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Central Warehouse site selecting by the use of COG and MCDM models
(CASE STUDY : Shamekh company Expansion and Relocating plan)

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ABSTRACT

This thesis makes a location analysis of site selecting the Shamekh company. Given the dynamic environment surrounding the automotive industries, expansion requirements, rapid growth rate of variable cost, and financial-constrained, the site selection of a supply distribution center is critical to the future operations and logistics supporting the Saipa Company. Moreover, this research analyzes site selection alternatives through the use of three modeling techniques; the Center of Gravity Method, AHP Method, and Multi attribute utility analysis. The results of the analysis indicate that the most advantageous location for the central warehouse is in the Tehran industrial zone.

1. Introduction

This report investigates the locating of Shamekh Company, which is one of the big subordinates of Saypa Car Manufacturing Company. Shamekh is responsible for performing logistic services of packing (of spare parts for export or repair), storing (including renting warehouse, and giving warehouse services) distribution and transportation services, manufacturing and providing packing facilities (either wooden or metal), management of containers (including wooden, metal and plastic pallets). In what follows the researcher gives a list of the customers of Shamekh Company in order to provide an image of the volume of their work and activities.

- SAIPA GROUP

SAIPA with 120 subsidiaries and affiliates (37 of them are direct investments) and close to 40,000 human resources is considered as one of the largest industrial groups in Iran. Currently, the company cooperates with more than 1,000 suppliers in the country and is in operation with an annual production capacity of 950 thousand vehicles. **(saipagroup.ir, 2015)**

- SAIPA YADAK

Saipa Yadak Company was established in 1992 to supply spare parts and submit after-sales services to SAIPA products regarding the customer satisfaction. Saipa Yadak covers after-sale services for 15 products including passenger and commercial vehicles from SAIPA **(saipayadak.org, 2015)**

- SAZEH GOSTAR SAYPA

Sazeh Gostar Saypa, is the first established company in Iran in the field of designing and manufacturing of spare parts and it is the main supplier of spare parts for Saypa Company. Sazeh Gostar has signed sale and purchase agreements with more than 500 manufacturers of spare parts. Therefore, it plays a critical role in providing spare parts for Saypa Group. **(sazehgostar.com, 2015)**

The main responsibility of the Shamekh Company is to receive the spare parts from Sazeh Gostar Company and to store and pack them, to prepare them for delivery to the official representatives of Saypa Yadak Company in Iran, which offers after sale services. In addition, the company packs and dispatches the spare parts prepared by Saypa Company for export. Considering the increasing activity of Shamekh Company, it is necessary for the company to expand its space and area. In this report, the researcher investigates the proper place for locating Shamekh Company, with the purpose of reducing the logistic charges and primary investment cost.

The effect of various important factors in locating the warehouse and the packing section differs in different situations. On the other hand, sometimes these important factors in choosing the location contradict each other. These two considerations make it difficult to choose a location because the decision maker has to deal with a variety of different and contradictory criteria and factors. Therefore, choosing a suitable location for implementation is a multi-criteria of decision-making. In this report, the researcher tries to investigate what constitutes the best choice, which is consistent with the important goals and criteria.

2. Objectives

One of the main purposes of investing on an industrial or service project (development or renewal, operation improvement and higher improvement), is to decrease the costs and increase the income which will lead to development and operational improvement of organizations and will result in higher financial and economic benefits. Considering the re-definition of the role of Shamekh Company, as that part of Saipa Yadak Company, which is responsible for packing of spare parts, and the fact that the storing and packing activities are done in a shared location under the supervision of the management of Saypa Yadak Company's warehouse, transportation constitutes the main part of operating charges. (Currently Saypa Yadak Company does the main part of the task in the warehouse of Pars Company).
On the other hand, the charges of finding a location for the implementation of the plan, facilities, and logistics are another important factor in locating. The proper condition for each of these factors is different and they are sometimes contradictory.
In the current report, the researcher tries to show that in locating Shamekh Company the fixed investment charges and transportation charges must be kept low, and at the same time the other important factors related to locating, like far distance between the manufacturer and the customer, availability of human force, ways to receive services, infrastructural facilities, geographical and local conditions, should be taken into consideration.

The main reasons for the need to develop and relocate Shamekh Company are listed below:

1. Currently, Shamekh Company in order to meet the needs of its customers (Sazehgostar and SaipaYadak) has provided some of its space requirements by leased spaces ((rental area of 100,000 square meters of Pars warehouse space) the continuation of which seems not to be cost-effective due to an increase in rental costs annually. During the proceeding years if the past trends (over 20 years) are repeated, the increase in the annual rent will be 33-fold over the next 10 years.
2. Because of the distance between Pars warehouse and Shamekh Co., some items are required to be transported from the original location to Pars

warehouse which imposes extra transport costs to the company and monitoring and control costs increase.

3. Due to space limitations around Shamekh Co., the development and purchase of surrounding lands in the current location is not possible and another location should be chosen to develop the company space.
4. Reduced operation costs due to the centralization of warehouses (packaging, storage, shop, etc.) and thus reducing the cost of parts with an approach to increase spare parts distribution network satisfaction and increase market share
5. Concentration and storage process improvement to increase the speed and quality in the distribution of spare parts in the after-sales service network
6. Improvement of employee productivity due to the centralization
7. The increase in appropriate generators with the nature of added value (purchase of fixed assets such as land due to significant inflation rate for a long period can be followed by non-operational income for the company)
8. The possibility of space development due to the increasing diversity of the vehicles and market share in the coming years

The following factors must be considered in site selection:

- Accessibility to the consuming market(Short distance to the market, Less probability of frequent stops on the road because of traffic, Less probability of frequent stops on the road because of traffic)
- providing the human resource(Population occupied in industrial section, Number of job seekers- diploma certificate, Number of job seekers- above diploma certificate, Number of job seekers- BA certificate and upper)
- Access points(Free way,rail road,air port)
- Geographical and local conditions(temperature, moisture, Speed of wind, Rate of raining)
- Infrastructural facilities(land, electricity, Drinking water, gas)
- Transportation charges of raw material
- Industrial infrastructures
- Educational facilities, Cost of resident ,Healthcare facilities

Other indicators can be considered in site selection but are not considered in this report for the following reasons:

1. Time-consuming and costly data collection relative to their importance
2. The absence of official sources that could be relied on their data
3. The complexity of indicators and their measurement

Some of the indicators with lower importance are not included in this report but are presented below and in case of need, they can be addressed in later studies.

1. Topographic information of the area
- Suitable slope
- Above sea level
- Not being at earthquake fault
2. Facilities
- Access to telecommunication systems (fiber optics)
- Proximity to urban areas
3. Supply Chain
- Proximity to bases for export
- Proximity to bases for import
- Proximity to harbor and waterfront
4. Social and cultural issues
- Being remote from marginal issue
- Social issues (immigration)
- readiness for development
- Coordination with government programs (20 years outlook)
- Culture of the region
- Higher Education level

5. Special advantages
- Local officials support of the projects
- Possible future development
- Having privileges and special permit on the ground

3. Methodology

3.1. Summary Of Site Selection Process

In short, the process of development and site selection of Shamekh Company is performed within 5 stages:

1. Analyzing the activities, objectives and strategies of Shamekh Co.: In the first phase the activities and strategy of the company over the coming years have been analyzed and considering the policies of Saipa and SaipaYadak Co. in line with market development and activities, the required amount of space required for the next 10 years is evaluated.
2. The analysis of Shamekh Company development plan in one of the provinces in the country: In order to identify the extent of the company's logistics network, the scope of spare part provider centers, after sales centers and export package terminals across the country have been investigated and the value and number of input and output packages of the company as well as their distance are estimated.
3. Given that the number of indicators to be evaluated is high, and examining them for all areas of the country is costly and time consuming, in order to reduce the number of options under study, based on the importance of the two major factors of fixed investment and transport costs, fixed and variable costs have been evaluated for the selected areas for developments in 5 steps:

- Continuing the present trend and renting warehouse: In order to draw the cost of continuing current trends and activities in rental warehouse, the related costs are estimated for the next 10 years.
- Purchase of land and construction of warehouse: According to the analyses conducted in the second step due to the concentration of transmission centers of spare parts and after-sales agencies within a radius of 400 km from Tehran and significant increase in the cost of transport outside the radius of 400 kilometers the area under study is limited to three zones including 1- Tehran Industrial Zone (preferably employer) 2- radius of 150 km from Tehran, 3-radius of 150 to 400 kilometers from Tehran and cost of purchase

