

Determine the optimal location for the industrial facility

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Abstract In the economies of countries, regardless of their political systems, industry is a major axis in their economic growth paths. These requirements are closely related to the technical and technical aspect of the production process, as they are also related to the spatial space in which this industry is held, in particular the choice of the site for its production activity. As this choice has an impact on the cost of the product, especially the costs of transferring inputs and outputs of the production process, otherwise, the improper choice leads to higher unit cost of the product for the consumer and affect the volume of production and consumption together, and the consequent economic effects with social implications on Individual and society. In this research, the optimal location of the industrial facility was determined when we have two sources of raw materials between them and the market and according to the Walter Izerd hypothesis using the CAD program to represent the graphs necessary to determine the optimal location of the industrial facility. This topic was addressed to its consequent life because the selection of the appropriate site for industrial ransom must be appropriate in terms of economic feasibility, as well as these sites must take into account their side effects on environmental pollution and develop appropriate solutions and how to get rid of these pollutants Production processes.



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INTRODUCTION

When the industrial facility is signed, those interested in determining these locations encounter the problem of locating the industrial facility, [1] in which it is guaranteed that transportation and production costs (inputs) are as low as possible. Outlay lines or price ratio lines for each item (according to Walter Izzard's assumptions) will be straight and with a negative slope of-) [2] The importance of the research lies in the scientific and applied benefits of the research results for the benefit of certain governmental bodies or institutions or for the benefit of the private sector. [3] It is to reach the results that the research will achieve upon completion of the research, which can be derived from the research hypotheses or questions. [4]

Research Methodology

The research will depend on Walter Izzard's analysis of the site triangle when two sources of raw materials and the market are available, and how the best location for the industrial [5] facility is determined between them, according to Izzard's hypothesis in the analysis. [6] The search will depend on the AutoCAD program to represent the graphs to reach the location. Relying on Arabic and English sources to confirm the required information.

Situ equilibrium of the industrial facility or the positional equilibrium of the industrial facility

To learn how to determine the best location for industrial activity according to Izzard's analysis, we must clarify the concept of the principle of substitution and how the transformation curve is formed. [7]

Transformation line:

It is the line on which the points represent the possible substitution points (lower cost points) for the two dependent variables and with the effect of the distance factor. [8] So that the transport inputs at one point will replace the transport inputs at another point with the change of distance. On this basis, a comparison is made to choose the point where the transportation cost is the least possible [9]. The nature of the transformation lines depends on the relative distance of the different points. The transformation curve is the equal output curve in production theory [10].

Transformation function:

The technical interrelationships between any pair of inputs or any pair of outputs or output-input, the transfer inputs are seen as any set of inputs in the process of productive transformation. It replaces or substitutes other inputs and

outputs. Therefore, the transformational relationship is limited to a harmonious set of changes in two distance variables [11].

Equal outlay lines:

They are called equal spending lines or price ratio lines. They show the costs resulting from the movement of raw materials to specific places with totals of different distances from the sites of raw materials [12]. Assuming that the number of raw materials from their sources is equal (for example, one ton of each material) and that the transport rates are equal and proportional to the distances (according to Izzard's assumption), [13] then these lines will be straight and with a negative decline.(1-)

Izzard relied on a set of hypotheses in his analysis of these data based on the cases of the locational triangle of (Weber) Which:

- 1) The establishment is single, which means that there are no other production units affiliated to it in another location .
- 2) The elements of production represented by (land, capital, labor) are available and obtainable everywhere and at all times and in the required quantities and in terms of costs are the same .
- 3) The raw materials are transportable (motile), but if they are immobile (non-movable), the production process will take place in the same location as the case is (such as the extractive industries and mining) .
- 4) There must be direct transport lines between the facility and the market and the locations of the basic raw materials (railway) .
- 5) Transportation operations and facilities are launched in all directions from all points at homogeneous (similar) costs. Izzard was influenced by Weber's idea by assuming that the weights of different raw materials and market demand were constant, so thinking about transport inputs is limited to the change in the distance in which raw materials and finished products move.

