On the use of GIS Technique to Analyze the Distribution of Primary Schools in Holy Karbala City

Noor Hashim Hameed
Building and Constructing Department, University of Technology/Baghdad
Email: noorhashim79@gmail.com

Received on: 30/6/2016 & Accepted on: 24/11/2016

ABSTRACT

This paper analyzes the spatial distribution of primary schools in Karbala city based on geographic information system (GIS). GIS has the ability to solve numerous geographic problems effectively and easily and to make spatial analysis in combination with database systems. In this paper, data of educational facilities and population are collected via comprehensive statistics in Karbala city. This data has been utilized to build a geo data base for study area after processing it. Statistical and spatial analyses were applied. The analysis tools in Arc GIS9.3 software include (standard distance, directional distribution, nearest neighbor, auto correlation and accessibility indicator). These tools were used for analyzing patterns of distribution. Statically analysis results showed that there is an argent need to 31 boys' primary schools and 30 girl's primary schools within study area while spatially analysis results showed that nearest neighbor value of 1.19 which is dispersed for boys' schools and 0.96 is random for girls' schools. The correlations indicated 0.19 which is random for boys and girls schools. The Calculate Accessibility Indicator's results showed there is a lack in achieving the Accessibility Indicator of most of the residential sectors.

Keywords: geographic information system, analysis, primary schools

INTRODUCTION

Educational sector is a critical issue for developing countries. Providing educational facilities by the government does not only mean developing schools, but also includes other services. These services involve developing a transportation network such as roads, adequate classrooms, sufficient number of teachers and good planning strategies [1]. The education sector in Iraq as in many other third world countries is faced with multi problems such as lack of human resource, infrastructure imbalance between demand and supply.

GIS is useful in the analysis and evaluation of the performance of different services, and identify disadvantaged urban areas for the redistribution of services where it also serves as compared to what is already planned and what is the reality of a specific area for determining the properties and legal liabilities and participates for building mathematical models of the slums by recognizing where urban growth trends to limit the spread and the development of existing areas [2]. GIS can be considered as a powerful set of tools that collect, retrieve, and store data, as well as displaying and transforming spatial data from real world for a specific purposes [3], GIS can be used for many different purposes in public services, especially in educational planning and management [4,5].

GIS provides a good platform for deeper geographical analysis of educational accessibility and has a great advantage. GIS has been participated greatly with number of studies that are dealing with measures of spatial access of educational services and resources. In developing countries, GIS

https://doi.org/10.30684/etj.34.15A.4
2412-0758/University of Technology-Iraq, Baghdad, Iraq

and school mapping (SM) technique are often used for creating the necessary conditions and increasing the access of primary and secondary education facilities [6].

GIS for school mapping has been used in the last three decades for educational planning [7]. GIS database supplies a universal framework and organization of spatial and non-spatial data for helping efficiently the decision makers and planners. It obviously provides a mapping tool for the relationships between school's distribution and school's age population of the populated areas [8]. GIS can be considered as an important tool for planning and managing the accessibility of the educational schools.

The potentials of GIS technology can be found in database creation and design in comparison with the manual approach. GIS links non spatial and spatial data so that statistical data can be presented not only as graphs and tables but also as a map, which help the user to look for spatial patterns. Geographic and location analysis is made easier by using GIS. GIS and school mapping of supporting the decision will make it very important for ministries of education and educational facilities regarding planning purposes [9].

Digital maps comprise the most effective tool for presenting digital spatial data. The map could be in general as an image map, a line map or a point map. Depending on the purpose, when the map is prepared for serving a specific purpose, then a line map or point map may be preferred [10].

