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WAREHOUSE LOCATION SELECTION IN RETAIL INDUSTRY USING MACHINE LEARNING AND MULTI CRITERIA DECISION MAKING

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CONTENT

ÖZET

PERAKENDE SEKTÖRÜNDE MAKİNE ÖĞRENMESİ VE ÇOK KRİTERLİ KARAR VERME İLE DEPO YERİ SEÇİMİ

Artan rekabet koşullarında firmaların faaliyetlerini devam edebilmeleri için doğru kararlar almaları gerekmektedir. Bu çalışmada bir perakende firması Türkiye'nin her bölgesine birer adet depo açmayı amaçlamaktadır. En uygun depo yeri seçiminde en az 2 seçenek ve en az 2 kriter bulunmaktadır. Bu durumda şirket en uygun alternatifleri seçebilmek için kanıtlanmış modellere sahip olmalıdır. Bu çalışmanın amacı, en az 2 alternatif ve en az 2 kriterin olduğu durumlarda en uygun alternatiflerin nasıl belirleneceğini göstermektir. En az 2 alternatif ve en az 2 kriterin olduğu durumlarda çok kriterli karar verme tekniklerinden biri kullanılabilir. Bu çalışmada kriterlerin ağırlıklarının belirlenmesinde Saaty Metodu, Entropi Metodu ve Gini Metodu kullanılmıştır. Bu veriler doğrultusunda ayrı ayrı TOPSIS metodu uygulanmıştır. TOPSIS metodunun işlem adımları da Excel üzerinde formüle edilmiştir. Ayrıca çalışmada makine öğrenmesinde denetimsiz öğrenmenin bir kolu olan k-means algoritması da kullanılmıştır. K-means algoritması ile bölgesel bazlı olmayan ve bölgesel bazlı olan 2 farklı kümeleme çalışması gerçekleştirilmiştir. Gini Metodu için, Rastgele Orman Teoremi kullanılmıştır. Bu sayede, 5 farklı yöntem ile en uygun depo yeri seçimi karşılaştırılmıştır.

Anahtar Kelimeler: Çok Kriterli Karar Verme, Topsis, Makine Öğrenimi, Depo

ABSTRACT

WAREHOUSE LOCATION SELECTION IN RETAIL INDUSTRY USING MACHINE LEARNING AND MULTI CRITERIA DECISION MAKING

In the circumstances of soaring rivalry, corporations must perform the right decisions in order to maintain their actions. In this implementation, a retail corporation intends so as to open a warehouse in each region of Turkey. There are at least two alternatives and at least two criteria in selecting the most convenient warehouse location. At that rate, the corporations must have a proven models to be able to select the best convenient alternatives. The aims of this implementation is to demonstrate how to find the most convenient alternatives in situations where there are at least two alternative and at least two criteria. In situations where there are at least two alternatives and at least two criteria, one of the Multi Criteria Decision Making techniques may be utilized. For the implementation, Saaty Method, Entropy Method and Gini Method were utilized to determine the weights of the criteria. In line with these data, the Topsis Method was applied separately. The operation steps of the TOPSIS method are formulated on Excel. In addition, the k-means algorithm, which is a branch of unsupervised learning in machine learning, was also used in the study. With the k-means algorithm, 2 different clustering studies, which are not regional based and regional based were carried out. The Random Forest Method is utilized for the Gini Method. In this way, the most suitable warehouse location selection was compared with 5 different methods.

Keywords: Multi Criteria Decision Making, Topsis, Machine Learning, Warehouse

SYMBOLS

A^* : Ideal Solution Set

A^- : Negative Ideal Solution Set

C_i^* : The Relative Proximity to the Positive Ideal Solution

n : Criterion

S_i^* : Ideal Distinction

S_i^- : Negative Ideal Distinction

W_j : Weight

λ_{max} : Eigenvalue

ABBREVIATIONS

D : Decision Matrix
K1 : Warehouse Maintenance Costs
K2 : Movement Flexibility
K3 : Avarage Distance to Main Supplier
K4 : Infrastructure
K5 : Skilled Worker Availability
K6 : Security of Region
MCDM : Multi Criteria Decision Making
R : Standard Decision Matrix
V :Weighted Standard Decision Matrix
TOPSIS : Technique for Order Preference by Similarity to Ideal Solution

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1. INTRODUCTION

Companies should provide their customers with products or services of appropriate quality reasonable prices in order to continue their commercial activities under increasing competitive conditions. Moreover the product or service should be delivered within the time interval requested by the consumer. The company should evaluate the processes of a product or service as a whole and minimize its costs without sacrificing quality within the framework of these conditions. Logistics expenses are one of the most important expense items of companies. The company should choose a suitable warehouse location to minimize logistics expenses.

Warehouses are crucial connections in a supply chain system at vernacular or universalized areas (Singh et al., 2018). Warehouse area in supply chain system defines productivity and velocity of supply chains (Singh et al., 2018).

With a warehouse that is not selected in the right location, the company's expenses increase. In the face of increasing expenses, the company can follow 2 different paths. First, increased expenses are reflected in the products or services offered as a raise. However, if there is a competitor company that produces products or services with the same quality, customers prefer the competitor's product or service. In this case, the company losses customers. Moreover, it can not keep up with the increasing competition conditions. As a second way, it may choose not to increase the price of its products or services in the face of increasing costs. However, in this case the profit margin decreases as the company's expenses increase. As the profitability of the company, whose profit margin decreases, will also decrease, it will again have difficulties in the increasing competition conditions. In this case, if the company can not choose a warehouse location in a suitable location for itself, it can not continue its existence. A warehouse chosen in the right location contributes to company's commercial existence.

Supply chain performance at the outset bounds up with the bonded and related functioning of its major drivers (Dey et al., 2016). Appropriate selection of the warehouse location will also contribute to customer satisfaction as it will ensure that the product or service is delivered to the customer on time.

Today, companies have at least two criteria and at least two alternatives when determining the warehouse location. The degree of importance of the identified alternatives may also differ. Making the right decision is extremely complicated when there are multiple criteria and multiple alternatives. More than one criterion should be considered in the choice of warehouse location. The degree of importance of these criteria may also differ between each other. In this study, it is aimed to hand over the products on time and to minimize the distribution costs.

Multi Criteria Decision Making (MCDM) is a discipline type belonging to procedures investigate that clearly guesses poly contradictory criteria in verdict-making in diverse ranges(Balusa and Gorai, 2019). Since there are at least two criteria and at least two alternatives to make a decision today, multi criteria decision making techniques have been extensively employed. There are more than one MCDM technique.

Table 1.1. Multi Criteria Decision Making Techniques

Some MCDM Techniques
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
Preference Ranking Organization Method for Enrichment Evaluations
Multi-Objective Optimization on the basis of Ratio Analysis
Vise Kriterijumska Optimizacija I Kompromisno Resenje
Complex Proportional Assessment
Operational Competitiveness Rating
Analytic Hierarchy Process

Aim of this paper is to assign the most suitable warehouse location with TOPSIS. Study will be used the TOPSIS method to define appropriate warehouse location for the corporation. My aim is to show how to formulate TOPSIS method in excel. In this way;

with the help of excel, we will determine the most suitable warehouse location with TOPSIS method.

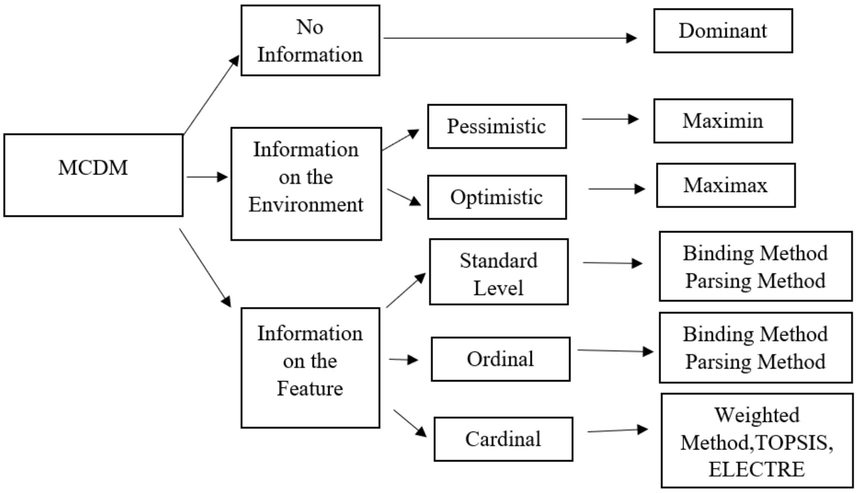

Figure 1.1. Classifying Multi Criteria Decision Making Methods

Hwang and Yoon classified plenty criteria decision methods above(Ozbek,2017).

In the classification invented by Hwang and Yoon, TOPSIS is included in information on the feature. This study will choose the most appropriate alternative among multiple criteria and multiple alternatives, owing to a mathematical model, in choosing the appropriate warehouse location of a business operating in every region of Turkey in the retail sector. Literature research will be taken into account while determining the criteria and alternatives. All process steps of TOPSIS will be formulated on excel and shown in the case study part. Machine learning has started to be applied in most areas. Machine learning algorithms will also be integrated into the study. Machine learning generally has three types of algorithms. These algorithms are supervised learning, unsupervised learning and reinforcement learning. Random Forest, which is a branch of supervised learning, and k-means algorithm, which is a branch of unsupervised learning, will be used in the study. Considering the alternatives and criteria, the result of the k-means algorithm and the Random Forest algorithm will be included in the study. In this way, the data of different methods will be compared.

2. LITERATURE REVIEW

While conducting a literature research, it is seen that companies have more at least two criteria and at least two alternatives in determining the warehouse location. At that rate, the corporation can reach the right result by utilizing a method from MCDM techniques. It is seen in the studies carried out this type of problems are utilized in many areas.

2.1. Determining the Suitable Warehouse Location

It is extremely significant that the warehouse is in a convenient location for the corporation. Warehouse is the area where one or more kinds of products or semi products are kept under appropriate conditions. The selection of the appropriate warehouse location has an extremely important area in the optimization of logistics areas. When the appropriate warehouse location is selected in the supply chain, efficiency increases, profitability increases and costs decreases.

Table 2.1.1. Warehouse Location Selection Criteria

The continuation of the table 2.1.1. is on the next page.

Warehouse Location Determination Criteria	**References**
Transport and connectivity	(Turgut et al., 2011);(Yang et al., 1997);(Wu et al., 2005)
Cost of land	(Ashrafzadeh et al., 2012); (Demirel et al., 2010); (Turgut et al., 2011); (Glasmeier et al., 1996); (Sivitanidou, 1996)
Taxation policies	(Demirel et al., 2010); (Yang et al., 1997)
Incentives	(Demirel et al., 2010)
Market size	(Vlachopoulou et al., 2001)

Proximity to main market	(Demirel et al., 2010);(Ashrafzadeh et al., 2012);(Turgut et al., 2011);(Huifing et al., 2008);(Durnus et al., 2012)
Scope for market growth	(Wu et al., 2005);(Polese et al., 2004);(Shearmun et al., 2002);(Elberto, 2000);(Maccanty et al., 2003)
Unit price, Stock holding capacity, Average distance to markets, Average distance to main supplier, Flexibility of movement	(Chen, 2001);(Ozcan et al., 2011);(Dey et al., 2015);(Ozbek et al., 2016);(Ozbek, 2017)
Responsiveness, Transportation Conditions, Cost related factors, Location properties, Favourable labour climate	(Karmaker, 2016)
Land size, Storage conditions, Shipping cost	(Comert and Yener, 2016)

As a result of the research, the criteria utilized for the choice of the convenient warehouse location are summarized in the table above.

2.2. Multi Criteria Decision Making Techniques

Companies must perform the correct decision in order to maintain their commercial activities. With the developing world, it is getting harder and harder to make the right decision. When the company decides on any issue, it chooses between more than one alternative. However, when choosing the most suitable alternative, it should make this decision in the face of more than one criterion. Therefore, corporation must have a proven model to select the best convenient alternative against multiple cirteria and multiple alternatives. MCDM techniques choose the most suitable alternative for us in the face of more than one alternative and more than one criterion. It also offers the possibility to sort through the alternatives. Thanks to multi criteria decision making techniques, companies can select and rank the most suitable alternative choice against more than one alternative and more than one criterion owing to a mathematical model.

Table 2.2.1. Some MCDM Techniques 1

The continuation of the table 2.2.1. is on the next page.