On this basis, we will discuss the situational cases resulting from the various sites of raw materials and the market [14].

First: the linear state (line locational)

For example, suppose that (C) is the location of the market in which all consumers of the produced goods are concentrated, and (M1) is the location in which the basic and necessary raw materials for the production process are concentrated. The line (C M1) is the engineering locus of all possible points for the industrial establishment's signature [15].

At the level of the distance traveled, there are two variables:

First: the distance from point C

Second: the distance from the point M1

In the embodiment of these two variables compared to the location of the facility, we get a graph that reflects the relative relationships between these two distances through the transformation line (-W V), the line of equal costs, which has a negative slope (-1) as in Figure (1).

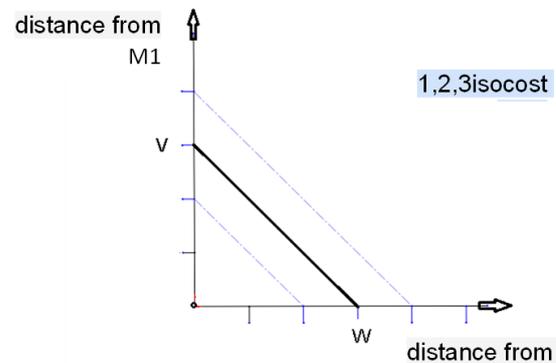


Figure No. (2) The linear case in determining the industrial location

When moving along the line from (V) to (W), the distance is less than (M1) and greater than (C), meaning that the transport inputs at one point will replace the transport inputs at another point. When adding equal output curves (transformation curve), it will apply to one of the equal cost lines, [16] which is as in Figure No. (2) the transformation line (V-W). In other words, all points of the line (V-W) have the same amount of transport costs and the sum of the distance variables from (C) and (1M) is equal to all points of the transformation line (V-W).

Thus, all the points of the site line (C M1) in have the same opportunity to establish the industrial facility there.

Secondly: the local triangle: This case emanates from the previous case when adding a second source of raw materials in the production process (M2) and thus the site triangle is formed. Two sources of raw materials are (M1, M2) and the market (C). Izzard added to this triangle the curve (TS) as a transformation curve. Where the points on this curve represent transport cost points for the two variables approved in the analysis and by the influence of the distance factor so that the transport inputs at a certain point will replace the transport inputs at another point as in Figure (3).

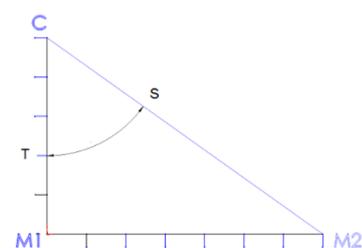


Figure No. (3) replace the transport inputs at another point.

The raw materials are movable and transportable. For every possible realistic distance from one of these sites, there is a transformation curve for the distance between the other two sites, and so on. Figure (4) shows that the shift from (S) to (T) will lead to a reduction in the distance from M1 and in excess of M2.

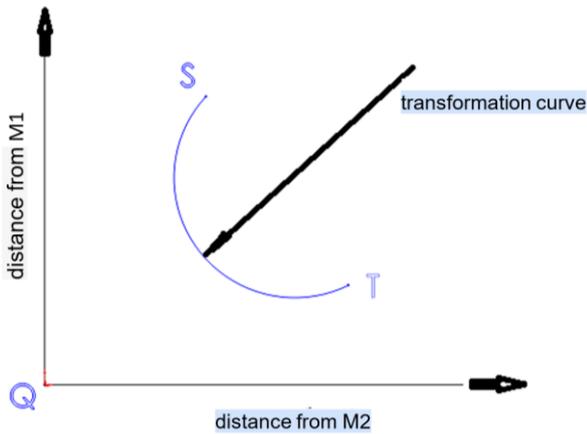


Figure No. (4) shift from (S) to (T) will lead to a reduction in the distance from M1 and in excess of M2

For every possible distance from (c) there is a transformation curve between two variables:

- Distance from (M1)
- Distance from (M2) For each possible distance from (M1) there is a transformation curve between two variables:
- Distance from (C)
- Distance from (m2) For each possible distance from (M2), there is a transformation curve between two variables:
- Distance from (C)
- Distance from (M1) The nature of these transformation lines depends on the

relative positions of the C points. M1, M2)) for example:

- The distance between (C) and (M2) = 8 units
- The distance between (M2) and (M1) = 7 units
- The distance between (M1) and (C) = 5 units

And to take a certain value that we consider (3) units for the course from (C), we get a transformation line that represents the possible sums of the two variables: the distance from (M1) and the distance from (M2) given by the arc (TS), which is the geometric locus of the points (J,H etc) with a radius of (3) units from the center (C) as in Figure (5). The transformation curve is convex with respect to the origin Q.

let's take a certain value that we consider (3) units of distance from (c) we get a transformation line representing the possible sums of the two variables:

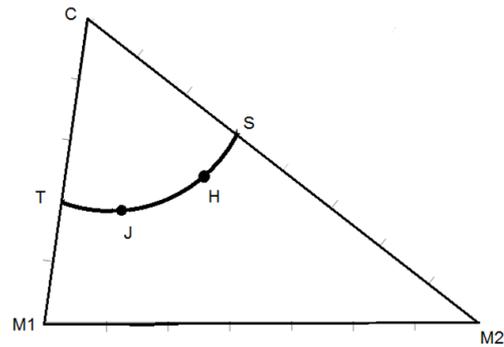


Figure No. (5) Triangle location at Izard [17]

The distance from (M1) and the distance from (M2) given by the arc (TS) which is the geometric locus of the points (J,H.....etc) with a radius of (3) units from the center (C) as in Figure (5) .

The transformation curve is convex with respect to the origin (Q).

As in Figure (6) when moving along the transformation curve from S to T, the distance from M1 will decrease and this distance from M2 will increase. That is, the mobile inputs at one point will replace the transport inputs at another point. On this basis, a trade-off is made to choose the distance whose transportation costs are the least possible, and therefore the best location is the equilibrium point along the curve (TS). It is the point of contact of the curve with the lowest value of the equal cost lines, which appears at point (J), for example, as in Figure (6).

Where this point represents the site equilibrium of the facility.

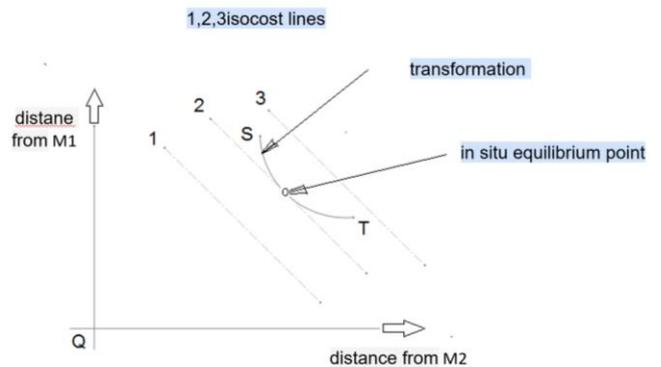


Figure (6) Determining the partial equilibrium point at ISERD

The intersection of (TS) with the equal cost lines depends on the relative weights of the raw materials. As the change or difference in the weights of raw materials or the change in transportation rates will change the decline and shape of the equal cost lines. If we assume that producing (1.5) tons of the final product requires (1) tons of (M1) and (2) tons of (M2), we get a new series of equal cost lines with a different decline, which is LG; As in Figure (7).