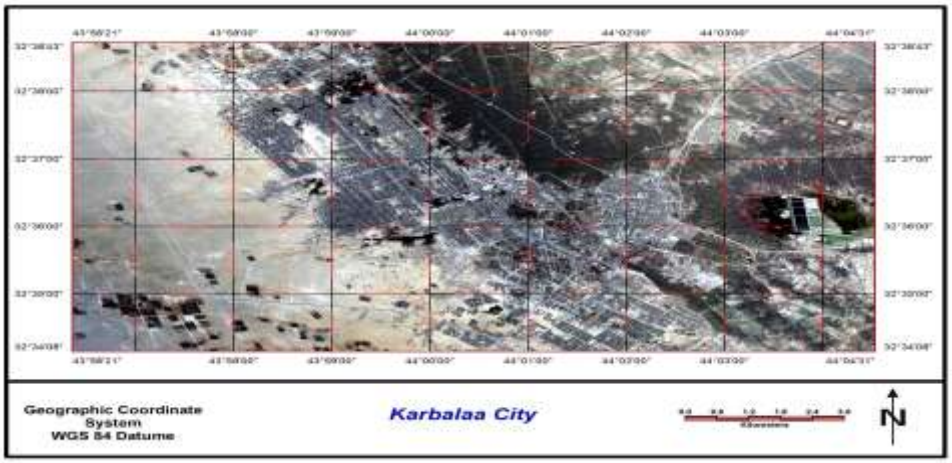
Spatial autocorrelation is the relationship between spatial distributions with values at certain locations and values at other locations. Spatial cluster is positive or negative spatial autocorrelation, positive when similar values are spatially clustered, while negative when the distribution of similar values is dispersed from each other [10].

Objective of the research

The objective of this paper is to create a database for the study area showing how the attribute in education system (Such as data of schools, teachers and pupils) connects to spatial data (such as the location of schools and boundary of districts), creating digital map shows primary school's locations, and using nearest neighbor analyzer statistical tool for determining their spatial distribution patterns. Using GIS will help us to analyze the present situation of educational service distribution, and to assist a decision maker for taking the right position of primary schools, as well as to be sure that the equitable distribution of educational services will be done for all districts.

Study Area

Karbala city is located in the middle of Iraq about 110Km south west Baghdad, as shown in figure 1. It is located between latitude 32N to latitude 33N and longitude 43E to longitude 44E. Average elevation is about 36m above mean sea level. Karbala city includes three provinces which are center of Karbala, Hendiah, and Ean tamer. Karbala city consists of 24 neighborhoods with area about 40 Km square, and its population is about 385000 (estimates of year 2009) with an annual growth rate of 3%. Karbala city has seen in last two decades a great incensement in urbanization as a result of the annual increase in population and migration to it. This increase in population was not accompanied by appropriate educational services for population with approved criteria. Kabala government includes urban and rural areas. There are over 196 primary schools within Karbala government, 100% of primary schools in urban areas work double shifts. The number of boys is 26316 with age between (6-11) years, and the number of girls is 20844 with age between (6-11) years. For Karbala city (ministry of planning, 2014) assigned the ratio of the primary school teachers about 19-25 pupils per teacher.



Figure(1) satellite image of Holy Karbala city (captured in٢٠١٣, 3bands, resolution 0.46m, Geo Eye 1).

The importa

Primary ed it plays an important rol he care of pupils, espec university education int n is very important at hich were classified by nstruction in 1982[11, 1

Dist	
Dist	

Methodology

In this pape tained by applying spatial and statistical analysis applications of GIS in order to identify the differences of the locations of the primary schools and their relationship with the population for the age group served (6-11) and their need of primary education services. Furthermore, its easy access to those schools and calculates average nearest neighbored and auto correlation (Moran factor) for schools. Figure 2 shows the research methodology.