MCDM Techniques	**Explanation**	**References**
TOPSIS	It was invented by Hwang and Yoon in 1980. It is divided into two as positive ideal solution(A^*) and negative ideal solution(A^*). A^* minimizes cost criterion and maximizes benefit criterion. After calculations, the alternative closest to the A^* is selected as the most suitable alternative.	(Ozbek, 2017); (Hwang et al., 1981); (Cheng et al., 2002); (Wang et al., 2006); (Ozden, 2011)
Step-wise Weight Assessment Ratio Analysis	It was invented by Zavadskas and Turskis in 2010. It is a method that believes that complex problems can be understood using simple relative comparisons and can involve the thoughts of expert ideas in the process.	(Ozbek, 2017); (Alimardani, 2013)
Preference Ranking Organization Method for Enrichment Evaluations	It was proposed by Jean Pierre Brans at a university conference in 1982. The method counts on pairwise comparison in accordance with assessment factors to define the ranking of decision options. It is a simple mathematical model.	(Ozbek, 2017); (Brans et al., 1992);(Senkay as et al., 2013); (Balli et al., 2007)
Multi-Objective Optimization on the basis of Ratio	It was invented by Brauers and Zavadskas in 2006. Different versions of MOORA are available. One of the outstanding features of	(Ozbek, 2017);(Gadakh ,2011);(Karaca

Analysis	the method is that it takes all criteria into account.	, 2011)

In addition to these, Vise Kriterijumska Optimizacija I Kompromisno Resenje, Complex Proportional Assessment, Operational Competitiveness Rating and Analytic Hierarchy Process techniques will also be explained in the table below.

Table 2.2.2. Some MCDM Techniques 2

The continuation of the table 2.2.2. is on the next page.

MCDM Techniques	**Explanation**	**References**
Vise Kriterijumska Optimizacija I Kompromisno Resenje	Opricovic and Tzeng were invented this method. The technique is to achieve the compromise solution that is closest to the solution and to choose the most correct alternative.	(Ozbek, 2017);(Opricovic et al., 2007)
Complex Proportional Assessment	It was invented by Zavadskas and Kaklauskas in 1996. It is used to rank the alternatives, taking into account that the criteria are maximization and minimization. In addition, the fuzzy version of COPRAS, the COPRAS-F method, was developed by Zavadskas and Antucheviciene in 2007.	(Ozbek, 2017);(Kaklauskas et al., 2005);(Zavadskas et al., 2008)
Operational Competitiveness Rating	It was developed by Parkan in 1994. It has been developed for use in performance and productivity analysis problems. This method has been applied in investment banking, industrial enterprises and many other areas.	(Ozbek, 2017);(Peters et al., 2010)

Analytic Hierarchy Process	It was invented by Thomas Saaty in 1977. First, the purpose is determined. Then, the factors and sub factors that affect the purpose are determined. It has a hierarchical structure. At the top of the hierarchy is purpose. At the lower level of the purpose, there are the main criteria. Below the main criteria are sub criteria. At the bottom, there are alternatives.	(Ozbek, 2017);(Saaty, 1980)

In that application, this study will be utilized the TOPSIS method. Thanks to MCDM methods, companies or individuals are enabled to choose the most suitable alternative. In addition, it offers the opportunity to sort among the alternatives. The company chooses the most suitable warehouse location by using this method in determining the appropriate warehouse location. It minimizes the cost. In this way, expense items are reduced. The profitability of the company, which decreases the expense item, increases. The company's determination of a suitable warehouse location provides the opportunity to continue its commercial activities.

2.3. Warehouse Location Selection Studies With MCDM Techniques

In the previous studies, this type of problem has been utilized in many areas. The following table will show the most appropriate storage ground choice studies utilizing MCDM techniques.

Table 2.3.1. Warehouse Location Selection Studies 1

The continuation of the table 2.3.1. is on the next page.

The Title of the Study	**Writer**	**Main Criteria**	**Method Used**
Selection of Logistics Center Location Using	Erdal and Aydogmuş	Costs,Land,Location,Socio-Economic Factors	Analytic Hierarchy

Analytic Hierarchy Process	, 2019		Process
The Selection of Dry Port Location by a Hybrid CFA-MACBETH-PROMETHEE Method: A Case Study of Southern Thailand	Komchornrit,2017	Seaport,Airport,Highway Industrial area, Local market, Regional market, Cross-border market	Hybrid CFA-MACBETH-PROMETHEE
Warehouse Location Selection in the Central Anatolia Region with Multi Criteria Decision Making Methods for a Logistics Company	Seker and Alakas, 2019	Affordable land/warehouse prices, Skilled workforce, Proximity to customers, Transportation network and accessibility, Infrastructure, Public and management factors	AHP, TOPSIS, PROMETHEE
Selection of Warehouse Location for a Global Supply Chain : A case study	Singh et al.,2018	Infrastructure, Government, Market	Fuzzy AHP

In these articles, different techniques are operated. In addition, it has been observed several criteria are utilized to define the best alternative. In the following study, the methods and main criteria used different articles will be shown.

Table 2.3.2. Warehouse Location Selection Studies 2

The continuation of the table 2.3.2. is on the next page.

The Title of the Study	Writer	Main Criteria	Method Used

A Decision Support System for Warehouse Location Selection: A Case Study	Karmaker, 2016	Responsiveness, Transportation conditions, Cost-related factors, Location properties, Favourable labour climate	Fuzzy AHP, Fuzzy TOPSIS
Sustainable Warehousing: Selecting The Best Warehouse for Solar Transformation	Boztepe and Cetin, 2020	Annual irradiation values of the regions, Solar annual time, Shadowiness risk of solar panel in future, Angle and direction of warehouse for sunshine, closeness of warehouse to nearest electricity network, Seasonality in solar electricity production, Area of the roof, Other factors that limit solar electricity production, Amount of wind in the area, Self consumption of the electricity in warehouse	TOPSIS

In the literature reviews, it is observed that this techniques are constantly operated in recent years. In the following study, the methods and main criteria used different articles will be shown.

Table 2.3.3. Warehouse Location Selection Studies 3

The continuation of the table 2.3.3. is on the next page.

The Title of the Study	**Writer**	**Main Criteria**	**Method Used**
Warehouse Location Selection by Fuzzy Multi Criteria Decision Making Methodologies Based On Subjective and Objective	Dey et al.,2016	Costs,Labor characteristics, Infrastructure, Markets,Macro environment	Fuzzy TOPSIS,Fuzzy SAW(fuzzy simple additive weighting),

Criteria			Fuzzy MOORA
The Most Suitable Factory Location Selection For Turkey's Domestic Automobile with Fuzzy TOPSIS Method	Yildiz and Demir, 2019	Economic features, Geolocation features, Infrastructure features, Technicial features, Social features	Fuzzy TOPSIS

Different studies were examined. The common feature of these studies is that all of them decide on the most suitable warehouse location. As the industries in which it operates change, the main criteria change. For example, it has been shown that a company running in the food sector and a company running in the energy sector do not use the same criteria in choosing the most suitable warehouse location. However, no matter what sector the company operates in, it creates a mathematical method for the best appropriate warehouse location selection. Moreover, it makes a ranking among the alternatives. Then, it chooses the most suitable alternative.

2.4. Studies Conducted In Different Fields With The TOPSIS Method

The usage areas of TOPSIS in different fields will be investigated. For this, different studies in the table below were examined. The names of different studies, their authors, the fields used and method used are shared.

Table 2.4.1. Study Areas Where The TOPSIS Method Is Used

The continuation of the table 2.4.1. is on the next page.

The Title of the Study	**Writer**	**Used Field**	**Method Used**
Risk Assessment of Floor Water Inrush in Coal Mines Based on MFIM-TOPSIS Variable Weight Model	Zhang et al., 2021	Coal Industry	TOPSIS, Multi factor interaction matrix
Investigation of Cash Flow	Acikgoz,	Manufacturing	TOPSIS

Profiles of Manufacturing Sector and Comparison of Financial Performances with TOPSIS Method	2021	Industry	
Identifying and Ranking the Factors Affecting Consumer Financial Behavior Using Multi Criteria Decision Making Technique (TOPSIS)	Hamadani et al., 2020	Financial Industry	TOPSIS
Using Improved TOPSIS and Best Worst Method in Prioritizing Management Scenarios for the Watershed Management in Arid and Semi Arid Environments	Alvandi et al., 2021	Agriculture Industry	TOPSIS
Personnel Selection Method Based on TOPSIS Multi Criteria Decision Making Method	Korkmaz, 2019	Human Resource Industry	TOPSIS
Benchmarking Methodology for Selection of Optimal COVID-19 Diagnostic Model Based on Entropy and TOPSIS Methods	Mohammed et al., 2020	Healthcare Industry	TOPSIS and ENTROPY
Performance Evaluation in	Karaman and	Human	TOPSIS

Family Physician: The Application of TOPSIS Multi Criteria Decision Making Method	Kazan, 2015	Resource Industry	

As seen in the studies, the TOPSIS has been successfully implemented in many different areas.

2.5. Machine Learning

Machine learning is as the area of running which serves computers the ability so as to ascertain without being frankly programmed (Mahesh,2018). It is a field of artificial intelligence. The primary target of machine learning is to work, engineer and develop mathematical algorithms that could be educated with condition connected data to conclude the future then to perform verdicts without finish information of entire influencing components (Bonaccorso,2017). Machine learning has various algorithms. These algorithms can be used for both prediction and classification. Thanks to labeled or unlabeled input data defined to the computer system algorithms can generate a prediction or a classification from the data.

Machine learning is generally divided into 3 main categories. These categories are supervised learning, unsupervised learning and reinforcement learning.

Table 2.5.1. Machine Learning Algorithms

The continuation of the table 2.5.1. is on the next page.

Machine Learning Categories	**References**
Supervised learning is a machine learning method for learning a context from education information. The target of supervised learning is so as to estimate the value of the context for any effective entry object after seeing a set of training examples. The Decision Tree, Naive Bayes and Support Vector Machine are the techniques used for supervised learning.	(Zhang,2010); (Mahesh,2018)

Unsupervised learning shows how to group based on information in a series of data sets. There are no right answers in unsupervised learning. K-means and principal component analysis techniques used in unsupervised learning is an example. It includes applications such as object segmentation, automatic tagging and similarity detection.	(Bonaccorso,2017); (Mahesh,2018)
Reinforcement learning does not have a real supervisor. However, it can receive feedback from the surroundings. Reinforcement learning is preferred when the environment is not entirely decisive. In addition, if the environment is not in a stable structure, reinforcement learning is preferred.	(Bonaccorso,2017)

Support Vector Machines, Naive Bayes, Decision Trees and Hierarchical Clustering are other techniques used in machine learning.

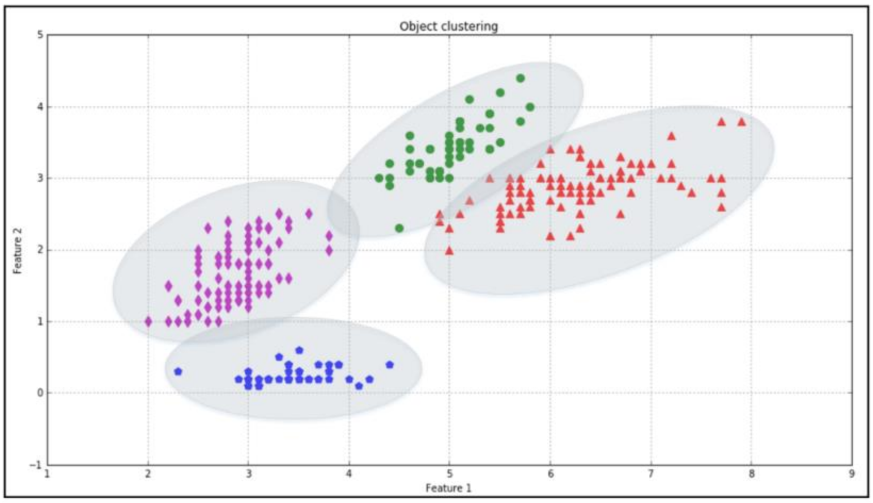

Figure 2.5.1. Example of Machine Learning

An example of unsupervised learning is shown in Figure 2.5.1. A clustering has been performed. As can be seen in Figure 2.5.1., 4 different clustering was carried out. The figure 2.5.1. is taken from the machine learning algorithms book (Bonaccorso,2017).

3. METHODOLOGY

TOPSIS method invented by Hwang and Yoon in 1980 and has been implemented in many areas. It aims to define the option with the shortest span to the A^* and the farthest span to the A^- (Ozbek, 2017).

In the method, the space to both A^* and A^- are taken into account when calculating the closeness required for the ideal solution. Best answer indicated as A^*; it is the solution minimizes the cost criterion and maximizes the benefit criterion. while A^- , it is the one minimizes the advantage criterion on maximizes the damage criterion. In short; while A^* consists of the top values to reach the criteria, the A^- is to the criteria consists of the worst possible values. By comparing the distances, all decision options can be listed (Ozbek, 2017; Wang et al., 2006; Ozden, 2011).

