Analysis of spatial distribution patterns of health centers in Rusafa district

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Abstract

The availability of health centers in the population sectors depends on their location, geographic, social and topographic nature. This research aims to reveal the spatial distribution pattern of health centers in Rusafa district, Baghdad and the general trend of that distribution using statistical spatial analysis methods, in which the Nearest Neighbor method, to determine the prevalence of points health centers The spatial distribution of the centers was based on factors (number of health centers per sector, name of the sector, population density in each sector), and research data obtained from the public sectors of the Baghdad Health Department. In 2017, the researcher concluded that the spatial distribution of health centers in each of the Rusafa sectors of Baghdad takes the form of a divergent random pattern ie there is no organization and planning in the presence of the number of health centers where the area and population of each sector were not taken into account. The research also found that the pattern of distribution of sectors in the district of Rusafa has taken a regular distribution according to the Lorenz index, which is one of the measures of concentration.

Key words: Spatial Statistics, Nearest Neighbor method, Lorenz index, number of centers, pattern distribution

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1- Introduction

Spatial relationships are the most important elements of urban planning. The spatial pattern is an image of the form, spread, and distribution of phenomena on the surface of the earth, as each phenomenon does not Their spread and distribution must have a special form called a pattern, which is produced by a combination of factors called pattern analysis.

2- Research Methodology

The research methodology is based on spatial analysis. Through the descriptive analysis methodology, it consists of a set of basics, applications, and methods on how to collect and analyze data. To achieve the objectives of a project, whether short-term or long-term in a coherent, homogeneous, responsible and repeatable methodology contains a set of criteria to evaluate each stage of the work.

3 - Research Objective

The objective of the research is to uncover the pattern of spatial distribution of health centers in the Rusafa district of Baghdad, to propose appropriate recommendations, with regard to the characteristics and problems of the spatial distribution of health centers to be a help for planners of the healthy environment to develop plans based on scientific, realistic and comprehensive, because of its place in raising the level Control of diseases and reduce their spread in general.

4-Theoretical Frame

4-1 Spatial Analysis

It is a method of measuring spatial relationships between phenomena, interpreting and utilizing them, understanding the causes of the existence and distribution of phenomena on the Earth's surface and predicting the behavior of those phenomena in the future. Study and characteristics of interest to man and his various activities

4-2 Nearest Neighbor index

The first uses of the nearest neighbor coefficient at the hands of botanists to describe and analyze living plant distributions in geographical areas, but in 1909 Hertz was the first to determine the origins of this indicator either the first to use the distance between the closest sites to measure the extent of the distribution pattern from the random situation Daisy was in 1952, but the development of the equations to calculate the nearest neighbor index to both Clark and Evans in 1954.[1][5]

The nearest neighbor index technique is used to analyze the distribution of geographical phenomena on the surface of the earth based on the straight distances between points. It then determines the general pattern of spread of points in spatial distributions and thus comparability of distribution patterns to more than one point. These distributions can be random, regular or centralized. The nearest neighbor index is easily applied when we have a small or medium-sized database either if the data is the calculation of this indicator is somewhat difficult.

The nearest neighbor index is the ratio of the average true distance between each adjacent site to the average expected distance between the same number of locations for the studied area, so the scale is based on knowing the distance between each location representing the point in the area (understudy) and the location (s). Closest to it.

4-3 Calculate Nearest Neighbor index

The nearest neighbor index is denoted by the symbol (NNI) and the calculation of the nearest neighbor index is based on balancing the average actual distances $\bar{d}$, It separates the points and their nearest neighbors in an actual spatial distribution with the expected mean distances τ , It separates those points from their neighbors in a random (theoretical) distribution. The nearest neighbor index (R) can be formulated according to the following equation:[4][6]

$$R = \frac{\bar{d}}{\tau} \;\ldots\ldots\ldots(\mathbf{1})$$

whereas:

R: represents the nearest neighbor index.

d¯: represents the average actual distances separating points and their nearest neighbors in the actual distribution of points.

$\boldsymbol{\tau}$: represents the average expected distance separating points and their nearest neighbors in a random (theoretical) distribution.

The closest point or neighbor next to a given point, such as y, is defined as the point where the distance from point y is less than any distance separating point y from any other point.