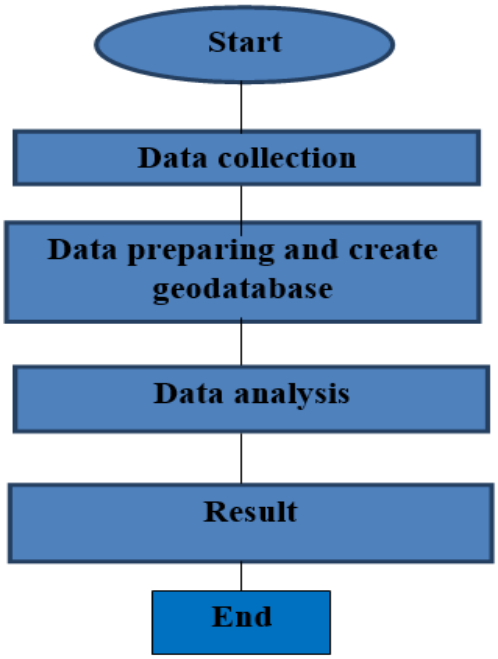


Figure (2) Block diagram

Data collection

The required data is compiled. It is included spatial and descriptive data from several different places:

1.(Ministry of Education ,2014), collecting needed data on existing primary school's location and descriptive data about primary schools such as (school name, ID, number of pupils, number of classes, number of teachers ,dependency of school: origin or host, schools type :for boys or girls, environment of school: urban or rural).

2. (Ministry of Planning and Statics),collecting data about population density for several years distributed to districts in Karbala city (2009), the proportion of the annual population growth and Karbala's population estimates by age group (٢٠١٤).

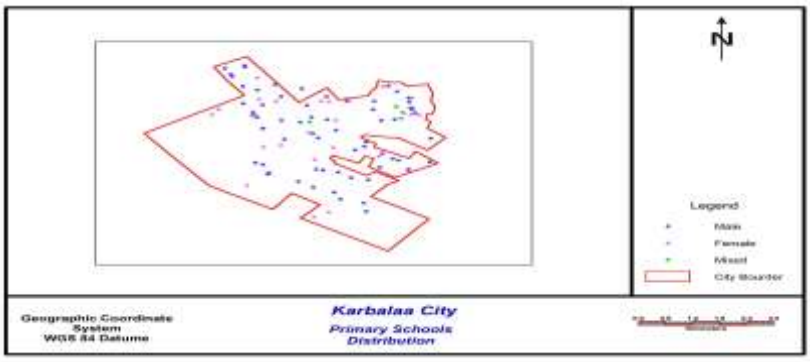
3. (Ministry of Planning and Statics, 2014), shape file states the boundary of Karbala city and districts which are 24 districts within center of Karbala.

Data preparing and creation geodatabase

This stage includes data processing, coding and data entry, and dropping data collected on digital maps and tables to accomplish an analysis the data by using ArcGIS9.3 software:

Selection of primary school in study area

This step involves processing data of the primary schools to determine the location of the schools that are located within the study area and excluded the schools locating out of the study area. GIS software has the ability to choose the part of the data, depending on the geographical location as shown in the figure 3.



Figure(3) primary schools within study area

Consequently, the output of this process concludes that there are 78 primary schools buildings in double shifted located within the study area. These buildings have been divided into 38 buildings for male's primary schools, and 40 buildings for original female's primary schools. Table 2 represents the result of spatial distribution of original primary schools in each district within study area by using Arc GIS 9.3 software.

Table (2) distribution of original primary school in each district within study area

District no.	Total no. of primary school per district	No. of boys original primary school per district	No. of girls original primary school per district
1	1	1	0
2	0	0	0
3	2	1	0
4	3	2	1
5	3	3	0
6	3	1	1
7	1	1	0
8	0	0	0
9	5	3	2
10	4	2	2
11	1	0	1
12	3	1	2
13	3	1	1
14	0	0	0
15	8	4	4
16	8	2	4
17	8	3	4
18	4	2	2
19	9	6	3
20	6	1	5
21	0	0	0

22	3	2	1
23	4	1	3
24	8	4	2

Processing population data

A population has considered age groups (0-80) for 2014 based on the following equation [1] by using 2009 population. Eq. 1 has used to determine the number of population for 2014, as well as to estimate the number of males and females within the age (6-11) for 2014 in each sector.

$$population\,1 = population0 \times e^{(t \times g)}$$

Population1:no. of population in target year
Population 0: no. population in basic year
t: difference in years between target and basic year
g: growth annual ratio …[1]

