Evaluation of School Buildings in Basrah using Geographic Information Systems and Artificial Neural Networks

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ABSTRACT
Education services are a basic requirement in any community for they have the responsibility to develop and promote communities. They are one cornerstone of life and a strong pillar of civilization. The current study aims to evaluate the locations of public school buildings in Basra City (at the south Iraq) using the integration of Geographic Information Systems (GIS) and Artificial Neural Networks(ANN), thus adopting a set of planning standards. Thus classified school buildings into classes ranged from (3-5) depending on the degree of conformity of every study stage where the percentages differed (0.69% rejected, 52.09% unsuitable, 36.36% acceptable, and 9.99% suitable and 1.74 good. This could be attributed to the random selection and bad planning of these locations which, in turn, shows that there is a failure in the plans of developing education services in the city. That is why the study recommends adopting modern technologies to contribute effectively to raising the efficiency of urban planning processes and improve the performance of the planning process in and decision-making to provide the best community services for residents of Basra, including education.

General Terms
Back propagation Algorithm, spatial analysis, modelling, evaluation Natural Breaks , classification

Keywords
ANN, GIS, Model, Geo_DB, location, data set.

1. INTRODUCTION [1, 2]
Planners describe the current era as the era of information, revolution and great technologies. The implications of such progress include various planning processes such as computer design, information systems, databases and remote sensing techniques, through which data can be collected, transferred and analyzed for many areas that require speed and accuracy when taking decisions. In view of the enormous urban development and the resulting problems such as the random increase in growth rates and lack of natural resources, as well as the random urban expansion, these and other reasons led to move from the work with tools and traditional analytical methods to the adoption of modern techniques at all stages of the planning process. Hence, GIS technologies and artificial intelligence, such as neural networks, are among the most important technologies adopted in the field of land use planning for their ability to represent real spatial data and computerized processing on spatial databases, which helps planners and decision makers to achieve the optimal planning of the city in line with future requirements. The importance of the study lies in the use of spatial modeling of school buildings locationsandtheir integration with neural network technology for the purpose of evaluation and recognition of the level of efficiency of use. More specifically, it aims to evaluate the locations of the school buildings in Basra by adopting the integrated approach between GIS and Neural

2. STUDY AREA [3, 4]
The city of Basra is located at the south of Iraq along the (east) meridians (47^0 44′ 47" 47^0 52′ 8") and the (north) longitudes (30^0 26′ 2″ 30^0 34′ 46″). It has a total area of 107 km^2. Its population is (1377104) according to the estimates of (2016). It is divided into (55) districts distributed among six administrative sectors. Figure (1) shows its residential quarters.

3. PLANNING STANDARDS [5, 6, 7]
The process of urban planning for the uses of the educational land is subject to a set of standards, so it has been adopted for the purpose of matching and evaluation. Four planning standards were chosen to evaluate the location of government school buildings in Basra. These are:

1. *Distance to Main Street*: This is the distance between the school and the main street. This distance varies according to the educational stages (kindergarten, primary, intermediate, high school). For example, primary schools need to move away from the main street by no less than 150 m while this distance is lower in intermediate schools where it reaches 100 m and so for the rest of the educational stages.

2. *Area*: This refers to the area allocated for each building. It varies according to study stages. For example, intermediate schools need an area of no less than (10000) m^2 and the primary schools need to have areas no less than (5000) m^2 and so for the rest of the other stages.

3. *Distance to Risk*: Petrol stations were regarded as dangerous places in the study area. School locations should be far from them in certain areas for the safety of pupils.

4. *Distance between Schools*: All schools are subject to distribution system that adopts certain distances between one school and another for the same school stages. For example, the planning standard sets the distance of (500m) among primary schools and (750m) among intermediate schools and so on for the rest of the schools. Table (1) illustrates these standards.

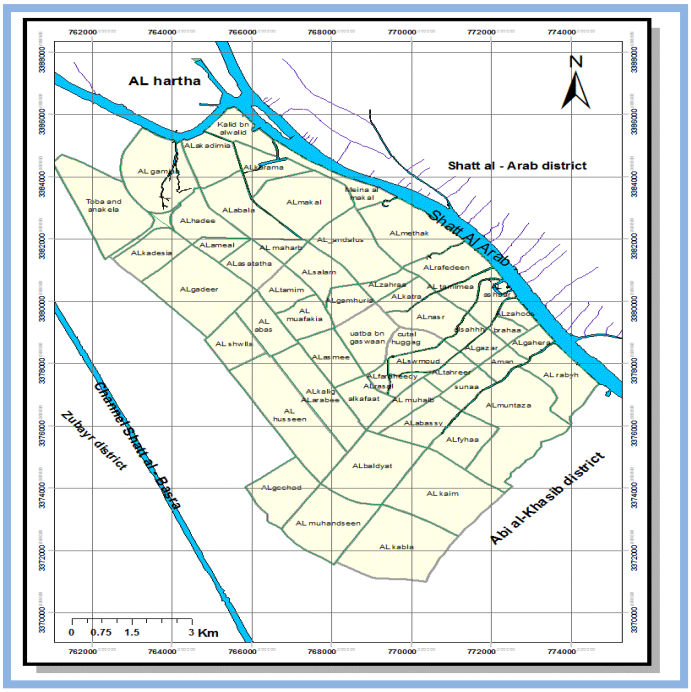

Figure (1) : Residential Quarters in Basr

Table 1. Approved Local Planning Standards adopted in the Present Study[1,10]

No	service	Local standard			
		Distance to main street/ m	Distance between schools/m	Distance to petrol station/m	Area/m^2
1	Kindergarten	150	500	100	3000-3500
2	Primary school	150	500	100	5000-7000
3	Intermediate school	100	750	100	8000-10000
4	High school	100	1500	100	10000-15000

4. GEOGRAPHIC INFORMATION SYSTEMS (GIS) [8, 9, 10, 11]

Geographic Information System (GIS) is defined as a computerized technology that is highly capable of building analytical models for processing spatial data. It combines information systems, databases, and visualization maps. Moreover, it is characterized by its high efficiency in geo-statistical analysis and the production of (two- and three-dimensional) maps, through the management of spatial data and representation of different-layer shapes depending on the nature of the studied parameters in addition to many other features. The layers in the geographic information system GIS software plays an important role in urban planning process because it has a high capacity to deal with different types of data to facilitate decision making and help in the completion of projects. Therefore, their use has become an indispensable necessity in facilitating urban land planning and can be used in different fields, such as crime management, crisis and disaster management, urban planning, environmental protection, positioning and others.

