Efficiency of Spatial Distribution of Gas Stations in Babylon Using (GIS)

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Abstract

Public services, including fuel and gas station services are among the most important services that reflect the extent of development witnessed by cities and the standard of living of the population. They also represent important facilities that provide continuous services to residents. The present study adopts the analytical approach and the use of GIS in Statistical analysis, Ministry of Oil and the Ministry of Housing and Construction criteria, and the spatial average center to determine the diameter of the center circle. The number of stations located within the circle of the center was (51) stations. Whereas, those located outside the circle were (25) stations. The present study applied the standard distance to determine the degree of the standard deviation, the distributional direction of the phenomenon to determine the path of the direction of the gas stations in Babylon, which starts from the northwest of Al-Musayyab district to the southeast of Al-Qassim district, and the analysis of the nearest neighbor, which analyzes the distribution pattern of the phenomenon. It was found that the distribution pattern of gas stations is a confluent pattern.

1. Introduction

Gas station services are among the vital and necessary services for the means of transportation, which represent the vital resource of the province of

Babylon that represents the link between the central and southern provinces of Iraq. It is bordered by four provinces, including Baghdad in the north, Diwaniyah in the east, Karbala in the west, and Najaf in the south. The province is in great demand for fuel products at the time of religious occasions that attract large numbers of visitors to Karbala by passing through it. Attention to this vital sector has become necessary to sustain the work of these services and provide service to citizens easily and to avoid crises in the fuel product to operate all industrial, agricultural, and commercial activities, as well as operating vital transportation routes within the province.

2. Concepts of the Present Study

1. Efficiency; It means the extent to which the goals are achieved. Therefore, it is measured by determining the relationship between the achieved results and the set goals. It is the success of the organization in achieving an expected result, which is synonymous with production and economic returns. It achieves the response to the desired goals in the work of the institution by using the same level of inputs while increasing the size of the outputs (Muhammad, 2015).

2. Gas Stations; Gas stations are among the important services in cities as they provide fuel for all types of vehicles within the study area and the villages affiliated to it. There are many fuel stations, including governmental and private ones, which resulted in a significant increase in the number of vehicles (Suleiman, 2020). They are the places designated for the sale of oil derivatives. They are licensed to engage in the activity of selling and distributing fuels. They are considered necessary services as they represent an important part of urban uses in the country. They are also considered among the most important service facilities for the movement of transportation. They include three types according to ownership, among which are the following: (Saqr, 2015).

A. Governmental Stations

B. Leased investment stations

C. Private stations

3. Geographical Information Systems (GIS); It is a computer-based means or tool to communicate and analyze things on the ground, as well as the events that occur through the work of program designs that determine the correct balance in the distribution of these stations in the province of Babylon with GIS technology (Al-Dulaimi, 2010).

1. Population size criterion; Social services are of great importance in human development plans for most countries of the world. This is done through the application of an approved and special standard that achieves the required balance between the number of the population and the services provided, including the services of gas stations so that it can cover the shortage and achieve a kind of efficiency in providing those services. The present study suggests using two criteria for population size. The first is the criterion of the Ministry of Oil (35,000) people

for each station. The second is the criterion of (12,000) set by the Ministry of Housing and Construction as shown in Table (1).

Table (1) clearly reveals that the number of stations required to be available after applying the standard of the Ministry of Oil of (35000) people for each station is (57) governmental stations in all administrative units of Babylon.

The current available governmental stations are only (16) governmental stations in Babylon. This means that the deficit is (41) stations throughout the province, distributed as follows:

The highest number is in Al-Hilla District. The number of stations required to be available according to the application of the standard is (25) stations. As for the currently available stations, there are only (6) stations with a deficit of (19) stations distributed among the administrative units of the district.

3. In Jurf Al-Sakhr, There Is Only (1) Governmental Station

As for the criterion of the Ministry of Housing and Construction of (12,000) people per station, the present study suggests applying this criterion to the centers of administrative units only throughout the province as noted in Table (2).

Table (2) clearly reveals that the number of currently available stations in the administrative units' centers of the province of Babylon is (40) stations. After applying the criterion of the Ministry of Housing and Construction, the need for additional stations appeared to be (84) stations, i.e., with a deficit of (44) additional stations for 2021. In order to discuss it in details, it can be done at the level of districts as follows:

The highest number is in Al-Hilla District as the number of current stations for the centers of administrative units is (20) stations. After the application of the standard for the Ministry of Housing and Construction, it appeared that there is a need for (45) stations, i.e. with a deficit of (25) stations distributed among the centers of administrative units as follows:

(26) stations in the center of Al-Hilla district, (2) stations in Al-Musayyib center, and (5) stations in the center of Al-Iskandaria. There is a surplus in the center of Sadat Al-Hindiya by (1) station. From The Ministry of Housing and Construction's criterion that has previously been applied to gas stations, it is important and necessary to compare the numbers available at the present time and what is required to be provided according to the criterion.

2. Standard of distance traveled (service range)

It is possible to identify the spatial efficiency of gas stations for vehicles in the province of Babylon by using the criterion for the size of the population through which the efficiency of those services can be evaluated.