In order for TOPSIS to be implemented, there must be at least two decision options. First of all, in the application of TOPSIS, all decision criteria should be determined. The criteria are divided into benefit criteria and cost criteria (Ozbek, 2017;Janic, 2003). It is determined as the biggest criterion in cost criteria and the smallest criterion in benefit criteria as the worst criterion (Ozbek, 2017; Cheng et al., 2001).

The TOPSIS method is preferred in many areas because the results are clear, understandable and easy to apply. The TOPSIS method can be implemented in dissimilar areas such as warehouse location selection, supplier selection, personnel selection. Scoring from 1 to 9 is used to determine criterion weights.

3.1. Steps Of The TOPSIS Process

A decision matrix consisting of n criteria and m decision options is created (Ozbek, 2017).

STEP 1: Creating the Decision Matrix (D)

The Step 1 is composed by verdict makers at the starting of operation (Ozbek, 2017).

$$D_{ij}= \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ \dots & \dots & \dots & \dots \\ d_{i1} & d_{i2} & \dots & d_{in} \\ \dots & \dots & \dots & \dots \\ d_{m1} & d_{m2} & \dots & d_{mn} \end{bmatrix}$$

STEP 2: Creating a Standard Decision Matrix (R)

R acquired by receiving the square root of the sum of squares of the values of each criterion of the decision matrix and dividing the relevant elements of the coloumn by this value. If the value of any element of the decision matrix is 0, the value of the relevant element in the standard decision matrix is also 0(Peters et al., 2007;Triantaphyllou, 2000;Ozbek, 2017).

$$\forall d_{ij} \neq 0: r_{ij} = \frac{d_{ij}}{\sqrt{\sum_{k=1}^{m} d_{kj}^2}} \quad \forall_i = 1, \dots, m \quad \forall_j = 1, \dots, n$$

$$\forall d_{ij} = 0: r_{ij} = 0; \qquad \forall_i = 1, \dots, m \ ;$$

$\forall_j = 1, \dots, n$

$$R_{ij}= \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ \dots & \dots & \dots & \dots \\ r_{i1} & r_{i2} & \dots & r_{in} \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

STEP 3: Creating a Weighted Standard Decision Matrix (V)

At this stage, the hefts of the preconcerted criteria are multiplied by elements of R , and V is obtained. The total of the heft worths of assessment criteria should be 1(Peters et al., 2007;Triantaphyllou, 2000;Ozbek, 2017).

$$V_{ij} = \begin{bmatrix} w_1r_{11} & w_2r_{12} & \dots & w_nr_{1n} \\ w_2r_{21} & w_2r_{22} & \dots & w_nr_{2n} \\ \dots & \dots. & \dots & \dots \\ w_1r_{m1} & w_2r_{m2} & \dots & w_nr_{mn} \end{bmatrix}$$

STEP 4: Creating Ideal (A^*) and Negative Ideal (A^-) Solutions

Two dissimilar answer sets named A^* and A^- are generated from the V. Providing that the assessment criteria are in terms of advantages; on the other hand the A^* consists of the top values of the weighted standard decision matrix; A^- occurs the worst values. Whether the assessment criteria are in point of cost, then the A^* occurs the smallest of the criteria values of the weighted standard decision matrix, while A^- occurs the largest values(Peters et al., 2007;Triantaphyllou, 2000;Ozbek, 2017).

$$A^* = \left\{ \left[\max_i v_{ij} \;\middle|\; j \,\varepsilon\, J\right], \left[\min_i v_{ij} \;\middle|\; j \,\varepsilon\, J'\right] \; i = 1,...,m \right\}$$

$$\left\{ A^* = v_1^*, v_2^*, \dots , v_j^*, \dots , v_n^* \right\}$$

$$A^- = \left\{ \left[\min_i v_{ij} \;\middle|\; j \,\varepsilon\, J\right], \left[\max_i v_{ij} \;\middle|\; j \,\varepsilon\, J'\right] \; i = 1,...,m \right\}$$

$$A^- = \left\{ v_1^-, v_2^-, \dots , v_j^-, \dots , v_n^- \right\}$$

$$J = \left[j = 1, \dots n \;\middle|\; \text{criteria from benefit type} \right]$$

$$J' = \left[j = 1, \dots n \;\middle|\; \text{criteria from cost type} \right]$$

$$J \cap J' = \emptyset \wedge J \cup J' = \{1, .., n\}$$

STEP 5: Calculation of Distinction Dimensions

In TOPSIS, two distinction dimensions, called ideal distinction (S_i^*) and negative ideal distinction (S_i^-) emerge for each option. S_i^* and S_i^- values are calculated as much as the number of decision options compared(Peters et al., 2007;Triantaphyllou, 2000;Ozbek, 2017).

$$S_i^* = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^*\right)^2} \quad \forall_i = 1, \ldots, m$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} \quad \forall_i = 1, \ldots, m$$

STEP 6: Calculation of Closeness to the Ideal Solution

The relative proximity to the positive ideal solution (C_i^*) for each option is calculated using the S_i^* and S_i^- measures. The alternative closest to A^* is defined as the most convenient decision option (Peters et al., 2007;Triantaphyllou, 2000;Ozbek, 2017).

$$C_i^* = S_i^- / (S_i^- + S_i^*) \quad 0 \leq C_i^* \leq \ \forall_{i=} 1, \ldots, m$$

The value C_i^* takes a value in the range of 0 to 1. There are more than one criterion and more than one alternative in today's problem. Determining the appropriate location of the warehouse in the enterprises is extremely crucial for the company to continue its life. This application is to show that multi criteria decision making methods guide us in choosing the right alternative to make decisions against more than one alternative and criterion. Moreover, it is one of the purposes of my carrying out this study to show that many criteria decision making methods must be used in Excel. It contributes to selection of the appropriate alternative while formulating multi criteria decision making techniques thanks to Excel.

3.2. Steps Of The Entropy Method

STEP 1: X matrix is created showing the value of the alternatives according to the criteria.

$$X = \left(X_{ij}\right)_{m*n} = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ \dots & \dots & \dots & \dots \\ X_{41} & X_{42} & \dots & X_{4n} \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix} \quad (i = 1,2..,m;\ j = 1,2,..,n)$$

STEP 2 : A normalized matrix is created.

$r_{ij} = x_{ij} - \min(x_{ij}) / \max(x_{ij}) - \min(x_{ij})$

$r_{ij} = \max(x_{ij}) - x_{ij} / \max(x_{ij}) - \min(x_{ij})$

i = 1,2,....,m and j = 1,2,....,n

STEP 3 : Entropy values are determined for the criteria.

$e_j = -\left(\sum_{j=1}^{n} f_{ij} \ln f_{ij}\right) / (\ln m)$ i = 1,2,....,m and j = 1,2,....,n

$f_{ij} = r_{ij} / \sum_{i=1}^{m} r_{ij}$ and $0 < e_j < 1$

STEP 4 : The Entropy weights are determined.

$wj = (1 - ej) / \left(n - \sum_{i=1}^{m} ej\right)$ $\sum_{j=1}^{n} wj = 1$ (Isik et al.,2017).

3.3. Steps Of The Saaty Method

Another method used to determine criterion weight is Saaty. A score from 1 to 9 is given among the criteria. For this method, the consistency ratio is calculated. It is found by dividing the consistency index by the random index. It is calculated as follows.

Consistency index = $(\lambda max - n) / (n - 1)$

n represents the number of criteria. The random index values are as follows.

n = 1 Random Index = 0.00

n = 2 Random Index = 0.00

n = 3 Random Index = 0.58

n = 4 Random Index = 0.90

n = 5 Random Index = 1.12

n = 6 Random Index = 1.24

The consisteny ratio is computed by dividing the consistency index by the random index. If the consistency ratio is less than 0.1, the matrix is considered to be coherent. If this ratio is exceed, the matrix is inconsistent. The Saaty comparison scale is as follows.

Importance 1 is equal importance that is equally important in both options. Importance 3 is a little important that is one criterion is considered slightly more important than the other. Importance 5 is too important that is one criterion is considered more important than the other. Importance 7 is absolute more important that is the criterion was clearly deemed too important compared to the other criterion. Importance 9 is highly important that is it is based on various information that one criterion is extremely important over the other (Ozbek, 2017).

3.4. Steps Of The K-Means Method

K-means, one of the unsupervised learning algorithms, is a technique used to solve clustering problems. The dataset can be classified thanks to the k-means algorithm. The steps of the are as follows.

STEP 1: K points are placed in the region representing the clustered objects. Centers of gravity are shown for the placed points.

STEP 2: All objects are placed in the group with the nearest center of gravity.

STEP 3: After the objects are placed in the respective group, the position of the k centroids is recalculated.

STEP 4: Step 2 and Step 3 are repeated until the centers of gravity remain constant (Kodinariya and Makwana,2013).

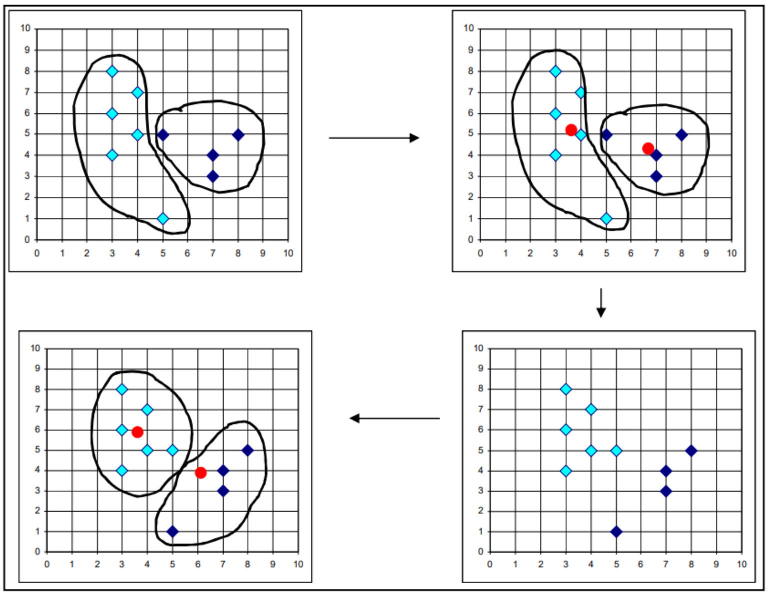

Figure 3.4.1. Examples of K-Means

The working steps of the K-means methodology are shown in figure 3.4.1. The process continues until the centers of gravity remain constant. Figure 3.4.1. is taken from Shukla its 2014 article. There are multiple approaches to choosing the correct k-value in the k-means algorithm. Examples of these approaches are Elbow method, Cross validation, by Rule of thumb, Choosing k using the silhouette.

3.5. Steps Of The Random Forest and Gini Method

Serving education vectors $x_i \in R^n$, i=1,..., I moreover tag vector $y \in R^1$,a decision tree can separate data so that data with the same or similar characteristics can be grouped together. Allow data at knot m be symbolized by Q_m withal n_m patterns. All nominee divide θ = (j,t_m) taking place a characteristic j then, sill t_m chamber the data into $Q_m^{left}(\theta)$ and $Q_m^{right}(\theta)$ subsets

$$Q_m^{left}(\theta) = \{(x,y) \mid x_i <= t_m\}$$

$$Q_m^{right}(\theta) = Q_m \setminus Q_m^{left}(\theta)$$

Quality of a nomine dividing of knot m is calculated then computed utilization an impurity or loss function H().

$$G(Q_m,\theta) = \left[(n_m^{left}) / (n_m)\right] H(Q_m^{left}(\theta)) + \left[(n_m^{right}) / (n_m)\right] H(Q_m^{right}(\theta))$$

Choose the parameters that reduces the impurity

$\theta^* = \text{argmin}_\theta\ G(Q_{m,}\theta)$

Repeat for subsets $Q_m^{left}(\theta^*)$ then $Q_m^{right}(\theta^*)$ till the maximal permissible depness is arrived, $n_m < min_{samples}$ or $n_m = 1$.

Provided that a goal is sorting result receiving on worths 0.,2,...8..,K-1, for knot m, allow $p_{mk} = 1/n_m \sum_{y \in Q_m} I(y = k)$ have the ratio of category k observations on knot m. Providing that m is a terminal knot, predict_proba for that zone is adjusted to p_{mk}.

Gini: $H(Q_m) = \sum_k p_{mk}(1-p_{mk})$ (Pedregosa et al.,2011).

4. CASE STUDY

There is a retail company operating in every region of Turkey. This company offers both food and non-food products to its customers. The company needs a new warehouse area in any region of Turkey. It will deliver its products from this central warehouse to its stores. There are multiple criteria and alternatives in choosing a suitable warehouse. It will use the TOPSIS method, in order to choose the best convenient alternative among these criteria and alternatives. Thanks to this method, the most suitable alternative will be selected among multiple criteria and multiple alternatives. In addition, the degree of importance among the criteria may differ from each other.