5. ARTIFICIAL NEURAL NETWORKS (ANN) [8, 9, 12, 13]

Artificial neural network (ANN) is one of the techniques of artificial intelligence, which can be defined as a mathematical software attempt used to simulate the biological cells in the human brain. It consists of a related set of processing elements in a form of units or nodes called neurons that are connected to each other by a set of associative weights used to determine the activity of the network as a whole, called links

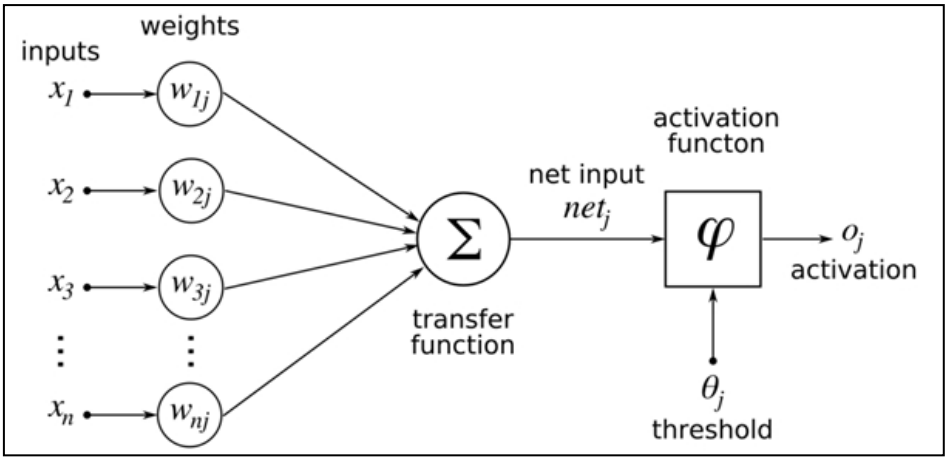

Figure (2): Neural Network Components [12]

each link has its own weight. Every processing element receives the stimulation from the adjacent elements that are connected to it to process data and produces different outputs. Theneurons aredivided, according to the nature of their work, into three types(input neurons receive stimulation from outside the net, output neurons produce outputs, and hidden neurons receive stimulation from the other elements inside the net and stimulate other processing elements).Neural networks derive their power from distributed parallel structures. The nodes connected to each other in parallel way perform several functions at the same time. This is what is called parallel processing. Besides, these nodes have the ability to educate in different ways: supervised, unsupervised, and education through re information. They are also characterized by generalization. The neural networks are divided into different types according to their structure, including the front and back feeding systems. They may be one-layeror multi-layer. They use different types of activation function such as step function and sign function. They have been successfully used in various biologic, medical, economic, environmental and land-use planning applications, etc. Figure (2) illustrates a model artificial neural network.[10,11,14]

6. APPLICATION MECHANISM

The work mechanism included three complementary stages applied to the study data, as follows:

6.1 First Stage: Building a Spatial Information System

The first stage included several steps that can be clarified as follows:

6.1.1 Data Collection

Preliminary data are the basis of the design, analysis and spatial processing processes to obtain more accurate results. They were reflected on both the 2013 Baseline Design map and the Satellite Image of Basrah. The coordinates of school buildings for all stages were recorded. The coordinates of petrol stations and other detailed data were inferred using spatial analysis model applied to the basic design map, which is available in a single layer, which includes all the uses of the urban land in the study area to be divided and to isolate the services from each other and compare what is related to the current study data with obtained preliminary data to examine their correctness.

6.1.2 Building the Geographic Database

The Geo-DB is a basic requirement for anyinformation system. Therefore, the data of the present study were organized into different data sets for the implementation of spatial analysis as follows:

A. Data set1: includes four categories of feature classes including school buildings according to educational stages (kindergartens, primary, intermediate, and secondary).

B. Data set2: includes feature classes (main streets, petrol stations, residential quarter's boundaries).

C.Data set3: includes three categories of landmarks (Shatt al-Arab, channel of Shatt al-Basra, the city limits).

It should be noted that structuring the database in this way helps to facilitate spatial processing and implementation of spatial relations between layers of different landmarks

6.1.3 Building an Analytical Model [14]

The GIS environment provides the possibility of working analytical models to simulate the work of tools and to facilitate access to them to save time. There are several advantages for using the constructor of models, such as putting any number of repetitions ina single process, facilitating access to the tools when the outputs of a single process is used as an input to another process, exporting software scripts to other work environments, adding output data as parameters of models on the map. This helps the user to execute the workflow by adding toolbars, input groups and output together in a single graphical environment. That is why the proposed model is designed to conduct a series of processes on the spatial database represented in a schematic diagram to facilitate the execution of processes. Figure (3) illustrates the structure of the model used in the spatial analysis of the current study.

The approved tools for building the model are clarified below:

1. Make XY Event Tool: This tool provides the possibility to add coordinates data from an external file and assign the values of both latitude and longitude (X, Y) to the changes (X, Y) of this tool to projection the coordinates of the school locations on their real places in the study area.

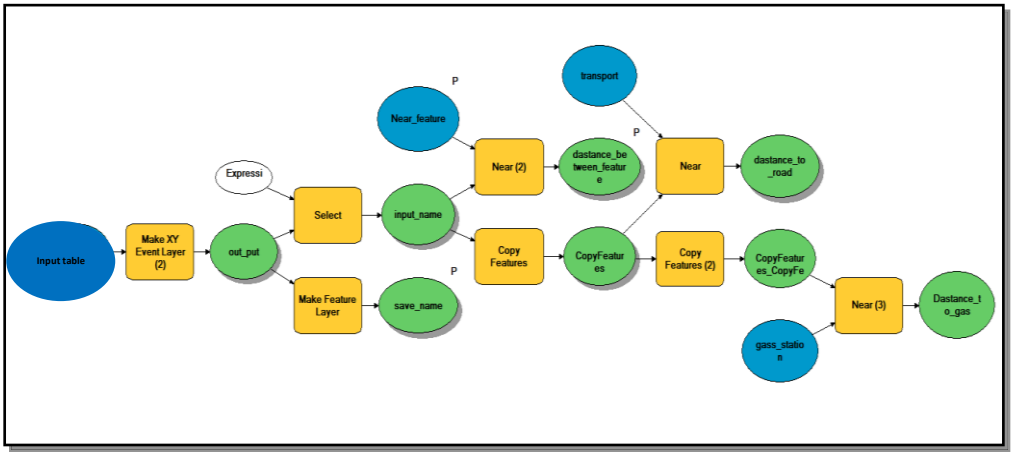

Figure (3): The Proposed Analytical Model in the Spatial Analysis of School Buildings Locations

2. Make Feature Layer Tool: This tool is used to convert the output of the previous tool (building locations) into a separate layer.
3. Copy Feature Tool: This tool is used to copy the required landmarks for analysis and processing.
4. Select Tool: This tool is used to select landmarks according to specific conditions. This is called conditional spatial query.
5. Near tool: - This tool is used to calculate the distance between the studied landmarks to match the results with the specified standards.

6.2 Second Stage: Design of Artificial Neural Network

The neural network for evaluating school building locations consists of three layers: the input layer, which consists of four nodes representing the neural network inputs, a hidden layer containing initially 30 nodes and one output layer. The neural network was trained by a training matrix consisting of [4 * 120] patterns and an output matrix consisting of [1 * 120] of patterns. The weights were stabilized after noting that the learning coefficient selection 0.05 and the permissible fault value of 0.005 and the choice of thirty hidden nodes in the medium layer that gives the best results. Figure (4) shows a simplified model of the neural network structure. Figure (5) shows the comparison of the actual output with the desired output of the training data. We observe the relative compatibility of the real output of the network with the desired outpu where we can see the relative conformity of the two outputs. The neural network was then tested by output data of school buildings to evaluate them.