In order to achieve this goal, the present study adopted the criterion of Ministry of Housing and Construction of (1600m) to determine the service range for each gas station in all administrative units by relying on the area of the municipality, the number of urban and rural residents, the number of serviced urban and rural residents,

Table 1. The Current Numerical Distribution of Gas Stations in Babylon for (2021)

Defficiency and surplus		Number of required stations according to the criterion	Number of currently available governmental stations	Number of population	Administrative Units	District
Siurplus	**Defficiency**					
–	13	18	5	628861	Center of Al-Hilla District	Al-Hilla District
–	3	4	1	157816	Al-Kifl	
–	3	3	–	122263	Abu Gharaq	
–	19	25	6	908940	Total	
–	2	3	1	131556	Center of Al-Mahaweel District	Al-Mahaweel District
–	3	4	1	143292	Al-Mashroo	
–	1	1	–	41507	Al-Imam	
–	1	1	–	66229	Al-Nile	
–	7	9	2	382584	Total	
–	1	1	–	40271	Center of Al-Hashimia District	Al-Hashimia District
–	4	5	1	179260	Al-Qassim	
–	3	4	1	152898	Al-Midhatyya	
–	1	2	1	98170	Al-Shomali	
–	1	1	–	43828	Al-Taliaa	
–	10	13	3	514427	Total	
–	–	1	1	61947	Center of Al-Musayyab District	Al-Musayyab District
–	1	3	2	130812	Saddat Al-Hindia	
–	1	1	–	53131	Jurf Al-Sakhr	
–	3	5	2	179296	Al-Iskandaryya	
–	5	10	5	425186	Total	
–	41	57	16	2231137	Total	

Source; The researchers based on number and criteria of stations for 2021

Table 2. Distribution of Gas Stations in The District Centers of Babylon for (2021)

Defficiency and surplus amount		Number of required stations according to the criterion	Number of currently available stations at district centers	Number of population	Centers of Administrative Units	District
Surplus	**Defficiency**					
–	26	41	15	492396	Center of Al-Hilla District	Al-Hilla District
2	–	2	4	24682	Al-Kifl	
–	1	2	1	27694	Abu Gharaq	
2	27	45	20	544772	Total	
–	1	2	1	33655	Center of Al-Mahaweel District	Al-Mahaweel District
–	2	3	1	41790	Al-Mashroo	
–	1	1	–	14005	Al-Imam	
1	–	–	1	7527	Al-Nile	
1	4	6	3	96977	Total	
–	1	3	2	40271	Center of Al-Hashimia District	Al-Hashimia District
–	5	7	2	88053	Al-Qassim	
–	4	5	1	64241	Al-Midhatyya	
–	–	1	1	19619	Al-Shomali	
–	–	–	–	9319	Al-Taliaa	
–	10	16	6	221503	Total	
–	2	5	3	61947	Center of Al-Musayyab District	Al-Musayyab District
1	–	3	4	36612	Saddat Al-Hindia	
–	–	–	–	6542	Jurf Al-Sakhr	
–	5	9	4	108713	Al-Iskandaria	
1	7	17	11	213814	Total	
4	48	84	40	1077066	Total	

Source; The researchers based on locations of gas stations for 2021and criteria of urban housing for 2010

and the urban and rural area served through the use of the (Arc, Gis) device, through which the serviced areas in urban and rural areas were reached and the deficit in those stations was identified. The purpose of using this technique is to determine the areas covered by the stations and the number of people served in them, whether in the centers of the administrative units or in the rest of the administrative units, as well as to determine the extent to which this criterion is applied to these stations and to explore the stations that cover, according to the standard, and the stations that are located far from this distance in order to show the ease of access of the serviced population to these stations so that these stations can achieve their efficiency in distributing their services to all serviced population within the specified scope.