After the literature research for the selection of a suitable warehouse location, the following 6 criteria were determined. Warehouse maintenance costs was not used as reference.

Table 4.1. Criteria To Be Used In The Study

The continuation of the table 4.1. is on the next page.

Criterion	**Explanation**	**References**
Warehouse Maintenance Costs	It includes the number of natural disasters of the region	-
Movement Flexibility	The area of the provinces is taken into account.	Ozcan et al., 2011
Average Distance to Main Supplier	A close warehouse with suppliers to save time should be selected	Ozcan et al., 2011
Infrastructure	Easy access to internet should be provided.	Dey et al., 2013
Skilled worker availability	A qualified workforce is needed for planning and	Dey et al., 2013

	organization	
Security of Region	Employees must work in a safe area. Products should be stored in a safe area	Ocampo et al., 2020

The table below contains the abbreviations to be used for the criteria.

Table 4.2. Criteria and Abbreviation Names

Criterion	**Abbreviation**
Warehouse Maintenance Costs	K1
Movement Flexibility	K2
Average Distance to Main Supplier	K3
Infrastructure	K4
Skilled Worker Availability	K5
Security of Region	K6

For the 1st criterion, the report prepared by the Disaster and Emergency Management Presidency of the Ministry of Interior of the Republic of Turkey on a provincial basis was used. In this report, the number of landslides and rockfalls, the number of floods and avalanches that occurred on a provincial basis between 1950-2019 were taken into account. The number of landslides and rockfalls, flood numbers and avalanches, whose numbers are given separately in the report, were collected. Then the targets of our 1st criterion were established on a provincial basis. For example, 915 landslides and rockfalls ,170 floods and 15 avalanches occured in Giresun, whose license plate code 28, between 1950 and 2019. There have been 1100 disasters in total.

For the 2nd criterion, the surface area of the provinces was taken into account. The transportation cost is directly proportional to the area of the provinces. If the area of the province is large, transportation the cost is high. For example, Artvin, with a license plate code of 8, has an area of 7393 square kilometers. The targets of our 2nd criterion were determined by considering the surface areas of the provinces.

For the 3rd criterion, the report prepared by the federation of tradesmen and craftsmen of Turkey was taken into account. In this report, the ratio of the number of tradesmen on a provincial basis to the total population of that province is included. The higher the tradesmen/population ratio for the criterion we have determined, the more advantageous it is for us. For example, in Usak, with a license plate code of 64, the tradesmen/population ratio is 3,79%. The targets of our 3rd criterion have been determined by considering the tradesmen/population ratio of the provinces.

For the 4th criterion, the report prepared by the Sectoral Research and Strategy Development Department of the Information Technologies and Communications Authority was taken into account. Fiber optic cable length information was shared on a provincial basis. Data for 2019 has been taken into account. The longer the fiber optic cable length of the region, the better the infrastructure. For example, the fiber optic cable length of Istanbul is 52762 kilometers. The targets of our 4th criterion have been determined by considering the fiber optic cable length information of the provinces.

For the 5th criterion, the report prepared by the Council of Higher Education was taken into consideration. In this report, the total number of associate, undergraduate, graduate and doctorate students studying at state and foundation universities on a provincial basis in 2020-2021 is given. The higher the number of students on a provincial basis, the higher our rate of finding qualified employees. For example, a total of 46514 students study in Canakkale. The targets of our 5th criterion were determined by considering the number of students in the provinces.

For the 6th criterion, the report prepared by the General Directorate of Criminal Records and Statistics of the Ministry of Justice of the Republic of Turkey was taken into consideration. In this report, the number of notification files in 2020 on a provincial basis is included. The population information of 2020 is taken from the Anatolian Agency. In 2020, the ratio of the number of notification files to the population was taken. This rate is the crime rate. Then, the confidence ratio was reached by making 1 – crime rate. Antalya confidence rate is 99.58%. The targets of our 6th criterion have been determined by considering the trust rate in the provinces.

Since Turkey has 81 provinces, 81 alternatives have been determined. Each province has a unique license plate code. Table 4.3 shows the plate codes of some provinces.

Table 4.3. Some Alternative and Abbreviation

Alternative	**Abbreviation**	**Abbreviation**	**Abbreviation**
01	S_1^*	S_1^-	C_1^*
25	S_{25}^*	S_{25}^-	C_{25}^*
54	S_{54}^*	S_{54}^-	C_{54}^*
67	S_{67}^*	S_{67}^-	C_{67}^*
78	S_{78}^*	S_{78}^-	C_{78}^*
...	...	...	...
81	S_{81}^*	S_{81}^-	C_{81}^*

After the criteria are determined, we must determine their weights. The technique created by Saaty will be used to determine the criterion weights. In the comparison scale developed by Saaty, 1 point indicates that the criteria have equal importance, 3 points indicates that one criterion is slightly more important than the other criterion, 5 points indicates that one criterion is more crucial than the other criterion, 7 points indicates that one criterion is definitely more crucial than the other criterion and 9 points indicates one criterion is extremely crucial compared to the other criterion.

Table 4.4. Pairwise Comparison Matrix

MATRIX	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**
K1	**1**	0.33	0.33	1	3	0.33
K2	3	**1**	0.33	1	3	0.33
K3	3	3	**1**	7	3	0.33
K4	1	1	0.14	**1**	1	0.2
K5	0.33	0.33	0.33	1	**1**	0.33
K6	3	3	3	5	3	**1**
SUM	11.33	8.66	5.13	16	14	2.52

After the Saaty process steps are applied, the criteria weights are as follows.

Table 4.5. Saaty Criteria Weights

SAATY	K1	K2	K3	K4	K5	K6
Wj	0.100	0.142	0.265	0.074	0.066	0.353
Direction	-	-	+	+	+	+

$$\sum_{j=1}^{6} w_j = 1$$

Once criterion weights have been determined, the consistency ratio should be less than 0.1. The consistency ratio of this study was 0.09484. For this study, criteria weights for which criteria are determined can be used.

Table 4.6. Initial Matrix with Saaty Method

	K1	K2	K3	K4	K5	K6
1	525	13,844	0.023	9,114	52,606	0.995
2	608	7,337	0.026	2,420	18,793	0.998
3	248	14,016	0.030	4,557	38,272	0.997
4	404	11,099	0.014	2,793	12,378	0.997
5	384	5,628	0.032	1,888	14,305	0.997
6	652	25,632	0.019	25,387	311,562	0.998
7	229	20,177	0.036	12,569	85,590	0.996
8	875	7,393	0.040	2,099	10,569	0.997
9	239	8,116	0.038	5,451	49,026	0.997
10	201	14,583	0.038	6,851	45,353	0.997
..	...	...	...	...	...	...
81	214	2,492	0.031	1,865	28,142	0.997
Square	22,932,015	10,879,116,644	0.065	5,398,909,631	878,195,956,096	80.533
Square Root	4,788.7	104,303.0	0.3	73,477.3	937,121.1	8.97

Table 4.6. contains the initial data set values collected for criteria and alternatives. For each coloumn in the table 4.6, the sum of its square and square root of the total of its squares are calculated.

Table 4.7. Standard Decision Matrix with Saaty Method

	K1	K2	K3	K4	K5	K6
1	0.110	0.133	0.089	0.124	0.056	0.111
2	0.127	0.070	0.101	0.033	0.020	0.111
3	0.052	0.134	0.118	0.062	0.041	0.111
4	0.084	0.106	0.054	0.038	0.013	0.111
5	0.080	0.054	0.125	0.026	0.015	0.111
6	0.136	0.246	0.075	0.346	0.332	0.111
7	0.048	0.193	0.142	0.171	0.091	0.111
8	0.183	0.071	0.158	0.029	0.011	0.111
9	0.050	0.078	0.150	0.074	0.052	0.111
10	0.042	0.140	0.147	0.093	0.048	0.111
..	...	....	....	....	.....	....
81	0.045	0.024	0.120	0.025	0.030	0.111

In table 4.7., the value of the alternative in each criterion is divided by the square root of total of the squares of whole alternatives in that criterion.

Table 4.8. Weighted Standard Decision Matrix with Saaty Method

	K1	K2	K3	K4	K5	K6
1	0.0109	0.0189	0.0236	0.0092	0.0037	0.0392
2	0.0127	0.0100	0.0268	0.0024	0.0013	0.0393
3	0.0052	0.0191	0.0313	0.0046	0.0027	0.0393
4	0.0084	0.0151	0.0142	0.0028	0.0009	0.0393
5	0.0080	0.0077	0.0331	0.0019	0.0010	0.0393
6	0.0136	0.0349	0.0198	0.0256	0.0220	0.0393
7	0.0048	0.0275	0.0376	0.0127	0.0060	0.0392
8	0.0182	0.0101	0.0417	0.0021	0.0007	0.0393
9	0.0050	0.0111	0.0398	0.0055	0.0035	0.0393
10	0.0042	0.0199	0.0390	0.0069	0.0032	0.0393
..	.....	......	......	......	.....	.....
81	0.0045	0.0034	0.0319	0.0019	0.0020	0.0393

In table 4.8., the standard decision matrix corresponding to alternative of the relevant criterion is multiplied by the heft of the relevant criterion.

Table 4.9. Ideal and Negative Ideal Solution Set with Saaty Method

	K1	K2	K3	K4	K5	K6
A*	0.0004	0.0011	0.0470	0.0532	0.0561	0.0393
A^-	0.0396	0.0556	0.0101	0.0008	0.0002	0.0391

In table 4.9., providing that the convenient criterion is negative, the ideal solution set takes the smallest value in the V. Providing that the convenient criterion is negative, the A^- gets the biggest value in the V. Providing that the convenient criterion is positive, A^* takes the largest value in the V. Providing that the relevant criterion is positive, the negative ideal solution set takes the smallest value in the V.

Table 4.10. Positive Ideal Distinction with Saaty Method

	K1	K2	K3	K4	K5	K6
S_1^*	0.0111	0.0316	0.0548	0.1935	0.2745	0.0000
S_2^*	0.0150	0.0079	0.0408	0.2574	0.3001	0.0000
S_3^*	0.0023	0.0324	0.0248	0.2360	0.2852	0.0000
S_4^*	0.0064	0.0197	0.1077	0.2536	0.3051	0.0000
S_5^*	0.0058	0.0043	0.0193	0.2629	0.3036	0.0000
S_6^*	0.0174	0.1144	0.0742	0.0761	0.1165	0.0000
S_7^*	0.0019	0.0697	0.0089	0.1641	0.2507	0.0000
S_8^*	0.0318	0.0081	0.0028	0.2607	0.3065	0.0000
S_9^*	0.0021	0.0099	0.0053	0.2274	0.2772	0.0000
S_{10}^*	0.0014	0.0352	0.0064	0.2141	0.2799	0.0000
..	......	....	....	....	....	....
S_{81}^*	0.0016	0.0005	0.0229	0.2631	0.2929	0.0000

In table 4.10., the value in the table 4.8 matrix is subtracted from the ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria.

Table 4.11. Negative Ideal Distinction with Saaty Method

	K1	K2	K3	K4	K5	K6
S_1^-	0.0820	0.1352	0.0181	0.0071	0.0012	0.0000
S_2^-	0.0724	0.2082	0.0278	0.0003	0.0001	0.0000
S_3^-	0.1184	0.1334	0.0446	0.0015	0.0006	0.0000
S_4^-	0.0971	0.1640	0.0016	0.0004	0.0000	0.0000
S_5^-	0.0997	0.2300	0.0528	0.0001	0.0001	0.0000
S_6^-	0.0676	0.0429	0.0093	0.0616	0.0474	0.0000
S_7^-	0.1211	0.0792	0.0753	0.0141	0.0034	0.0000
S_8^-	0.0456	0.2075	0.0997	0.0002	0.0000	0.0000
S_9^-	0.1197	0.1986	0.0877	0.0022	0.0011	0.0000
S_{10}^-	0.1252	0.1279	0.0835	0.0038	0.0009	0.0000
..	....	....	....	....	....	....
S_{81}^-	0.1233	0.2727	0.0473	0.0001	0.0003	0.0000

In table 4.11., the value in the table 4.8 matrix is subtracted from the negative ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria.

