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Site Selection for Establishing the Distribution Agency of "Mihan" Food Industries Using Multi-Criteria Decision-Making Techniques

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ABSTRACT

Proper location of distribution centers in manufacturing companies is of critical importance and is typically decided at the highest managerial levels. The aim of this study was to determine the optimal location for establishing a distribution branch for Mihan Food Industries using multi-criteria decision-making techniques. The implementation process involved several steps. First, using the Delphi technique, the selection criteria for the distribution warehouse location were obtained from experts. Next, the Analytic Hierarchy Process (AHP) and pairwise comparisons were applied to evaluate the priorities of criteria and alternatives. The data were analyzed using SPSS and Excel software. According to the results, five criteria were selected. The findings indicated that the minimum construction cost (land, building, and equipment) (0.211), time efficiency (0.208), and technical issues (technical reports from production and market experts) (0.204) had the highest priority, respectively. Health parameters (distance from pollution sources) (0.194) and minimum transportation costs (0.183) ranked next. Based on these results, the highest priority location for establishing the distribution branch is Location 3, while Locations 1 and 2 follow closely with only minor differences in ranking.

1. INTRODUCTION

Although the supply chain for delivering goods to stores is complex, it has an organizational structure that enables cost reduction through optimal location at the right point, facilitating the distribution of goods to fixed destinations. Nowadays, distribution centers play a significant role in allocating costs within the distribution network and supply chain units of production facilities. In this regard, supply chain management aims to optimize the logistics network through distribution center location. Correct location is essential for enhancing competitive capabilities, reducing transportation costs, and effectively managing demand. Providing better services through distribution centers has gained special attention in recent years [1]. Distribution network design issues, with the general goal of determining the optimal route for transferring goods from suppliers to demanders, aim to minimize total distribution costs while meeting customer demand. Location problems often include determining the required

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number of distribution warehouses, finding suitable locations for these warehouses, specifying the size and capacity of each distribution center, and determining how to allocate demand services to each of these centers [1]. The location-routing problem considers intermediate points or local distribution centers in a three-level supply chain, including the supplier and central warehouse, intermediate points or local distribution centers, and the customer or final destination [3].

In this chain, local distribution centers receive customer order lists, prepare packages, and send them via delivery vehicles (vans or motorcycles). Route planning for these vehicles is usually done manually or by route planning applications, prioritizing mental destinations and supervised by the delivery personnel [3]. Since local distribution centers and vehicles have limited capacity, they replenish their daily or weekly shortages from the central warehouse. In this context, efficient supply replenishment, low-cost, and regular inventory cycles become crucial. Warehouse replenishment periods, shortage registration times, shortage registration rates, delivery times, and similar factors require awareness of the time intervals needed for the precise delivery of goods at the distribution center based on demand and sales capabilities [4]. Therefore, the location of central warehouses and local distribution centers has become important and requires multi-variable analyses [4].

Correct distribution center location in manufacturing companies holds special importance and is decided at the highest managerial levels, impacting economic, social, and technical dimensions in the long run [5]. Profitability is one of the factors effective within the organizational context for manufacturing companies, and externally, it can influence various economic, social, and environmental conditions. Sometimes, creating an efficient production line may be more cost-effective than establishing a distribution center, leading to lower overall costs [5]. Proper location for distribution centers should be conducted in a way that results in competitive and strategic advantages compared to other competitors. In recent years, with the expansion of manufacturing companies and substantial investments in increasing production volume, the establishment of distribution centers in various locations to expand the distribution network has gained special attention [5]. The location of distribution centers can be studied through various knowledge, diverse models, and decision-making techniques [5].

The establishment of distribution centers in optimal conditions not only pursues material benefits but also aims to improve services to customers. Decisions related to location, selection, and adaptation of its features significantly impact the ability to gain and maintain a competitive advantage [6]. Errors in distribution center location can lead to irreparable losses, sometimes resulting in changing locations with high costs or recession and failure of marketing strategies in the covered region [6]. Often, mistakes in location issues arise due to the multitude of variables and options that must be considered in selecting options. If appropriate decision-making techniques are not utilized, mistakes in the results are likely to occur [6]. In many cases, managers simply compare options mentally and make decisions without using decision-making techniques, leading to failure in most cases [6].