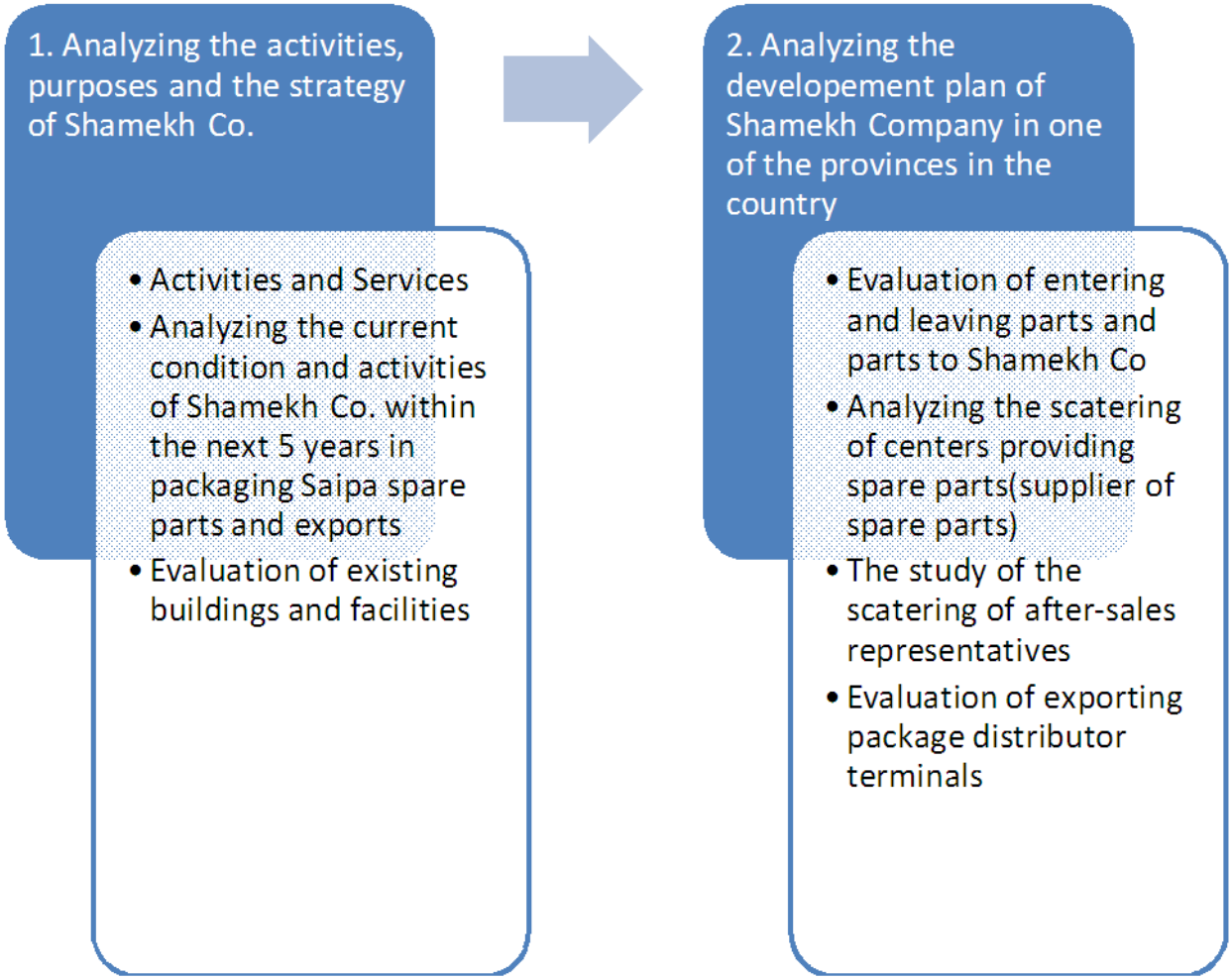
of land, construction and transportation costs over a 10 year period is estimated.

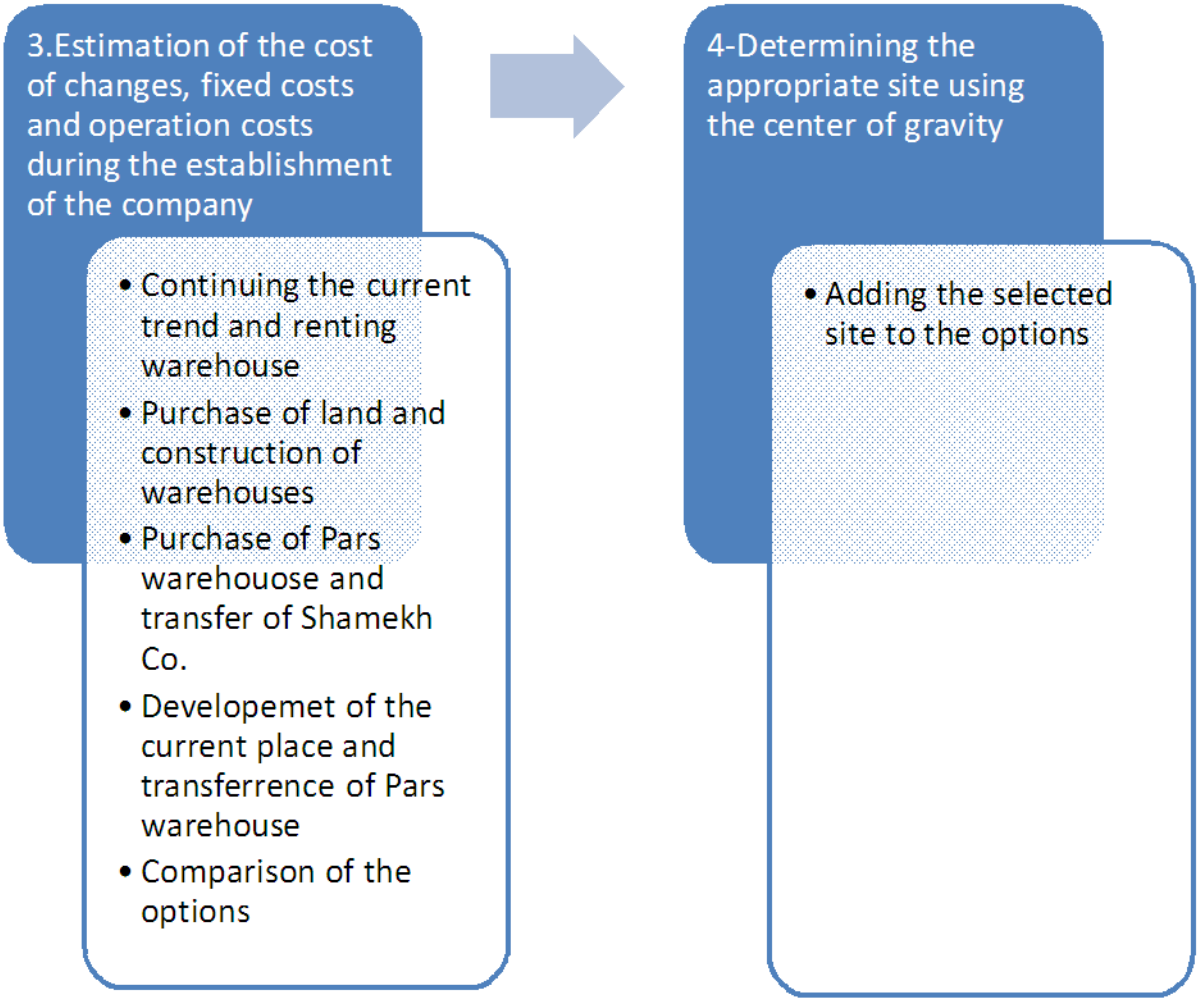
- Land purchase and transfer of Shamekh Company: Right now the main activities of packaging and storage of spare parts are performed in the area rented by Shamekh Company (Pars warehouse) and the owner of the land is ready to sell it to a Shamekh Company and with regard to the benefits associated with this location and employer preferences in choosing this location, this options is analyzed.
- Developing the current location of Shamekh Company and transfer of Pars warehouse: Because of some advantages regarding the lack of Shamekh Company movement as well as the idea of some senior managers regarding the Shamekh Company development in the current area (in case of purchasing the surrounding lands) and transferring Pars warehouse to this location, the current facilities of Shamekh Company as well as costs related to the development of the current location are examined.
- Comparison of the options: At this stage, the results of 4 previous steps have been analyzed and based on the lack of justification, three options were omitted at this stage including: movement within a radius of 150 to 400 kilometers from Tehran and The fourth option.

4. Given that the most important factor in determining the site of warehouse is reducing the cost of transport and in order to verify the lack of removing an option falsely, at this stage the gravity center model was used to determine the place of warehouse. The center of gravity model is used to determine the site of a "central" warehouse and it is mostly focused on the cost. In other words, the purpose is to determine the location of a warehouse which is suitable for manufacturing plants and markets. In this method a cost criteria which is composed of distance and volume is used. Using these criteria, the best site is the one that minimizes the weight distance between warehouse and the factory or market. In which two sites locate within 150 kilometers of Tehran (Kashan and Saveh) were added to the options to be evaluated.
5. At the end of the analysis in order to consider other factors affecting location (factors stated in objectives section) the Analytic Hierarchy Process (AHP) model is used to determine the weight of each index in which the idea of the major expert was used to perform pair-wise comparison between the indices

and determine the priority of each index over another one and finally while collecting the data related to each option (to choose the central site of the warehouse) and placing then in the Multi attribute utility analysis
from methods of Multi-Criteria Decision-Making Models(MCDMM) , the score of each option is calculated and finally among the top administrative constraint options (such as the possibility of buying land with the intended area, the possibility of obtaining a license, employer preferences) were applied and the final option is suggested.

The flowchart below summarizes the procedure for determining the target location:




3.Estimation of the cost of changes, fixed costs and operation costs during the establishment of the company
• Continuing the current trend and renting warehouse
• Purchase of land and construction of warehouses
• Purchase of Pars warehouuse and transfer of Shamekh Co.
• Developemet of the current place and transferrence of Pars warehouse
• Comparison of the options
4-Determining the appropriate site using the center of gravity
• Adding the selected site to the options

5. Selecting the developement site using AHP and MCDMM models

- Determining the factors affecting the site selection
- Determining the options under study
- Obtaining the weights of the various factors involved in determining the location of Shamekh Co.
- Obtaining the data related to the studied cities
- Obtaining the rank of stats and data related to provinces under study
- Obtaining the weighted rank statistics and information on the cities studied

3.2. Warehouse site selection

The main models are applied to locate the central warehouse is as following :

3.2.1. Center-of-Gravity Model (COG)

The center-of-gravity model helps determine the optimal location for an individual warehouse if proximity to customers is the only criterion. To select a site for an individual distribution center to serve local customers, the model suggests finding the location closest to the center of demand for all customers. Customers are assumed to be located on a grid system, each with a given fixed annual demand. The location of each customer is represented by an x and y coordinate. The COG model finds the approximate location for a single warehouse to best serve all customers. The center-of-gravity model is a weighted approach that locates the warehouse closest to customers with highest demand. This is an empirical method minimizing the distribution distances weighted by shipping volume. The following formula is used to find the COG location (x, y) for the warehouse.

$$X = \frac{\sum_i x_i d_i}{\sum_i d_i} \quad ; \quad Y = \frac{\sum_i y_i d_i}{\sum_i d_i}$$

Where x_i and y_i are the coordinates of the i^{th} customer, and d_i is annual demand of the i^{th} customer. **(Adams, 2010)**

Center-of-Gravity Method This method is useful when the geographic position of a location is important in terms of distribution of the services or materials. For instance, a multihospital system may want to locate their supply warehouse in a community or region that will minimize the distribution distance based on the volume of transactions from this warehouse to each hospital or clinic. Similarly, locating a specialty laboratory, a blood bank, or an ambulance service may use this method, which is based on minimum distribution costs. The method works with coordinates on a map and shows existing facilities or communities with respect to the proposed new facility **(Ozcan, 2005)**

3.2.2. Multi-Criteria Decision-Making Models (MCDM)

Frequently, decision makers face numerous elements on a project that superficially seem mutually exclusive, yet in reality, each component is an intrinsic element of the system as a whole. As a consequence, every component in a system must be evaluated. This task entails many disciplines. Therefore, making decisions about any subject requires an interdisciplinary approach. Essentially, decision-making means solving problems. In other words, the decision maker is forever at a dichotomy. Sometimes, simple scientific methods are enough to solve the myriad of dichotomies, at other times, approaching the event multi dimensionally is necessary **(ITU, 2000)**. A decision maker often uses more than one criteria or objective to evaluate the alternatives in a decision problem. Usually, these criteria conflict with one another. There are many types of multi-criteria problems; they are very common in everyday life. For example, Multi-Criteria Decision-Making (MCDM) methods can be easily applied in choosing government projects, choosing new products, selecting candidates for a professional position, preparing equipment plans, selecting sites for various types of facilities, etc. MCDM refers to making decisions in the presence of these multiple criteria problems. MCDM methods employ multi-dimensional and interdisciplinary approaches **(Ragsdale, 2001)**.