Table 4.12. Ranking Calculations with Saaty Method

S_i^*		S_i^-		C_i^*		Ranking
S_1^*	0.7520	S_1^-	0.493565437	C_1^*	0.3963	66
S_2^*	0.7882	S_2^-	0.555685403	C_2^*	0.4135	54
S_3^*	0.7620	S_3^-	0.546385517	C_3^*	0.4176	50
S_4^*	0.8322	S_4^-	0.513056653	C_4^*	0.3814	69
S_5^*	0.7719	S_5^-	0.618617804	C_5^*	0.4449	29
S_6^*	0.6313	S_6^-	0.47824192	C_6^*	0.4310	44
S_7^*	0.7037	S_7^-	0.541439373	C_7^*	0.4348	40
S_8^*	0.7809	S_8^-	0.594138389	C_8^*	0.4321	42
S_9^*	0.7224	S_9^-	0.639748015	C_9^*	0.4697	12
S_{10}^*	0.7328	S_{10}^-	0.584122652	C_{10}^*	0.4435	31
..	...	...	...	..	...	..
S_{81}^*	0.7623	S_{81}^-	0.66616788	C_{81}^*	0.4664	15

In table 4.12., the S_i^* value, S_i^- value and C_i^* value are calculated. All criterion values of the relevant alternative in the ideal solution set are added. Then the square root of this value is taken. All criterion values of the relevant alternative in the ideal solution set are added. Then the square root of this value is taken.

$C_i^* = (S_i^-) / (S_i^- + S_i^*)$

Then C_i^* values are sorted from largest to smallest.

After the Saaty Technique, the criterion weights of the alternatives in the implementation will be determined by considering the Entropy Method. According to the Entropy Method, the weights of the criteria are as follows.

Table 4.13. Entropy Criteria Weights

ENTROPY	K1	K2	K3	K4	K5	K6
Wj	0.202	0.108	0.024	0.264	0.402	0.0000003

$$\sum_{j=1}^{6} w_j = 1$$

As it can be understood from the criterion weights, the weight of the K6 criterion for this method is almost zero. The greater the difference between the alternatives for this method, the more important the weight of the criterion. The criterion weight of K6 was found to be very low since there was very little difference between the alternatives for K6. Since K6's weight is too low, K6 will be excluded from alternatives. The study will continue with 5 criteria and 81 alternatives. Entropy Method was used considering 5 criteria and 81 alternatives. The revised criteria weights are as follows.

Table 4.14. Revised Entropy Criterion Weights

ENTROPY	K1	K2	K3	K4	K5
Wj	0.202	0.108	0.024	0.264	0.402
Direction	-	-	+	+	+

$$\sum_{j=1}^{5} w_j = 1$$

In table 4.14., while K1 and K2 criteria are cost oriented, other criteria are benefit side. Cost oriented criteria are indicated by – (negative), while benefit oriented criteria are indicated by + (positive).

Table 4.15. Initial Matrix with Entropy Method

	K1	K2	K3	K4	K5
1	525.000	13,844.000	0.023	9,114.000	52,606.000
2	608.000	7,337.000	0.026	2,420.000	18,793.000
3	248.000	14,016.000	0.030	4,557.000	38,272.000
4	404.000	11,099.000	0.014	2,793.000	12,378.000
5	384.000	5,628.000	0.032	1,888.000	14,305.000
6	652.000	25,632.000	0.019	25,387.000	311,562.000
7	229.000	20,177.000	0.036	12,569.000	85,590.000
8	875.000	7,393.000	0.040	2,099.000	10,569.000
9	239.000	8,116.000	0.038	5,451.000	49,026.000
10	201.000	14,583.000	0.038	6,851.000	45,353.000
..	....	....	....	....	....
81	214.000	2,492.000	0.031	1,865.000	28,142.000
Square	22,932,015	10,879,116,644	0.065	5,398,909,631	878,195,956,096
Square Root	4,788.7	104,303.0	0.3	73,477.3	937,121.1

Table 4.15. contains the initial data set values collected for criteria and alternatives. In the table 4.15. for each coloumn in the table, the total of its square and square root of the total of its squares are calculated.

Table 4.16. Standard Decision Matrix with Entropy Method

	K1	K2	K3	K4	K5
1	0.110	0.133	0.089	0.124	0.056
2	0.127	0.070	0.101	0.033	0.020
3	0.052	0.134	0.118	0.062	0.041
4	0.084	0.106	0.054	0.038	0.013
5	0.080	0.054	0.125	0.026	0.015
6	0.136	0.246	0.075	0.346	0.332
7	0.048	0.193	0.142	0.171	0.091
8	0.183	0.071	0.158	0.029	0.011
9	0.050	0.078	0.150	0.074	0.052
10	0.042	0.140	0.147	0.093	0.048
..	...	...	...	...	...
81	0.045	0.024	0.120	0.025	0.030

In table 4.16., the value of the alternative in each criterion is divided by the square root of the total of the squares of whole alternatives in that criterion.

Table 4.17. Weighted Standard Decision Matrix with Entropy Method

	K1	K2	K3	K4	K5
1	0.0222	0.0143	0.0021	0.0327	0.0226
2	0.0257	0.0076	0.0024	0.0087	0.0081
3	0.0105	0.0145	0.0028	0.0164	0.0164
4	0.0171	0.0115	0.0013	0.0100	0.0053
5	0.0162	0.0058	0.0030	0.0068	0.0061
6	0.0276	0.0265	0.0018	0.0911	0.1337
7	0.0097	0.0208	0.0034	0.0451	0.0367
8	0.0370	0.0076	0.0038	0.0075	0.0045
9	0.0101	0.0084	0.0036	0.0196	0.0210
10	0.0085	0.0151	0.0035	0.0246	0.0195
..	...	...	...	...	...
81	0.0090	0.0026	0.0029	0.0067	0.0121

For table 4.17., the process in table 4.8. is repeated.

Table 4.18. Ideal and Negative Ideal Solution Set with Entropy Method

	K1	K2	K3	K4	K5
A^*	0.0008	0.0008	0.0043	0.1894	0.3414
A^-	0.0803	0.0422	0.0009	0.0028	0.0012

In table 4.18., providing that the convenient criterion is negative, the ideal solution set takes the smallest value in the V. Providing that the convenient criterion is negative, A^- gets the biggest value in the V. Providing that the convenient criterion is positive, A^* takes the biggest value in the V. Providing that convenient criterion is positive, the negative ideal solution set takes the smallest value in the V.

Table 4.19. Positive Ideal Distinction with Entropy Method

	K1	K2	K3	K4	K5
S_1^*	0.0458	0.0181	0.0005	2.4548	10.1633
S_2^*	0.0620	0.0046	0.0003	3.2655	11.1093
S_3^*	0.0094	0.0186	0.0002	2.9942	10.5592
S_4^*	0.0265	0.0113	0.0009	3.2173	11.2935
S_5^*	0.0238	0.0025	0.0002	3.3349	11.2380
S_6^*	0.0716	0.0658	0.0006	0.9656	4.3143
S_7^*	0.0079	0.0400	0.0001	2.0816	9.2812
S_8^*	0.1310	0.0046	0.0000	3.3073	11.3457
S_9^*	0.0087	0.0057	0.0000	2.8841	10.2615
S_{10}^*	0.0059	0.0203	0.0001	2.7160	10.3627
..	...	...	...	...	...
S_{81}^*	0.0068	0.0003	0.0002	3.3379	10.8435

In table 4.19., the value in the table 4.17. matrix is subtracted from the ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria.

Table 4.20. Negative Ideal Distinction with Entropy Method

	K1	K2	K3	K4	K5
S_1^-	0.3379	0.0777	0.0001	0.0898	0.0458
S_2^-	0.2984	0.1197	0.0002	0.0035	0.0048
S_3^-	0.4878	0.0767	0.0004	0.0185	0.0233
S_4^-	0.4000	0.0943	0.0000	0.0053	0.0017
S_5^-	0.4108	0.1322	0.0004	0.0016	0.0025
S_6^-	0.2784	0.0247	0.0001	0.7810	1.7556
S_7^-	0.4991	0.0455	0.0006	0.1794	0.1264
S_8^-	0.1878	0.1193	0.0008	0.0023	0.0011
S_9^-	0.4931	0.1142	0.0007	0.0283	0.0395
S_{10}^-	0.5160	0.0735	0.0007	0.0477	0.0335
..	...	...	...	...	...
S_{81}^-	0.5081	0.1568	0.0004	0.0016	0.0119

In table 4.20., the value in the table 4.17. matrix is subtracted from the negative ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria.

Table 4.21. Ranking Calculations with Entropy Method

S_i^+		S_i^-		C_i^*		Ranking
S_1^+	3.5613	S_1^-	0.742536698	C_1^+	0.1725	45
S_2^+	3.8002	S_2^-	0.653098734	C_2^+	0.1467	67
S_3^+	3.6853	S_3^-	0.778884611	C_3^+	0.1745	41
S_4^+	3.8144	S_4^-	0.708054541	C_4^+	0.1566	62
S_5^*	3.8209	S_5^-	0.739935187	C_5^+	0.1622	56
S_6^*	2.3276	S_6^-	1.685143521	C_6^+	0.4199	2
S_7^*	3.3780	S_7^-	0.922557987	C_7^*	0.2145	5
S_8^*	3.8456	S_8^-	0.557938821	C_8^*	0.1267	73
S_9^*	3.6277	S_9^-	0.822052329	C_9^*	0.1847	21
S_{10}^*	3.6201	S_{10}^-	0.819328298	C_{10}^*	0.1846	22
..	...	..	...	..	...	..
S_{81}^*	3.7668	S_{81}^-	0.823842239	C_{81}^*	0.1795	33

Table 4.21. shows the ranking of the alternatives.

Using the unsupervised learning techniques k-means algorithm, 7 clusters were created for

5 criteria and 81 alternatives. Regions were not taken into account when creating 7 different clusters. Since regions are not taken into account, more than one city from the same region may be closest to the center of gravity of different clusters. Some of the clusters created with the help of Python are as follows.

Table 4.22. Some k-means Cluster

	K1	K2	K3	K4	K5	Cluster
1	525	13844	0.0228	9114	52606	6
2	608	7337	0.0259	2420	18793	4
3	248	14016	0.0302	4557	38272	4
4	404	11099	0.0137	2793	12378	1
.	..	..	..	..	..	.
6	652	25632	0.0191	25387	311562	7
7	229	20177	0.0363	12569	85590	2
8	875	7393	0.0403	2099	10569	5
9	239	8116	0.0384	5451	49026	2
28	1100	7025	0.0324	2828	26120	5
..	..	..	..	..	..	.
31	338	5524	0.027	4388	36895	4
34	105	5461	0.0166	52762	795738	3
..	..	..	..	..	..	.
46	606	14520	0.0221	4548	34925	6
47	84	8780	0.0163	3159	12908	1
48	105	12654	0.0432	8006	42336	2
49	277	8650	0.0182	1358	9534	1
50	250	5485	0.0381	2200	25895	2
51	178	7234	0.0312	2532	24500	4
52	442	5861	0.0314	3231	16634	4
53	1429	3835	0.032	2021	17213	5
54	190	4824	0.0304	4468	69184	4
55	485	9725	0.0296	6316	50866	4
56	268	5718	0.0143	1706	15727	1
57	462	5718	0.034	1435	12233	4
58	1011	28164	0.0236	5570	45726	7
..	.	..	..	..	..	.
81	214	2492	0.0308	1865	28142	4

Table 4.22 shows which cluster some license plate codes belong to. The center of gravity of the clusters is shown in table 4.23.

Table 4.23. Centers of Gravity of Clusters

	K1	K2	K3	K4	K5
1	210.40	8,857.73	0.02	3,457.93	24,572.20
2	143.67	10,136.67	0.04	5,298.83	42,695.08
3	105.00	5,461.00	0.02	52,762.00	795,738.00
4	300.11	6,910.26	0.03	3,261.51	31,947.69
5	1,231.80	7,189.00	0.03	2,740.20	25,932.40
6	746.67	13,626.33	0.02	5,190.00	35,765.67
7	840.25	29,910.00	0.02	12,009.50	136,548.50

In table 4.23., the center of gravity of each cluster is available. The plate codes closest to the center of gravity of each cluster are as follows.

Table 4.24. Plate Codes Closest to the Center of Gravity

	K1	K2	K3	K4	K5	Cluster
9	239	8116	0.0384	5451	49026	2
28	1100	7025	0.0324	2828	26120	5
31	338	5524	0.027	4388	36895	4
34	105	5461	0.0166	52762	795738	3
46	606	14520	0.0221	4548	34925	6
49	277	8650	0.0182	1358	9534	1
58	1011	28164	0.0236	5570	45726	7

In table 4.24., the plate codes closest to the center of gravity of the clusters are shared.

Then, considered each region as a cluster. Here, after creating the region-based clusters, the middle point of each cluster is found. Then, the license plate code closest to the middle point of each cluster was selected.

