

LOCATION CHOICE FOR FURNITURE INDUSTRY FIRMS BY USING ANALYTIC HIERARCHY PROCESS (AHP) METHOD

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ABSTRACT

In this research, the Analytical Hierarchy Process (AHP), which is used in general problem solving processes, is adapted to the problem of location choice for furniture industry firms in Turkey. Regarding the current industrial conditions relevant to marketing and investment potentials İstanbul, Ankara, Kayseri, Denizli and Adana cities were determined as candidate places. According to the priority values, İstanbul is the most suitable location for furniture industry and it is followed by Ankara, Kayseri, Denizli, and Adana. In the case of changing priorities of the factors, according to the sensitivity analysis, Ankara is the most suitable city for location when the exact priority values of production factors is over 83%. Except for this, the decrease or increase in the priorities of the other factors does not change the result.

Key words: Plant location choice, analytical hierarchy process (AHP), furniture industry

MOBİLYA ENDÜSTRİSİNDE ANALİTİK HİYERARŞİ SÜRECİ (AHS) YÖNTEMİ İLE KURULUŞ YERİ SEÇİMİ

ÖZET

Bu araştırmada, kuruluş yeri seçiminde etkili olan, somut ve soyut faktörlerin etkilerinin birlikte değerlendirilebilmesine imkan veren, genel anlamda tüm karar verme problemlerine uygulanabilen Analitik Hiyerarşi Süreci (AHS) yöntemi ile, "Mobilya endüstrisi işletmeleri için en uygun kuruluş yeri neresi olabilir?" sorusuna cevap aranmıştır. Türkiye'nin çeşitli bölgelerine göre pazar ve yatırım için cazibe merkezleri durumunda bulunan İstanbul, Ankara, Kayseri, Denizli ve Adana illeri örnek bölgeler olarak belirlenmiştir. Analiz sonucunda; öncelik değerlerine göre 0,382 ile İstanbul en uygun kuruluş yeri seçilmiştir. İstanbul'u sırasıyla 0,239 ile Ankara, 0,132 ile Kayseri, 0,124 ile Denizli ve 0,123 ile Adana illeri izlemiştir. Faktörlerin öncelik değerlerinin değişmesi durumunda, alternatif illeri belirlemek üzere yapılan duyarlılık analizinde, üretim faktörlerinin tam öncelik değerinin %83'ün üzerine çıkması halinde Ankara kuruluş yeri için en uygun il olmaktadır. Bunun dışında diğer faktörlerin değerlerinin artması veya azalması, sonucu değiştirmemektedir.

Anahtar kelimeler: Kuruluş yeri seçimi, analitik hiyerarşi süreci (AHS), mobilya endüstrisi

1. INTRODUCTION

Companies must optimally gather three production factors, namely labour, capital and land, at the profitable manufacturing occupations. Plant location and conformity of the land are ultimately important points at investments because of the reason that investments and manufacturing activities take place in this location. In principle, the company location is not considered as a piece of land only. Company is in obligation in terms of carrying on relations with its close and far environs at the focus point centralised with land. For this reason, with the selection of company location, the company environs and its relation level with these environs are determined.

According to these explanations, company location can be defined as a geographical and central place for the company to realise its all basic occupations and to carry on relations with its close and far environs.

Because of the reason that the plant location choice is highly important for companies, many methods have been presented for this purpose. If the transportation costs are important for the company which will be set up, transportation model will be used for plant location choice. If annual profits or set up cost are important then the method of profitability comparisons and scoring methods are used. If multipurpose decision making is adopted for plant location choice, the Analytic Hierarchy Process (AHP) Method can be used. Three most important advantages of AHP are; many qualitative and quantitative factors which are important for the companies can be appreciated all together, plant location decision can be looked over the changes at importance level of factors in the future, and possible plant location decision is taken regarding the views of a group of experts instead of a single person. AHP is the most profitable method for plant location choice because of its advantages for all industrial manufacturing affairs (1). This advantages clearly indicate why AHP is preferred for solving the problem of plant location choice for furniture industry companies. Many papers and books on this subject are drawn up by researchers but, just a few of this works are relevant to wood products/furniture industry.

In the paper of Chan and Abhary (1996) titled as "Design and evaluation of automated cellular manufacturing systems with simulation modelling and AHP approach" perform an AHP multi-attribute analysis by using AUTOMAN, a decision support software package. This package evaluates and combines the qualitative and quantitative factors for different configuration designs (2).