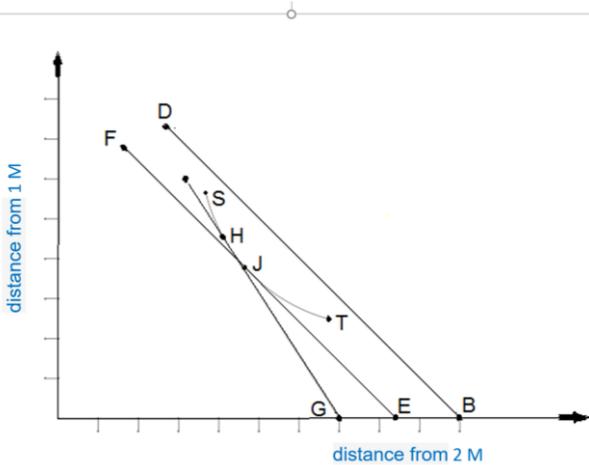


Figure (7) Determining the partial equilibrium point at ISERD

Thus, point H will be the best compared to point J as a point of local equilibrium for the two variables:

- Distance from M1
- Distance from M2

In the same way, the other equilibrium point will change with the change in the relative weights. In the case of adding a third source of basic raw materials in the production process, we get the locational polygon.

Determining the best location for the industrial activity according to the ISERD analysis

Determining this location for the industrial activity, which achieves the lowest reduction in transportation costs, is carried out through two stages of analysis:

- The stage of partial equilibrium of the facility.
- The general equilibrium stage of the establishment.

Partial equilibrium position:

It is the process of first determining the best location for the facility. This means choosing the optimal point on the transformation curve, where transportation costs are least. To get this site, we take the following example: If we assume that (C) represents the market, (A, B) are two sources of raw materials, the distance between them = (150 km) = 150 km.

- The distance from source A to market C = (100 km) = 100 km.
 - The distance from source B to market C = (180 km) = 180 km.
 - In this example, how can we sign the industrial facility, which achieves the lowest possible cost for us?
 - To solve this example, follow these steps:
- 1) To form and draw the triangle, we choose an appropriate scale, and the scale chosen is 1/1,000,000, so we have each (1 cm) representing (10) km.

- 2) The dimensions of the triangle are: The distance between A and B = 15 cm. The distance between A and C = 10 cm. The distance between B and C = 18 cm .
- 3) We draw a straight line of length (15 cm) representing the line A B (we take the scale of 1/1000000) we focus the compasses at point A and with an aperture of (10 cm), which represents the distance AC, we draw an arc. We focus the compasses again at point B and with an opening of (18 cm), which represents the distance BC, we draw an arc, and the two arcs intersect at point C, which represents the location of the market, so we have the locational triangle ABC .
- 4) To draw the transformation curve, we focus the gap at point C and with an opening of (4 cm) we draw an arc where the arc intersects with the line CB at point S and this arc intersects with the line CA at point T, so we get the transformation curve ST. So the distance from A to T = 6 cm. The distance from B to S = 14 cm. See Figure No.(8) .
- 5) We draw the perpendicular axes, one of which represents the distance from A and the other the distance from B as in Figure (9).

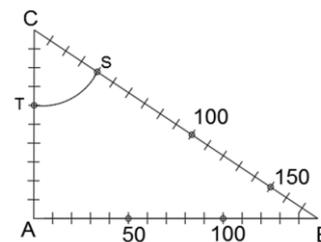


Figure (8) represents the transformation curve

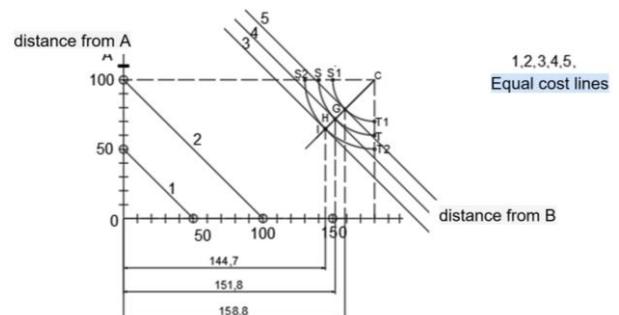


Figure (9) represents the transformation curves

We take a distance on the vertical axis representing the distance from A by (10 cm) which represents the distance from A.

- 1) We take a distance on the horizontal axis, which represents the distance from B by 18 cm, which represents the distance BC, so the intersection point represents the location of the center (market C).
- 2) We focus the compasses at point C and draw an arc with an opening of (4 cm) we get the transformation curve ST.

b) the distance from A.