Through an illustrative table, it is possible to determine the serviced urban and rural population density, the number of urban residents and the urban area by defining the municipal area for urban and rural areas by (Arc, Gis) as shown in Table (3) and Map (1).
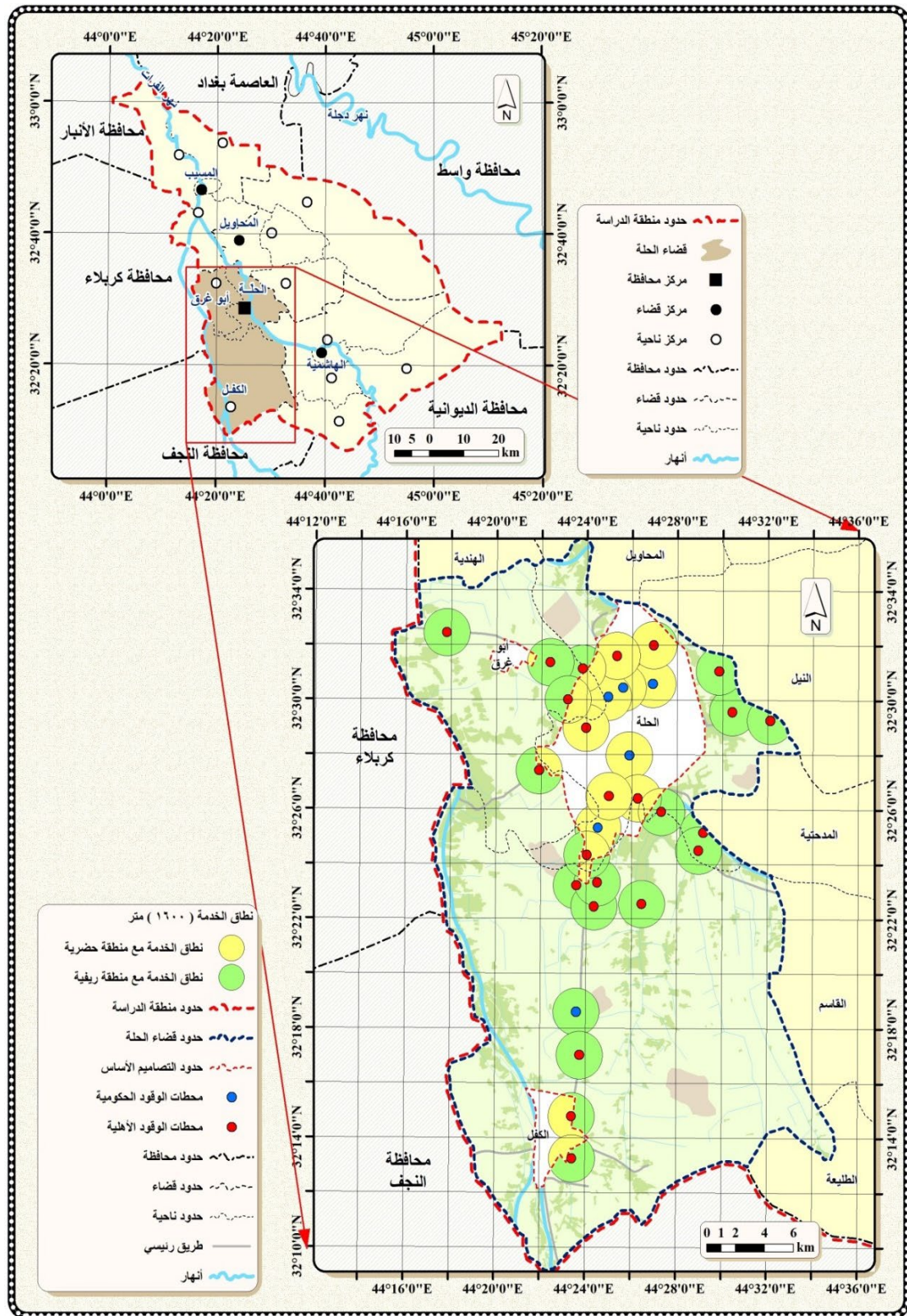
1. Al-Hilla District

The number of stations in Al-Hilla District is (30) stations distributed on its three administrative units, which are the center of Al-Hilla district by (20) governmental and private gas stations Al-Kifl by (6) Governmental and private stations, and Abu Gharaq by (4) only private stations. Table (3) reveals that Al-Hilla district is divided into three units that can be detailed as follows:

In the center of Al-Hilla district, the number of urban residents is (492,396 people. Whereas, the area of the municipality is (118) km2, and the urban serviced area is (3.1 km2) with a percentage of (90.8) %. The number of serviced urban population is (304,827) people, and the density of serviced urban population is (4.17). The rural population is (136,465) people. Whereas, the rural area is (34.2 km2) with a percentage of (30.1 %). The number of the rural population served is (108414) people. Whereas, the density of the serviced population is (3.17) people.

In Al-Kifl district, the urban population is (24,682) people, the area of the municipality is (14.4) km2, the urban serviced area is (7) km2, with a percentage of (7%), the number of the city's served population is (1197), the density of the served urban population is (1.71) people, the rural population is (133,134) people, and the rural area served is (53.6) km2 at a percentage of (47.1) %, and the number of the rural population served is (13948).) people, the density of the serviced population of the countryside is (26,23).

In Abu Gharaq, the urban population is (27,694) people, the area of the municipality is (3.7) km2, the serviced urban area is (0.4) km2, at a percentage of (0.5). The number of the served urban population is (2992) and its density is (7.48), the rural population is (94,569) and the rural area served is (25.9) km2 at a percentage of (22.8%), and the number of the rural population served is (13076) Population and density is (504,90) as shown in Map (2).

3. Al-Mahaweel District

The number of stations in Al-Mahaweel district is (11) stations distributed over four administrative units: Al-Mahaweel Center, Al-Imam, Al-Nile, and Al-Mashrou. In the center of Al-Mahaweel district, the number of serviced urban population is (33,655)people, the minicipality area is (7) km2, the serviced urban area is (3)km, at a percentage of (51.7%). The number of serviced urban population is (144) people and their density is (4.80), the rural population is (97,901), the serviced rural area is (37,8) km2 at a percentage of (43). 5%. The number of serviced rural residents is (6240) and their density is (165.09).