3.2.2.1. Analytic Hierarchy Process (AHP)

T. Saaty has proposed AHP as a systematic method for comparing a list of objectives or alternatives. AHP is especially suitable for complex decisions that involve the comparison of decision elements, which are difficult to quantify. AHP assumes that, when faced with a complex decision, the natural human reaction is to cluster the decision elements according to their common characteristics **(Saaty, 1980)**.AHP is widely used all over the world. Many applications can be found in the literature and lively discussions on its theoretical validity can also be found .Although some controversy surrounds the theoretical basis of the method, it easy to use and produce results that match the intuitive expectations of the users. Despite its ease of use, the procedure for processing information obtained from the decision maker is far from transparent. This makes the methods less suitable for

situations with many stakeholders, In addition , for AHP, the number of pair wise comparison to be made increases rapidly with the number of criteria. Therefore the use of a hierarchal structure of goals. Sub-goals and criteria may be a better option **(Noorul Hassan Zardari, 2015)**

3.2.2.2. Multi attribute utility analysis

All methods evaluate the attractiveness of alternatives in terms of three discrete elements.

The consequences of the alternatives in terms of the decision criteria the relative preference the criteria are denoted in terms of weight; and if the effect scores are measured on different scales, they must be standardized to a common dimensionless number. The methods vary with respect to their treatment of scores and weights.

3.2.2.2.1. Weighted summation

Weighted summation is the simplest form of multi-attribute utility analysis that applies a linear relationship, it involves standardizing the scores across all criteria, assigning preference weights, multiplying the weights by the scores, adding up the resulting scores to obtain total weighted scores for each alternative, and determining the ranking or the total weighted scores.

Although the method requires quantitative information on scores and priorities, only the relative values are used in the assessment. The method does, however, provide a complete ranking of alternatives and information on the relative differences between alternatives. (Noorul Hassan Zardari, 2015)

3.2.2.3. Ideal point model

Based on the concept of value or utility maximization, the ideal point method ranks the alternatives in terms of the degree to which they achieve a pre-specified target or ideal situation (i.e. their distance from the target outcome). Alternatives that are closer to the ideal are preferred to those that are further away. By using a scaling coefficient it allows for the inclusion of the relationship between relative size of the effect and weight into the decision rule.

The ideal point method provide a complete ranking of alternatives and information on the relative distance of each from the ideal solution **(Noorul Hassan Zardari, 2015)**.

4. Results

4.1. analyzing the activities, purposes and the strategy of Shamekh Co.

In this part of the report, the researcher investigates the current situation of the Shamekh Company in terms of the volume of operation. Also considering the new tasks given to the company, and the 5-year plan of Saypa, the researcher will estimate the expected volume of operation in two sections of packing and storing of spare parts and export goods. The results are illustrated in the following tables.

Table 1- estimation of the number of pickings of spare parts in the next 5 years (Shamekh c. o., 2014)

Description	2015	2016	2017	2018	2019	2020
Export of CKD&S KD car	21,500	32,500	41,250	48,000	58,250	77,500
The number of packing needed in a year	19,200,000	30,000,000	33,600,000	37,800,000	41,400,000	45,000,000

In order to know the required space for the development of Shamekh Company, the researcher gathered the information of the current space owned by Shamekh Company, and the space dedicated to them by Saypa Yadak for the purpose of packing and storing the spare parts. He estimated the required space with regard to the increase of the company's activity in future years. The results are illustrated in the following tables.

Table 2- the total spaces dedicated to Shamekh and Pars warehouse (Shamekh, 2014)

Type of the space	Area (sq.m)
Warehouse and the space of packing	26,375
office	3,868
Parking	13,540
parks	3,900
Pars Warehouse	100,000
Total	147,683

Table 3- total space needed for the future developments (sq.m) (Shamekh, 2014)

Project/area	Packing Saloon	Closed warwhouse	Open warehouse	Office	Total
export	9,000	18,000	13,000	-	40,000
Saypa Yadak	7,586	12,000	5,414		25,000
Rented wharehouse	-	7,686	-		7,686
Total space which can be developed for Shamekh in the current location	16,586	37,686	18,414	3,868	76,554
total space owned by Shamekh					47,683
required space in development section					28,871
current space for Pars warehouse					100,000
total space required for export and spare parts					176,554
Total required space considering the developmental space for the activities of Shamekh company					200,000

4.2. Analyzing the development plan of Shamekh Company in one of the provinces in the country

With regard to the obtained re-definition of Shamekh Company, the responsibility for storage and packaging Saipa Yadak parts and based on the extension of the current activities of the company including packaging the exporting items, packaging Zamyad parts and producing pallets, packaging SAIPA Yadak spare parts is the most important activity of this company. Comparing the volume of Shamekh Company activities in packaging of export packs sector, the scope of packaging parts in spare parts section is 5 times greater than the export sector(from the point of view of the operational areas). Accordingly the share of part suppliers for distribution of after-sales service network is analyzed.

The next step is to investigate the incoming and outgoing of materials and spare parts to Shamekh, supposing that Saypa Yadak has merged its warehouse with that of Shamekh. Then the volume of incoming spare parts to Shamekh based on the distance with the dispatching station and the volume of outgoing packages based on distance with receiving station, for the future years are investigated.

4.2.1.1. The study of the scattering of spare parts supplier

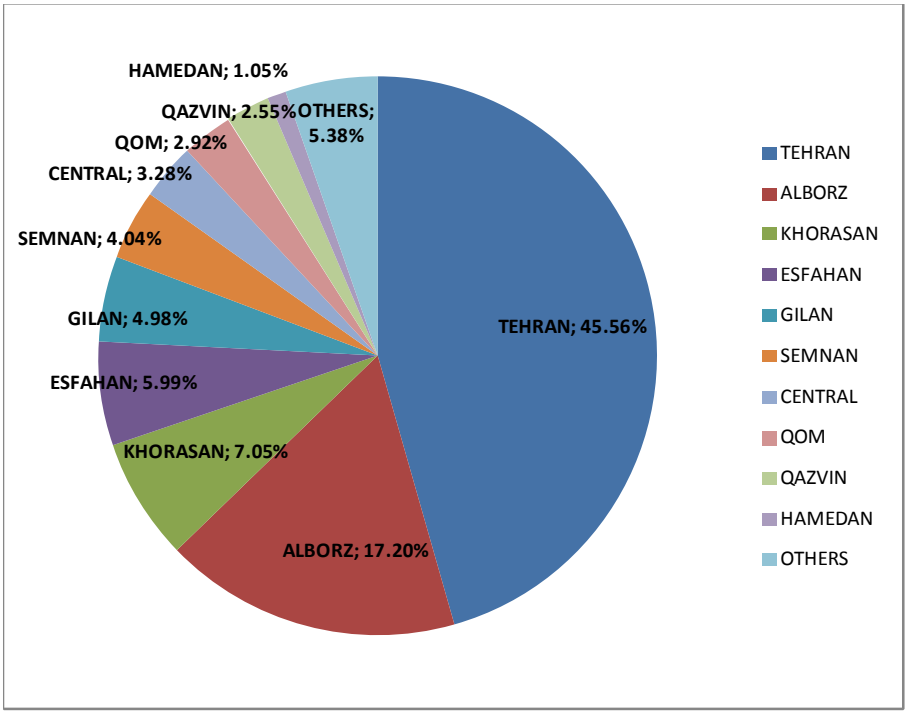
Based on the information presented by Planning Deputy of SaipaYadak Company, the total parts obtained from various centers in 2014 are based on the following table.

Table 4- The share of supplying spare parts for Saipa Yadak (SaypaYadak, 2014)

Row	Province	The number of received pieces	Providing percent
1	Tehran	2,362,606	%45.56
2	Alborz	892,011	%17.20
3	Khorasan	365,371	%7.05
4	Esfahan	310,472	%5.99
5	Gilan	258,076	%4.98
6	Semnan	209,680	%4.04
7	Markazi	170,086	%3.28
8	Qom	151,459	%2.92
9	Qazvin	132,421	%2.55
10	Hamedan	54,384	%1.05
11	Mazandaran	44,146	%0.85
12	Kermanshah	40,850	%0.79
13	Kerman	38,899	%0.75
14	Fars	14,216	%0.27
15	Bandarabas	9,548	%0.18
16	Azerbaijan	8,029	%0.15
17	Khoozestan	5,316	%0.10
18	Yazd	4,990	%0.10
19	Zanjan	1,378	%0.03
20	Other	111,666	%2.15
Total		5,185,604	%100.00

The concentration of manufacturers in each province is presented as follows:

Figure 1- the share of providers in each province in the supply of spare parts (SaypaYadak, 2014)



As a result of this analysis the level of annual transport costs as a result of selecting each province as the location site are calculated based on the following table:

Table 5- The annual transport costs as a result of selecting each province

Province	**Transportation costs (billion Rials)**
Tehran	26.25
Alborz	30.06
Qazvin	39.37
Qom	41.61
Semnan	64.17
Mazandaran	70.48
Markazi	72.83
Gilan	75.76

Province	Transportation costs (billion Rials)
Zanjan	76.72
Hamedan	82.59
Golestan	97.77
Esfahan	103.08
Lorestan	116.13
Kordestan	118.50
Kermanshah	123.66
Charmahal o Bakhtiari	125.66
Ardabil	133.71
Azerbaijan Sharqi	136.95
Khorasan Jonoobi	162.47
Ilam	162.51
Khozestan	198.25
Khorasan Razavi	199.03
Azerbaijan Qarbi	200.45
Shahrekord	203.66
Fars	206.73
Kerman	229.36
Boushehr	267.92
Khorasan Shomali	288.91
Hormozgan	295.03
Sistan Baloochestan	341.22