Rangone (1996) aims to show the potential of the analytical hierarchy process for assessing and comparing the overall manufacturing performance of different departments. Rangone does not report the detailed analytical description of the AHP, but focuses on the practical problems and managerial implications related to its application to performance measurement (3).

Albayrak 1997 found out with his study titled as "a model of decision support system for plant location choice of concrete central" that Istanbul was the most suitable place for concrete central (4).

Giresunlu et al. (1998) found out by using AHP that Düzce district was the most appropriate land for a plant which will manufacture Medium Density Fiberboard (MDF) among provinces or districts of Ankara, Düzce, İnegöl, Kastamonu, Tekirdağ and Gaziantep in Turkey (5).

Taylor and Hoffman (1998) use AHP for evaluating job and/or promotion of candidates by using a number of criteria such as education, experience, personality, etc. in their paper titled as "Personnel evaluation with AHP" (6).

Cheng and Li (2001) state in their paper that AHP is useful in making business decisions, such as the evaluation of alternative marketing strategies, the choice of candidates for jobs. Comments and discussions regarding the AHP method are also provided (7).

AHP is used to determine correlation factors to estimate the impact on profit of various product issues that must be addressed by a company during the product development process. Owing to interactions between the alternatives, as expected, the AHP cannot be used directly to determine these correlation factors. A procedure has been developed to overcome this problem (Muller and

Fairlie 2001)(8).

Any research which uses AHP in plant location choice has been encountered relevant to the furniture industry.

2. APPLICATION OF ANALYTIC HIERARCHY PROCESS TO THE PLANT LOCATION CHOICE FOR FURNITURE INDUSTRY

3.1. Method of The Study

Method has been taken from Thomas L. Saaty who was the builder of AHP (9). In order to answer the question of which city is the most appropriate plant location for furniture manufacturing company to be settled Ankara, İstanbul, Kayseri, Denizli, and Adana were determined as candidate cities for plant location by considering plant location choice factors such as population manipulation, population increase speed in respect to fecundity ratio, sub-structure, transportation easiness in product distribution to other regions, qualified labour possibilities, and existing constitution. Furthermore, the factors effecting plant location choice are classified under four main titles and a hierarchic structure with four levels was formed by determining sub-factors in these titles (Figure 1). In order to evaluate the factors in the hierarchic structure a group of decision makers constituted by 9 people involving as academicians and top managers in furniture industry. A questionnaire was prepared to compare as to hierarchic structure which was formed for this purpose. After the necessary explanations relevant to the questionnaire, decision makers filled the questionnaire out. There are many methods, introduced by Ramathan and Ganesh, in order to reduce group preferences which were obtained from questionnaire to a single preference (10). In this study, first geometrical means of evaluations were calculated by using geometrical mean method and then priority values and consistency ratios by EXPERT CHOICE computer program.

3.2. Method Application

Only one matrix from 22 pairwise matrices obtained from evaluation of plant location choice factors is given Table 1 as an example. After the calculation of the priority values of both factors and alternatives as to each sub-factors, exact priority values of the alternatives were calculated (Table 2). Exact priority values for factors and sub-factors are found by multiplying their priority values by their bounded priority values at proceeding row. For example, 0.050 exact priority value of raw material related to production factors was found by multiplying 0.334 priority level of production factor by 0.149 priority level of raw material. Exact priority values of alternatives were calculated with sum of the numbers obtained by multiplying priority values of each alternatives by each priority values of 17 sub-factors connected to the alternatives (Table 3). For example, 0.382 exact priority values of İstanbul was found multiplying each exact priority values of 17 sub-factors which İstanbul is connected in proceeding level (0.050, 0.081, 0.120, 0.083, 0.054, 0.110, 0.101, 0.029, 0.115, 0.039, 0.046, 0.061, 0.011, 0.045, 0.015, 0.022, 0.019) by priority values (0.522, 0.201, 0.210, 0.076, 0.517, 0.589, 0.391, 0.546, 0.589, 0.471, 0.445, 0.245, 0.172, 0.496, 0.137, 0.144, 0.477) and then sum of multiplication values.