In Al-Imam district, the urban population is (14,005) people, the area of the municipality is (1,1) km 2, the urban area and urban population did not exist, but the density of serviced urban population is (12.73), the rural population is (27,502), the serviced area of the countryside is (7), at a percentage of (8.1)%, the number of serviced rural population is (2605) and their density is (372.15). In Al-Nile district, the urban population is (7,527) people, the municipality's area is (1) km2, the urban serviced area is (0.8) km2, with a percentage of (13.8)%, the number of serviced urban population is (6056) people, and their density is (7.57). As for the rural population, it is (58,702 .), the serviced rural area is (24,4) km2, with a percentage of (28.1%), and their density is (373.89).

Map (1) Service range 1600)m (of gas stations in Babylon for 2021
Source; The researchers based on stations distribution and the statistical equasion (Gis)

Map 2. Applying service range 1600)m (for gas stations distribution in Al-Hilla district for 2021

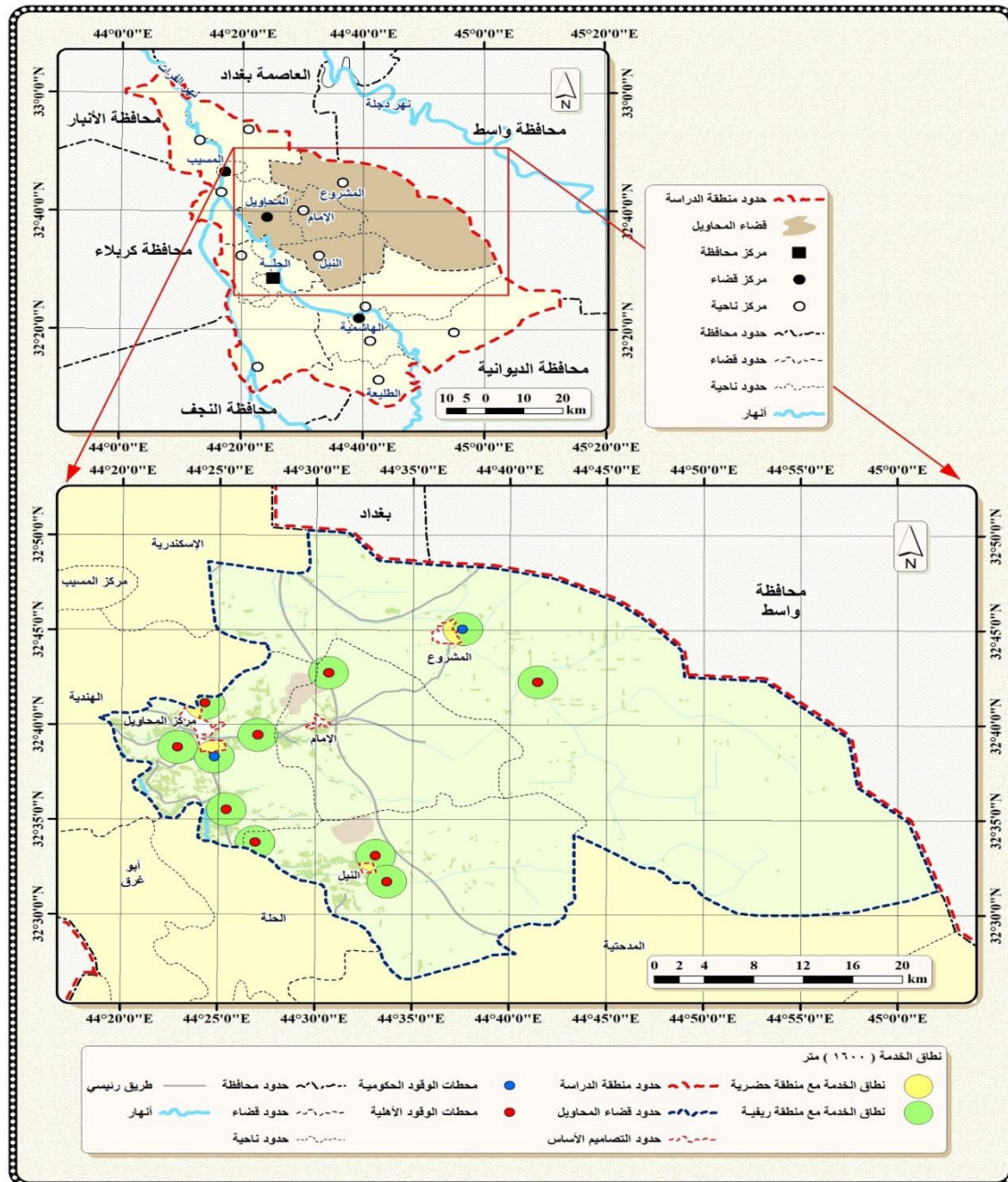Source; The researchers based on Table (60)and space visions using)Arc,Gis.