6.3 Third Stage: Classification [4]

The classification is one of the most important and most common spatial analyses. It provides a clear explanation of the nature of the studied landmarks and their representation in special maps to determine their optimal uses. Geographic information systems (GIS) provide different classification methods that depend on two factors (number of layers and type of classification required). Natural Breaks represent a standard classification method, providing data types according to the concept of clustering and gaps in it. This is based on natural herarical data setsand in our present study it representsthe neural network ratings which determined conformity to the approved planning criteria.One of the advantage of this method is that any update of the data does not affect its performance, as well as the possibility of control on (number of classes, the exclusion of some spatial features in the layers, change of color totals, rearrangement layers and others).

7. DISCUSSION OF RESULTS

The results of the integration of GIS outputs with the neural network of the current study data showed a set of results presented for discussion as follows:

7.1 Kindergarten Stage

It was found that (2) of the school buildings were evaluated (0.23884) of the total (30) buildings or (6.66%) and 16 school buildings obtained an evaluation of (0.50421) which represents (53.33%), while 10 buildings were evaluated (0.7398) which means that they represent (33.33%) of the total buildings, and only two buildings were evaluated (0.965) or (6.66%). This means that only two buildings have met the criteria which are(Themar Al-Qulub in Shu'la and Ahbab Rahman in Al-Hussein Qurter) and 10 of the buildings have met three planning standards and 16 of the buildings have met two of the standards but the remaining buildings, which are (2), met only one stand as shown in Table (2).

7.2 Primary School Stage

It was noticed that one building out of (173) buildings obtained the evaluation (0.02565) by (0.57%) and(98) buildings obtained (0.2388), which is (56.64%), while 62 school buildings obtained (0.493429), which represents (35.83%) of the total buildings, and (10) of the buildings obtained (0.7398) , i.e. (5.78%) of the total buildings, and only two buildings obtained (0.96517) which represents (1.1 %) of the school buildings, indicating that one building did not meet any approved planning standards and that 98 of the buildings had met one planning standard and that (62) of the school buildings had met two planning standardand (10) of them had met three planning standards and only (2) have got perfect matching which are (Al-Nashi'a School in Abellah and Al-Sahabi in Al-Ma'qal) as shown in Table (2).

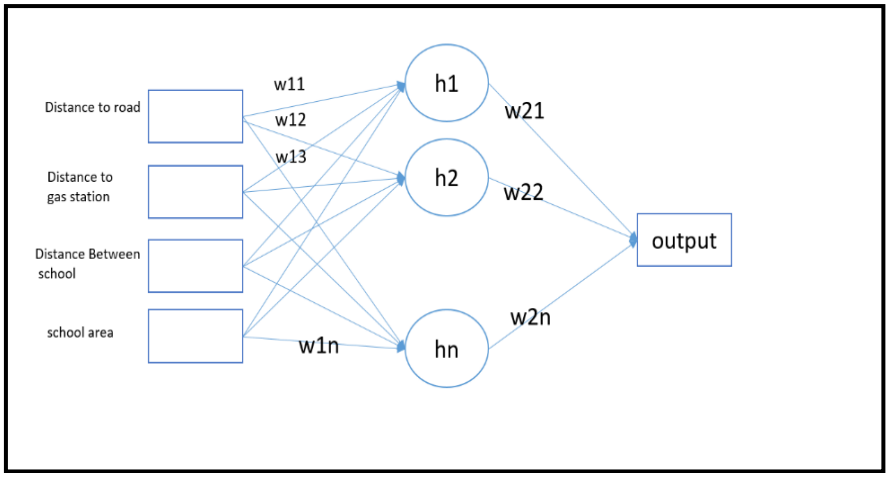

Figure (4): Architectural Structure of the Proposed Neural Network

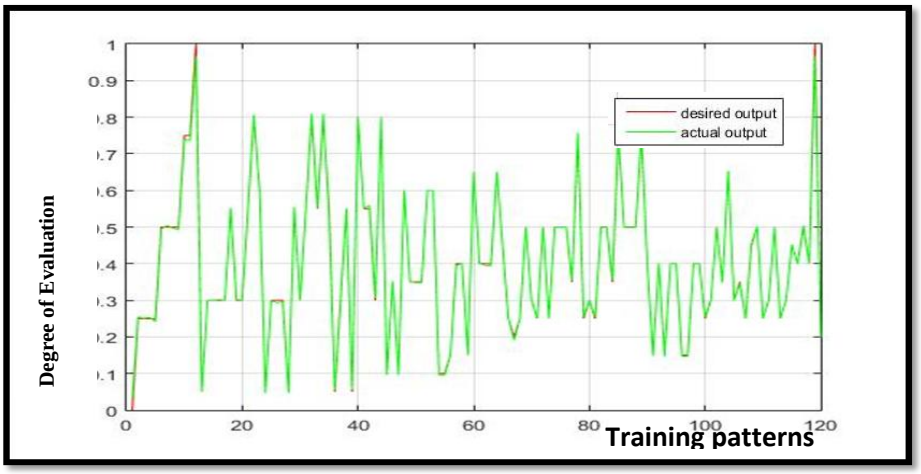

Figure (5): Comparison of the Actual Output with the Desire

7.3 Intermediate School Stage

It was found that only one building obtained the evaluation (0.0256) and (2.4%) of the total number of school buildings which is (41) and(21) buildings obtained (0.2388) or (51.2%), while we can see that (14) buildings were evaluated (0.4667), which represents (34.1%) of the total buildings, and (4) of them obtained the evaluation (0.7398) or (9.7%). Only one building has obtained (0.96517) which represents (2.4%). This indicates that one building did not meet any planning standard while (21) met one planning standard, (14)met twoplanning standards , (4)met three standards, and only one building had a perfect match which is Al-Jawaheri School in Al-Methaq Quarter as shown in Table (2).

7.4 High School Stage

It was found that (28) out of (42) buildings were evaluated by (0.23884) and (66.66%), and (12) buildings were evaluated (0.50421), or (28.57%) while only two buildings obtained The (0.7398) by (4.7%). As can be noticed in Table (2) , (28) of the buildings have met one planning standard and (12) of them have met two standards and only (2) have met three standard. Figure (6) outlines the results of the neural network evaluation of all stages

7.5 Classification

After noting the variation in the degree of conformity, the school buildings were classified into multiple categories. Table (3) shows the difference in the number of classes from one stage to another. We find them in kindergarten (4 classes) while (5 classes) in primary and intermediate but (only 3 classes) in high school. This was due to the difference in the degrees of confirmity between the results of the neural network and the approved planning standards. Based on this, school buildings of all stages can be classified in terms of conformity into five classes: (no conformity(rejected), conform to one standard(unsuitable), conform to two standards(acceptable), conform to three standards(suitable), perfect conformity(good)). Tabe (4) and Figure (7) show the number of school buildings and their perecntages where (rejected) class got (0.699%), unsuitable got (52.097%), acceptable got (36.36%), suitable got (9.090%) while (good) class got (1.748%). Appendix (1) / Figures (8, 9 10, 11) illustrate the classification categories.