4.2.2. The study of the scattering of after-sales representatives

Information on transmitted spare parts in after-sales service network based on the provinces and transport costs are presented based on the following tables:

Table 6-The amount of transmitted spare parts in after-sales service network based on the provinces

Province	Sales value (billion Rial)	Transports (billion Rial)	Share of order in each province	The share of transportation costs
SEMNAN	13.08	0.31	%1.0	%0.8
KHORASAN JONOOBI	7.51	0.38	%0.6	%1.0
KHORASAN RAZAVI	55.55	2.74	%4.1	%7.3
KHORSAN SHOMALI	10.02	0.43	%0.7	%1.2
GOLESTAN	35.82	1.51	%2.6	%4.0
MAZANDARAN	74.14	1.87	%5.5	%5.0
KERMAN	45.12	1.81	%3.3	%4.8
YAZD	26.34	0.85	%1.9	%2.3
HORMOZGAN	23.86	1.07	%1.8	%2.9
SISTAN O BALOUCHESTAN	12.17	0.53	%0.9	%1.4
ALBORZ	61.53	0.90	%4.5	%2.4
ARDABIL	20.94	0.82	%1.5	%2.2
QAZVIN	17.83	0.33	%1.3	%0.9
GILAN	54.31	1.34	%4.0	%3.6
BOUSHEHR	12.37	0.49	%0.9	%1.3
FARS	62.89	2.64	%4.7	%7.1
QOM	19.57	0.41	%1.4	%1.1
KOHKILOOYE	7.02	0.24	%0.5	%0.6

Province	Sales value (billion Rial)	Transports (billion Rial)	Share of order in each province	The share of transportation costs
VA BOYER AHMAD				
ESFAHAN	83.46	2.22	%6.2	%5.9
CHARMAHAL O BAKHTIARI	8.60	0.31	%0.6	%0.8
MARKAZI	17.85	0.64	%1.3	%1.7
AZARBAYJAN SHARQI	56.35	2.08	%4.2	%5.5
AZARBAYJAN QARBI	35.14	1.14	%2.6	%3.0
ZANJAN	15.38	0.42	%1.1	%1.1
KERMANSHAH	23.09	0.86	%1.7	%2.3
HAMEDAN	24.82	0.63	%1.8	%1.7
ILAM	8.05	0.35	%0.6	%0.9
KORDESTAN	10.16	0.28	%0.8	%0.8
LORESTAN	14.96	0.55	%1.1	%1.5
KHOOZESTAN	90.36	3.85	%6.7	%10.3
TEHRAN	404.02	5.41	%29.9	%14.5
TOTAL	1,352.29	37.40	%100	%100

Provinces that have 80% of the total distribution of spare parts and transportation costs of spare parts are presented in the following figures:

Figure 2- Each province's share of the distribution of spare parts (SaypaYadak, 2014)

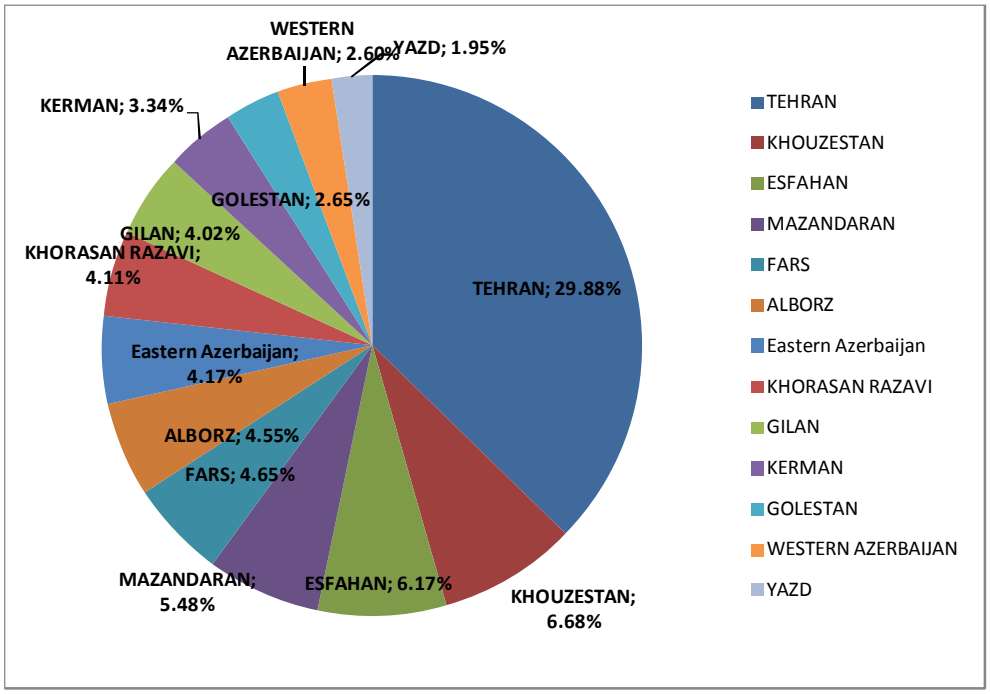
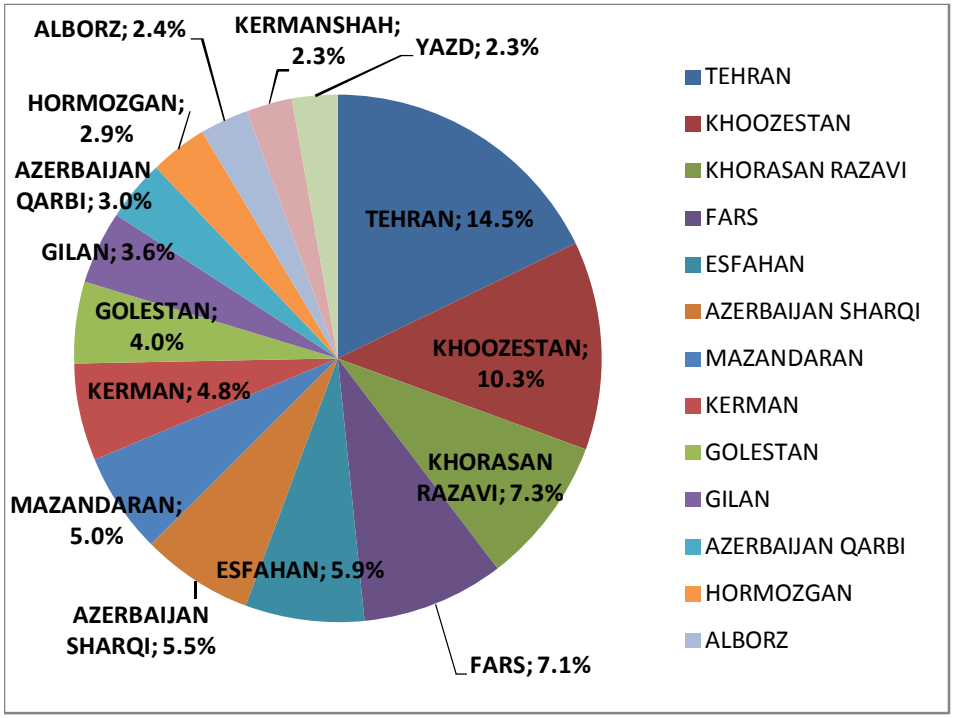


Figure 3- Each province's share of total costs of transport-distribution network (SaypaYadak, 2014)



However, transport costs have more balanced conditions than the distribution share the main reason of which is closeness of the current location of warehouse and packaging area to Tehran and Alborz provinces that despite considerable share of distribution, they have a reasonable cost of storage and packaging

As per the above illustrations, Tehran and Alborz have acquired 34 percent of the total number of spare part distributions and 63 percent of total capacity of provision around the country. This shows the importance of short distance between the storing place and where the spare parts are packed.

Considering the Saypa Yadak spending on year 2014 for distribution of spare parts to other provinces around the country, the researches shows, in the table, how the charges will differ if the location of storing place changes.

Table 7- changes in annual charges of transportation of spare parts based on the place where the warehouse and packing section have been located

Province center	The total transport costs (billion Rial)
TEHRAN	37.40
ALBORZ	40.79
QOM	43.67
QAZVIN	45.07
MARKAZI	60.71
SEMNAN	61.49
MAZANDARAN	62.34
HAMEDAN	65.91
ZANJAN	67.70
GILAN	69.51
ESFAHAN	78.10
GOLESTAN	79.60
LORESTAN	84.91
KORDESTAN	86.94
KERMANSHAH	90.16
CHARMAHAL O BAKHTIARI	93.25
ARDABIL	102.19
AZERBAIJAN SHARQI	104.39
ILAM	113.60
KHORASAN SHOMALI	122.22
KHOOZESTAN	133.33
FARS	140.78
AZARBAIJAN QARBI	142.04
KHORASAN RAZAVI	144.57
KOHKILOOYE O BOYER AHMAD	145.36
KERMAN	158.26
BOOSHEHR	176.87
KHORASAN JONOOBI	199.97
HORMOZGAN	200.97
ZAHEDAN	231.04

As the results show, choosing some provinces as the location for warehouse and packing will increase the transportation charges by six times. Changing the place

of warehouse and packing of spare parts, will make a great change in the transportation charges in distribution section. In addition, this will affect the transportation charges of the manufacturers of the spare parts, and this indirectly affects the charges of providing spare parts by Saypa group. Therefore, the researcher estimated the charges arise from changing the place of warehouse and packing section for the manufacturers.

4.2.3. Evaluation of distribution of export terminal of packages

Right now the responsibility of sending and transporting packages for export purposes is on Saipa logistic company and Shamekh Company delivers the prepared packages to Saipa logistic company in Chahardangeh-Eslamshahr-Tehran. This indicates the necessity of closeness of Shamekh Company to Tehran. However, due to the limited volume of export shipments compared to packaging of spare parts, as well as the increased costs of transportation aligned with transport costs in the distribution of spare parts sector we did not calculate the costs in case of moving the company to each one of the provinces.