Table 3. Service Range for Fuel and Gas Stations in Babylon (1600m)

Dencity of serviced roral population	Number of serviced roral population	Percentage	Serviced roral area km	Roral population	Dencity of serviced urban population	Number of serviced urban population	Percentage	Serviced urban area km	Minicipality area km	Urban population	Number of gas stations	Administrative units	District	No.
3,17	108414	30,1	34,2	136,465	4,17	304827	90,8	3,1	118	492,396	20	Center of Al-Hilla	Al-Hilla	-1
26,23	13948	47,1	53,6	133,134	1,71	1197	8,7	7	14,4	24,682	6	Al-kifl		
504,90	13076	22,8	25,9	94,569	7,48	2992	0,5	0,4	3,7	27,694	4	Abu Gharaq		
-	-	100	-	364,168	-	-	100	-	-	544,772	30	Total		
–	–	11,8	9,5	–	7,32	2562	17,3	3,5	5,5	40,271	2	Al-Hashimia	Al-Hashimia	
209,39	5862	34,7	28	88,657	17,84	33896	9,4	1,9	3,6	64,241	4	Al-Midhatyya		
305,85	458775	1,9	1,5	91,207	3,05	4514	73,3	14,8	28,8	88,053	2	Al-Qassim		-2
118,7	95096	9,92	8	34,509	3,45	–	–	–	2,7	9,319	1	Al-Taliaa		
158,46	5324	41,68	33,6	78,551	8,53	–	–	–	2,3	19,619	4	Al-Shomali		
-	-	100	-	292,924	-	-	100	-	-	221,503	13	Total		

Dencity of serviced roral population	Number of serviced roral population	Percentage	Serviced roral area km	Roral population	Dencity of serviced urban population	Number of serviced urban population	Percentage	Serviced urban area km	Minicipality area km	Urban population	Number of stations	Administrative units	District	No.
165,09	6240	43,5	37,8	97,901	4,80	144	51,7	3	7	33,655	5	Al-Mahaweel	Al-Mahaweel	
372,15	2605	8,1	7	27,502	12,73	–	–	–	1,1	14,005	1	Al-Imam		-3
373,89	9122	28,1	24,4	58,702	7,57	6056	13,8	0,8	1	7,527	3	Al-Nile		
122,21	2150	20,3	17,6	101,502	11,94	2388	34,5	2	3,5	41,790	2	Al-Mashroo		
-	-	-	-	285,607	-	-	100	-	-	96,977	11	Total		
–	–	10,18	9,3	–	1,57	3768	40,2	24	39,4	61,947	4	Al-Musayyab	Al-Musayyab	
194,49	10658	60,02	54,8	70,583	4,33	93961	36,3	21,7	25,1	108,713	12	Al-Iskandaria		-4
404,81	8581	23,2	21,2	94,200	1,50	21	23,5	14	24,3	36,612	5	Al-Sadda		
276,32	1657	6,6	6	46,589	4,67	–	–	–	1,4	6,542	1	Al-Jurf		
-	-	100	-	211,372	-	-	100	-	-	213,814	22	Total		

Source; The researchers based on) (Gis)

In Al-Mashroo district, the number of urban residents is (41,790) people. The area of the municipality is (3.5) km2 and the urban serviced area is (2) km2 at a percentage of (34.5%). The number of serviced urban residents is (2388 people and their density is (11,94). The rural population is (101,502) people and the serviced rural area is (17.6) km2 at a percentage of (20.3%). The number of the serviced rural population is (2150) and their density is (122.21) as shown in Map (3). Map 3. Application of the Service Range (1600) M to Gas Stations in Al-Mahaweel District 2021

Map 3. Applying service range 1600)m (on gas stations in Al-Mahaweel District for 2021

Source; The researchers based on station locations and the statistical equason Arc,(Gis)

4. Al-Hashimi District

The number of stations in Al-Hashimi district is (13) stations distributed over the following administrative units:

In the center of Al-Hashimi district, the urban population is (40,271) people, the area of the municipality is (5.5) km2, the serviced urban area is (3.5) km2 by (17.3%. The number of the serviced urban population is (2562), and its density is (7.32), the rural area is (9.5) km2 at a percentage of (11.8)%, the urban population is (64,241) people, the municipality's area is (3.6) km2, the serviced urban area is (1,9) km2, at a percentage of (9.4%), the serviced urban population is (33896) people and their density is (17,84), the rural population is (88,657), the serviced rural area is (28) km2 with a percentage of (34.7%), the serviced rural population is (5862), and their density is (209,39).

In Al-Qassim district, the urban population is (88,053) people, the municipality's area is (28.8) km2 and the urban serviced area is (14.8) km2 with a percentage of (73.3%), the number of serviced urban population is (4514) people and their density is (3.05), The rural population is (91,207), the serviced rural area is (1.5) km2 with a percentage of (1.9 %), the number of serviced rural population is (458775) people and their density is (305.85).

In Al-Taliaa district, the number of urban residents is (9,319), the area of the municipality is (2.7 km2), the density of the serviced urban population is (3.45), the rural population is (34,509), the serviced rural area is (8) km2 at a percentage of (9.92)%, the serviced rural population is (95096) and their density is (118.7).

In Al-Shomali district, the number of urban population is (19,619) people, the area of the municipality is (2.3) km2, the serviced urban population is (8.53), the rural population is (78,551), the serviced rural area is (33.6) km2, with a percentage of (41, (68%), the serviced rural population is (5324) and its density is (158.46) as shown in Map (23).

4. Al-Musayyab District

The number of stations in Al-Musayyab district is (22) stations distributed over four administrative units as follows:

In Al-Musayyab district center, the urban population is (61,947), the municipality's area is (39.4) km2, the serviced urban area is (24) km2 with a percentage of (40.2%), the number of the serviced urban population is (3768) and its density is (1,57), the serviced rural area is (9.3) km2 at a percentage of (10.18%).