Table (3) number of boy and girl (6-11) in each district

District no.	Population 2009	Population 2014	Boy (6-11)	Girl (6-11)
1	34845	40484	2606	2104
2	13839	16079	1035	835
3	18881	21937	1412	1140
4	39272	45528	2937	2372
5	23952	27828	1791	1446
6	17623	20475	1318	1064
7	16970	19716	1269	1025
8	18335	21302	1371	1107
9	14465	16806	1081	873
10	8020	9318	599	484
11	14483	16827	1083	874
12	27965	32491	2091	1689
13	16445	19106	1229	993
14	18373	21346	1374	1109
15	4400	5112	329	265
16	4422	6751	1023	630
17	6753	7846	505	407
18	636	739	47	380
19	9314	8017	251	203
20	17382	20195	1300	1049
21	6243	7253	466	377
22	3371	3917	252	203
23	616	716	46	37
24	3478	5940	900	80

Creating of Geodatabase

Developing integrated geospatial database will be done by linking spatial data to non-spatial data and then entering it to geographical database (Arc Catalog). Various elements of spatial database will properly be linked with their corresponding attributes. Thus, the attribute data which

is in tabular format, as previously presented in table 3, has to be integrated with the district map of Karbala city by connecting these tables with thematic layer. Then use the order (join data from

another layer based on spatial location) to add a non-spatial data like (total number of pupils of all schools in district, number of schools in district) of boy primary schools layer and girl primary schools layer to district layer [14]. Generating the integrated geospatial database for the proposed study area will be done under GIS environment.

Data analysis

The study area consists of 24 sectors. The original primary schools of boys' and girls' have distributed in each sector as shown in Figure 5a, b. Spatial and statistical analysis have accomplished for the educational facilities of the primary schools of each sector of the study area. The spatial and statistical analysis have accomplished by using Arc GIS9.3 software

Statistical analysis

The statistical analysis is database analysis process by which the numbers of the boys' primary schools and girls' primary schools have been accounted. Table 4, shows the actual numbers of the boys' primary schools and girls' primary schools in each sector of the study area and suggests the need of these schools of each sector in the study area.

Table (4) number of actual and needs of primary schools

No. district	No. boy primary schools	Needs of boy primary schools	No. girl primary schools	Needs of girl primary schools
1	1	5	0	4
2	0	2	0	2
3	1	2	0	2
4	2	6	1	5
5	3	3	0	3
6	1	3	1	2
7	1	2	0	2
8	0	3	0	2
9	3	2	2	2
10	2	1	2	1
11	0	2	1	2
12	1	4	2	3
13	1	2	1	2
14	0	3	0	2
15	4	1	4	1
16	2	2	4	1
17	3	1	4	1
18	2	1	2	1
19	6	1	3	1
20	1	3	5	2
21	0	1	0	1
22	2	1	1	1
23	1	1	3	1
24	4	2	2	1

Spatial Analysis

Analysis of the spatial data such as distribution style using the Spatial Statistics tools (Spatial Analyst and Analysis Tools), nearest neighbor and correlation (Moran) using the pattern analysis from the spatial statistics and calculate accessibility indicator using buffer. All these techniques are available in ArcMap9.3 software.

Distribution style

Measuring the degree of dispersed of features with respect to the geometric mean center will be done by using standard distance tool which is a useful statistical technique provides a unique summary measurement for the distribution of the features around their center (i.e., similar to standard deviation measurement) [15]. Figure 5 shows 68% of primary schools are within circle of standard deviation.