Table 2. Percentage of Neural Network Results by Number of Buildings and Levels of Conformity to the Approved Standards for All Levels

NO	Stage	No. of Buldings	Results of Evalution	%	Level of confirmity
1	Kindergarten	2	0.23884	6.67	1
		16	0.50421	53.33	2
		10	0.7398	33.33	3
		2	0.965	6.67	4
2	Primary school	1	0.02565	0.58	0
		98	0.2388	56.65	1
		62	0.49343	35.84	2
		10	0.7398	5.78	3
		2	0.96517	1.16	4
3	Intermediate school	1	0.02565	2.43	0
		21	0.2388	51.21	1
		14	0.4667	34.14	2
		4	0.7398	9.75	3
		1	0.96517	2.43	4
4	High school	28	0.23884	66.66	1
		12	0.50421	28.57	2
		2	0.7398	4.76	3

Table 3. Classifications of School Buildings according to Degrees of Conformity for every stage

NO	Stage	Class	No. of Buildings	Value	Kind of class
1	Kindergarten	First	2	0.23884	unsuitable
		Second	16	0.50421	acceptable
		Third	10	0.7398	Suitable
		Fourth	2	0.965	good
2	Primary school	First	1	0.02565	rejected
		Second	98	0.2388	unsuitable
		Third	62	0.49343	acceptable
		Fourth	10	0.7398	Suitable
		Fifth	2	0.96517	good
3	Intermidiate school	First	1	0.02565	rejected
		Second	21	0.2388	unsuitable
		Third	14	0.4667	acceptable
		Fourth	4	0.7398	Suitable
		Fifth	1	0.96517	good
4	High school	First	28	0.23884	unsuitable
		Second	12	0.50421	acceptable
		Third	2	0.7398	Suitable

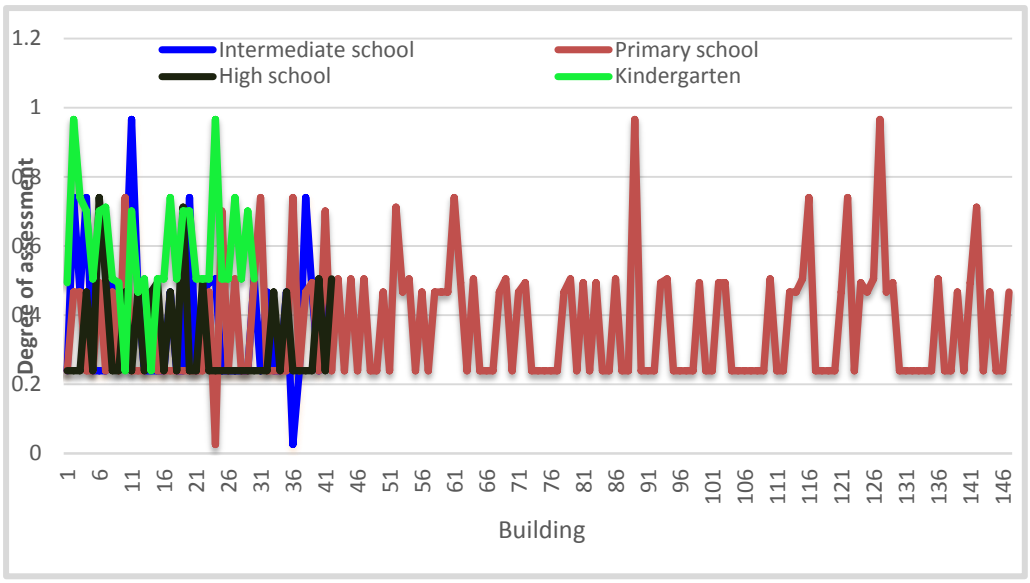

Figure (6): Results of the Neural Network Evaluation for the sites of the Educational Buildings according to Stage

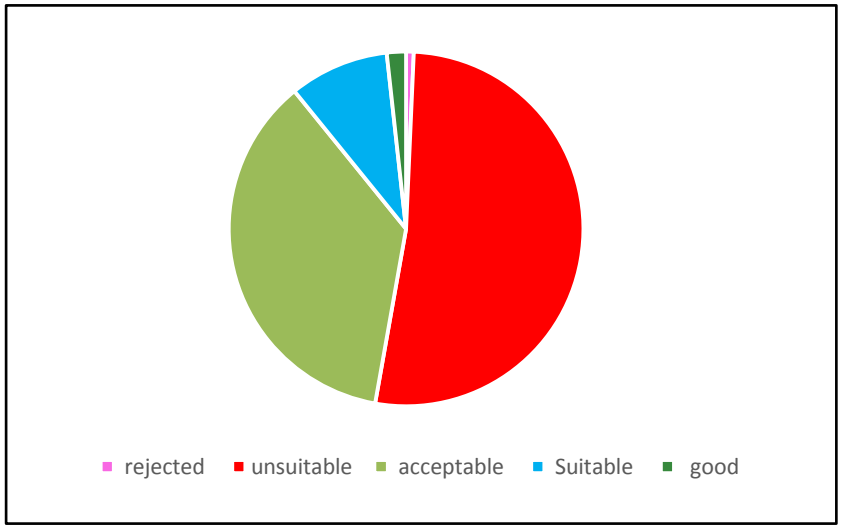

Figure (7): Classification of School Buildings according to to Kind of Approved Conformity of All Stages

8. CONCLUSION

Based on the above, it was concluded that:

1. There is a clear variation in the number of categories of classification of school buildings by stages, ranged between (3-5), and this difference is due to the discrepancy in conformity with standards which refers the bad distribution of school buildings and that mostof them aren't found in their correct sites or locations.
2. There is a clear discrepancy among the numbers of school buildings in terms of the kind of conformity of all stages where we can find that the majority of buildings have not obtained perfect conformity (good) and this can be attributed to random planning because there was no prior organisation to the management of educational services projects in the study area.

Therefore, the research recommends the following:

1. The need to adopt the planning standards for the management of educational services projects and commensurate with the rapid population growth and continuous urbanization in the city.
2. The need to carry on studies like the present one to evaluate all community services and city management that takes into consideration the requirements of continous progress.
3. The need to adopt modern techniques in the management of all urban planning projects to assist in the process of supporting decision and the possibility of future prediction of the actual need. Moreover, these techniques can proviode researchers and beneficiaries with detailed spatial databases on urban planning projects that can be updated constantly to find solutions to help solve the problems of failure in all community services and not only education.

Table 4. Percentages of the Classification of School buildings

Stage	No. of buildings	Percentage for kind of classes				
		Rejected	Unsuitable	Acceptable	Suitable	good
Kindegarten	30	-	2	16	10	2
Primary school	173	1	98	62	10	2
Intermidiate school	41	1	21	14	4	1
High school	42	-	28	12	2	-
total	286	2	149	104	26	5
percentage	-	0.699%	52.097 %	36.363 %	9.090 %	1.748

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10. APPENDIX

Appendix (1)