In Al-Iskandaria, the number of urban residents is (108,713 people, the area of the municipality is (25.1) km2, the serviced urban area is (21.7) km2 with a percentage of (36.3%), the number of serviced urban population is (93961) and their density is (4.33), the rural population is (70,583), the serviced rural area is (54.8) km2 with a percentage of (60.02%), the serviced rural population is (10,658) and their density is (194.49).

In Saddat Al-Hindia, the urban population is (36,612) people, the municipality area is (24). 3, km2, the serviced urban area is (14) km2 at a percentage of (23.5%), the number of serviced urban population is (21) people and their density is (1,50), the rural population is (94,200), the serviced rural area is (21,2) km2 at a percentage of (23.2%), the number of serviced rural population is (8581) and its density is (404,81).
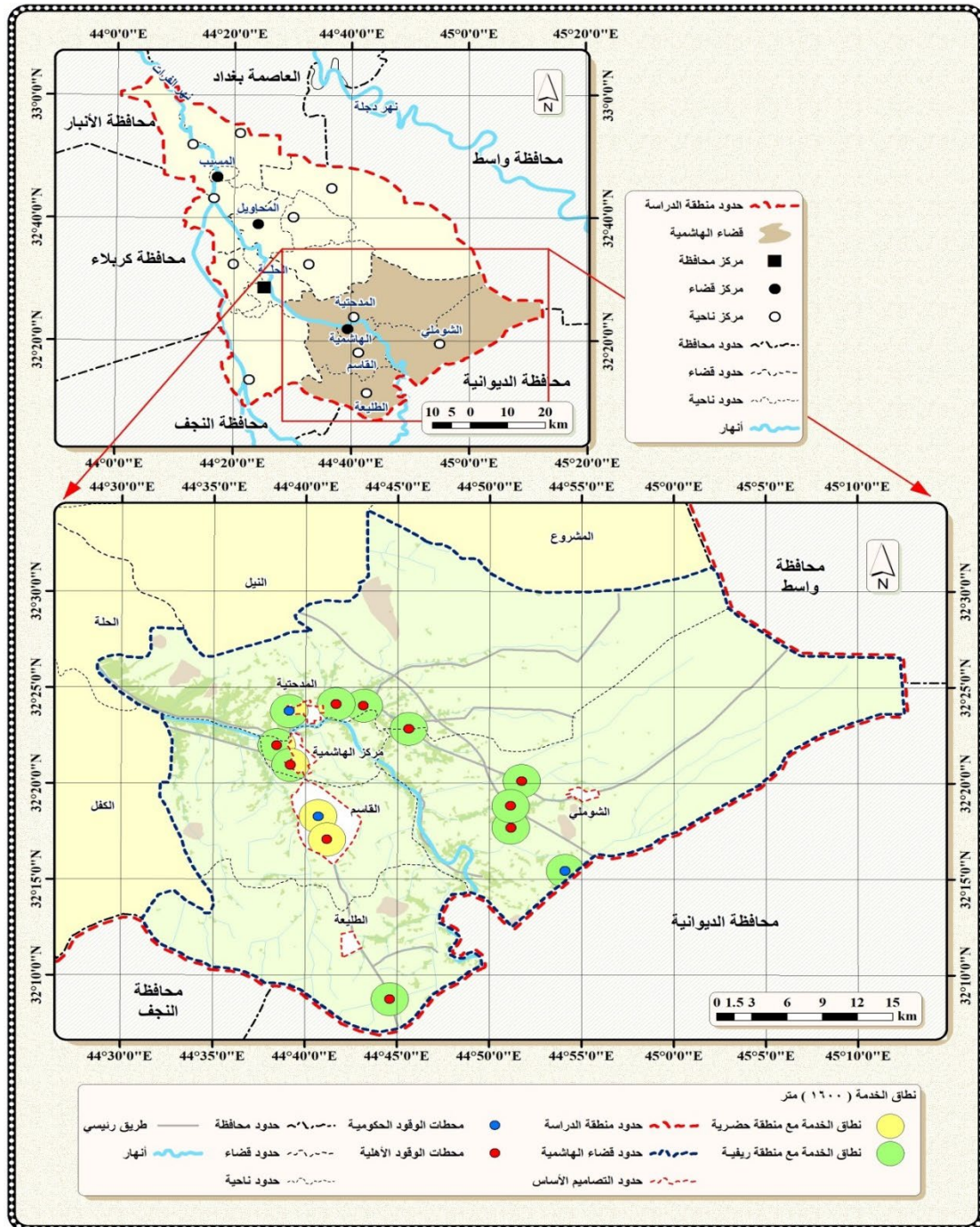
Map 23. Applying service range 1600)m (on gas stations in Al-Hashimia district for 2021

Source; The researchers based on station locations and the statistical equasion Arc,(Gis)