4.2.4. Estimating the cost of changes, the fixed costs and operation costs in the case of Shamekh relocating

In order to investigate the financial and economic consequences of the decisions made about the place of implementation of the plan, the researcher gives an estimation of the required investment charges including the purchase of land, its preparing (building of warehouse and surroundings) and transportation charges in the distribution section based on the information provided by Shamekh company, and management of Saypa Yadak warehouses and considering the researcher investigations on the subject. In order to estimate shipping costs in case of selecting a site within 150 to 400 kilometers from Tehran, 4 points in North, South, East and West were selected and transport costs were calculated based on increase and reduction of transportation distances for spare parts to be distributed in after-sales agencies nationwide in comparison with the current situation, the results of which are presented in the following tables:

Table 8- transportation costs increase is case of selecting a site within 400 km from Tehran

Province Center Name	The current transportation distance	The current transportation cost in 2014 (IRR)	Rasht city	Increase or decrease(folded)
THRAN	75	5,405,833,487	325	4.33
AHVAZ	874	3,852,830,040	1039	1.19
ESFAHAN	439	2,738,937,120	764	1.74
SARI	267	2,637,719,820	368	1.38
SHIRAZ	924	2,221,535,780	1249	1.35
ALBORZ	50	2,075,327,960	275	5.50
TABRIZ	599	1,869,474,450	485	0.81
MASHHAD	894	1,811,625,848	1067	1.19
RASHT	325	1,507,144,360	0	0.00
KERMAN	1038	1,342,003,855	1363	1.31
GORGAN	397	1,136,888,360	498	1.25
OROUMIE	907	1,070,991,105	793	0.87
YAZD	677	897,179,681	1002	1.48
HAMEDAN	337	861,690,584	401	1.19
BANDAR ABBAS	1334	845,444,840	1659	1.24
KERMANSHAH	526	824,579,088	590	1.12
ARDABIL	591	641,539,488	266	0.45
QOM	132	628,311,905	457	3.46
ARAK	293	548,726,768	577	1.97
QAZVIN	150	532,153,825	185	1.23
ZANJAN	319	485,095,832	348	1.09
KHORAM ABAD	499	430,128,690	664	1.33
SEMNAN	236	419,601,215	561	2.38
BOUSHEHR	1228	407,537,485	1524	1.24
ZAHEDAN	1567	382,718,168	1892	1.21
SANANDAJ	501	348,702,640	565	1.13
BOJNOORD	713	334,696,545	814	1.14
YASOOJ	738	311,674,592	8063	10.93
ILAM	710	308,009,236	774	1.09
BIRJAND	1313	281,351,320	1548	1.18
SHAHREKORD	543	238,142,705	868	1.60
	19196	37,397,596,792.00	25,412	1.85

Table 8- transportation costs increase is case of selecting a site within 400 km from Tehran,

Province Name	Semnan	The amount of increase or decrease in the distance	Esfahan	The amount of increase or decrease in the distance	Hamedan	The amount of increase or decrease in the distance
THRAN	236	3.15	439	5.85	337	4.49
AHVAZ	1,110	1.27	745	0.85	638	0.73
ESFAHAN	675	1.54	0.00	0.00	464	1.06
SARI	205	0.77	706	2.64	604	2.26
SHIRAZ	1,160	1.26	485	0.52	949	1.03
ALBORZ	286	5.72	489	9.78	387	7.74
TABRIZ	835	1.39	1,038	1.73	609	1.02
MASHHAD	658	0.74	1,222	1.37	1,231	1.38
RASHT	561	1.73	764	2.35	401	1.23
KERMAN	1,274	1.23	661	0.64	1,125	1.08
GORGAN	377	0.95	836	2.11	734	1.85
OROUMIE	1,143	1.26	1,074	1.18	610	0.67
YAZD	913	1.35	300	0.44	734	1.08
HAMEDAN	573	1.70	464	1.38	0.00	0.00
BANDAR ABBAS	1,570	1.18	975	0.73	1,421	1.07
KERMANSHAH	762	1.45	653	1.24	189	0.36
ARDABIL	828	1.40	1,030	1.74	667	1.13
QOM	368	2.79	279	2.11	289	2.19
ARAK	529	1.81	288	0.98	176	0.60
QAZVIN	386	2.57	480	3.20	244	1.63
ZANJAN	555	1.74	757	2.37	329	1.03
KHORAM ABAD	735	1.47	370	0.74	263	0.53
SEMNAN	-	0.00	675	2.86	573	2.43
BOUSHEHR	1,464	1.19	580	0.47	1,044	0.85
ZAHEDAN	1,609	1.03	1,190	0.76	1,654	1.06

Province Name	Semnan	The amount of increase or decrease in the distance	Esfahan	The amount of increase or decrease in the distance	Hamedan	The amount of increase or decrease in the distance
SANANDAJ	737	1.47	627	1.25	164	0.33
BOJNOORD	543	0.76	1,152	1.62	1,050	1.47
YASOOJ	974	1.32	299	0.41	763	1.03
ILAM	946	1.33	678	0.95	373	0.53
BIRJAND	1,139	0.87	1,173	0.89	1,637	1.25
SHAHREKORD	779	1.43	104	0.19	568	1.05
	23,930	1.54	20,533	1.72	20,227	1.42

According to the results of the above table the cost increase in transport distances in case of choosing any of the four directions can be 1.6 times higher in average but because of the differences between cities in terms of density of agencies, transportation costs vary above 1.6 times and the actual value is about 1.85 times higher. The increased cost of delivery for the parts providers is calculated by a model similar to the above tables and as a result the transportation costs becomes 3.1 times higher for the manufacturers in other words, the costs of transportation are increased from 26 billion Rials to 81 billion Rials annually.

If the project site is located in one of the Tehran suburb industrial zones (at a distance of less than 150 kilometers) the amount of increase or decrease of distance from Saipa Yadak is presented in the following table

Table 9- increased transportation costs in case of selecting an area within a radius of 150 km from Tehran,

Province center Name	Alborz	The amount of increase or decrease in the distance	Qazvin	The amount of increase or decrease in the distance	Qom	The amount of increase or decrease in the distance
THRAN	100	1.33	150	2.00	132	1.76
AHVAZ	934	1.07	882	1.01	715	0.82
ESFAHAN	489	1.11	480	1.09	279	0.64
SARI	317	1.19	417	1.56	399	1.49
SHIRAZ	974	1.05	965	1.04	764	0.83
ALBORZ	50	1.00	100	2.00	182	3.64
TABRIZ	549	0.92	455	0.76	731	1.22
MASHHAD	944	1.06	1,044	1.17	1,026	1.15
RASHT	275	0.85	185	0.57	457	1.41
KERMAN	1,088	1.05	1,172	1.13	846	0.82
GORGAN	447	1.13	547	1.38	529	1.33
OROUMIE	857	0.94	763	0.84	1,039	1.15
YAZD	727	1.07	780	1.15	485	0.72
HAMEDAN	387	1.15	244	0.72	289	0.86
BANDAR ABBAS	1,384	1.04	1,455	1.09	1,142	0.86
KERMANSHAH	576	1.10	433	0.82	499	0.95
ARDABIL	541	0.92	451	0.76	723	1.22
QOM	182	1.38	282	2.14		0.00
ARAK	343	1.17	303	1.03	134	0.46
QAZVIN	100	0.67	0.00	0.00	282	1.88
ZANJAN	269	0.84	175	0.55	451	1.41
KHORAM ABAD	549	1.10	507	1.02	340	0.68

Province center Name	Alborz	The amount of increase or decrease in the distance	Qazvin	The amount of increase or decrease in the distance	Qom	The amount of increase or decrease in the distance
SEMNAN	286	1.21	386	1.64	368	1.56
BOUSHEHR	1,278	1.04	1,060	0.86	876	0.71
ZAHEDAN	1,617	1.03	1,717	1.10	1,375	0.88
SANANDAJ	551	1.10	453	0.90	474	0.95
BOJNOORD	763	1.07	863	1.21	845	1.19
YASOOJ	788	1.07	779	1.06	595	0.81
ILAM	760	1.07	617	0.87	648	0.91
BIRJAND	1,363	1.04	1,463	1.11	1,445	1.10
SHAHREKORD	593	1.09	584	1.08	367	0.68
	20,081	1.06	19,712	1.09	18,437	1.10

As the above table shows in case of choosing any of the 3 regions within a radius of 150 kilometers of Tehran we will be faced with cost increase in transport distances which is about 1.08 The increased rates of transport costs in the distribution in representatives and part manufacturers are 1.15 and 1.4 times in average.

Given the above, in order to calculate the cost of transport and mobility by taking all three scenarios, the following assumptions have been considered:

- ✓ The total transport costs of Saipa Yadak and part manufacturers in 2014 were 37.39 and 26.25 billion Rials respectively which is 46.73 and 32.81 billion rials in 2015 with regard to the increase in road transportation costs (25% increase).
- ✓ The increase in transportation costs is 10% due to annual inflation
- ✓ The plan of increasing the volume of Saipa Yadak activities is an average of 10 percent annually based on car production trend in the previous years.
- ✓ The duration of the construction of the new location and movement is about 3 years.

- ✓ Increased transportation costs to distribute parts between the representatives and manufacturers within the radius of 400 kilometers are 1.85 and 3.1 and 1.15 and 1.4 within the radius of 150 kilometers in 2015 respectively.
- ✓ It is assumed that the lease contract will be extended until the transfer to the main site and there is no need for extra movement during the next three years.
- ✓ The total cost of transportations costs of Shamekh Company to package 10,000 exporting vehicles in 2010 is equal to 1.5 billion rials.
- ✓ The volume of export sector is forecasted to increase 10,000 units annually.
- ✓ Due to the proximity of Saipa logistic company to Shamekh Company in case of movement to the radius of 400 km, the costs will be 4 folded and in case of movement to the radius of 150 km, the costs will be 1.5 folded.
- ✓ If the project site is chosen within the industrial area of Tehran, there will be no increase in cost for the distance.