If we denote the actual distance between sites and their nearest neighbors in the symbol d and the number of locations in the symbol k, the average actual distances d⁻ for the nearest neighbor is calculated as follows

$$\bar{d} = \frac{\sum_{i=1}^{n} di}{k} \ldots\ldots\ldots.(2)$$

The mean distance expected to the nearest neighbor of the theoretical random distribution, which is denoted by the symbol τ, which separates the points and its nearest neighbors in a theoretical random distribution.

$$\boldsymbol{\tau} = \frac{1}{2\sqrt{\varphi}} \ldots\ldots\ldots.(3)$$

Note that there are many cases of distributions that are described as consistent or regular, except that the degree of dispersion in each of them is not equal, λ representing area of points in the region i.e. the density of sites in the actual distribution and that the density of the area φ is calculated from the product of dividing the number of points or (the number of sites n) on the general area of area m and as follows:

$$\varphi = \frac{\mathbf{n}}{\mathbf{m}} \ldots\ldots\ldots.(\mathbf{4})$$

whereas

n: represents the number of locations or points in the studied area.

m: actual area of the region.

Substituting equation (4) in equation (3), results in us that the average expected distance.

τ, become the following formula:

$$\boldsymbol{\tau} = \frac{\mathbf{1}}{\mathbf{2}\sqrt{\frac{n}{m}}} \ldots\ldots\ldots.(\mathbf{5})$$

By substituting with equation (5) in equation (1), we produce another formula for calculating the nearest neighbor indicator:

$$\mathbf{R} = \frac{\bar{d}}{\frac{1}{2\sqrt{\frac{n}{m}}}}$$

$$\mathbf{R} = \bar{\boldsymbol{d}}\left(2\sqrt{\frac{\mathbf{n}}{\mathbf{m}}}\right)$$

$$\mathbf{R} = \mathbf{2}\boldsymbol{d}\sqrt{\frac{\boldsymbol{n}}{\boldsymbol{m}}} \qquad (6)$$

Equation (6) can be written as[4]:

$$\bar{\boldsymbol{d}}\sqrt{\varphi} \qquad (7) \qquad \mathbf{R} = \mathbf{2}$$

It is inferred from the value of R, which represents an indicator of the closest neighbor, to reaching a quantitative criterion by which we can infer the spatial distribution pattern of the centers represented by these points and whose quantitative significance is between zero and 2.1491 on the distribution. It is also used to compare between one distribution pattern and another, as well as between the degrees of one pattern.

4-4 Euclidean distance measure[3]

The nearest neighbor indicator measures the Euclidean distance between each point and the closest point to it and notes that when the data pattern is aggregated at that point, the Euclidean distance is very small between each point and the adjacent point. However, as the data values diverge and disperse, the distances between points become large. There are several methods for measuring the traditional distance between points, and among these methods: The Euclidean dimension is one of the most common methods and the Euclidean dimension is defined as the distance between two points drawn in the diffusion drawing. This dimension is called the actual distance between the point and its neighbor d (x_i, y_j). The actual distance or the Euclidean dimension is calculated using the equation taken from the Pythagorean law and defined by the following formula:

This equation can be written in the following formula:

$$\mathrm{d}(\mathrm{x_i}, \mathrm{y_j}) = \sqrt{(\mathrm{x_{i1}} - \mathrm{y_{j1}})^2 + (\mathrm{x_{i2}} - \mathrm{y_{j2}})^2} \quad (8)$$

This equation can be written in the following formula:

$$d(x_i, y_j) = \sum_{k=1}^{n} (x_{ik} - y_{jk})^2 \quad (9)$$

4-5 Distribution pattern:

The value of the nearest neighbor coefficient (R) expresses the distribution pattern. The value of the nearest neighbor coefficient is limited between zero and 2.149, as $0 \leq R \leq 2.149$. The higher the value of R, the more points the spread increases to reach its maximum limit of 2.149 when the distribution reaches the maximum degrees of spread. In light of this, there are three main spatial distributions, namely the

convergent distribution pattern, the random distribution pattern, and the spaced distribution pattern with other secondary patterns close to it.
The value of the nearest neighbor coefficient (R) ranges between zero and less than one, i.e. $0 \leq R \leq 1$. If the value of R = 0, then the apparent point is in this case grouped in one location. Either if the value $0.5 \leq R \leq 0$ then the pattern, in this case, is converging and the closer to zero the closer the convergence becomes and the distribution pattern becomes a cluster (grouped) and if the value of $0.5 \leq R \leq 1$ then the pattern is convergent and goes towards the random pattern as in the figure (1).[2]