Table 1. Priority values and Consistency Ratio(CR) of factors in respect of plant location choice

PLS	PF	M	T	RF	Priority values	CR
PF	1	1.100	1.734	2.935	0.334	0.024
M	0.909	1	3.235	4.260	0.409	
T	0.576	0.309	1	1.167	0.146	
RF	0.340	0.234	0.856	1	0.112	

3.3. Findings

According to the exact priority values of alternatives in Table 3, it was found that İstanbul is the most appropriate plant location for a furniture manufacturing factory. Ankara, Kayseri, Denizli and Adana are lined up after İstanbul with the exact priority values of model 0.239, 0.132, 0.124, 0.123 respectively. Consistency ratio is calculated as 0.02. Since this value is smaller than 0.1, judgement of the decision makers are consistent. At the last level of the problem, it has been determined by making sensitivity analysis that how priority of the alternatives changes with changing of factors' priority values.

Table 2. Priority and exact priority values of sub factors

Factors and Priority values	Sub factors	Priority values	Exact priority values
PF(0.344)	RM	0.149	0.050
	A	0.243	0.081
	MP	0.358	0.12
	CSP	0.249	0.083
M(0.409)	DC	0.132	0.054
	SV	0.269	0.110
	RF	0.247	0.101
	IN	0.071	0.029
	EX	0.282	0.115
T(0.146)	R	0.266	0.039
	TS	0.318	0.046
	TC	0.416	0.061
RF(0.112)	C	0.098	0.011
	AI	0.402	0.045
	SE	0.138	0.015
	LT	0.194	0.022
	SF	0.167	0.019

Table 3. Priority and exact priority values of alternatives

Sub factors and exact priority values	Priority values of alternatives in respect of sub factors					
		İstanbul	Ankara	Kayseri	Denizli	Adana
RM	0.050	0.522	0.262	0.092	0.073	0.051
A	0.081	0.201	0.240	0.206	0.204	0.150
MP	0.12	0.210	0.380	0.186	0.114	0.109
CSP	0.083	0.076	0.132	0.288	0.288	0.216
DC	0.054	0.517	0.237	0.095	0.073	0.078
SV	0.110	0.589	0.216	0.063	0.056	0.075
RF	0.101	0.391	0.306	0.120	0.101	0.081
IN	0.029	0.546	0.179	0.061	0.098	0.116
EX	0.115	0.589	0.160	0.052	0.076	0.123
R	0.039	0.471	0.227	0.100	0.093	0.110
TS	0.046	0.445	0.241	0.084	0.097	0.133
TC	0.061	0.245	0.213	0.154	0.158	0.229
C	0.011	0.172	0.156	0.110	0.297	0.265
AI	0.045	0.496	0.292	0.098	0.060	0.053
SE	0.015	0.137	0.152	0.262	0.275	0.174
LT	0.022	0.144	0.165	0.226	0.239	0.226
SF	0.019	0.477	0.284	0.063	0.072	0.105
Exact priority values of alternatives		0.382	0.239	0.132	0.124	0.123

EXPERT CHOICE computer program was used for this purpose. Results are given graphically with figure 3 for production factors, figure 4 for marketing factors, figure 5 for transportation, and figure 6 for regional factors. The vertical lines in the graphics describe the priority values of factors. If these vertical lines slide from left to right, the priority values of factors increase. On the contrary, they decrease. Changing of the priority values of alternatives is interpreted according to these increases or decreases.

4. CONCLUSION

With this study, it is determined that İstanbul with the 0.382 exact priority level is the most preferable province among other pre-selected provinces. This result was obtained by using the AHP method, which is one of the multi-criteria decision making systems. Ankara (0.239), Kayseri (0.132), Denizli (0.124) and Adana (0.123) are lined up following İstanbul. Values in the parenthesis are exact priority levels of provinces. This sequence of provinces complies with the sizes of marketing, production factors, transportation and regional factors of furniture industry. For example, rate of population increase which is a factor effect sales volume, is the highest at Marmara Region between years 1990-1997 with the rate of 28.33% according to the data of DIE(State Institute of Statistics of Turkey) (11). İstanbul is in this region. As a consequence of the increase in population, building construction increases, which directly effects furniture sales volume. This increase in the building construction is maximum at this region with the rate of 31.07% (12). Going to the fore of İstanbul under these circumstances is a indicator harmonized with this research results.

According to the answers which are given to the question "which factor related to plant location selection is the most important one?", marketing goes to the fore with the 40.9% weight values. Production, transportation and regional factors follow marketing with 33.4%, 14.6% and 11.2% weight values respectively. According to the results of sensitivity analysis, İstanbul and Ankara have equal preference level with an increase of weight value of production factors to the 83% level. With the exceeding of 83%, Ankara goes to fore as its weight value of production factors is above the 83% level. Decrease or increase of priority values of marketing, transportation and regional factors does not change the order of İstanbul and Ankara but changes preference values.

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