The transportation costs over the next 10 years are predicted according to the following tables:

Table 10- total transport costs in the distribution of spare parts, rent and transportation given radius of 400 km

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation costs of Saipa Yadak	51.42	62.22	75.29	91.10	203.92	246.74	298.56	361.26	437.12	528.92
Rent costs	30.28	30.28	60.00	66.00	-	-	-	-	-	-
Movement cost	-	-	-	-	14.90	-	-	-	-	-
Export sector transportation costs,	3.00	6.60	10.89	15.97	87.85	115.96	148.81	187.08	231.51	282.95
Total costs	84.70	99.10	146.18	173.07	306.67	362.70	447.37	548.33	668.63	811.87

Table 11- total costs of transport in a radius of 400 kilometers in manufacturer sector

(Figures are in million Rials)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation to manufacturers costs	36.09	43.67	52.84	63.94	239.85	290.22	351.16	424.90	514.13	622.10

Table 12- total transport costs in the distribution of spare parts, rent and transportation given radius of 150 km

(Figures are in million rials)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation costs of Saipa Yadak	51.42	62.22	75.29	91.10	126.76	153.38	185.59	224.56	271.72	328.79
Rent costs	30.28	30.28	60	66	-	-	-	-	-	-
Movement cost	-	-	-	-	14.9	-	-	-	-	-
Export sector transportation costs,	3	6.6	10.89	15.972	32.94225	43.48	55.80	70.15	86.82	106.11
Total costs	84.70	99.10	146.18	173.07	174.60	196.86	241.39	294.72	358.54	434.89

Table 13- total costs of transport in a radius of 150 kilometers in manufacturer sector

(Figures are in million Rials)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation to manufacturers costs	36.09	43.67	52.84	63.94	108.32	131.07	158.59	191.89	232.19	280.95

Table 14- total transport costs in the distribution of spare parts, rent and transportation in Tehran industrial zone

(Figures are in million rials)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation costs of Saipa Yadak	51.42	62.22	75.29	91.10	110.23	133.37	161.38	195.27	236.28	285.90
Rent costs	30.28	30.28	60.00	66.00	-	-	-	-	-	-
Movement cost	-	-	-	-	14.90	-	-	-	-	-
Export sector transportation costs,	3.00	6.60	10.89	15.97	21.96	28.99	37.20	46.77	57.88	70.74
Total costs	84.70	99.10	146.18	173.07	147.09	162.36	198.59	242.04	294.16	356.64

Table 15 - total costs of transport in Tehran industrial zone in manufacturer sector

(Figures are in million Rials)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Transportation costs to manufacturers	36.09	43.67	52.84	63.94	77.37	93.62	113.28	137.07	165.85	200.68

Total costs over a period of 10 years for each of the three above scenarios under two conditions, with or without considering the manufacturers transport costs are presented the following tables

Table 16- Total cost of transporting spare parts over 10 years for each of the three scenarios (Figures are in million Rials)

Radius of 400 km from Tehran,	Radius of 150 km from Tehran,	Tehran Industrial Zone
3,648.61	2,204.06	1,903.93

Table 17 - total cost of transporting spare parts over a period of 10 years for each of the three scenarios (Figures are in million Rials)

Radius of 400 km from Tehran,	Radius of 150 km from Tehran,	Tehran Industrial Zone
6,287.53	3,503.62	2,888.34

The total amount of investment and operation costs over 10 years for each scenario with or without considering the transportation costs of the manufacturers are based on tables 18 and 19.

Table 18. Total cost of transportation of spare parts distribution over a period of 10 years for each of the three scenarios (Figures in billion Rials) without considering the transportation costs of the manufacturers

Description	The cost of buying the land and landscaping	Construction of buildings and municipal license	Administrative and support buildings	Transport and transfer of spare parts	Total
Radius of 150 to 400 kilometers of Tehran					
Deprived areas	60.00	500.00	30.00	3,648.61	4,238.61
Industrial towns with average facilities	80.00	450.00	27.00	3,648.61	4,205.61
Industrial towns with suitable facilities	120.00	400.00	24.00	3,648.61	4,192.61

Industrial city near Tehran (radius of 150 km)					
Industrial towns with average facilities	130.00	450.00	27.00	2,204.06	2,811.06
Industrial towns with suitable facilities	220.00	400.00	24.00	2,204.06	2,848.06
Tehran Industrial Zone					
	420.00	700.00	24.00	1,903.93	3,047.93

Table 19- Total cost of transportation of spare parts distribution over a period of 10 years for each of the three scenarios (Figures in billion Rials) including the transportation costs of the manufacturers

Description	The cost of buying the land and landscaping	Construction of buildings and municipal license	Administrative and support buildings	Transport and transfer of spare parts	Total
Radius of 150 to 400 kilometers of Tehran					
Deprived areas	60.00	500.00	30.00	6,287.53	6,877.53
Industrial towns with average facilities	80.00	450.00	27.00	6,287.53	6,844.53
Industrial towns with suitable facilities	120.00	400.00	24.00	6,287.53	6,831.53
Industrial city near Tehran (radius of 150 km)					
Industrial towns with average facilities	130.00	450.00	27.00	3,503.62	4,110.62
Industrial towns with suitable facilities	220.00	400.00	24.00	3,503.62	4,147.62
Tehran Industrial Zone					
	420.00	700.00	24.00	2,888.34	4,032.34

To summary up, results are illustrated in the following tables.

Table 20- estimation of total investment charges (land purchase, establishment of the infrastructure, acquiring municipal permissions)(billion Rials)

Development of current space of Shamekh	Purchase of Pars warehouse	Land purchase and establishment of warehouse			Continuation of the current flow and rent of warehouse
		Tehran Industrial zone	in a radius of 150 KM	in a radius of 400 KM	
The needed space is not available	787.60	1,144.00	625.50	563.67	-

Table 21- estimation of total investment and usage charges in a period of 10 years for each of the items regardless of the transportation charges for the manufacturers

Development of current space of Shamekh	Purchase of Pars warehouse	Land purchase and establishment of warehouse			Continuation of the current flow and rent of warehouse
		Tehran Industrial zone	in a radius of 150 KM	in a radius of 400 KM	
The needed space is not available	2,535.25	3,047.93	2,829.56	4,212.28	4,273.92

Table 22- estimation of total investment and usage charges in a period of 10 years for each of the items with regard to the transportation charges for the manufacturers

Development of current space of Shamekh	Purchase of Pars warehouse	Land purchase and establishment of warehouse			Continuation of the current flow and rent of warehouse
		Tehran Industrial zone	in a radius of 150 KM	in a radius of 400 KM	
The needed space is not available	3,519.66	4,032.34	4,129.12	6,851.20	5,258.33

The table shows great difference between "*in a radius of 400 KM*" and" *Continuation of the current flow and rent of warehouse*" and other options. Therefore, comparing these two options with other alternatives we conclude that "*in a radius of 400 KM*" and" *Continuation of the current flow and rent of warehouse*" are considered negative in terms of economic matters. On the other hand, "*Development of current space of Shamekh*" is not feasible because of limitation on land purchases. Finally, the remaining three options provide more or less the same financial condition. In what follows, the researcher will investigate the score of each of these three options considering other parameters.

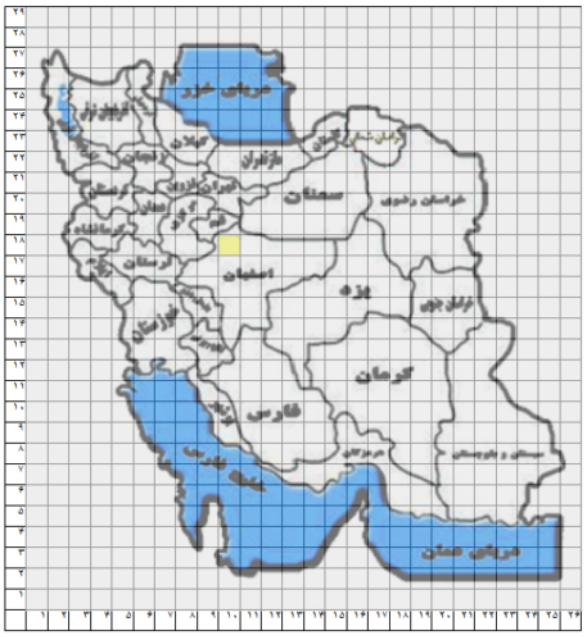
The researcher did not consider some factors including the value added on land purchase in future years on the ground that the prediction of the affecting factors on inflation of land price in different parts of the country is difficult and complicated. Thus considering the history of significant increase in the land price in Tehran and its surroundings, he concludes that it is better to keep the Pars warehouse, although considering the factor of inflation of land piece in the above-mentioned options and for the purpose of comparison, is very difficult.

4.3. Determining the appropriate site using the center of gravity

Minimizing transportation costs is quite important in site selection projects for a new warehouse, a logistics center or a new central warehouse. The Center of Gravity method focuses on the transportation costs. Obviously, many other factors must be considered during the process of selecting a site. The Center of Gravity method presents a basic solution to the site selection problems. However, the outcome of this method is still quite valid. **(ITU, 2000)**

This method emphasizes the minimization of the transportation charges and the short distance to the consuming market. Given the information about the volume of spare parts required by each province, provided by Shamekh Company, we can locate these site on points 10.13 and 18.8 marked on the map of Iran.