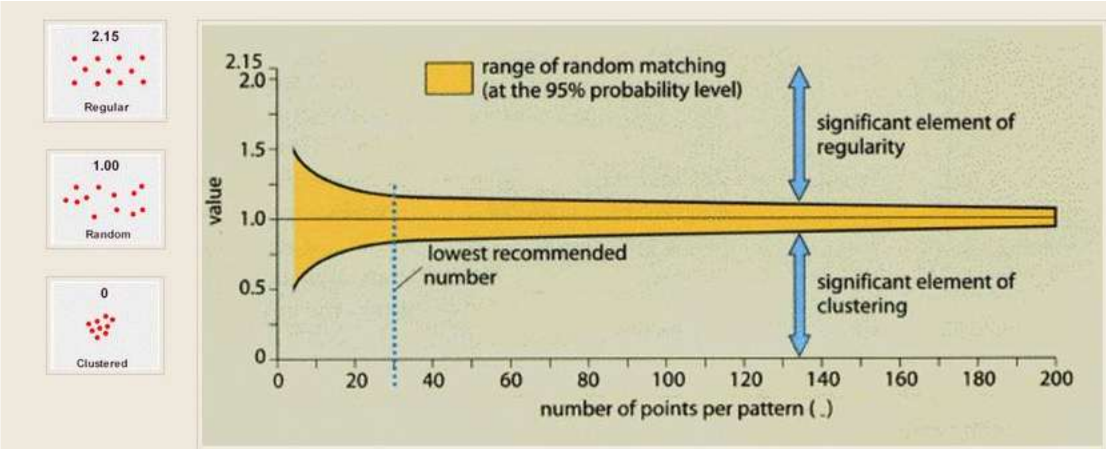

Figure 1: Potential R values based on distribution points[2]

In Figure 1 we note that the possible R values are on the vertical line, while the number of points in the distribution is on the horizontal axis. The misleading internal space in the horizontal bell shape indicates that any value that R takes and falls within this bell is an indication of the randomness of the distribution under a significant level equal to 0.05 while the higher values of it for the period of uniformity of the distribution (the space of regularity) and those that fall under it indicate the distribution pool (Space of assembly). Table (1) shows the values of the nearest neighbor index and the distribution patterns.

Table (1) Nearest Neighbor Index and its distribution patterns

Nearest Neighbor Index R	Distribution pattern
R = 0	clustered
0 < R < 0.5	Converge
0.5 < R < 1	Convergent and heading towards random pattern
R = 1	Random
1 < R < 2	Irregularly spaced
R = 2	Regularly spaced
R = 2.149	Very regularly spaced

4-6 Lorenz Consort[5]

It is one of the measures of concentration that is used in the following fields:

1- It is used to measure the degree of concentration in spatial distributions.

2- To measure the extent of spread in spatial distributions.

3- Measuring the different extent of frequency distributions from the regular distribution, that is, the balance between the frequency distributions and the regular distribution, and the rate of its difference from it.

4- It is used to measure the degree of specialization of a specific region in one of the industries or services.

5- It is used in the study of minorities or an some of society within a large city.

To calculate Lorenz's context, we use the following equation:

$$Q = \frac{F - A}{F - Z} \qquad (10)$$

Whereas:Q: represents Lorenz consort.

F: the cumulative frequency of descending order%.

A: Represents regular cumulative iteration.

Z: the concentrated cumulative iteration.

5. Applied Frame

In this regard, the closest neighbor was calculated to describe the nature of the spread of health centers in each sector and then using the Lorenz index to calculate the degree of concentration or spread of health centers in the Rusafa district in Baghdad in general.

1- The nearest neighbor coefficient:

This aspect included the calculation of the closest neighbor parameter using the statistical program Spss v22, Excel to describe the spatial statistical analysis and the nature of the spread and distribution of health centers, calculated it was according to the sector and the number of centers and population density by each sector, and the population density is measured by dividing the population in each sector by the land area of that sector We count in calculating the nearest neighbor parameter to the number of adjacent points in the symbol K as (K = 3) for each center and the year 2017, and to calculate the factor we relied on the data of Table (2) that represents the sector and the number of centers and population density for each sector, and the analysis of the closest neighbor will be calculated according to Analysis algorithm Mentioned previously.

Table (2) shows the sector, number of centers, and population density

Sector	Number of centers	Population density
Adhamiya	8	13971
Istiqlal	11	3470
Rusafa	10	4167
New Baghdad	8	5182
First Baladiaat	11	21124
Second Baladiaat	11	1044
Al Madaeen	15	3366
Sadr City	21	24504
Shaab	14	10948

- **Calculating the coefficient of the closest neighbor**

The number of points K is determined for each site to determine the closest neighbor, and the calculation will be done according to K = 3, which will determine for us the three closest adjacent sites to the chosen location and Figure (1) shows the nature of the spread and distribution of sites according to the sector and the number of population density centers according to each sector.