Mistakes made in this regard include issues such as:

1. Ignoring some conditions and shortcomings.
2. The interference of some biases of officials and personal interests in accepting or not accepting logical and scientific facts.
3. Lack of prioritization or appropriate weighting of decision-making criteria.
4. Lack of sufficient and accurate information about the desired criteria and so on [7].

The Mihan Industrial Group, in the field of food industries, has an extensive distribution at the national and international levels for its products. The company, with the establishment of distribution centers in various regions of the country, always seeks to better distribute its products. Currently, with 60 distribution centers and the creation of a large distribution network in the country, the company supplies its products to over 200,000 stores nationwide, holding over 50% of the market share for sterilized milk and 65% of the market share for ice cream [7]. Factors such as shorter time intervals and lower distribution costs play a role in determining the location of this company's distribution. In line with the goal of increasing its distribution centers, the study of the location allocation of establishing distribution agency for Mihan's food industries is of special importance. In this regard, this study has been conducted to locate the allocation of establishing a distribution agency for Mihan's food industries using multi-criteria decision-making techniques [7].

1.1. Research Methodology

In this study, the criteria and indicators for location selection were chosen based on interviews with experts from Mihan Company. Experts in the sales field were selected as the statistical population for participation in this research. Considering the purposive sampling method, a sample size of 7 informed individuals was determined. The execution stages were as follows: initially, using the Delphi technique, location selection criteria for distribution warehouse were obtained through a questionnaire in three stages from the experts. Subsequently, to prioritize the criteria and options using the Analytical Hierarchy Process (AHP) and pairwise comparisons, a pairwise comparison questionnaire was designed, and the received responses were evaluated. Given that the location selection process is a multi-criteria decision-making issue, and there are multiple options from the company's perspective, the Fuzzy AHP technique and Excel software were employed.

1.2. Background research

The concept of location theory refers to a set of principles used to determine the optimal location for industrial activities (the point that maximizes profit) by adhering to these principles. Decision-making regarding facility location involves crucial elements in the strategic planning of both large private and public companies [8]. Due to the high costs associated with construction and operation, location projects have evolved into long-term investments. Decision-making regarding facility locations is primarily derived from long-term and strategic decisions within private and governmental sectors, where the success or failure of facility centers in each sector depends entirely on the chosen locations for them. Factors influencing location decisions include proximity to raw materials, the cost and accessibility of energy and facilities, availability of skilled labor, government regulations at various central, local, and regional levels, taxes at different central, local, and regional levels, insurance, land and construction costs, political and governmental stability, exchange rate fluctuations, import and export regulations, taxes, and levies, transportation systems, technical reports, environmental laws at central, local, and regional levels, support services, public and community services, climate, proximity to customers, business conditions, among others [9].

Decision-making about facility location primarily involves long-term and strategic decisions. In this decision-making process, various objectives must be considered, sometimes conflicting with each other. Apart from customers, facilities, space (including network or surface), and distance functions, various factors influence location models. One of these factors is the incorporation of decision-makers' opinions into the model [10]. Location evaluation is often performed through multi-criteria optimization methods. Multi-criteria decision-making creates an optimal solution that balances between objectives and available resources, achieving goals considering constraints. The accurate and proper definition of criteria (weighting) and scales is crucial. In multi-criteria decision-making, the regional, cultural, social, natural, and other regional features must be considered [11].

The distribution system of goods, considered as a vital part of the domestic and international marketing process, can be perceived as software, working alongside and serving the global freight and transportation industry. If roads, air routes, rail systems, motor vehicles, trains, airplanes, and maritime transport routes are viewed as hardware components of the transportation industry, then software factors such as distribution planning, distribution intermediaries, wholesalers, retailers, transport brokers, and industrial distributors also play a crucial role. The distribution system, in terms of location, eliminates the distance between goods or services and the consumer, providing significant assistance in terms of both space and time [12].