Figure 4- Iran Map



The best location based on this model is selected according to the following tables:

Table 23- calculation assumption of selected location based on COG model

PROVINCE	Share of order in each province(di)	Xi	Yi	∑Xidi	∑Yidi
TEHRAN	%29.90	10	20	2.99	5.98
KHOOZESTAN	%6.70	6	14	0.402	0.938
ESFAHAN	%6.20	12	17	0.744	1.054
MAZANDARAN	%5.50	11	22	0.605	1.21
FARS	%4.70	12	11	0.564	0.517
ALBORZ	%4.50	10	22	0.45	0.99
AZARBAYJAN SHARQI	%4.20	3	24	0.126	1.008
KHORASAN RAZAVI	%4.10	19.5	21	0.7995	0.861
GILAN	%4.00	8	23	0.32	0.92
KERMAN	%3.30	17	12	0.561	0.396
GOLESTAN	%2.60	14.5	23	0.377	0.598
AZARBAYJAN QARBI	%2.60	3	22.5	0.078	0.585
YAZD	%1.90	15	15.5	0.285	0.2945
HORMOZGAN	%1.80	6	19.5	0.108	0.351
HAMEDAN	%1.80	16	8	0.288	0.144
KERMANSHAH	%1.70	4	18.5	0.068	0.3145
ARDABIL	%1.50	7	24.5	0.105	0.3675
QOM	%1.40	8.5	18.5	0.119	0.259
QAZVIN	%1.30	7.5	18.5	0.0975	0.2405
MARKAZI	%1.30	8	21	0.104	0.273
ZANJAN	%1.10	6	22	0.066	0.242
LORESTAN	%1.10	6	17	0.066	0.187
SEMNAN	%1.00	14	20	0.14	0.2
SISTAN O BALOUCHESTAN	%0.90	9.5	10	0.0855	0.09
BOUSHEHR	%0.90	22.5	7.5	0.2025	0.0675
KORDESTAN	%0.80	4.5	20.5	0.036	0.164

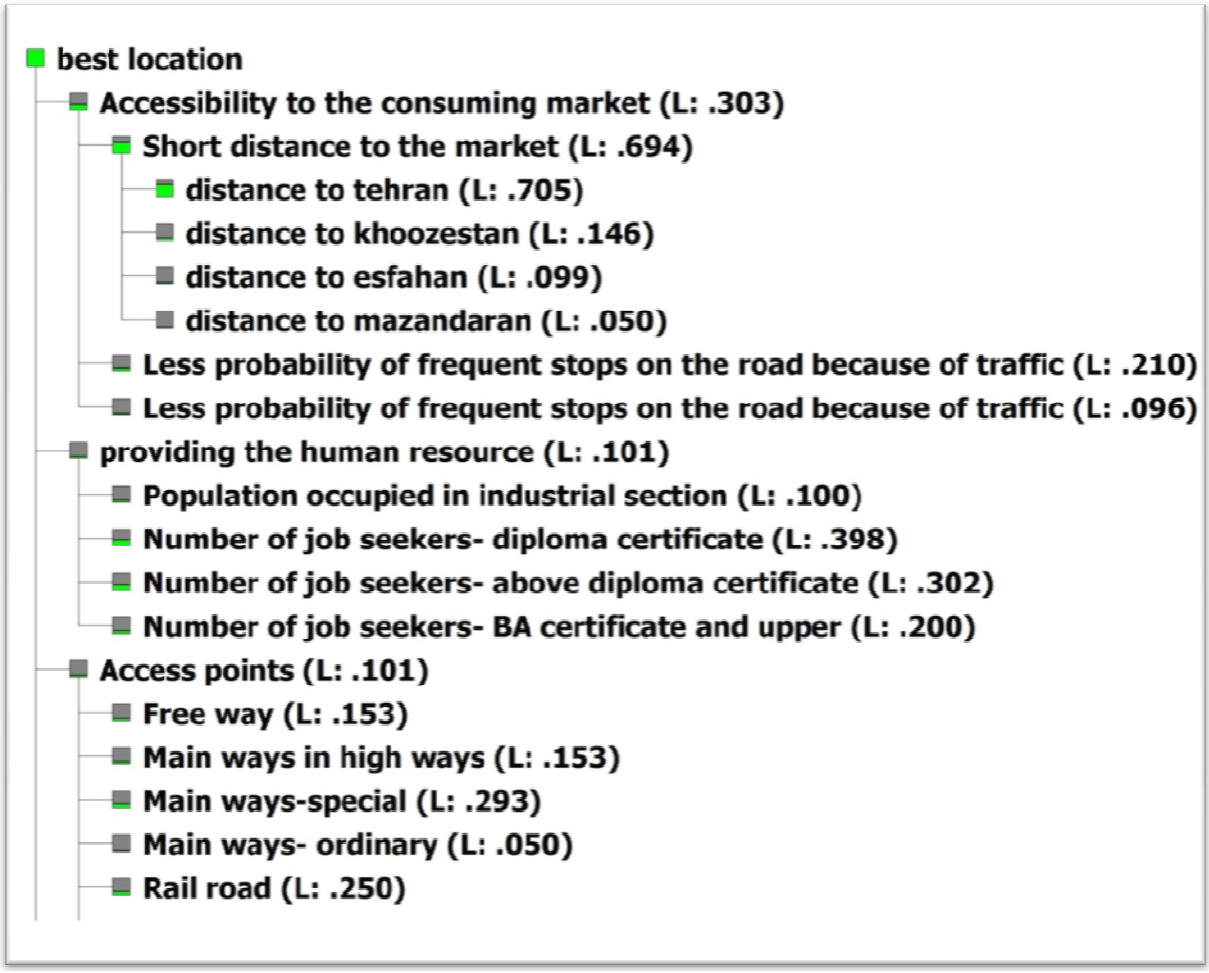
KHORSAN SHOMALI	%0.70	16.5	23	0.1155	0.161
KHORASAN JONOOBI	%0.60	8	15	0.048	0.09
CHARMAHAL O BAKHTIARI	%0.60	3	17	0.018	0.102
ILAM	%0.60	20	15	0.12	0.09
KOHKILOOYE VA BOYER AHMAD	%0.50	9	13	0.045	0.065
				∑Xidi/∑di	∑Yidi/∑di
	1			10.13	18.76

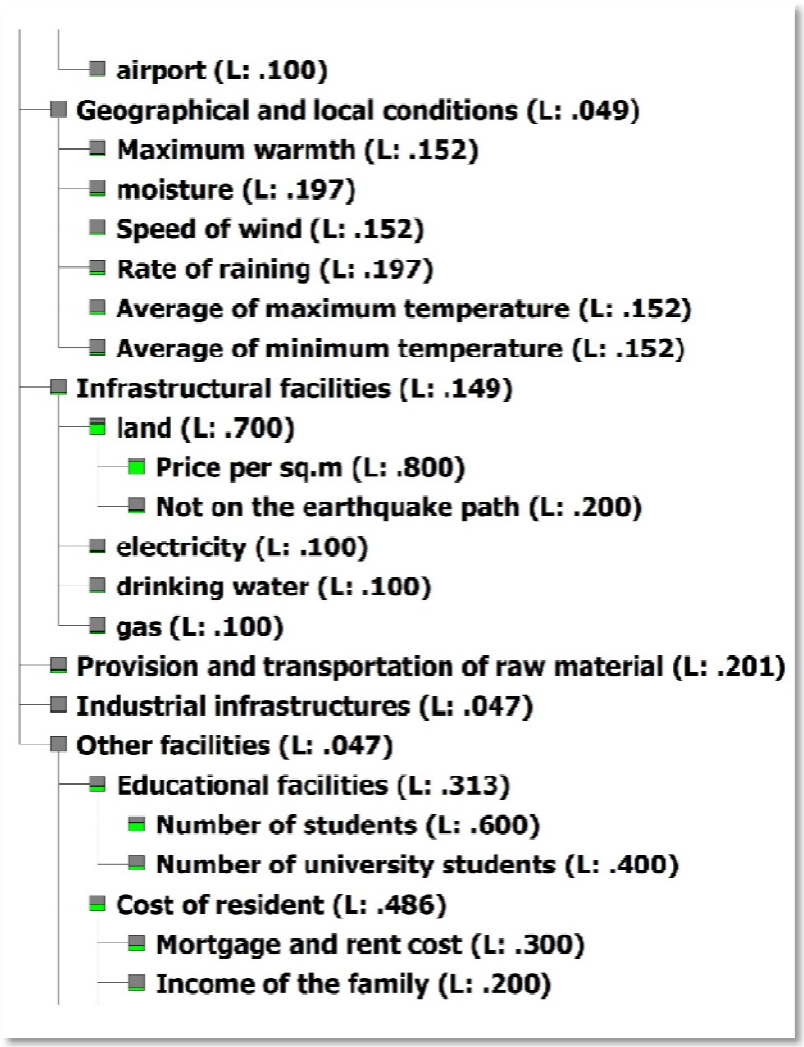
Best place has been located in Kashan, somewhere between Isfahan and Qom. The site of Saipa Kahsan, car production factory is in this area and it is possible to purchase a land here or in Saveh, which is near to this area (the chosen land for establishing the factory is 131 Hectares and has 8KM distance from Saveh-Salafchegan road) and these are considered as Saypa facilities in this location. In the Center of Gravity models, the researcher will investigate these two areas as well which have 150 KM distance to Tehran.

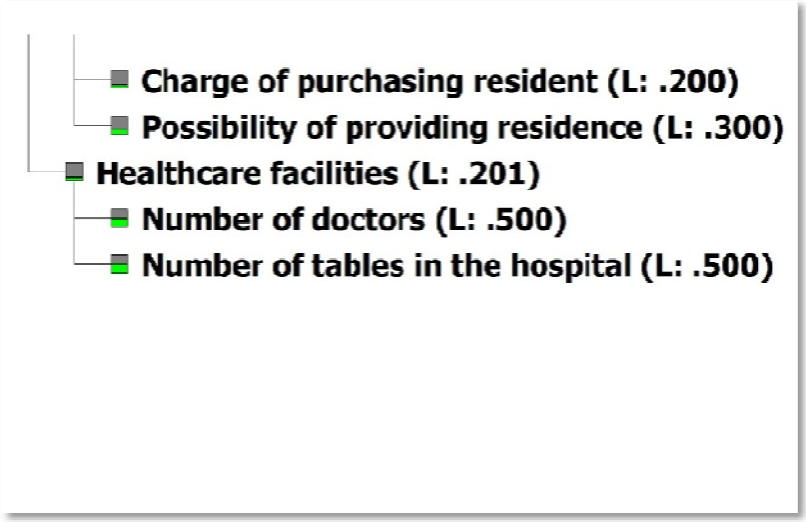
4.4. Selecting the selected site using Multi-Criteria Decision-Making Models

The researcher restricted his investigation to Tehran Industrial Cities, Tehran Industrial Zone, Kashan and Saveh. in order to consider other factors affecting location (factors stated in objectives section) the Analytic Hierarchy Process (AHP) model is used to determine the weight of each index in which the idea of the major expert was used to perform pair-wise comparison between the indices and determine the priority of each index over another one the analysis of pair-wise comparison is calculated by Expert choice software that it's result are shown as the following figures :

Figure 5- pair-wise comparison of indices (result of Expert choice software)




airport (L: .100)
Geographical and local conditions (L: .049)
Maximum warmth (L: .152)
moisture (L: .197)
Speed of wind (L: .152)
Rate of raining (L: .197)
Average of maximum temperature (L: .152)
Average of minimum temperature (L: .152)
Infrastructural facilities (L: .149)
land (L: .700)
Price per sq.m (L: .800)
Not on the earthquake path (L: .200)
electricity (L: .100)
drinking water (L: .100)
gas (L: .100)
Provision and transportation of raw material (L: .201)
Industrial infrastructures (L: .047)
Other facilities (L: .047)
Educational facilities (L: .313)
Number of students (L: .600)
Number of university students (L: .400)
Cost of resident (L: .486)
Mortgage and rent cost (L: .300)
Income of the family (L: .200)