Using the equal cost lines, we get the partial equilibrium point for the two variables A, C, let it be Y1. We measure the distance AY1 on the vertical axis and it is equal to (4.75 cm). Going back to Figure No. (10) we focus the compasses at point A and with an opening of (4.75 cm) we draw the third arc, so the intersection with the second arc is point 1 Y.

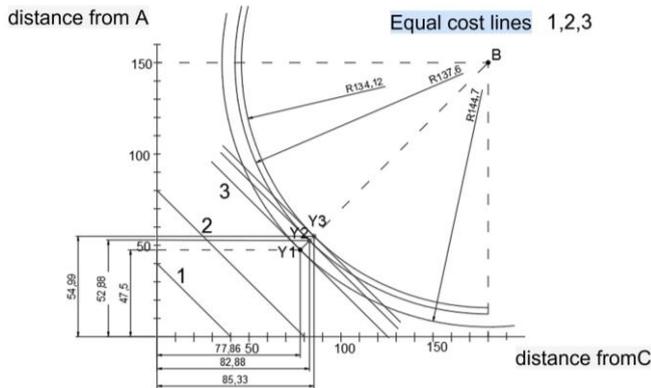


Figure (12) represents the determination of the location of points (Y1, Y2, Y3) on the transformation curves and their distance from location C

We establish the distance from A and make it equal to the amount 2AY = (4.75 cm) as in Figure No. (13) and then we draw the transformation curve for the two variables:

- a) the distance from C.
- b) the distance from B.

Using the steps of equal costs, we get the partial equilibrium point for the two variables B, C, let it be Z1. We measure the distance CZ1 on the horizontal axis and it is equal to (6.6 cm). Going back to Figure No. (10) we focus the compasses at point C and with an aperture of (6.6 cm) we draw an arc that intersects with the third arc at a location representing point Z1. So we get points Z1, Y1, X1

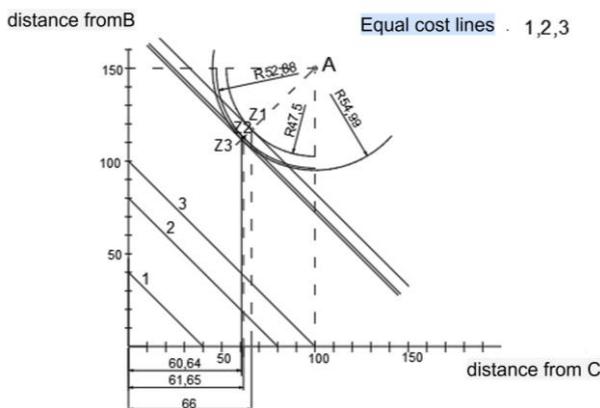


Figure (13) represents the determination of the location of points (Z1, Z2, Z3) on the transformation curves and their distance from C

second try

We repeat the same previous steps, assuming the distance taken from the market site is (6 cm) = 60 km.

- 1- We establish the distance from C and as much as (6 cm) = 60 km, we draw the first arc as in Figure No. (14) we get the transformation curve for the two variables:
 - a) distance from.
 - b) distance from

And by using the lines of equal costs as in Figure (11) we get to determine the partial equilibrium point of the two variables above, let it be 2 X.

- 2- We measure the distance (2 X to B) on the horizontal axis and it was (13.76 cm = 137.6 km). Going back to Figure No. (14) we focus the compasses at point B and with an aperture of (13.76 cm) we draw an arc that intersects with the first arc in a position representing 2 X.
- 3- We fix the distance from B and make it equal to 2 BX = (13.76 cm) as in Figure No.(12) .
- 4- Then we draw the transformation curve for the two variables
 - a) distance from C
 - b) distance from A

Using the lines of equal costs, we get the partial equilibrium point for the two variables (A, C), and let Y2 measure the distance AY2 on the vertical axis, which is equal to (5.288 cm). Going back to Figure No. (14) we focus the compasses at point A and with an opening of (5.288 cm) we draw the third arc, so the intersection with the second arc is Y2 as shown in Figure (14).