In Jurf al-Sakhr district, the urban population is (6,542), the municipality area is (1.4) km2, the density of the serviced urban population is (4,67), the rural population is (46) , 589), the serviced rural area is (6) km2 at a percentage of (6.6%), the number of serviced rural population is (1657) and their density is (276,32) as shown in Map (24).
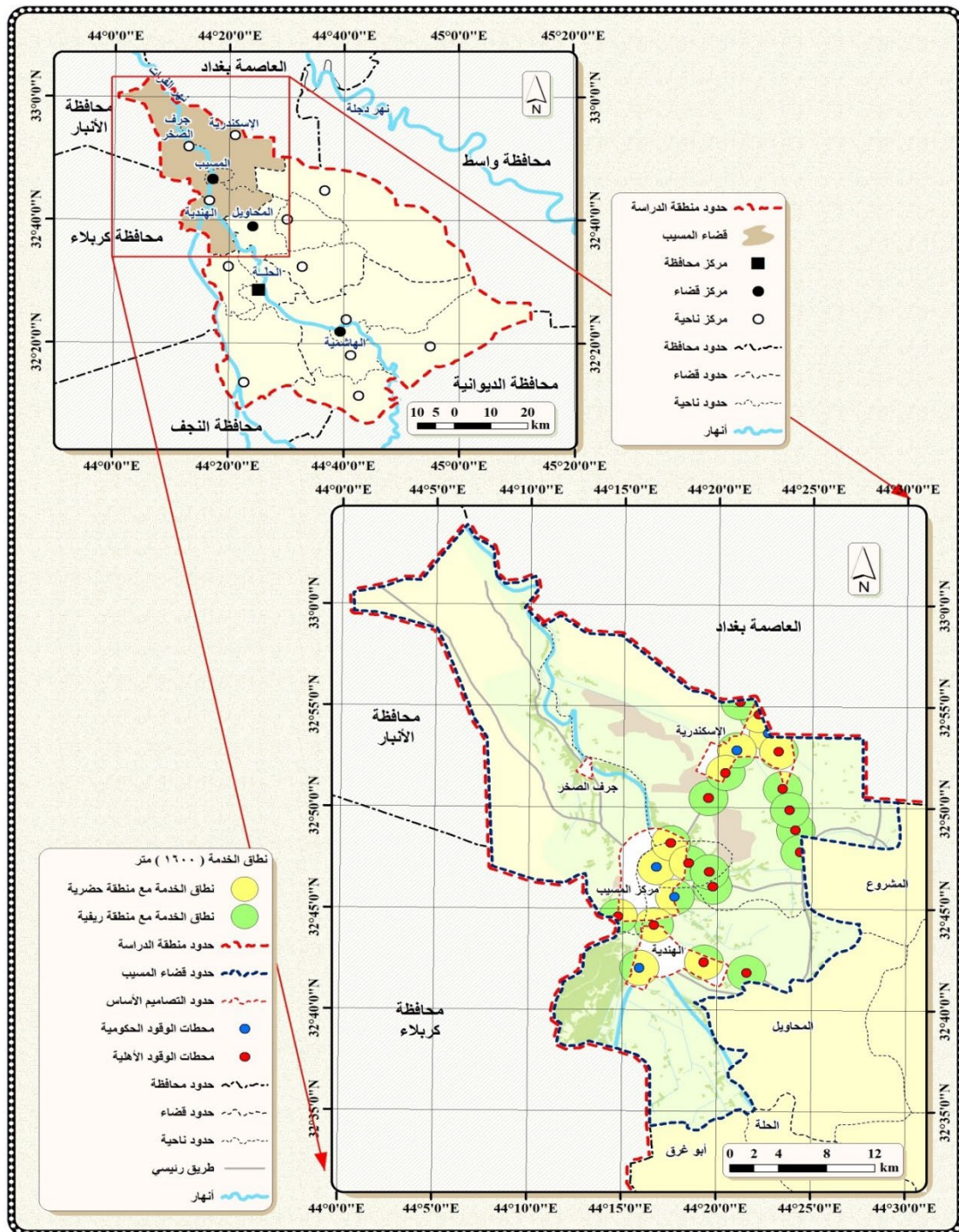
Map 24. Applying service range 1600)m (on gas station in Al-Musayyab district for 2021
Source; The researchers based on stations locations and the statistical equasion Arc,(Gis)

5. Presumption of the nearest neighbor

It is one of the most famous statistical methods through which the pattern of distribution of phenomena is spatially determined, which is represented by a point. It determines the real distance between gas stations on maps in the form of points to indicate the pattern in which these stations are distributed in the province of Babylon, as well as determining the expected distance separating them in the random pattern distribution in order to reach results through which it is possible to infer the shape of the distribution of these stations spatially. It is also a tool for measuring the extent of dispersal or concentration of gas station locations and the method of their distribution and spread, whether random, aggregated, regular, or

Concentrated. As for the distribution pattern, it is the shape or direction in which the phenomenon points of gas stations are formed and distributed on the surface of the earth. The pattern is divided into types and detailed shapes as follows:

1. The aggregative pattern in which the value of the neighborly relationship = less than (1), that is, the value of the neighborly relationship = zero, so the pattern is aggregated.

2. The random pattern, in which the value of the neighborly relationship = (1), but the distance separating the points is irregular.

3. The divergent pattern, in which the value of the neighborly relationship is confined between greater than (1) and (2,15).