Mousakhani and colleagues (2020) conducted research titled "Developing an Integrated Location-Production-Distribution Model in the Green Supply Chain," considering the service level. In this article, a new model comprising manufacturing plants, distribution centers, and customers for various products over multiple time periods was presented. Through a case study, the applicability and efficiency of the proposed model were evaluated and compared, considering two indicators: customer service levels and the green approach in production and distribution. The results indicated the favorable performance of the proposed model in reducing costs in the green supply chain [13].

Faizi and Nedaal (2020) conducted a study with the aim of prioritizing factors influencing the location of medical complexes compared to the urban road network and proposed a location model. Findings demonstrated that seven main criteria significantly affect the location of medical centers, including 1) alignment of medical use with the first-degree communication network, 2) distance from the roadway, 3) distance from industrial workshops, 4) distance from medical centers (overlap), 5) distance from major commercial centers, 6) distance from bus terminals and railway stations, and 7) intersection distance to the medical center. Also, based on the obtained criteria and the proposed method, a suitable location for establishing clinics and medical complexes in the city of Yazd was identified as a case study. In conclusion, a suitable location model for medical complexes was presented. Proximity of medical centers to a first-degree communication network for ensuring fast and convenient access for patients is a priority in the factors influencing the location selection (placement) of medical complexes [14].

Abdollahzadeh Fard (2017) conducted a study titled "Locating Human Settlements with the Aim of Achieving Sustainable Development (Case Study: Shiraz Urban Complex)." In this study, the impact of each factor was determined, and suitable and unsuitable locations were introduced for the establishment of new human settlements. Taking a sustainable development approach and strengthening the relationship between rural and urban areas, the Shiraz urban complex was selected as the study area. Subsequently, location criteria for placing new settlements in this area were identified and categorized into five groups: environmental criteria, economic-social criteria, physical-spatial criteria, urban facilities and equipment criteria, and communication and transportation network criteria. These criteria were evaluated using expert opinions and established scoring from conducted studies. Finally, using the Analytical Hierarchy Process (AHP) model and with the assistance of ARC GIS software, the locations suitable and unsuitable for establishing new settlements were analyzed. As a result, suitable and unsuitable areas for the establishment of new settlements were identified [15].

2. DATA ANALYSIS AND EXAMINATION

2.1. Identification criteria

To identify the criteria for establishing distribution representation of Mihan food industries, the Delphi method was utilized. Table 1 illustrates the location criteria for the allocation of distribution representation of Mihan food industries from the perspective of experts. The criteria were categorized into five general criteria, including minimum construction costs (land, construction, and equipment), minimum transportation costs, time efficiency, health parameters (distance from pollution centers), and technical issues (technical reports from production and market experts).

Table 1. criteria for locating the distribution agency of the food industry of the country from the point of view of experts

Criteria				
Technical issues (technical reports of production and (market experts	Health parameters away from pollution) (centers	Time efficiency	Minimum shipping costs	**Minimum construction cost land, construction and) (equipment**

The Kendall's coefficient values for the criteria are as follows: Minimum Cost of Construction (Land, Building, and Equipment): Kendall's Coefficient - 0.63, Significance Level - 0.00 (indicating a significant observed level of agreement). Minimum Transportation Cost: Kendall's Coefficient - 0.59, Significance Level - 0.00. Time Efficiency: Kendall's Coefficient - 0.72, Significance Level - 0.00. Hygiene Parameters (Distance from Pollution-Creating Centers): Kendall's Coefficient - 0.68, Significance Level - 0.00. Technical Issues (Technical Reports from Production and Market Experts): Kendall's Coefficient - 0.65, Significance Level - 0.00. According to the results, there is more than a fifty percent agreement for all criteria, and the observed level of agreement is significant for each criterion.