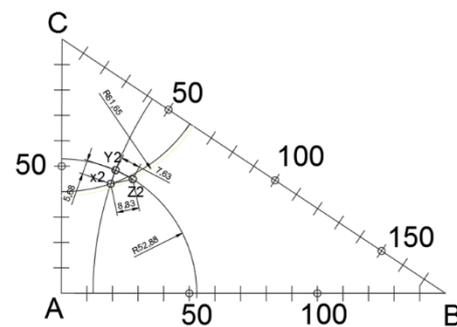


Figure (14) represents locating the points (X2, Y2, Z2) on the transformation curves (second attempt).

We establish the distance from A and make it equal to the amount 2AY = (4.75 cm) as in Figure No. (13) and then we draw the transformation curve for the two variables:

- distance from C.
- The distance from B.

And by using the steps of equal costs, we get the partial equilibrium point for the two variables B, C, let it be Z2. We measure the distance CZ2 on the horizontal axis and it is equal to (6.165 cm). Going back to Figure No. (14) we focus

the compasses at point C and with an opening of (6.165 cm) we draw an arc that intersects with the third arc at a location representing point Z2. So we get the points Z2,Y2,X2.

Third attempt:

We repeat the same previous steps, assuming the distance taken from the market site is (5.75 cm) = 57.5 km.

We establish the distance from C and as much as (5.75 cm) = 57.5 km, we draw the first arc as in Figure No. (15) we get the transformation curve for the two variables:

- distance from A
- distance from B

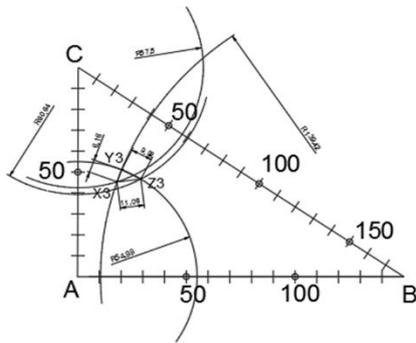


Figure (15) represents locating the points (X3,Y3,Z3) on the transformation curves (the third attempt)

And by using the lines of equal costs as in Figure (11) we get to determine the partial equilibrium point for the above two variables, let it be 3 X.

- 2 We measure the distance (3 X to B) on the horizontal axis and it was (13.942 cm = 139.42 km). Going back to Figure No. (15) we focus the compasses at point B and with an opening of (13.942 cm) we draw an arc that intersects with the first arc in a position representing 3X.

We prove the distance from B and make it equal to 3 BX = (13.942 cm = 139.42 km)) as in Figure No. (15).

Then we plot the transformation curve of the two variables

- distance from C
- distance from B

Using the lines of equal costs, we get the partial equilibrium point of the two variables (A, C), let it be Y3

As in Figure No. (12), we measure the distance AY3 on the vertical axis, which is equal to (5.499 cm). We return to Figure No. (15) we focus the compasses at point A and with an opening of (5.499 cm) we draw the third arc, so the intersection with the second arc is Y3 as shown in Figure.(15)

-We prove the distance from A and make it equal to the amount 3AY = (5.499 cm) as in Figure No. (13) and then we draw the transformation curve for the two variables:

- distance from C.
- The distance from B.

And by using the steps of equal costs, we get the partial equilibrium point for the two variables B, C, let it be Z3. We measure the distance CZ2 on the horizontal axis and it is equal to (6.064 cm). Going back to Figure No. (15) we focus the compasses at point C and with an opening of (6.064 cm) we draw an arc that intersects with the third arc at a location representing point Z3. So we get Z3, Y3, X3 points. Referring to the geometric figures (10), (14), (15) respectively, we note that the perimeter of the triangle (X1,Y1,Z1) in Figure (10) has a length of (39.22 mm) and the perimeter of the triangle (X2,Y2,Z2) in Figure No. (14) has a length of (22.14 mm) and the perimeter of the triangle (X3,Y3,Z3) in Figure No. (15) has a length of (27.14 mm). It becomes clear to us that the second attempt is closer to reality in order to determine the best location for the industrial facility. Determining the best location for the industrial facility depends on the attempts that hit and fail until all three points (Xn,Yn,Zn) are converged in one point. Figure No. (16) where the point (o) represents the optimal location for the industrial facility.