Classification of school Buildings of all study stages

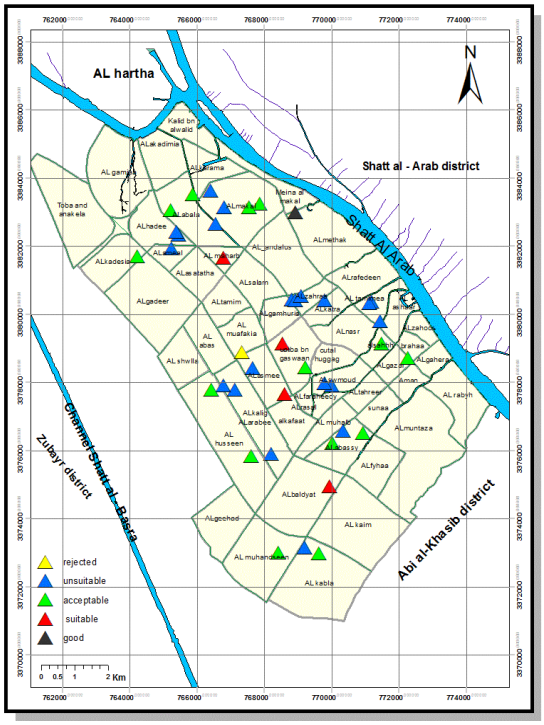

Figure (8): Classification of kindergartens building

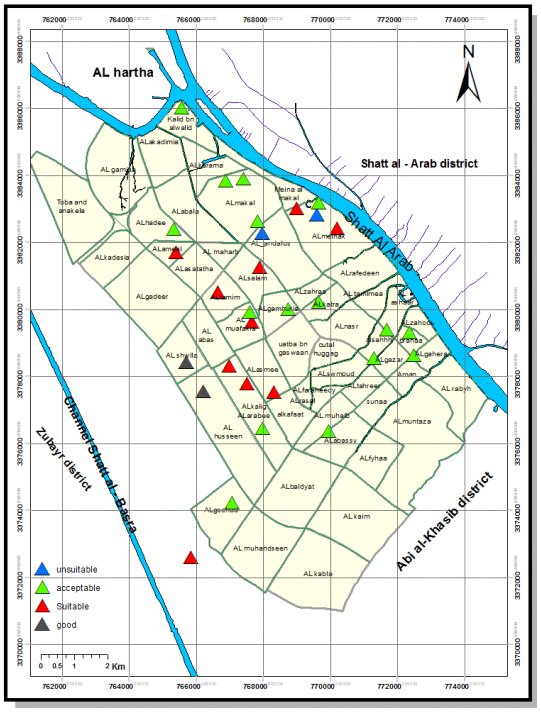

Figure (10) : Classification of Intermediate school buildings

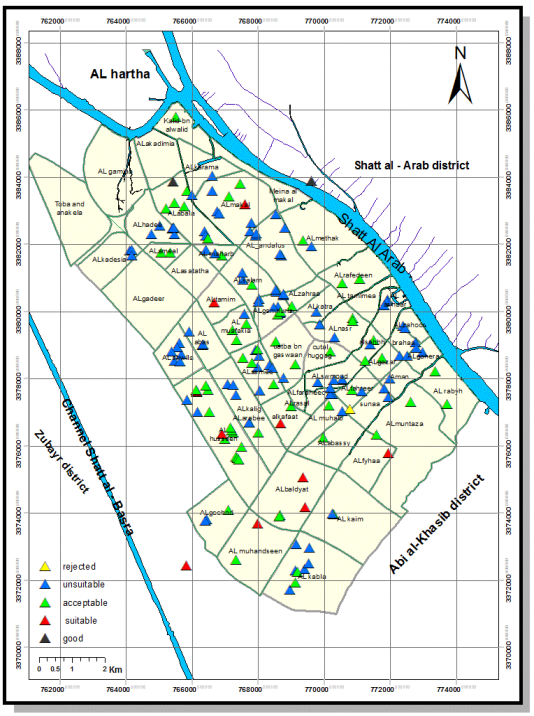

Figure (9) : Classification of primary school buildings

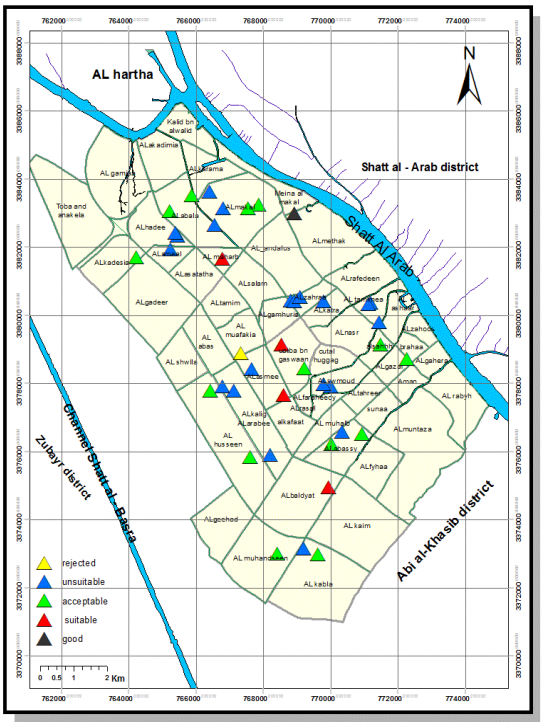

Figure (11) : Classification of High school buildings

Appendix (2) Results of Spatial Analysis and Nueral Network of all stages

Table 1 . Kindergarten stage

code	Longtitude (x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
1	767829.7	3382635	124.2524	380.6889	117.3731	4200	0.493429
2	765701.7	3378422	705.8539	998.9479	187.2743	4200	0.965179
3	768984.7	3383028	1025.311	645.5042	198.355	1300	0.739891
4	768307.9	3377535	1059.718	838.2013	119.3396	3000	0.700573
5	766872.7	3383852	1433.592	534.1011	23.97202	2000	0.504218
6	766637	3380516	1671.861	1113.77	22.84219	3600	0.700573
7	767641.7	3379632	534.8029	308.2473	242.7132	3600	0.712045
8	767402.6	3383919	1378.605	534.1011	104.4668	2000	0.504218
9	767587.8	3379936	785.2598	308.2473	80.71709	3600	0.493429
10	769598.9	3382829	1587.15	372.43	100.9536	1500	0.23885
11	765379.1	3381715	675.2793	689.7285	10.82347	3600	0.700573
12	769646.3	3383198	1707.032	372.43	200.9985	2700	0.466781
13	765560.3	3386019	3653.833	2533.219	76.99697	600	0.504218
14	767979.5	3382285	362.2903	380.6889	29.86988	2400	0.23885
15	768724.6	3380011	945.9922	939.3119	15.76548	1600	0.504218
16	772479.3	3378628	1559.908	697.6861	30.04402	400	0.504218
17	765838.6	3372598	793.2811	2032.339	692.4693	200	0.739891
18	771282.5	3378553	409.8882	934.8341	11.46491	800	0.504218
19	770180.9	3382427	1351.271	707.393	84.35599	3000	0.700573
20	767506.9	3377782	1091.798	767.1433	127.2008	5400	0.700573
21	769638.1	3380230	913.8846	939.3119	73.58733	2400	0.504218
22	769935.4	3376382	809.921	1964.692	0.62576	1200	0.504218
23	765332.7	3382403	233.5979	689.7285	31.75814	2400	0.504218
24	766202.3	3377558	875.7714	998.9479	264.0967	3600	0.965179
25	771665.2	3379405	987.9165	689.268	19.43828	1125	0.504218
26	767050.6	3374230	733.5689	2032.339	83.76482	900	0.504218
27	766969.9	3378329	585.9335	767.1433	153.4136	2500	0.739891
28	767972.1	3376457	863.4426	1128.756	92.41888	2068	0.504218
29	767875.1	3381253	1020.005	1037.777	16.97863	4200	0.700573
30	772348.2	3379313	1530.341	689.268	4.920259	500	0.504218