Table 4.25. Mediterranean Region Cluster

	K1	K2	K3	K4	K5
1	525.000	13,844.000	0.023	9,114.000	52,606.000
7	229.000	20,177.000	0.036	12,569.000	85,590.000
15	110.000	7,175.000	0.045	2,085.000	31,438.000
31	338.000	5,524.000	0.027	4,388.000	36,895.000
32	139.000	8,946.000	0.031	2,580.000	66,295.000
33	472.000	16,010.000	0.028	7,689.000	47,722.000
46	606.000	14,520.000	0.022	4,548.000	34,925.000
80	166.000	3,320.000	0.027	2,003.000	12,134.000
Middle point	**323.13**	**11,189.50**	**0.030**	**5,622.00**	**45,950.63**

Table 4.25. cluster of Mediterranean Region was created. Also, plate code 31, painted in orange, is closest to the middle point of the cluster.

Table 4.26. Eastern Anatolia Region Cluster

	K1	K2	K3	K4	K5
4	404.00	11,099.00	0.01	2,793.00	12,378.00
12	1,154.00	8,004.00	0.02	1,849.00	15,650.00
13	924.00	8,294.00	0.02	1,916.00	9,366.00
23	412.00	9,383.00	0.03	4,000.00	39,412.00
24	838.00	11,815.00	0.02	3,220.00	23,179.00
25	1,451.00	25,006.00	0.02	6,827.00	67,357.00
30	212.00	7,095.00	0.02	1,741.00	2,701.00
36	329.00	10,193.00	0.02	2,768.00	19,142.00
44	838.00	12,259.00	0.03	4,449.00	38,059.00
49	277.00	8,650.00	0.02	1,358.00	9,534.00
62	761.00	7,582.00	0.03	1,357.00	6,240.00
65	582.00	20,921.00	0.02	4,498.00	25,747.00
75	89.00	4,934.00	0.03	1,196.00	5,562.00
76	171.00	3,664.00	0.02	1,240.00	9,950.00
Middle point	**603.00**	**10,635.64**	**0.02**	**2,800.86**	**20,305.50**

Table 4.26. cluster of Eastern Anatolia Region was created. Also, plate code 36, painted

in orange, is closest to the middle point of the cluster.

Table 4.27. Aegean Region Cluster

	K1	K2	K3	K4	K5
3	248.00	14,016.00	0.03	4,557.00	38,272.00
9	239.00	8,116.00	0.04	5,451.00	49,026.00
20	179.00	12,134.00	0.04	5,672.00	49,667.00
35	258.00	11,891.00	0.03	19,187.00	171,826.00
43	127.00	11,634.00	0.03	3,276.00	49,511.00
45	207.00	13,339.00	0.04	6,281.00	45,220.00
48	105.00	12,654.00	0.04	8,006.00	42,336.00
64	46.00	5,556.00	0.04	2,150.00	28,319.00
Middle point	176.13	11,167.50	0.03	6,822.50	59,272.13

Table 4.27. cluster of Aegean Region was created. Also, plate code 20, painted in orange, is closest to the middle point of the cluster.

Table 4.28. Southeast Anatolia Region Cluster

	K1	K2	K3	K4	K5
2	608.00	7,337.00	0.03	2,420.00	18,793.00
21	317.00	15,168.00	0.01	5,591.00	28,947.00
27	148.00	6,803.00	0.02	6,305.00	52,747.00
47	84.00	8,780.00	0.02	3,159.00	12,908.00
56	268.00	5,718.00	0.01	1,706.00	15,727.00
63	125.00	19,242.00	0.02	4,908.00	26,004.00
72	105.00	4,477.00	0.01	1,942.00	12,525.00
73	80.00	7,078.00	0.01	2,071.00	3,972.00
79	36.00	1,412.00	0.03	768.00	9,362.00
Middle point	196.78	8,446.11	0.02	3,207.78	20,109.44

Table 4.28. cluster of Southeast Anatolia Region was created. Also, plate code 47, painted in orange, is closest to the middle point of the cluster.

Table 4.29. Central Anatolia Region Cluster

	K1	K2	K3	K4	K5
6	652.00	25,632.00	0.02	25,387.00	311,562.00
18	371.00	7,542.00	0.02	1,803.00	17,674.00
26	107.00	13,960.00	0.02	6,595.00	68,301.00
38	781.00	16,970.00	0.02	9,427.00	74,637.00
40	66.00	6,589.00	0.03	1,860.00	18,680.00
42	247.00	40,838.00	0.03	10,254.00	121,549.00
50	250.00	5,485.00	0.04	2,200.00	25,895.00
51	178.00	7,234.00	0.03	2,532.00	24,500.00
58	1,011.00	28,164.00	0.02	5,570.00	45,726.00
66	320.00	13,690.00	0.03	2,657.00	19,969.00
68	168.00	7,659.00	0.03	2,478.00	20,790.00
70	200.00	8,678.00	0.03	1,859.00	17,292.00
71	146.00	4,791.00	0.03	1,931.00	33,589.00
Middle point	345.92	14,402.46	0.03	5,734.85	61,551.08

Table 4.29. cluster of Central Anatolia Region was created. Also, plate code 70, painted

in orange, closest to the middle point of the cluster.

Table 4.30. Black Sea Region Cluster

	K1	K2	K3	K4	K5
5	384.00	5,628.00	0.03	1,888.00	14,305.00
8	875.00	7,393.00	0.04	2,099.00	10,569.00
14	187.00	8,313.00	0.03	2,232.00	31,815.00
19	624.00	12,428.00	0.03	3,107.00	16,589.00
28	1,100.00	7,025.00	0.03	2,828.00	26,120.00
29	408.00	6,668.00	0.03	1,544.00	19,184.00
37	855.00	13,064.00	0.04	2,731.00	26,978.00
52	442.00	5,861.00	0.03	3,231.00	16,634.00
53	1,429.00	3,835.00	0.03	2,021.00	17,213.00
55	485.00	9,725.00	0.03	6,316.00	50,866.00
57	462.00	5,718.00	0.03	1,435.00	12,233.00
60	509.00	10,042.00	0.03	3,097.00	29,250.00
61	1,900.00	4,628.00	0.03	4,022.00	48,782.00
67	602.00	3,342.00	0.03	2,182.00	33,718.00
69	191.00	3,746.00	0.03	1,138.00	12,936.00
74	452.00	2,330.00	0.03	1,303.00	18,180.00
78	501.00	4,142.00	0.03	1,638.00	44,824.00
81	214.00	2,492.00	0.03	1,865.00	28,142.00
Middle point	**645.56**	**6,465.56**	**0.03**	**2,482.06**	**25,463.22**

Table 4.30. cluster of Black Sea Region was created. Also, plate code 28, painted in orange, is closest to the middle point of the cluster.

Table 4.31. Marmara Region Cluster

	K1	K2	K3	K4	K5
10	201.00	14,583.00	0.04	6,851.00	45,353.00
11	76.00	4,179.00	0.03	1,759.00	16,036.00
16	362.00	10,813.00	0.03	10,900.00	74,631.00
17	96.00	9,817.00	0.04	4,710.00	46,514.00
22	43.00	6,145.00	0.04	4,017.00	40,296.00
34	105.00	5,461.00	0.02	52,762.00	795,738.00
39	19.00	6,459.00	0.04	3,594.00	22,687.00
41	158.00	3,397.00	0.02	7,889.00	76,073.00
54	190.00	4,824.00	0.03	4,468.00	69,184.00
59	44.00	6,190.00	0.03	5,471.00	26,500.00
77	111.00	798.00	0.03	1,530.00	14,020.00
Middle point	127.73	6,606.00	0.03	9,450.09	111,548.36

Table 4.31. cluster of Marmara Region was created. Also, plate code 54, painted in orange, is closest to the middle point of the cluster.

In this study, Random Forest Classification belonging to the supervise learning algorithm was used. Here, 70% of the alternatives are defined in the system, together with the value of the 5 criteria. There are 7 different classes for the defined alternatives. With 70% of the data defined to the system with supervise learning, the classes of the remaining data are tried to be predicted. While making this estimation, the importance level of 5 criteria in estimation was calculated with Gini Technique. The importance of the criteria in determining the classification is as follows.

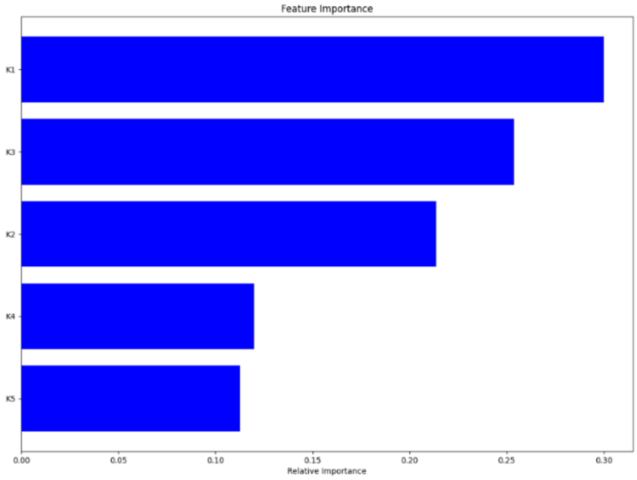

Figure 4.1. Feature Importance With Gini Method

K1 has a value of 0.3003, K2 has a value of 0.2136, K3 has a value of 0.2537, K4 has a value of 0.1198 and K5 has a value of 0.1126. After TOPSIS process steps are applied, some of the rankings are as follows.

Table 4.32. Results With Gini Methods

S_i^*		S_i^-		C_i^*		Ranking
S_1^*	1.2358	S_1^-	1.0425	C_1^*	0.4576	62
S_2^*	1.3184	S_2^-	1.0738	C_2^*	0.4489	64
S_3^*	1.2506	S_3^-	1.1916	C_3^*	0.4879	44
S_4^*	1.3239	S_4^-	1.1192	C_4^*	0.4581	61
S_5^*	1.2849	S_5^-	1.2131	C_5^*	0.4856	46
S_6^*	1.0111	S_6^-	1.0080	C_6^*	0.4992	39
S_7^*	1.1583	S_7^-	1.1796	C_7^*	0.5046	33
S_8^*	1.3720	S_8^-	0.9869	C_8^*	0.4184	69
S_9^*	1.2032	S_9^-	1.2736	C_9^*	0.5142	21
S_{10}^*	1.2137	S_{10}^-	1.2295	C_{10}^*	0.5032	36
..	..	..	..	..	..	..
S_{81}^*	1.2561	S_{81}^-	1.3333	C_{81}^*	0.5149	19

The ranking among the alternatives was shown according to the criterion weights determined by Gini Method.

5. FINDINGS AND RESULTS

In the study, it was tried to determine where the most suitable warehouse location could be with 5 different techniques. In the study, the criteria weights were determined by using the Topsis Method with Saaty Technique, the Topsis Method with the Entropy Technique, the k-means algorithm that is one of the unsupervised learning techniques without region separation, the k-means algorithm with region separation and random forest algorithm, which is the supervised learning utilized to identify region. While determining the regions, the weights of the criteria were determined by Gini Method. Then, the criteria weights determined were applied in the Topsis Method. Plate codes chosen by 5 different solutions will be shown in table below.

Table 5.1. Region Based Selected Plate Codes

Method	Region						
	Mediterranean	Eastern Anatolia	Aegean	Southeast	Central Anatolia	Black Sea	Marmara
Entropy with Topsis	7	75	35	27	6	81	34
Saaty with Topsis	15	75	35	79	50	81	34
k-means without considering regions	31-46	49	9	-	58	28	34
k-means considering regions	31	36	20	47	70	28	54
Random Forest with Topsis	15	75	35	79	40	81	34

While 15 plate codes were selected in the Mediterranean Region with the Saaty Technique and Random Forest Technique, the plate codes 31 and 46 were selected for k-means without considering regions. In addition, 31 plate codes were selected for k-means considering regions. Plate code 7 was chosen for the Entropy Technique. 31 plate codes are common in both unsupervised learning techniques. When the map of Turkey is examined, it is seen that the plate codes 7 and 15 are adjacent to each other. Also, plate codes 31 and 46 are extremely close to each other. But they are not neighbors. In the Eastern Anatolia Region, 75 plate codes were chosen in first place for Entropy Technique, Saaty Technique and Random Forest Technique. However, license plate codes 49 were selected for k-means without considering regions, while license plate codes 36 were selected for k-means considering regions. In all results using Topsis Method, 75 plate codes took the first place. When the map of Turkey is examined, 75 plate codes and 36 plate codes are adjacent to each other. Also, plate codes 49 and 36 are close to each other. But they are not neighbors. In the Aegean Region, 35 plate codes are in the first place in Entropy Technique, Saaty Technique and Random Forest Technique. In all methods using the Topsis Technique, 35 plate codes took the first place. In the k-means without considering regions technique, 9 plate codes took the first place, while in the k-means considering regions technique 20 plate codes took the first place. When the map of Turkey is examined, 35 plate codes and 9 plate codes are adjacent to each other. In addition, 9 plate codes and 20 plate codes are adjacent to each other. Plate codes 35 and plate codes 20 are close to each other. But, they are not neighbors. In the Southeast Anatolia Region, 79 plate codes were in the first place in the Saaty Method and Random Forest Method. While 27 plate codes are in the first place in the Entropy Method, 47 plate codes are in the first place in the k-means considering technique. In the k-means without considering regions technique has no plate code. In the solution with two Topsis Method, 79 plate codes took the first place. When the map of Turkey is examined, 79 plate codes and 27 plate codes are adjacent to each other. 47 plate codes and 27 plate codes are considered close to each other. However, they are not neighbors. In the Central Anatolia Region, 6 plate codes took the first place in the Entropy Method. In the Saaty Method, 50 plate codes took the first place. In the k-means without considering regions, 58 plate codes took the first place. In the k-means considering regions, 70 plate codes took the first place. In the Random Forest, 40 plate codes took the first place. For the 5 techniques, the plate codes in the first row are different. When the map of Turkey is examined 6 plate codes and 40 plate codes are adjacent. In addition, 50 plate codes and 40 plate codes are adjacent. 6 plate codes and 50 plate codes are close to each other. But they are not neighbors. In the Black Sea Region, 81 plate codes were in the first place in the Entropy Method, Saaty Method and Random Forest Method. In the k-means without considering regions and k-means considering regions methods, 28 plate codes took the first place. In Topsis solution, 81 plate codes took the first place for all 3 techniques. In the k-means method, which is one of the unsupervised learning techniques, 28 plate codes were in the first place for both. When the map of Turkey is examined, 81 plate codes and 28 plate codes are not close to each other. In the Marmara Region, 34 plate codes took the first place in the Entropy Method, The Saaty Method, the k-means without considering regions method and Random Forest Method. In the k-means considering regions method, 54 plate codes took the first place. When the map of Turkey is examined, 34 plate codes and 54 plate codes are close to each other. But they are not neighbors.