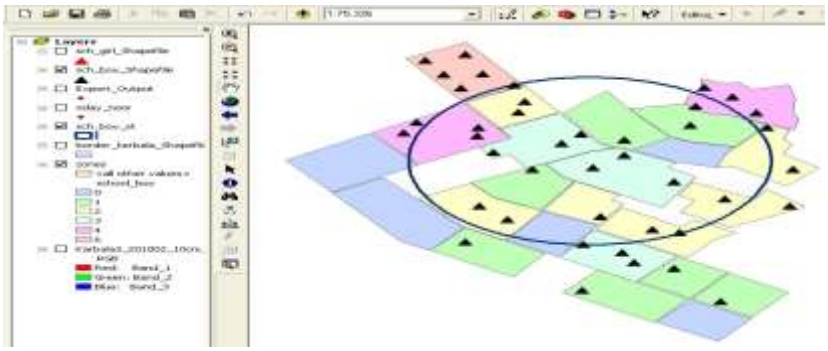


Figure (5): Standard distance of primary schools

Directional distribution (standard deviation ellipse) tool has the ability of measuring whether a distribution of features shows a directional tendency (whether features are far away from a specified point in one direction than another direction). The ellipse is indicated for the standard deviational ellipse since the method determines the standard deviation of the x-coordinates and y-coordinates from the mean center to define the axes of the ellipse. The ellipse permits for seeing whether the distribution of features is expanded and hence has a particular orientation [15]. Figure 6 shows the primary schools take north- west directional.

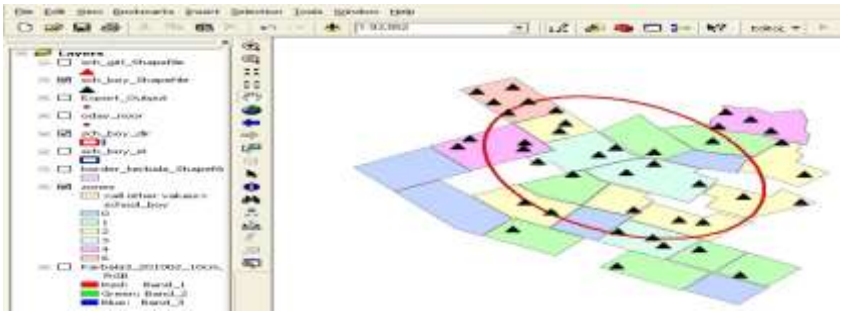
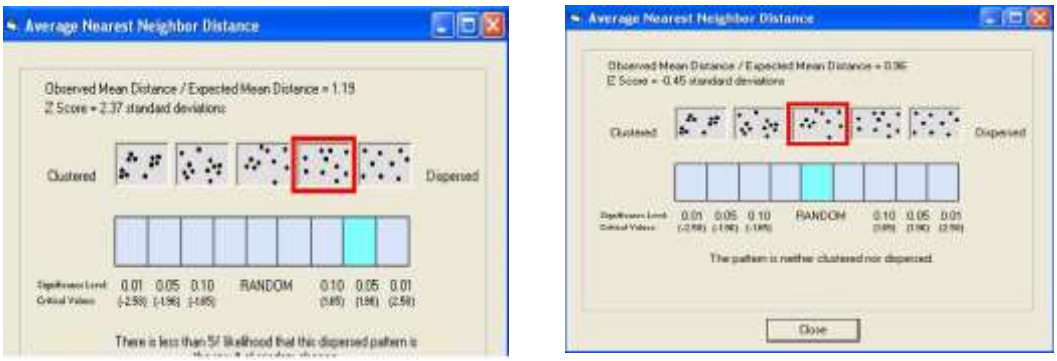


Figure (6): directional distribution of primary schools, a) Boys. b) Girls

Analyzing patterns

Measuring the distance between each feature centroid and its nearest neighbor's centroid is done by using Average nearest Neighbor Distance tool. These tools then will averaging all these nearest neighbor distances [15]. ArcGIS 9.3 has been used for analyzing the nearest neighbor by using the spatial statistics from its toolbox by selecting the Average nearest Neighbor. Figure 7a, b show analysis of the nearest neighbor of boy's primary schools, and analysis of the nearest neighbor of girl's primary schools and table 5 shows the results of nearest neighbor analysis