By analyzing the results related to the nearest neighbor, the following can be concluded:

1. The total value of the standard degree (Z-score = 4.59) means that the pattern in which the spatial distribution of gas stations in the study area is within the critical value range (Crtitcal value) that ranges between (2.5 - 2.58) It thus falls within the acceptance region. Therefore, the initial null hypothesis, which states that the expected pattern of gas stations is an aggregated pattern is accepted.

2. Confidence level (P_ value = 0.00) which indicates a proBabylonity of 0%, i.e. less than 1%, meaning that the proBabylonity of the spatial distribution pattern of gas stations is an aggregated pattern.

3. The value of the nearest neighbor and the pattern for the distribution of gas stations in the study area is (a convergent pattern) as shown in Figure (17).

5. Results

1. It was found that there is a deficit in governmental fuel stations according to the application of the criterion of Ministry of Oil (35,000) people, at a percentage of (41) governmental stations throughout the province of Babylon.

2. The study showed that there is a shortage of fuel stations in the centers of administrative units according to the criterion of the Ministry of Housing and Construction (12,000) people, at a percentage of (44) stations.

3. The study concluded that the pattern in which gas stations are distributed is a clustered pattern.
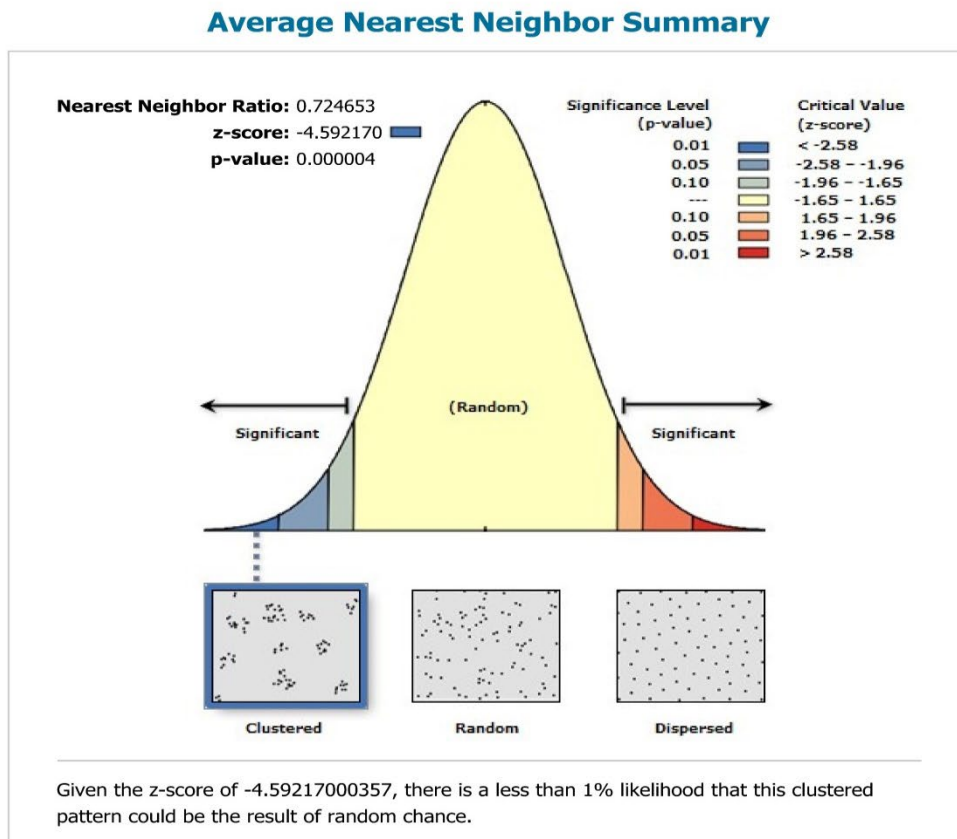
Average Nearest Neighbor Summary

Observed Mean Distance:	3004.3206 Meters
Expected Mean Distance:	4145.8746 Meters
Nearest Neighbor Ratio:	0.724653
z-score:	-4.592170
p-value:	0.000004

Dataset Information

Input Feature Class:	محطات الوقود في محافظة بابل
Distance Method:	EUCLIDEAN
Study Area:	5225235868.000000
Selection Set:	False

Figure 1. Results of analysis of nearest neighbor in the study area for 2021
Source; The researchers based on the statistical analysis.

4. The study showed that there is a clear discrepancy between the stations in their structure, the number of pumps and tanks, their capacity and the type of facilities attached to the station.

5. The study showed that the distribution trend of the fuel stations starts from the northwest of Al-Musayyab district, all the way to the southeast of Al-Qassim district.

6. There is a lack of conformity of some stations with the approved standards through their proximity to residential neighborhoods, educational and health institutions, bridges and major intersections.

Recommendations

1. The study recommends restoring the balance between population numbers and the number of stations in each area, while adhering to the population size standards.

2. The study suggests that there should be joint cooperation between the public and private sectors for the purpose of establishing integrated stations that contain all attached facilities.

3. The study suggests that the station owners should abide by the established regulations.

4. The study suggests opening and establishing a number of governmental stations, especially in areas experiencing an increase in population.

5. Increasing the quantities of the product during the days when the demand for fuel increases, especially during religious occasions.

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