Table 2. screening of extracted criteria using Kendall's test

level of significance	Kendall coefficient	Criterion
0.000	0.630	**Minimum construction cost (land, construction and equipment)**
0.000	0.590	**Minimum shipping costs**
0.000	0.720	**Time efficiency**
0.000	0.680	**Health parameters (away from pollution centers)**
0/000	0/650	**Technical issues (technical reports of production and market experts)**

2.2. Weight Determination of Criteria

In this stage, considering the conceptual model of the research and using pairwise comparisons, the weight of each criterion is calculated. For this purpose, the Fuzzy Analytical Hierarchy Process (FAHP) under the Chang's developmental analysis is employed. Examining experts' opinions regarding pairwise comparisons of criteria for their weighting required a matrix of outcomes or, more precisely, an outcome and aggregation of experts' opinions in the form of a unit matrix. For this purpose, the geometric mean was utilized, as shown in Table 3. According to this table, each element of this matrix contains fuzzy triangular numbers, representing the estimated geometric mean of experts' opinions.

Table 3. Results of experts' opinions on the criteria

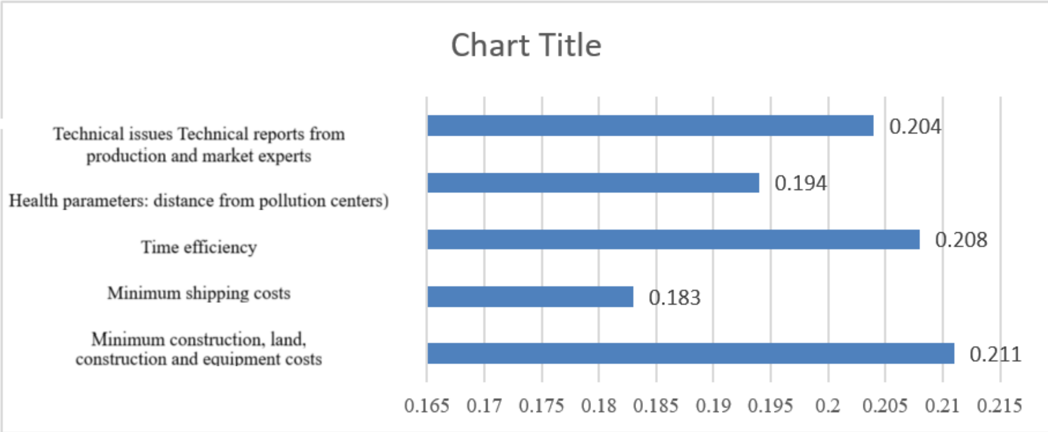
Technical issues technical reports of) production and (market experts	Health parameters away from) (pollution centers	Time efficiency	Minimum shipping costs	Minimum construction cost land, construction) (and equipment	Criterion
(71/1 ,15/3 ,43/5)	(27/3 ,43/4 ,87/6)	(37/1 ,85/2 ,07/5)	(24/1 ,71/1 ,93/3)	(1 ,1 ,1)	Minimum construction cost land, construction and) (equipment
(3 ,51/5 ,11/7)	(37/2 ,66/4 ,76/6)	(24/1 ,71/1 ,93/3)	(1 ,1 ,1)	(0.25 ,0.58 ,0.8)	Minimum shipping costs
(37/1 ,55/3 ,62/5)	(66/2 ,21/3 ,79/5)	(1 ,1 ,1)	(0.25 ,0.58 ,0.8)	(0.15 ,0.23 ,0.52)	Time efficiency
(55/1 ,90/1 ,21/4)	(1 ,1 ,1)	(0.17 ,0.19 ,0.38)	(0.14 ,0.21 ,0.42)	(0.17 ,0.33 ,0.42)	Health parameters (away (from pollution centers
(1 ,1 ,1)	(0.23 ,0.52 ,0.64)	(0.17 ,0.27 ,0.72)	(0.13 ,0.17 ,0.33)	(0.2 ,0.98 ,0.58)	Technical issues (technical reports of production and (market experts

Table 4. Weight of criteria

Fuzzy weights of criteria	Criteria
0.211	Minimum construction cost (land, construction and equipment)
0.183	Minimum shipping costs
0.208	Time efficiency
0.194	Health parameters (away from pollution centers)
0.204	Technical issues (technical reports of production and market experts)

Considering the obtained results, the criteria of Minimum Cost of Construction (Land, Building, and Equipment) (0.211), Time Efficiency (0.208), and Technical Issues (Technical Reports of Production and Market Experts) (0.204) were prioritized in descending order. Parameters related to Hygiene (Prevention of Pollution from Facilities) (0.194) and Minimum Transportation Costs (0.183) were placed in subsequent ranks. It is noteworthy that the significant differences in the calculated weights will have a substantial impact on the decision-making process.