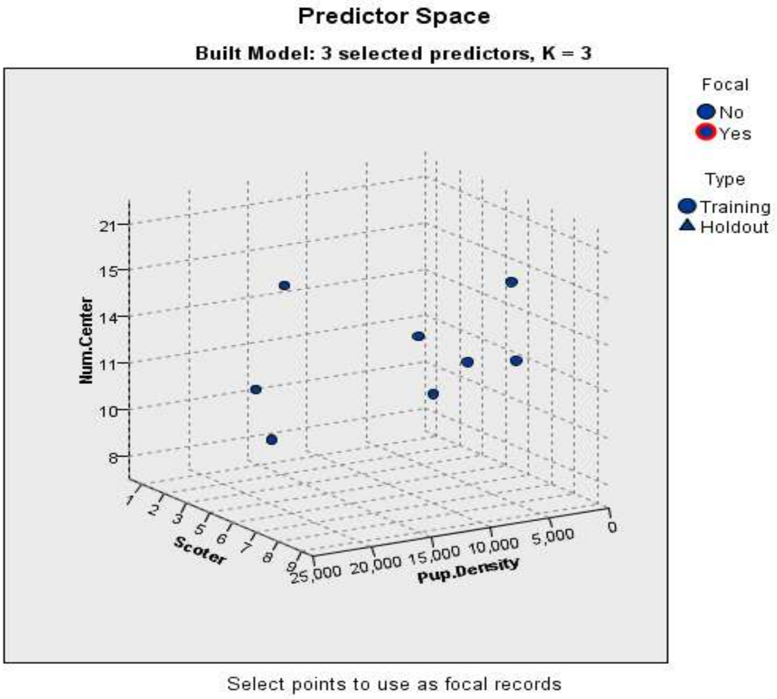

Figure (1) shows the spread of points, depending on the sector, number of centers, and population density

From Figure (1) we find that only one sector was excluded, which is the New Baghdad sector, and after determining the spreading shape of the sites and the excluded sector When K=3 then we move to the second step.

2- Determine the distance d between each location and the nearest neighbor.

That is, we will find the distance between each point and the closest three points adjacent to it according to the location of the point, depending on the sector, the number of centers, and the population density of each sector, as shown in Table (3).

Table (3) shows the distance of each point with its nearest neighbors

Points	1	2	3
1	2.017	2.091	2.168
2	1.429	2.000	2.001
3	2.001	2.001	2.018
5	2.021	2.065	2.091
6	1.429	2.010	2.018
7	2.000	2.001	2.010
8	2.021	2.192	2.310
9	2.017	2.082	2.099

From Table No. (3), we find that for every point that has close points to represent the neighbor link with it, there are points far from it that are not connected with any link, and to clarify the points that are closest to each other in terms of distance and according to the order of the closest is shown in Table(4).

Table (4) shows the closest sectors for each sector

Sector	Nearest Sector	Second closest sector	Third Closest Sector
Adhamiya	Shaab	First Baladiaat	Rusafa
Istiqlal	First Baladiaat	Al Madaeen	Rusafa
Rusafa	Istiglal	Al Madaeen	Second Baladiaat
First Baladiaat	Sader city	Istiqlal	Adhamiya
Second Baladiaat	Istiglal	Al Madaeen	Rusafa
Al Madaeen	Istiglal	Rusafa	Second Baladiaat
Sader City	First Baladiaat	Adhamiya	Shaab
Shaab	Adhamiya	Rusafa	Istiqlal

This convergence has been determined according to the sector, the number of centers, and the population density of each sector, where we find that the Adhamiya sector is the closest sector to it which is the people and then the first municipalities and then Rusafa. As for independence, we find that the closest sector to it is the second municipalities sector then the cities and then the Rusafa sector, and so on for the rest Sectors as shown in Table (4).

3- calculation Average after the location to its nearest neighbors ($\bar{d}$)

The average will be calculated from its nearest neighbors and for each sector based on equation (2) as shown in Table (5).

Table (5) shows the average actual distance for each sector

Sector	$\sum d_i$	$\bar{d}$
1	6.276	2.092
2	5.430	1.810
3	6.020	2.007
5	6.177	2.059
6	5.452	1.817
7	6.011	2.004
8	6.523	2.174
9	6.198	0.066

4- Calculating the average expected distance τ

The expected distance is calculated based on equation (3). As for the density of the area, it is calculated from the product of dividing the number of points (the number of sectors) by the actual area of the region m, as the number of points n= 3) for each sector, and table (6) shows the average expected area for each sector.