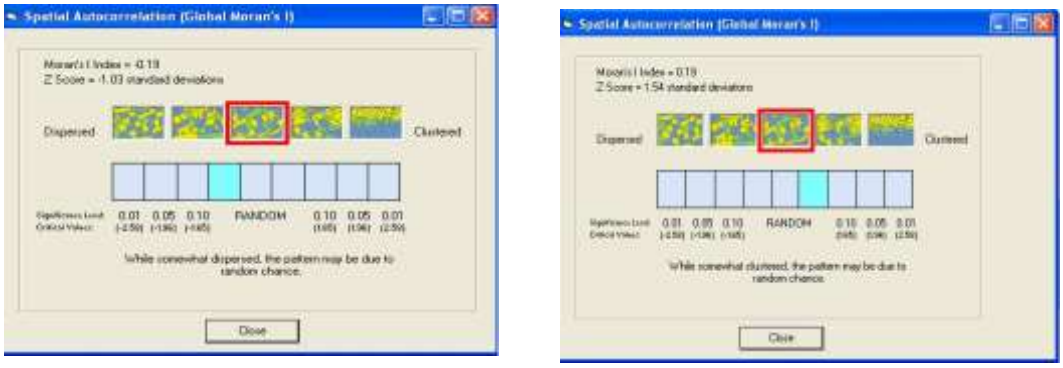
(a) **(b)**

Figure (7): Average nearest neighbor, a) boys. b) Girls

Table (5) results of nearest neighbor analysis

Nearest neighbor results	Boys primary schools	Girls primary schools
Distribution type	dispersed	Random
Nearest neighbor ratio	1.19	0.96
significant level	0.05	
critical value	1.96	
Z source	2.37	0.45

Spatial autocorrelation tool measures the spatial autocorrelation based on feature locations and attribute values. A set of features and their associated attribute will be provided, by evaluating whether the expressed pattern is clustered, dispersed, or random. This tool determines Moran's I Index value [15]. The feature class for which auto correlation will be calculated is primary schools layer and numeric field used is number of pupils. Figure 8 a, b show auto correlation analysis for boy's primary schools, girl's primary schools. Table 6 shows the auto correlation analysis results.



(a) **(b)**

Figure 8: auto correlation analysis, a) boys. b) girls

Table 6, auto correlation results

Results	Boys primary schools	Girls primary schools
Distribution type	random	Random
Moran index	0.19	0.19
Z source	1.03	1.54

Calculate Accessibility Indicator

Calculate Accessibility Indicator provides information about the actual distribution of primary schools in study area depending on accessibility which is the distance between the residence and the primary school.

The area of the occupied residence has computed within 500 of the arrival distance to the primary schools for each sector. Then the rate between the residential area, which the Calculate Accessibility Indicator has achieved, and the total area of the residential sector, as shown in the followed formula:

Calculate Accessibility Indicator = residential area, which the Calculate Accessibility Indicator has achieved/ total area of the residential sector

Table (7) Accessibility Indicator results

No. district	Area of district m2	Accessible percentage of boys primary schools	Accessible percentage of girls primary schools
1	1842788	55%	0
2	1144706	0	0
3	836771	44%	0
4	1462502	77%	24%
5	1520492	87%	0
6	1522727	28%	18%
7	1641838	37%	0
8	1610623	0	0
9	1508553	52%	43%
10	895327	67%	40%
11	1606836	0	33%
12	1606836	34%	26%
13	1898093	23%	62%
14	1142447	0	0
15	1377333	74%	35%
16	2353633	48%	76%
17	1690398	65%	69%
18	16226497	83%	26%
19	1136604	100%	55%
20	1556692	33%	78%
21	1063472	0	0
22	1652672	45%	18%
23	1242365	55%	34%
24	1122601	85%	42%

DISCUSSION

The results of this research includes two parts: The first part of the results is the results of the statistical analysis that found there is a lack of the educational services of the primary schools for the study area about 31 boys schools and 30 girls schools of the all residential sectors within the city of Karbala. The statistical analysis results also found there are 6 sectors have increase in the boys' schools, and other 7 sectors have increase in the girls' schools. The statistical analysis results found only two sectors are perfect (organized well).