Chart 1. Weight of the examined criteria



The inconsistency ratio in both matrices has become less than 1/0, indicating favorable comparisons by the experts. There is no need for the elimination or modification of pairwise comparison questionnaires, as the opinions are consistent.

3. PRIORITIZATION OF PROPOSED OPTIONS FOR DISTRIBUTION CENTER ALLOCATION

Considering the company's inclination to establish a distribution center in the west of the country, its export position to Iraq, and the distribution among the western provinces, four proposed options were taken into account in decision-making and evaluation. To prioritize the options, a pairwise comparison questionnaire was prepared based on the four proposed options and the five criteria presented by the experts. Experts were requested to evaluate the options through pairwise comparisons based on each criterion. At this stage, the weight of each option was extracted based on each criterion. Subsequently, by calculating the product sum of the weights of criteria in each option and the final weights of the options in the corresponding criteria, the final weights of the options were determined.

Table 5. Weight of criteria and weight of options in each criterion

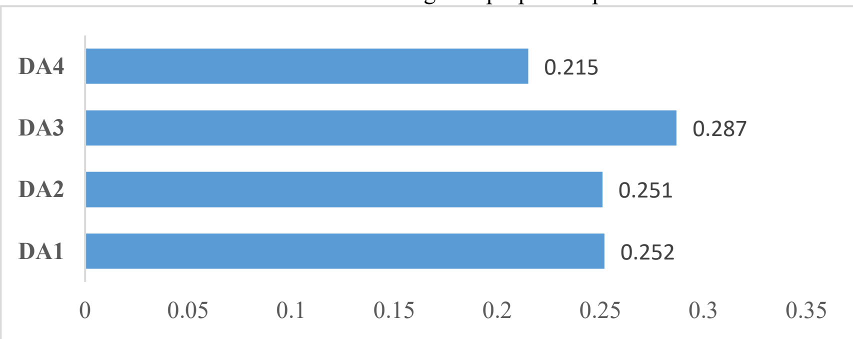
Technical issues technical reports) of production and (market experts	Health parameters away from) (pollution centers	Time efficiency	Minimum - shipping costs	Minimum construction cost land, construction) (and equipment	Location options
0.204	0.194	0.208	0.183	0.211	
0.153	0.325	0.210	0.285	0.293	DA1
0.377	0.121	0.234	0.299	0.224	DA2
0.312	0.287	0.306	0.237	0.289	DA3
0.159	0.267	0.250	0.206	0.194	DA4

Table 6. Final weight of the proposed options for creating a distribution center

Final weight	Location options
0.252	DA1
0.251	DA2
0.287	DA3
0.215	DA4

Based on the results of the above table, After the final calculation and incorporating the weights of the criteria into the weight of each location option, the priority for selecting a location to establish a distribution center is with Location 3. Options 1 and 2 are ranked very closely in the next positions.

Chart 2. Final weight of proposed options



4. CONCLUSION AND RECOMMENDATIONS

There are various factors and factors involved in the site selection and determination of specific locations. It is recommended that in each project; by examining the existing literature, the oversight of some important factors should be avoided, as neglecting these factors can have undesirable consequences after project implementation.
It is also suggested that for a specific project, the main stakeholders, who can provide genuine insights regarding the criteria, should be actively involved in decision-making. Their non-participation in decision-making can lead to a lack of alignment between the obtained results and the stakeholders' objectives.
Furthermore, it is recommended to utilize fuzzy decision-making techniques in location studies. This is because such techniques can precisely consider experts' opinions in decision-making with a larger number of factors, ensuring a more accurate decision-making process. The precise weights of each factor can be employed in decision-making, enhancing the applicability of the study results.

Transparency Statement

The data supporting this study are available upon reasonable request to the corresponding author, subject to ethical and confidentiality considerations.

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Declaration of Interest

The authors declare that they have no competing interests.

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