	12500	0.5	1	1200	0.038831
49	AlQae'm	49580	0	0	0.038831	0	0	0.5	1	1344	0.5

Code	District	Population	No. Of Parks	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Clubs	Average Distance	Degree of Fuffification Evaluation	No. Of Sport Stadiums	Average Distance	Degree of Fuffification Evaluation
50	Alfayha'	17918	0	0	0.038831	0	0	0.5	0	0	0.5
51	Alrabee'	15954	0	0	0.038831	0	0	0.5	0	0	0.5
52	Almutanazh'	24054	0	0	0.038831	0	0	0.5	0	0	0.5
53	Jame'a	982	0	0	0.5	0	0	0.5	0	0	0.5
54	Alakadeem'a	2700	0	0	0.5	0	0	0.5	0	0	0.5
55	Maqal Port	4418	0	0	0.5	0	0	0.5	0	0	0.5

Appendix (2) : Figure(1) : Samples Evaluation of Sport Clubs in a number of Districts in the Study Area



Appendix (2) : Figure(2): Samples Evaluation of Parks in a number of Districts in the Study Area



Appendix (2): Figure(3) : Samples Evaluation of Sport Stadiums in a number of Districts in the Study Area