Table 2. Primary Stage

code	Longtitude(x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
1	772987.1	3378783	2062.95998	234.317	125.3557	2136	0.23885
2	771496	3379145	693.667628	170.2393	185.8766	3000	0.466781
3	766490.4	3377667	1136.82224	148.9231	230.4201	4900	0.466781
4	769405.8	3372332	366.084083	209.1813	43.95898	2500	0.23885
5	767336.4	3377506	1339.62038	313.8418	98.00953	4000	0.23885
6	765339	3381744	660.275007	271.2918	15.3567	6720	0.493429
7	769873.7	3379601	781.8398	0	51.57347	3600	0.23885
8	768663.1	3373947	909.149867	57.47391	293.8064	2800	0.466781
9	769164.6	3373079	966.474405	407.6648	94.88119	4500	0.23885
10	765823	3372432	723.111618	1453.547	682.3139	2400	0.739891
11	770556.5	3377967	867.131253	6.165874	128.9978	4350	0.23885
12	769552.9	3372955	665.045161	407.6648	140.2767	3600	0.23885
13	771150.3	3377625	668.435385	310.9575	11.07522	2000	0.23885
14	767342	3375683	688.57535	62.74691	266.4335	2400	0.466781
15	769812.7	3377896	1041.41125	409.3725	111.9011	4589	0.23885
16	767992.5	3378350	889.834105	221.2034	55.77643	3500	0.23885
17	768606.6	3380133	968.99313	131.172	35.76537	2500	0.23885
18	767797.2	3382644	156.195097	271.7926	147.6499	2200	0.23885
19	767739.3	3376691	1132.4566	8.02602	103.6925	3500	0.23885
20	766612.1	3383595	1216.90933	430.1058	12.39684	3600	0.23885
21	766446.9	3373812	1330.85281	64.69482	18.38737	4000	0.23885
22	772389	3379560	1673.0044	86.24537	70.8328	1800	0.23885
23	769370.9	3382111	1136.2014	310.3619	210.8663	4200	0.466781
24	770788	3377082	44.6938173	249.4324	0	3000	0.025651
25	771943.9	3375775	1782.32014	654.7437	107.2168	6904	0.700573
26	765684.2	3378724	975.073005	226.3775	20.11565	2400	0.23885
27	769981.7	3376255	694.723968	953.5777	102.453	2500	0.504218
28	768535.5	3382901	560.551892	495.1563	87.39162	3360	0.23885
29	770253	3377534	659.715647	57.02731	0	2700	0.23885
30	773721.6	3377236	2980.19632	1045.113	105.1971	3600	0.504218
31	769358.6	3375063	687.277771	897.3423	300.3407	2500	0.739891
32	768823.9	3382499	826.949232	495.1563	23.78438	3000	0.23885
33	772453.8	3379504	1704.19941	86.24537	74.30337	1750	0.23885
34	771920.7	3380345	1879.40583	40.57475	58.82031	4600	0.23885
35	771999.6	3378011	1305.98463	359.9565	16.12231	2827	0.23885
36	769425	3374168	1464.91133	793.466	216.6286	2500	0.739891
37	768672.2	3379953	867.587988	42.87929	17.53631	3000	0.23885
38	766993.9	3376212	693.13896	156.6448	214.068	2500	0.466781

39	768013.5	3376395	799.815889	399.443	17.88249	10000	0.493429
40	768956.3	3371714	1020.60939	281.8938	7.713769	3600	0.23885
41	766683.8	3380269	1534.84807	963.5169	45.09262	6000	0.700573
42	765423.2	3382498	192.7027	23.03929	29.22564	2603	0.23885
43	771082.3	3380974	1189.48041	553.584	0	3304	0.504218
44	772778.7	3379079	1882.93113	172.2396	63.83399	1250	0.23885
45	769128.7	3378426	610.459454	533.1421	28.19825	3000	0.504218
46	766401.9	3373765	1383.60534	64.69482	11.98279	2400	0.23885
47	771758.4	3378625	843.538127	508.4629	7.423575	2000	0.504218
48	770552.7	3377971	864.386331	6.165874	135.149	4550	0.23885
49	765411.8	3382473	185.661768	27.42611	38.71558	2400	0.23885
50	768476.7	3377833	1109.02391	356.7892	176.8562	3000	0.466781
51	765475.2	3382296	111.998531	187.8857	30.78799	4200	0.23885
52	766919.2	3376350	627.821448	156.6448	249.3254	6724	0.712045
53	765862.1	3383599	1269.35485	193.405	203.9459	3600	0.466781
54	765514.6	3385795	3430.25559	1934.584	29.25522	3600	0.504218
55	768354	3378400	962.010628	116.9509	26.05565	2400	0.23885
56	767827.9	3380798	1389.783	314.0585	217.2344	3600	0.466781
57	768778.5	3380488	1280.37073	30.65431	28.2679	4200	0.23885
58	767250.6	3376403	963.398749	62.7395	242.3168	2500	0.466781
59	767647.6	3379625	525.997526	316.1989	237.9484	2400	0.466781
60	766910.7	3381660	536.498416	216.543	179.8538	3600	0.466781
61	767991.1	3373681	425.495737	680.1873	195.8309	4200	0.739891
62	769127.1	3371938	753.181372	281.8938	21.72046	9600	0.493429
63	767931.8	3378849	494.200968	62.34108	16.89003	3600	0.23885
64	767093.3	3374088	667.045465	702.842	25.65039	3500	0.504218
65	766425.8	3381824	778.199592	295.4947	100.5706	2500	0.23885
66	765462	3378529	732.452324	187.3155	9.504369	4200	0.23885
67	768570.7	3380586	1357.10128	72.91899	25.45275	3000	0.23885
68	766157.4	3377611	818.591123	2.552665	253.3066	4800	0.466781
69	767343.8	3372601	819.448934	1258.985	19.80384	4200	0.504218
70	771816.9	3377701	1231.91552	268.0621	25.61516	2400	0.23885
71	767363.3	3379155	331.013995	315.803	249.7128	2000	0.466781
72	769035.3	3380153	1268.98058	387.5466	38.3308	7315	0.493429
73	768532.5	3380648	1402.24436	72.91899	36.11142	2400	0.23885
74	769125.5	3372277	648.22839	73.13358	86.53851	3600	0.23885
75	769759	3379982	1090.34273	397.8572	74.74253	2849	0.23885
76	768765.4	3380515	1278.87708	30.65431	32.53961	3000	0.23885
77	766316.7	3378990	946.486583	35.74897	145.8928	2600	0.23885
78	767230.8	3379441	598.63459	315.803	430.3445	3600	0.466781
79	767126.9	3383431	1031.53717	502.0947	32.33969	3000	0.504218