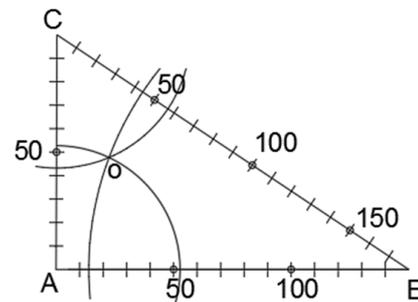


Figure No. (16) represents determining the best location for the industrial facility

Autocad software:

Autocad is one of the programs that are used for drawing and designing on the computer. This program makes it easier for a computer user to create all graphics, whether they are two-dimensional or three-dimensional.

This program was developed in 1982 for computers. In 2010 this program became widely available.

This program was developed by Autodesk, which released the initial versions of it. This program has become one of the leading programs since that time, which is used by most engineers. This program works on Windows computer systems without any problems and in an excellent manner, and also allows its user to complete any design on the ground with high accuracy and the transfer of the project to reality quickly, in addition to the high accuracy calculated for everything. The AutoCAD program enables its user to have the right design appropriately so that he can reduce all errors and speed up the decision-making process well. It also helps to reduce production time through the auxiliary tools in the

AutoCAD program, so the user can choose the analyzes that help in accessing, activating and using geospatial data. Significantly improve performance.

Conclusions:

- 1) In this research, it was reached to determine the best location for the industrial facility by using the hypothesis of (Walter Izzard) by analyzing the site triangle between two sources of raw materials and the location of the market.
- 2) The location of the industrial activity, which achieves the lowest decrease in transportation costs, was determined through two stages of analysis: the partial equilibrium stage of the facility and the general (complete) equilibrium stage of the facility.
- 3) In the first attempt to determine the location, we obtained the location represented by the drawing in the form of number (10), which was confined to the boundaries of the triangle that we obtained, which is (X_1, Y_1, Z_1) .
- 4) The second attempt we obtained the location represented by the triangle (X_2, Y_2, Z_2) . We note from Figure (14) that the second attempt is the closest to reality in representing the site because the area of the triangle is smaller than the area of the triangle (X_1, Y_2, Z_1) that appeared to us On the first try.
- 5) In the third attempt, we got the location, which is within the triangle (X_3, Y_3, Z_3) , as shown in Figure (15). It appears to us that the area of the triangle (X_3, Y_3, Z_3) is slightly larger than the area of the triangle (X_2, Y_2, Z_2) on the second attempt.

- 6) We conclude from these three attempts that the best location of the facility is the one that is achieved for us through repeated attempts, where the ideal location is obtained in which the locations of the points (X_n, Y_n, Z_n) converge at one point. Where (n) represents the number of attempts.

Recommendations:

- 1) The use of the usual geometric tools in the geometric drawing t square, scale, geometric triangle and compasses in drawing geometric shapes does not give us high accuracy in measurement as if we used the AutoCAD program in drawing special graphs in the analysis.
- 2) The AutoCAD program is a sophisticated program that is preferred to be used in the analysis of such research that requires detailed analysis of graphic forms in order to obtain accuracy in measuring the necessary dimensions needed by the analysis.
- 3) The use of (Walter Izzard) theorem in analyzing the locational triangle to choose the optimal location for the industrial facility is one of the realistic theories that contribute significantly to determining the optimal location of the industrial facility, which achieves for this location the lowest decrease in transportation costs.
- 4) One of the important matters that this research focuses on is the necessity of using such successful programs (AutoCAD) in the research submitted by researchers, whose research requires the use of graphs and geometric shapes in their research.

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