6. DISCUSSION and CONCLUSION

In this implementation, it is purposed for the retail corporation serving all province of Turkey to open a new warehouse in every region. There are 7 regions in Turkey. One new warehouse will be opened in each region. With the increasing competition conditions and the developing world, companies have at least one criterion or at least one alternative when they will make the most appropriate choice for their own interests. After the literature review was carried out in the study, 6 criteria and 81 alternatives were determined. So as to identify the score hefts among the criteria, the Saaty Technique was used at first. Then, a solution was reached for 81 alternatives and 6 criteria with TOPSIS Method. However, it has been observed that the Entropy Method is also frequently used in criterion weighting. When the score hefts were computed between the Entropy Technique and the criterion, the weight of the security of region criterion was extremely low. The reason for that is that there are almost no deviation values in the alternatives of this criterion. Due to extremely low weight of the criterion, the security of region criterion was excluded from this implementation. For this reason, weights were determined for 5 criteria in the Entropy Method. Then, for 81 alternatives and 5 criteria, a solution was reached with the TOPSIS Method. Then, it has been understood by the literature reviews that machine learning techniques can help in the study. In this direction, k-means algorithm, one of the unsupervised learning techniques in machine learning, was used. In this implementation, it was carried out with 2 different k-means. In the first, it was requested to form 7 different clusters with 81 alternatives and 5 criteria values, without making any regional distinction. The centroids of each cluster were calculated. Plate codes closest to the calculated centroids for each cluster were selected. In the second k-means solution, regions of 81 alternatives and 5 criteria were determined. 7 clusters were created based on region. The center of gravity of each cluster is determined. Then, the plate codes closest to the center of gravity of each cluster were selected. Another technique is the Random Forest Technique, one of the supervised learning techniques in machine learning. Here, 70% of the data is defined to the system and it is taught which region the data belongs to. Then, the remaining data is entered into the system and it is learned which region they belong to. In this direction, the weights of the criteria in determining which region the alternatives belong to were calculated. Here, the weight of the criteria in determining the regions was calculated with Gini Method. Then, the Topsis Method was run again by using the criterion weights in these data. Region-based best alternatives have been identified. In this way, 5 different techniques were used to determine the most suitable warehouse location.

Multi criteria decision making techniques should be used to reach the right result against at least one criterion and at least one alternative. TOPSIS Technique and machine learning techniques were utilized to figure out the trouble. In addition, in the criterion weighting study, Saaty Method, Entropy Method and Random Forest Method were used. Thanks to the techniques used, plate codes were determined for region-based warehouse location. Topsis Technique were formulated with Excel. In machine learning, data is processed into the system with Python.

In multi criteria decision making techniques, a new criterion or a new alternative can be added after the Excel formulation. After formulating the added alternative or criterion, it can easily reach the result in the most reliable and fastest way. In this implementation, the Saaty Technique was first used while determining the criterion weights. Then, criterion weights were determined by Entropy Method. However, in the Entropy Method, the weight of the security of region criterion is almost absent. For this reason, the relevant criterion was removed from the application of the Entropy Method and the weights of the remaining criteria were taken into account. Entropy Method and Saaty Method were used to determine the criterion weights. Then, a criterion weight was also determined with the Random Forest. Also, 2 different clusters were studied with k-means. The most suitable alternatives were determined by applying the TOPSIS Method and k-means method separately. Thanks to the application, the company will open warehouses in the most suitable locations. In this case, the company will minimize the cost of opening warehouses.

In this implementation, Saaty Method, Entropy Method and Gini Method were used to determine criterion weights. In addition, the TOPSIS Method was used to determine the alternatives. Then, k-means algorithms and Random Forest algorithm were applied. In future studies, one of the multi criteria decision making techniques, Copras and Swara Techniques can also be used. Algorithms that can be used in machine learning techniques other than k-means and Random Forest algorithms can be researched. In this framework, we can see which new algorithms can choose which plate codes first in the warehouse location selection. By increasing the 5 comparison made in the study, we can learn the plate codes that come first in choosing the most suitable warehouse location with 8 or 9 comparisons. In this way, we can also compare the results of the algorithm.

REFERENCES

Acikgoz, T. (2021) Investigation of Cash Flow Profiles of Manufacturing Sector and Comparison of Financial Performances with TOPSIS Method. Journal of Accounting and Finance, 90, 127-148.

Alvandi, E., Soleimani-Sardo, M., Meshram, S.G., Giglou, B.F., Ghaleno, M.R.D. (2021) Using Improved TOPSIS and Best Worst Method in Prioritizing Management Scenarios for the Watershed Management in Arid and Semi Arid Environments. Soft Computing, 25, 11363-11375.

Balusa, B.C., Gorai, A.K. (2019) A Comparative Study of Various Multi Criteria Decision Making Models in Underground Mining Method Solution. The Institution of Engineering, 100(1), 105-121.

Bonaccorso, G., (2017). Machine Learning Algorithms, 1st Edition., Packt Publishing, Birmingham, Ingiltere.

Boztepe, R., Cetin, O. (2020) Sustainable Warehousing: Selecting The Best Warehouse for Solar Transformation. Alphanumeric Journal, 8(1), 97-110.

Comert, S.E., Yener, F. (2016) Using Fuzzy Analytical Hierarchy Process for Warehouse Location Selection in a Food Company. International Journal of Economics and Administrative Sciences, 2(2), 161-177.

Confederation of Turkish Tradesmen and Craftsmen, https://www.tesk.org.tr/resimler/sicil/4.pdf , (31.03.2022).

Demirel, T., Demirel, N.Ç., Kahraman, C. (2010) Multi Criteria Warehouse Location Selection Using Choquet Integral. Expert Systems with Applicaitons, 37, 3943-3952.

Dey, B., Bairagi, B., Sarkar, B., Sanyal, S.K. (2016) Warehouse Location Selection by Fuzzy Multi Criteria Decision Making Methodologies Based On Subjective and Objective Criteria. International Journal of Management Science and Engineering Management,11(4),262-278.

Dey, B., Bairagi, B., Sarkar, B., Sanyal, S.K. (2013) A Hybrid Fuzzy Technique for the Selection of Warehouse Location in a Supply Chain Under a Utopian Environment.

International Journal of Management Science and Engineering Management, 8(4), 250-261.

Erdal, H., Aydogmus, H.Y. (2019) Selection of Logistics Center Location Using Analytic Hierarchy Process. Journal of Social Sciences of Mus Alparslan University, 7(6), 129-136.

Hamadani, M.H.L., Dastgir, M., Heidari, S.A. (2021) Identifying and Ranking the Factors Affecting Customer Financial Behavior Using Multi Criteria Decision Making Technique (TOPSIS). Advances in Mathematical Finance & Applications, 6(3), 479-492.

Higher Education Information Management System, https://istatistik.yok.gov.tr/ ,(2019).

Isık Tus, A., Adalı Aytac, E. (2017) The Decision-Making Approach Based On the Combination of Entropy and Rov Methods for the Apple Selection Problem. European Journal of Interdisciplinary Studies, 3(3), 80-86.

Kadinariya, T., Makwana, P., (2013). Review on Determining Number of Cluster in K-means Clustering. International Journal of Advance Research in Computer Science and Management Studies, 1(6), 90-95.

Karaman, E., Kazan, H. (2015) Performance Evaluation in Family Physician: The Application of TOPSIS Multi Criteria Decision Making Method. Alphanumeric Journal, 3(2), 001-012.

Karmaker, C.L., (2016) A Decision Support System for Warehouse Location Selection: A Case Study. Journal of Supply Chain Management System, 5(4), 27-37.

Komchornrit, K. (2017) The Selection of Dry Port Location by a Hybrid CFA-MACBETH-PROMETHEE Method: A Case Study of Southern Thailand. The Asian Journal of Shipping and Logistics, 33(3), 141-153.

Korkmaz, O. (2019) Personnel Selection Method based on TOPSIS Multi Criteria Decision Making Method. International Journal of Economic and Administrative Studies, 23, 1-15.

Mahesh, B., (2018). Machine Learning Algorithms – A Review. International Journal of Science and Research, 9(1), 381-386.

Mohammed, M.A., Abdulkareem, K.H., Al-Waisy, A., Mostafa, S.A., Al-Fahdawi, S., Dinar, A.M., Alhakami, W., Baz, A., Al- Mhiqani, M.N., Alhakami,H., Arbaiy, N., Maashi, M.S., Mutlag, A.A., Garcia-Zapirain, B., Diez, I.D.L.T. (2020) Benchmarking Methodology for Selection of Optimal COVID-19 Diagnostic Model based on Entropy and TOPSIS Methods. IEEE Access, 8, 99115-99131.

Ocampo, L., Genimelo, G.J., Lariosa, J., Guinitaran, R., Borromeo, P.J., Aparente, M.E., Capin, T., Bongo, M. (2020) Warehouse Location Selection with TOPSIS Group Decision Making Under Different Expert Priority Allocations. Engineering Management in Production and Services, 12(4), 22-39.

Ozbek, A. (2017) Multi Criteria Decision Making Methods and Problem Solving with Excel, ISBN 978-975-02-4513-8, 1st Edition, Seckin Publisher, Ankara,Turkiye.

Ozcan, T., Celebi, N., Esnaf, S. (2011) Comparative Analysis of Multi Criteria Decision Making Methodologies and Implementation of a Warehouse Location Selection Problem. Expert System with Applications, 38, 9773-9779.

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion; B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., Vanderplas, J., Passos, A., Cournapeau, D., Brucher, M., Perrot, M., Duchesnay, E., (2011). Scikit-learn: Machine Learning in Phyton. Journal of Machine Learning Research, 12, 2825-2830.

Pham, T.Y., Ma, H.M., Yeo, G.T. (2017) Application of Fuzzy Delphi TOPSIS to Locate Logistics Centers in Vietnam: The Logisticians’ Perspective. The Asian Journal Shipping and Logistics, 33(4), 211-219.

Seker, O., Alakas, H.M. (2019) Selection of Warehouse Location in Central Anatolia Region with Multi Criteria Decision Making Methods for a Logistics Company. 7th International Symposium on Innovative Technologies in Engineering and Science, 22-24 November, SanliUrfa,Turkey.

Shukla, S., Shukla N., (2014). A Review on K-means Data Clustering Approach. International Journal of Information & Computation Technology, 4(17), 1847-1860.

Singh, R.K., Chaudhary, N., Saxona N. (2018) Selection of Warehouse Location for a Global Supply Chain: A Case Study. IIMB Management Review,30, 343-356.

T.C. Department of Sectoral Research and Strategy Development (2020) Annual

Statistical Bulletin on the Electronic Communication Sector on a Provincial Basis, Ankara.

T.C. General Directorate of Criminal Records and Statistics (2020) Forensic Statistics 2020, Ankara.

T.C. Ministry of Interior Disaster and Emergency Management Presidency (2020) Overview of 2019 within the Scope of Disaster Management and Statistics of Natural Events, Ankara.