The second type of the results is the results of the spatial analysis. The spatial analysis results showed that the distribution of the boys' schools was divergent with value of 1.19 while the distribution of the girls' schools was random with value of 0.96, based on the analysis of the link neighborhood. Moran analysis showed the random distribution of the schools and its relationship with the residences having age between (6-11) years with value of 0.19. The Calculate Accessibility Indicator's results showed there is a lack in achieving the Accessibility Indicator of most of the residential sectors.

CONCLUSIONS

In this paper, a proposed geo data base is created to include all the data. The data was collected from Ministry of education and Ministry of Planning and Statics after processed it. The processed data consists of two steps; the first step is selecting only the primary schools in study area (78

schools) that run double shift , then separate them to 40 original boys primary and 38original girls primary schools. The second step is processing population data to calculate the population 2014 and population boys and girls with age (6-11)year 2014 in study area. Statically and spatially analysis by Arc GIS 9.3 were used. Statically analysis showed that there is an argent need to 31 boys' primary schools and 30 girl's primary schools within study area. The tool of analysis (standard distance, directional distribution, nearest neighbor, auto correlation Moran, and accessibility indicator) are used for analyzing patterns of distribution. The results show the value of 1.19 for boys' schools which is dispersed, 0.96 for girls' schools which is random. The auto correlations indicated value of 0.19 which is random for both boys and girls schools and accessibility indicator shows a great limitation.

REFERENCES

[1] Nigig, M., Musiega, D. and Mulefu, F.," Planning and Analysis Educational Facilities using GIS", conference.AGSE, July 2012.

[2] Geographic information system, Wikipedia, the free encyclopedia. 16-Feb-2015.

[3] Burrough, P. A. and McDonnell, R. A., "Principles of Geographic Information Systems," 2nd Ed., 2Rev Ed edition. Oxford; New York: OUP Oxford, 1998.

[4] Attfield, I., Tamiru, M., and Parolin, B., "Improving Micro-Planning in Education through a Geographical Information System: Studies on Ethiopia and Palestine,"published by International Institute for Educational Planning, UNESCO, December 2001.

[5] Kong, F., Yin, H., and Nakagoshi ,N., "Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China, Land scape and Urban Planning", vol. 79 , no. 3–4, pp. 240–252, Mar 2007.

[6] Shah, T. I., Bell, S., and Elahi, M., "School mapping in education micro-planning: a case study of Union Council Chak 84/15L, District Khanewal, Pakistan", vol.14, ISSN1911-5814, 2008.

[7] Maguire, D. J., Goodchild, M. F. and Rhind, D. W., "Geo- graphical Information Systems: Principles and Applica- tions," Longman, Harlow, 1991.

[8] Hite, S. J., "GIS-Generated School Mapping Materials of Two Counties in Hungary Prepared for Françoise Cail- lods. International Institute for Educational Planning", Paris, 2006.

[9] ERAY, O., "Application of Geographic Information System (GIS) in Education". Journal of Technical Science and Technologies, 1(2):53-58, ISSN: 2298-0032, 2012.

[10] Aliyu, A., Shahidah, M.A.,and Aliyu, R.M. , "Mapping and Spatial Distribution of Post Primary Schools in Yola North Local Government Area of Adamawa State, Nigeria," International Journal of Science and Technology Volume 2 No. 5, ,ISSN 2049-7318, May 2013.

[11] Amuyunzu, C.L and Bijl, B.C, "Integration of Remote Sensing and GIS for management, decision support in protected areas FUTY, "Journal of the Environment, Volume 1, NO. 1, 1999.

[12] Ali, H.,"Urban evaluation of educational and health services in Najif city'', MSc. Thesis. University of technology, 2011.

[13] Jasim, F.,"Spatial analysis of educational facilities using GIS". Deploma in urban planning. University of Baghdad, 2009.

[14] ALshawi, H., Evaluation of secondary schools educational service in holy Karbala city, using geographic information systems techniques", M.Sc. thesis. University of Technology, 2015.

[15] Mitchell, Andy. The ESRI Guide to GIS Analysis, Volume 2. ESRI Press, 2005.

.