80	766702.9	3381721	656.268848	216.543	54.12208	4900	0.23885
81	768612.5	3379911	796.345701	72.88706	19.08598	5000	0.493429
82	766344.9	3379012	922.4454	35.74897	117.87	1800	0.23885
83	770296.8	3373964	1689.2937	41.94688	71.72439	6860	0.493429
84	765647.1	3378500	753.070359	187.3155	92.10057	3750	0.23885
85	769630.1	3381940	877.254992	310.3619	114.4189	3600	0.23885
86	770547.3	3380832	702.630252	553.584	25.40488	2560	0.504218
87	766381.6	3382383	546.315744	131.4559	8.181784	4200	0.23885
88	767587.8	3379936	785.259805	316.1989	80.71709	2400	0.23885
89	769630.1	3383887	2010.49926	1472.966	473.843	10000	0.965179
90	768778.3	3378024	1097.85253	356.7892	72.80429	3000	0.23885
91	765612.5	3379062	1282.9508	141.7693	26.08865	4400	0.23885
92	771941.1	3377463	1251.9374	268.0621	91.25371	1600	0.23885
93	767542.5	3378620	366.646149	304.2848	4.436603	6300	0.493429
94	773372.3	3378221	2504.80255	681.3752	44.89538	3600	0.504218
95	767752.7	3382376	337.112975	199.6513	7.192038	2400	0.23885
96	769873.7	3379601	781.8398	0	51.57347	2500	0.23885
97	768022.6	3380366	1045.72567	72.46184	33.77739	3600	0.23885
98	772788	3378907	1870.03678	172.2396	25.11763	2000	0.23885
99	765758.2	3383126	785.317654	307.8296	20.17503	5880	0.493429
100	768035.7	3378677	645.71342	198.7209	68.84618	4500	0.23885
101	770196	3377536	704.940872	57.02731	10.00025	1200	0.23885
102	767810.8	3378476	668.687308	221.2034	83.17502	5400	0.493429
103	770148.6	3377196	604.876015	343.7677	99.45085	5000	0.493429
104	768057.1	3377652	1335.969	457.314	140.2018	4000	0.23885
105	766424.7	3382259	527.153394	111.1262	37.26622	2500	0.23885
106	768703.3	3381672	1222.74324	41.8	33.42368	3600	0.23885
107	772297.5	3378681	1374.93425	225.812	20.8697	4200	0.23885
108	770257.8	3373980	1663.55888	41.94688	51.69142	4500	0.23885
109	767082.6	3377827	1030.4162	166.5128	14.42969	2500	0.23885
110	768550.4	3379095	524.868617	603.4469	123.5726	2500	0.504218
111	771906.4	3380308	1839.6394	40.57475	96.94002	4200	0.23885
112	768477.6	3380109	883.611296	131.172	6.431507	3627	0.23885
113	765067.9	3381754	786.387104	271.2918	159.0328	3000	0.466781
114	766524.5	3377013	805.308892	356.2934	260.2486	3600	0.466781
115	771594.7	3376329	1143.34344	654.7437	0	4096	0.504218
116	767599.8	3383193	650.572141	529.8272	229.754	3000	0.739891
117	764117.3	3381822	692.950891	70.62195	20.10049	2700	0.23885
118	767546	3380937	1165.70901	215.4371	98.52701	2400	0.23885
119	768669.9	3381697	1183.31286	41.8	22.48871	1690	0.23885
120	766764.7	3382969	573.12389	90.64248	26.34102	3600	0.23885

121	768636.6	3373896	889.480603	57.47391	298.7375	3600	0.466781
122	768683.1	3376679	655.225992	604.9103	233.7727	2400	0.739891
123	770297	3377951	967.435127	256.5095	39.78267	4256	0.23885
124	769190	3372243	587.903543	73.13358	65.16451	5400	0.493429
125	767375.5	3375630	650.443257	59.43741	262.0753	3600	0.466781
126	767455.3	3383811	1259.00171	502.0947	1.100972	3000	0.504218
127	765421.4	3383863	1504.2618	513.6796	261.2071	8400	0.965179
128	766421.4	3377799	1059.68091	148.9231	240.5296	4200	0.466781
129	767990.3	3378871	459.165481	62.34108	10.51578	7128	0.493429
130	765995.8	3383459	1176.38128	193.405	83.04806	3600	0.23885
131	767247.9	3377807	1035.83006	166.5128	15.61058	4200	0.23885
132	764187.7	3381826	757.89921	70.62195	0	4200	0.23885
133	765556.4	3378931	1144.69153	141.7693	22.94536	2500	0.23885
134	770182.4	3377720	841.61046	184.1444	129.21	1720	0.23885
135	765917.9	3379398	1444.54765	454.108	128.1655	2200	0.23885
136	772625.2	3377314	1893.21404	700.1287	25.82366	4200	0.504218
137	765442.9	3382486	170.258636	23.03929	24.93581	2400	0.23885
138	768011.8	3380294	974.828327	72.46184	40.81295	2400	0.23885
139	767210.3	3376451	933.500254	62.7395	265.1338	3000	0.466781
140	772523.3	3378678	1600.63065	225.812	23.78344	3000	0.23885
141	765217.2	3383067	782.768796	306.3903	129.3855	6000	0.493429
142	766155.6	3377613	816.409922	2.552665	252.7237	5600	0.712045
143	768444.1	3378326	1061.33576	116.9509	1.703676	3200	0.23885
144	767508.2	3375963	634.491139	325.8157	231.1194	3000	0.466781
145	764174.6	3381666	810.511221	160.5677	21.45622	3000	0.23885
146	765389.6	3378817	1013.60734	202.4383	25.54031	4200	0.23885
147	767412.8	3375584	612.247961	59.43741	203.194	3600	0.466781
148	767917.5	3382250	397.841153	76.73541	22.38462	3000	0.23885
149	771388.5	3379013	532.447762	170.2393	15.96002	3000	0.23885
150	764768.2	3382308	797.047751	356.3907	26.4348	1500	0.23885
151	766830.7	3382907	496.971561	90.64248	2.683373	4788	0.23885
152	766624.1	3384025	1633.7607	430.1058	22.09477	3000	0.23885
153	771828.7	3380182	1691.94165	147.7053	126.836	2800	0.23885
154	769526.3	3372503	301.88846	209.1813	54.37483	4200	0.23885
155	771259.9	3378525	404.996776	504.3818	8.675441	4288	0.504218
156	767737.1	3376683	1125.56596	8.02602	97.72225	3600	0.23885
157	766168.3	3377005	777.989676	356.2934	30.45312	4200	0.23885
158	765471.6	3383238	877.749406	306.3903	302.9974	3600	0.466781
159	766495.1	3382173	497.220537	111.1262	23.34285	10000	0.493429
160	770545.6	3377024	211.218886	249.4324	69.96066	3000	0.23885
161	770841.3	3377660	573.922857	310.9575	167.3045	3300	0.466781

162	770878.1	3379797	1045.68614	76.63392	20.82552	10000	0.493429
163	766121.3	3377673	770.704108	68.85946	255.0609	3500	0.466781
164	765022.5	3382557	573.760652	356.3907	39.7556	2500	0.23885
165	770317.6	3379241	779.310302	451.273	0	2806	0.23885
166	767531.7	3381152	954.563959	215.4371	79.52068	3600	0.23885
167	765860.9	3377367	663.042967	383.8598	29.52934	2500	0.23885
168	767169.9	3376545	920.927656	101.8338	251.6893	2400	0.466781
169	770866.3	3379721	970.67985	76.63392	20.26707	5400	0.493429
170	770192.7	3378807	730.746978	451.273	251.5662	4800	0.466781
171	769011.9	3377187	276.982658	604.9103	59.7058	2400	0.504218
172	768681.8	3379994	904.814806	42.87929	45.70938	5000	0.493429
173	767944.9	3382322	324.674206	76.73541	25.44015	4000	0.23885