Table (6) expected area for each sector

Sector	Area m	Density of Area φ	Expected distance τ
1	15.8	0.189873	1.147461
2	92.2	0.032554	2.771883
3	62.6	0.047923	2.284002
5	32	0.093750	1.632993
6	53.8	0.055762	2.117388
7	424.48	0.007067	5.947549
8	47.5	0.063158	1.989556
9	50.4	0.059524	2.049390

5- Calculating the nearest neighbor coefficient

The closest neighbor R to each sector will be determined using equation (1).

Table (7) shows the coefficient of the closest neighbor with the distribution pattern

Sector	Nearest Neighbor Coefficient R	Distribution pattern
1	1.823156	Spaced with minor and irregular patterns
2	0.652986	Convergent and heading towards random pattern
3	0.878575	Convergent and heading towards random pattern
5	1.260875	Spaced with minor and irregular patterns
6	0.85829	Convergent and heading towards random pattern
7	0.33689	Convergent with secondary patterns within the converged pattern
8	1.092874	Spaced with minor and irregular patterns
9	1.008109	Spaced with minor and irregular patterns

From Table (7), we note that the value of the nearest neighbor coefficient for the Istiqlal, Rusafa, and second Baladiaat is between(0.5<R<1) and this means that health centers in these sectors take a distribution pattern converging and tend towards a random pattern, whereas the pattern of spread of health centers in the Adhamiya sector And the First Baladiaat, Sadr City, and the Shaap, the value of neighborhood parameter closest to these sectors is directed towards a divergent and irregular pattern according to the confined values (1 <R <2), and finally the value of the nearest neighbor coefficient for the Al Madaeen sector, which is between zero and half, meaning that the pattern of distribution of health centers for this sector is directly towards distribution pattern converging.

6- The Lorenz Consort

The Lorenz index was extracted by relying on the number of centers in each sector to measure the extent concentration of health centers in the Rusafa sector using Excel and according to equation No. (10) as shown in the table below.

Table (8) shows the distribution of health centers in the Rusafa sector in Baghdad

Seector	Nu. health centers	The ratio%	Descending order of proportions	A	Regular distribution	R	Dis. center	**Z**
Adhamiya	8	7.33945	19.2661	19.2661	11.11	11.11	100	100
Istiqlal	11	10.0917	13.7615	33.0275	11.11	22.22	0	100
Rusafa	10	9.17431	12.844	45.8716	11.11	33.33	0	100
New Bagdad	8	7.33945	10.0917	55.9633	11.11	44.44	0	100
First Baladiaat	11	10.0917	10.0917	66.0551	11.11	55.55	0	100
Second Baladiaat	11	10.0917	10.0917	76.1468	11.11	66.66	0	100
Al Madaeen	15	13.7615	9.17431	85.3211	11.11	77.77	0	100
Sader City	21	19.2661	7.33945	92.6606	11.11	88.88	0	100
Shaab	14	12.844	7.33945	100	11.11	99.99	0	100
Total	109	100	100	574.312	99.99	499.95	100	900

Lorenz Consort Q=0.18

If Lorenz's presumption is between 0.5 and 0.5, this is the health center regularly deployed in the Rusafa sector

Regular Distribution **0.18**	Distribution center
+1 **0**	**0.5**

5-Conclusions&recommendations

First: the conclusions

1- About population density, we find that the Sadr City sector is the most densely populated, followed by the first municipalities sector, then the Adhamiya sector, then the people sector, then the New Baghdad sector, after the Rusafa sector, then the cities, and finally the second municipalities sector.

2- In terms of population, we find that the Sadr City sector is the most populated and densely populated, then the first municipal sector, then the people after the second municipalities, followed by the Mada'in sector, then the New Baghdad sector, followed by the Independence sector, and finally the Adhamiya sector.

3- If we compare the area of each sector with the other sectors, we find that the cities sector is the highest, followed by the independent sector, followed by the new Baghdad sector, followed by Rusafa, followed by the second municipalities, then the people, then Sadr City, then the first municipal sector, and finally the Adhamiya sector.

4- Concerning the analysis of the closest neighbor, we found that the pattern of distribution of health centers in the sectors (Adhamiya, First Municipalities, Sadr City, Al-Shaab) is irregular and divergent, but in the sectors (Independence, Second Municipalities, Rusafa) the distribution pattern was approximately And it tends towards the random pattern, but in the cities sector it tends towards the convergent distribution.

5- The pattern of distribution of health centers in the Rusafa district in Baghdad regularly, and this is good from the planning point of view of the health centers in this district.

Second: Recommendations

1- Depending on the area and population in the distribution of health centers for each sector.

2- Exploiting uninhabited areas and providing all human needs in terms of infrastructure, schools, health centers, and others to reduce population density in areas with high population density.

3- Using spatial statistics methods in studying all the different phenomena to help decision-makers in terms of better urban planning.

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