Charge of purchasing resident (L: .200)
Possibility of providing residence (L: .300)
Healthcare facilities (L: .201)
Number of doctors (L: .500)
Number of tables in the hospital (L: .500)

Numerical Assessment

Compare the relative importance with respect to: best location

	Accessibilit	providing the human res	Access poi	Geographic	Infrastructu	Provision a	Industrial ir	Other facili
Accessibility to the consuming marke		5.0	5.0	5.5	2.0	1.0	5.0	5.0
providing the human resource			1.0	2.0	1.0	1.0	1.5	1.5
Access points				2.0	1.0	1.0	1.5	1.5
Geographical and local conditions					(4.5)	(5.5)	1.5	1.5
Infrastructural facilities						1.0	3.5	3.5
Provision and transportation of raw m							6.0	6.0
Industrial infrastructures								1.0
Other facilities	Incon: 0.04							

Numerical Assessment

Compare the relative importance with respect to: Accessibility to the consuming market

	Short dista	Less probability of frequ	Less proba
Short distance to the market		3.0	8.0
Less probability of frequent stops on the road because of traffic			2.0
Less probability of frequent stops on the road because of traffic	Incon: 0.01		

Numerical Assessment

Compare the relative importance with respect to: Accessibility to the consuming \ Short distance to the market

	distance to	distance to khoozestan	distance to	distance to
distance to tehran		5.0	7.0	14.0
distance to khoozestan			1.5	3.0
distance to esfahan				2.0
distance to mazandaran	Incon: 0.00			

Numerical Assessment

Compare the relative importance with respect to: providing the human resource

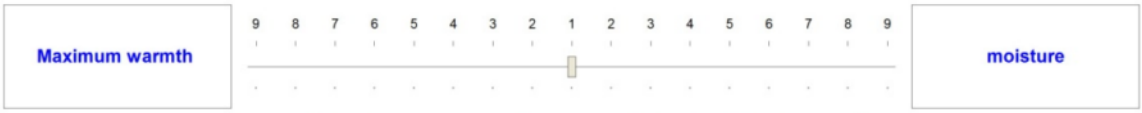
	Population	Number of job seekers- d	Number of	Number of
Population occupied in industrial section		(4.0)	(3.0)	(2.0)
Number of job seekers- diploma certificate			1.3	2.0
Number of job seekers- above diploma certificate				1.5
Number of job seekers- BA certificate and upper	Incon: 0.00			

Numerical Assessment

Compare the relative importance with respect to: Access points

	Free way	Main ways in high ways	Main ways-	Main ways-	Rail road	airport
Free way		1.0	(2.0)	3.0	(1.5)	1.5
Main ways in high ways			(2.0)	3.0	(1.5)	1.5
Main ways-special				6.0	1.0	3.0
Main ways- ordinary					(5.0)	(2.0)
Rail road						2.5
airport	Incon: 0.00					

Numerical Assessment



Compare the relative importance with respect to: Geographical and local conditions

	Maximum w	moisture	Speed of w	Rate of rain	Average of	Average of
Maximum warmth		(1.3)	1.0	(1.3)	1.0	1.0
moisture			1.3	1.0	1.3	1.3
Speed of wind				(1.3)	1.0	1.0
Rate of raining					1.3	1.3
Average of maximum temperature						1.0
Average of minimum temperature	Incon: 0.00					

Numerical Assessment

Compare the relative importance with respect to: Infrastructural facilities

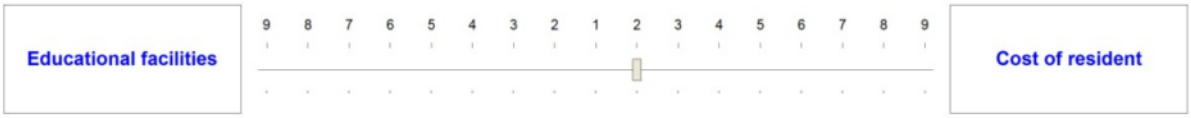
	land	electricity	drinking wa	gas
land		7.0	7.0	7.0
electricity			1.0	1.0
drinking water				1.0
gas	Incon: 0.00			

Numerical Assessment

Compare the relative importance with respect to: Infrastructural facilities \ land

	Price per sq	Not on the earthquake pa
Price per sq.m		4.0
Not on the earthquake path	Incon: 0.00	

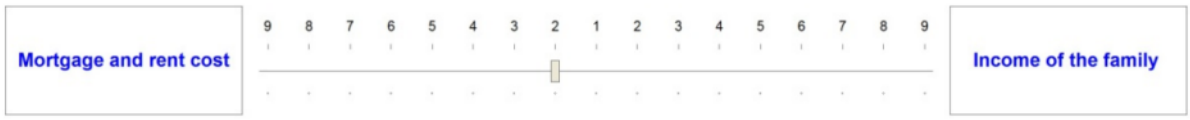
Numerical Assessment



Compare the relative importance with respect to: Other facilities

	Educationa	Cost of resident	Healthcare
Educational facilities		(1.5)	1.5
Cost of resident			2.5
Healthcare facilities	Incon: 0.00		

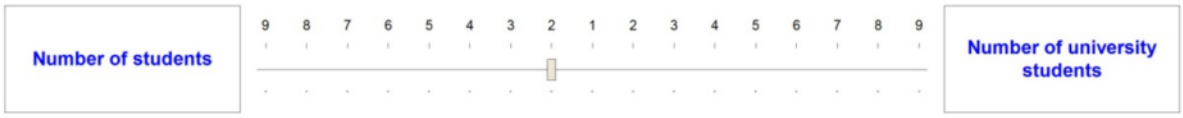
Numerical Assessment



Compare the relative importance with respect to: Other facilities \ Cost of resident

	Mortgage a	Income of the family	Charge of p	Possibility
Mortgage and rent cost		1.5	1.5	1.0
Income of the family			1.0	(1.5)
Charge of purchasing resident				(1.5)
Possibility of providing residence	Incon: 0.00			

Numerical Assessment



Compare the relative importance with respect to: Other facilities \ Educational facilities

	Number of	Number of university stu
Number of students		1.5
Number of university students	Incon: 0.00	

Numerical Assessment

Compare the relative importance with respect to: Other facilities \ Healthcare facilities

	Number of	Number of tables in the l
Number of doctors		1.0
Number of tables in the hospital	Incon: 0.00	

and finally while collecting the data related to each option (to choose the central site of the warehouse) and placing then in the Multi attribute utility analysis from methods of Multi-Criteria Decision-Making Models(MCDMM) , the score of each option is calculated and finally among the top administrative constraint options (such as the possibility of buying land with the intended area, the possibility of obtaining a license, employer preferences) were applied and the final option is suggested.

the important factors in decision-making and their weights is as following table :

Table 24- the important factors in decision-making and their weights

first level factors	Weight of the factor	Second level factors	Weight of the factor	Third level of factors	Weight of the factor
Accessibility to the consuming market	0.3	Short distance to the market	0.7	Distance to Tehran (Saypa location)	0.7
				Distance to khozestan	0.15
				Distance to Isfahan	0.1
				Distance to Mazandaran	0.05
		Less probability of frequent stops on the road because of traffic	0.2		
		Less probability of frequent stops on the road because of traffic	0.1		
providing the human resource	0.1	Population occupied in industrial section	0.1		
		Number of job seekers- diploma certificate	0.4		
		Number of job seekers- above diploma certificate	0.3		
		Number of job seekers- BA certificate and upper	0.2		
Access points	0.1	Free way	0.15		
		Main ways in high ways	0.15		
		Main ways-special	0.3		
		Main ways- ordinary	0.05		
		Rail road	0.25		
		Air port	0.1		
Geographical and local conditions	0.05	Average of maximum temperature	0.15		
			0.15		

first level factors	Weight of the factor	Second level factors	Weight of the factor	Third level of factors	Weight of the factor
		Average of minimum temperature			
		Maximum warmth	0.15		
		moisture	0.2		
		Speed of wind	0.15		
		Rate of raining	0.2		
Infrastructural facilities	0.15	land	0.7	Price per sq.m	0.8
				Not on the earthquake path	0.2
		electricity	0.1	Access to network facilities	
		Drinking water	0.1	Access to enough recourses	
		gas	0.1	Accessibility to gas lines	
Provision and transportation of raw material	0.2	Transportation charges of raw material	1		
Industrial infrastructures	0.05	Number of industrial units	1		
Other facilities	0.05	Educational facilities	0.3	Number of students	0.6
				Number of university students	0.4
		Cost of resident	0.5	Mortgage and rent cost	0.3
				Income of the family	0.2
				Charge of purchasing resident	0.2
				Possibility of providing residence	0.3
		Healthcare facilities	0.2	Number of doctors	0.5
				Number of beds in the hospital	0.5

5- Conclusion

Considering the above-mentioned index and weights mentioned in table 24, the researcher assigns a score to them, which you can see in table 25.

Table 25- Score of each zone

Ranking	Province	Industril zone/Industrial city	Weighted Score
1	Tehran	Parand	6.96
2	Alborz	Karaj (50 KM to Tehran)	6.08
3	Tehran	Tehran Industrial City	5.37
4	Alborz	Eshtehard	5.03
5	Tehran	Nasirabad	4.63
6	Arak	Saveh	4.38
7	Alborz	Hashtgerd-Savojbalagh	4.28
8	Tehran	Varamin-salarieh-charm shahr	3.77
9	Alborz	Nazarabad	3.56
10	Isfahan	Kashan	2.95
11	Tehran	Firouzkooh	2.93

In this table, Parand Industrial city with the score of 9.96, Karaj (50 KM from Tehran), and Tehran industrial zone have acquired the first, second and third place respectively.

Investigations by the researcher shows that it is too difficult to find land with the required area and specification in Parand Industrial city (they have permission for establishing a 10 hectares of open warehouse for storing purpose) and Karaj, and more investigations must be done on this subject. As for Tehran Industrial city, it seems that the current location of Pars warehouse has a very good condition. It is very difficult to find a warehouse like Pars in this area. According to the consultants, considering the fact that there is a slight difference between the scores

of different options, managerial considerations have an important role in choosing the location of the warehouse.

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