Table 3. Intermediate stage

Code	Longtitude(x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
1	771179.8	3380377	1472.388	77.74655	34.01862	3600	0.23885
2	768595.7	3377670	908.7294	996.8908	109.0726	2500	0.739891
3	770926.1	3376523	598.6874	579.2121	164.9454	2856	0.466781
4	769936.6	3374953	641.3239	1268.32	201.0006	3000	0.739891
5	765445.1	3382345	119.6475	113.0459	43.04097	3000	0.23885
6	770349.4	3376577	650.684	491.4258	86.98887	3600	0.23885
7	771120.1	3380327	1446.938	77.74655	25.67436	3600	0.23885
8	772260.8	3378717	1336.93	892.4189	23.82111	2800	0.504218
9	767609.4	3375839	481.8633	605.0141	242.4124	2400	0.466781
10	770012.8	3376219	669.0589	491.4258	149.6987	3600	0.466781
11	768916.8	3382988	948.1706	1084.232	201.9796	8000	0.965179
12	765220.6	3383061	775.6328	644.0954	127.3429	5400	0.466781
13	771441.3	3379792	1161.614	624.0422	8.322519	3812	0.23885
14	766406.7	3383630	1317.803	540.755	5.696093	6000	0.23885
15	768805.6	3380445	1278.258	119.1641	25.62654	4200	0.23885
16	766552.9	3382663	445.9016	547.0499	24.14857	3600	0.23885
17	771482.5	3379154	687.7809	639.6576	183.3153	2200	0.466781
18	767647.3	3378435	568.5256	552.8934	38.81487	4200	0.23885
19	766804.1	3383149	739.2556	547.0499	40.47924	2500	0.23885
20	768542	3379154	494.4023	970.7324	142.8213	2400	0.739891
21	768923	3380424	1190.974	119.1641	16.61025	2600	0.23885
22	769213.1	3378452	543.7643	744.5486	116.4297	6000	0.466781
23	767864.6	3383249	584.8784	344.5741	45.56607	8000	0.493429
24	764224	3381705	836.6288	1044.591	29.19837	2400	0.504218
25	765243.3	3381934	537.0382	458.632	79.79073	3000	0.23885
26	769995	3377909	1107.712	221.4738	51.92993	2400	0.23885
27	769782.9	3377973	1006.311	221.4738	36.44754	5000	0.23885

Code	Longtitude(x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
28	769083.6	3380552	986.2869	205.179	52.72162	3600	0.23885
29	769189.8	3373152	1009.359	454.061	76.99593	2400	0.23885
30	768407.7	3373005	353.6052	795.7303	45.82983	4200	0.504218
31	767117.7	3377799	1053.099	345.6545	29.64823	2450	0.23885
32	765875.4	3383530	1205.618	540.755	202.9406	2500	0.466781
33	765377.8	3382436	198.5748	113.0459	40.34916	3600	0.23885
34	769783.7	3380418	696.8399	712.7883	30.27287	3600	0.23885
35	767535.1	3383149	653.4616	344.5741	300.7043	2400	0.466781
36	767325.1	3378884	83.97073	552.8934	16.14542	3600	0.025651
37	768209.7	3375914	368.5426	605.0141	74.62779	5600	0.23885
38	766791.7	3381660	621.0626	1030.855	160.7185	4200	0.739891
39	769609.6	3372979	671.5084	454.061	105.4622	2800	0.466781
40	766791.9	3377914	1036.616	345.6545	33.63162	3600	0.23885
41	766426.7	3377793	1064.963	384.7833	239.2825	2400	0.466781

Table 4. High stage

code	Longtitude(x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
1	771074.9	3378355	424.2267	280.2251	21.78511	3600	0.23885
2	766093.7	3383468	1223.688	956.0143	1.313818	6000	0.23885
3	765521.6	3378592	804.3084	228.0426	26.9894	3900	0.23885
4	768197.9	3377722	1250.74	157.6417	155.1007	2400	0.466781
5	768247	3377871	1301.976	157.6417	45.50954	4800	0.23885
6	770348.1	3374465	1239.342	2082.501	117.053	3600	0.739891
7	769260	3372053	580.634	2037.09	70.85331	2400	0.504218
8	767971.6	3383206	523.1631	743.5291	28.09357	2600	0.23885
9	767902.8	3382248	401.4565	960.3897	35.16001	3000	0.23885
10	767140.8	3376604	915.3015	584.2045	229.018	3600	0.466781
11	770542.7	3377827	760.9575	691.1527	34.37308	4500	0.23885
12	769714.1	3377600	744.7903	171.162	102.5618	3980	0.466781
13	768192	3380575	1258.433	961.8295	92.17419	4500	0.23885
14	769151.5	3380509	957.1432	961.8295	106.6277	5400	0.466781
15	767214.4	3377865	978.8543	830.1353	13.72746	10000	0.493429
16	770905.9	3379578	826.3095	865.5028	15.48863	3000	0.23885
17	766858.5	3377115	1038.404	584.2045	221.358	3600	0.466781
18	766425.1	3374080	1334.037	687.1179	30.16373	2500	0.23885
19	767961.2	3373622	461.8298	1044.975	143.6621	10000	0.712045
20	766351.1	3382418	575.6387	214.0392	27.64897	3600	0.23885
21	768123.4	3376361	772.1655	353.4765	29.56481	5400	0.23885
22	766927.6	3383000	580.755	591.1653	0	10000	0.493429

code	Longtitude(x)	Latitude(y)	Distance to petrol station	Distance between schools	Distance to main street	Area of school	Result of evaluation
23	767748.2	3378544	579.5042	837.5917	89.54303	4800	0.23885
24	772746.8	3379106	1856.612	475.4162	60.86107	2870	0.23885
25	771144.8	3378627	253.51	280.2251	96.30081	2870	0.23885
26	765649.9	3378780	1018.392	228.0426	6.402242	4200	0.23885
27	771737.8	3379339	1003.274	208.4642	24.88177	4500	0.23885
28	772410.7	3378770	1486.435	71.14989	95.88665	4000	0.23885
29	772347.3	3378738	1423.031	71.14989	27.55739	4000	0.23885
30	772347.3	3379494	1604.654	455.2984	25.88572	4500	0.23885
31	772509.1	3380053	2050.38	582.2799	25.491	3500	0.23885
32	771892.3	3379479	1210.672	208.4642	93.39019	2640	0.23885
33	769005.3	3382679	987.0888	1160.341	169.1831	4500	0.466781
34	767914	3383948	1266.672	743.5291	4.375418	4000	0.23885
35	767150	3383548	1150.378	591.1653	112.9309	8000	0.466781
36	767953.2	3376051	461.656	353.4765	56.2752	3600	0.23885
37	766567.3	3376398	310.0398	609.1675	6.986935	2500	0.23885
38	767099.2	3374213	682.3154	687.1179	71.10298	2500	0.23885
39	766503.5	3382267	449.8211	214.0392	26.10098	6000	0.23885
40	773449.1	3377341	2715.617	1766.657	17.23659	7500	0.504218
41	769869	3377673	902.655	171.162	59.75791	3600	0.23885
42	771993.7	3375742	1840.756	2082.501	47.14767	2500	0.504218