Yıldız, A., Demir, Y. (2019) The Most Suitable Factory Location Selection for Turkey's Domestic Automobile with Fuzzy TOPSIS Method. Business & Management Studies: An International Journal, 7(4), 1427-1445.

Zhang, G., Xue, Y., Bai, C., Su, M., Zhang, K., Tao, Y. (2021) Risk Assessment of Floor Water Inrush in Coal Mines based on MFIM-TOPSIS Variable Weight Model. Journal of Central South University, 28, 2360-2374.

Zhang, Y., (2010). New Advances in Machine Learning, Sonja Mujacic Editor Intech Open, Rijeka, Croatia.

APPENDICES

APPENDIX 1- Table 1 contains the values of all data collected for criteria and alternatives. It also contains values for the sum of their squares and the square root of the sum of their squares for each coloumn. They are common data for Saaty and Entropy Method.

	K1	K2	K3	K4	K5	K6
1	525	13,844	0.023	9,114	52,606	0.995
2	608	7,337	0.026	2,420	18,793	0.998
3	248	14,016	0.030	4,557	38,272	0.997
4	404	11,099	0.014	2,793	12,378	0.997
5	384	5,628	0.032	1,888	14,305	0.997
6	652	25,632	0.019	25,387	311,562	0.998
7	229	20,177	0.036	12,569	85,590	0.996
8	875	7,393	0.040	2,099	10,569	0.997
9	239	8,116	0.038	5,451	49,026	0.997
10	201	14,583	0.038	6,851	45,353	0.997
11	76	4,179	0.027	1,759	16,036	0.997
12	1154	8,004	0.017	1,849	15,650	0.997
13	924	8,294	0.020	1,916	9,366	0.997
14	187	8,313	0.028	2,232	31,815	0.997
15	110	7,175	0.045	2,085	31,438	0.997
16	362	10,813	0.026	10,900	74,631	0.997
17	96	9,817	0.042	4,710	46,514	0.997
18	371	7,542	0.022	1,803	17,674	0.997
19	624	12,428	0.032	3,107	16,589	0.993
20	179	12,134	0.036	5,672	49,667	0.998
21	317	15,168	0.013	5,591	28,947	0.996
22	43	6,145	0.040	4,017	40,296	0.997
23	412	9,383	0.027	4,000	39,412	0.993
24	838	11,815	0.025	3,220	23,179	0.997
25	1451	25,006	0.022	6,827	67,357	0.995
26	107	13,960	0.021	6,595	68,301	0.997
27	148	6,803	0.019	6,305	52,747	0.994
28	1100	7,025	0.032	2,828	26,120	0.995
29	408	6,668	0.025	1,544	19,184	0.997
30	212	7,095	0.015	1,741	2,701	0.997
31	338	5,524	0.027	4,388	36,895	0.998
32	139	8,946	0.031	2,580	66,295	0.997
33	472	16,010	0.028	7,689	47,722	0.997
34	105	5,461	0.017	52,762	795,738	0.997
35	258	11,891	0.028	19,187	171,826	0.999
36	329	10,193	0.020	2,768	19,142	0.997
37	855	13,064	0.036	2,731	26,978	0.997
38	781	16,970	0.021	9,427	74,637	0.994
39	19	6,459	0.037	3,594	22,687	0.997
40	66	6,589	0.029	1,860	18,680	0.997
41	158	3,397	0.021	7,889	76,073	0.998
42	247	40,838	0.026	10,254	121,549	0.996
43	127	11,634	0.028	3,276	49,511	0.997
44	838	12,259	0.025	4,449	38,059	0.997
45	207	13,339	0.035	6,281	45,220	0.997
46	606	14,520	0.022	4,548	34,925	0.998
47	84	8,780	0.016	3,159	12,908	0.997
48	105	12,654	0.043	8,006	42,336	0.998
49	277	8,650	0.018	1,358	9,534	0.997
50	250	5,485	0.038	2,200	25,895	0.997
51	178	7,234	0.031	2,532	24,500	0.997
52	442	5,861	0.031	3,231	16,634	0.997
53	1429	3,835	0.032	2,021	17,213	0.997
54	190	4,824	0.030	4,468	69,184	0.999
55	485	9,725	0.030	6,316	50,866	0.998
56	268	5,718	0.014	1,706	15,727	0.997
57	462	5,718	0.034	1,435	12,233	0.997

	K1	K2	K3	K4	K5	K6
54	190	4,824	0.030	4,468	69,184	0.999
55	485	9,725	0.030	6,316	50,866	0.998
56	268	5,718	0.014	1,706	15,727	0.997
57	462	5,718	0.034	1,435	12,233	0.997
58	1011	28,164	0.024	5,570	45,726	0.996
59	44	6,190	0.030	5,471	26,500	0.997
60	509	10,042	0.028	3,097	29,250	0.997
61	1900	4,628	0.034	4,022	48,782	0.997
62	761	7,582	0.029	1,357	6,240	0.997
63	125	19,242	0.018	4,908	26,004	0.999
64	46	5,556	0.038	2,150	28,319	0.997
65	582	20,921	0.016	4,498	25,747	0.997
66	320	13,690	0.033	2,657	19,969	0.997
67	602	3,342	0.027	2,182	33,718	0.996
68	168	7,659	0.029	2,478	20,790	0.997
69	191	3,746	0.026	1,138	12,936	0.997
70	200	8,678	0.029	1,859	17,292	0.997
71	146	4,791	0.026	1,931	33,589	0.997
72	105	4,477	0.011	1,942	12,525	0.997
73	80	7,078	0.010	2,071	3,972	0.997
74	452	2,330	0.032	1,303	18,180	0.997
75	89	4,934	0.027	1,196	5,562	0.997
76	171	3,664	0.019	1,240	9,950	0.997
77	111	798	0.031	1,530	14,020	0.997
78	501	4,142	0.032	1,638	44,824	0.997
79	36	1,412	0.030	768	9,362	0.997
80	166	3,320	0.027	2,003	12,134	0.997
81	214	2,492	0.031	1,865	28,142	0.997
Square	22,932,015	10,879,116,644	0.065	5,398,909,631	878,195,956,096	80.533
Square Root	4,788.7	104,303.0	0.3	73,477.3	937,121.1	9.0

APPENDIX 2-Table 2 includes dividing the value of the alternative in each criterion by the square root of the total of the squares of whole alternatives in that criterion. All data are in appendix 2. It includes the operations in the Saaty Method part.

	K1	K2	K3	K4	K5	K6
1	0.110	0.133	0.089	0.124	0.056	0.111
2	0.127	0.070	0.101	0.033	0.020	0.111
3	0.052	0.134	0.118	0.062	0.041	0.111
4	0.084	0.106	0.054	0.038	0.013	0.111
5	0.080	0.054	0.125	0.026	0.015	0.111
6	0.136	0.246	0.075	0.346	0.332	0.111
7	0.048	0.193	0.142	0.171	0.091	0.111
8	0.183	0.071	0.158	0.029	0.011	0.111
9	0.050	0.078	0.150	0.074	0.052	0.111
10	0.042	0.140	0.147	0.093	0.048	0.111
11	0.016	0.040	0.106	0.024	0.017	0.111
12	0.241	0.077	0.066	0.025	0.017	0.111
13	0.193	0.080	0.078	0.026	0.010	0.111
14	0.039	0.080	0.108	0.030	0.034	0.111
15	0.023	0.069	0.178	0.028	0.034	0.111
16	0.076	0.104	0.101	0.148	0.080	0.111
17	0.020	0.094	0.165	0.064	0.050	0.111
18	0.077	0.072	0.087	0.025	0.019	0.111
19	0.130	0.119	0.124	0.042	0.018	0.111
20	0.037	0.116	0.141	0.077	0.053	0.111
21	0.066	0.145	0.050	0.076	0.031	0.111
22	0.009	0.059	0.156	0.055	0.043	0.111
23	0.086	0.090	0.106	0.054	0.042	0.111
24	0.175	0.113	0.096	0.044	0.025	0.111
25	0.303	0.240	0.085	0.093	0.072	0.111
26	0.022	0.134	0.083	0.090	0.073	0.111
27	0.031	0.065	0.073	0.086	0.056	0.111
28	0.230	0.067	0.127	0.038	0.028	0.111
29	0.085	0.064	0.098	0.021	0.020	0.111
30	0.044	0.068	0.060	0.024	0.003	0.111
31	0.071	0.053	0.106	0.060	0.039	0.111
32	0.029	0.086	0.119	0.035	0.071	0.111
33	0.099	0.153	0.109	0.105	0.051	0.111
34	0.022	0.052	0.065	0.718	0.849	0.111
35	0.054	0.114	0.111	0.261	0.183	0.111
36	0.069	0.098	0.079	0.038	0.020	0.111
37	0.179	0.125	0.140	0.037	0.029	0.111
38	0.163	0.163	0.084	0.128	0.080	0.111
39	0.004	0.062	0.146	0.049	0.024	0.111
40	0.014	0.063	0.115	0.025	0.020	0.111
41	0.033	0.033	0.081	0.107	0.081	0.111
42	0.052	0.392	0.100	0.140	0.130	0.111
43	0.027	0.112	0.111	0.045	0.053	0.111
44	0.175	0.118	0.099	0.061	0.041	0.111
45	0.043	0.128	0.138	0.085	0.048	0.111
46	0.127	0.139	0.086	0.062	0.037	0.111
47	0.018	0.084	0.064	0.043	0.014	0.111
48	0.022	0.121	0.169	0.109	0.045	0.111
49	0.058	0.083	0.071	0.018	0.010	0.111
50	0.052	0.053	0.149	0.030	0.028	0.111
51	0.037	0.069	0.122	0.034	0.026	0.111
52	0.092	0.056	0.123	0.044	0.018	0.111
53	0.298	0.037	0.125	0.028	0.018	0.111
54	0.040	0.046	0.119	0.061	0.074	0.111
55	0.101	0.093	0.116	0.086	0.054	0.111
56	0.056	0.055	0.056	0.023	0.017	0.111
57	0.096	0.055	0.133	0.020	0.013	0.111
58	0.211	0.270	0.092	0.076	0.049	0.111
59	0.009	0.059	0.116	0.074	0.028	0.111
60	0.106	0.096	0.109	0.042	0.031	0.111
61	0.397	0.044	0.131	0.055	0.052	0.111
62	0.159	0.073	0.115	0.018	0.007	0.111
63	0.026	0.184	0.072	0.067	0.028	0.111
64	0.010	0.053	0.148	0.029	0.030	0.111
65	0.122	0.201	0.061	0.061	0.027	0.111
66	0.067	0.131	0.127	0.036	0.021	0.111
67	0.126	0.032	0.107	0.030	0.036	0.111
68	0.035	0.073	0.113	0.034	0.022	0.111
69	0.040	0.036	0.100	0.015	0.014	0.111
70	0.042	0.083	0.112	0.025	0.018	0.111
71	0.030	0.046	0.103	0.026	0.036	0.111
72	0.022	0.043	0.043	0.026	0.013	0.111
73	0.017	0.068	0.038	0.028	0.004	0.111
74	0.094	0.022	0.125	0.018	0.019	0.111
75	0.019	0.047	0.106	0.016	0.006	0.111
76	0.036	0.035	0.072	0.017	0.011	0.111
77	0.023	0.008	0.121	0.021	0.015	0.111
78	0.105	0.040	0.126	0.022	0.048	0.111
79	0.008	0.014	0.117	0.010	0.010	0.111
80	0.035	0.032	0.104	0.027	0.013	0.111
81	0.045	0.024	0.120	0.025	0.030	0.111

APPENDIX 3-Table 3 shows all the results of the operations in table 4.8. All data are in appendix 3. It includes the operations in the Saaty Method part.

	K1	K2	K3	K4	K5	K6
1	0.0109	0.0189	0.0236	0.0092	0.0037	0.0392
2	0.0127	0.0100	0.0268	0.0024	0.0013	0.0393
3	0.0052	0.0191	0.0313	0.0046	0.0027	0.0393
4	0.0084	0.0151	0.0142	0.0028	0.0009	0.0393
5	0.0080	0.0077	0.0331	0.0019	0.0010	0.0393
6	0.0136	0.0349	0.0198	0.0256	0.0220	0.0393
7	0.0048	0.0275	0.0376	0.0127	0.0060	0.0392
8	0.0182	0.0101	0.0417	0.0021	0.0007	0.0393
9	0.0050	0.0111	0.0398	0.0055	0.0035	0.0393
10	0.0042	0.0199	0.0390	0.0069	0.0032	0.0393
11	0.0016	0.0057	0.0281	0.0018	0.0011	0.0393
12	0.0240	0.0109	0.0175	0.0019	0.0011	0.0393
13	0.0192	0.0113	0.0207	0.0019	0.0007	0.0393
14	0.0039	0.0113	0.0285	0.0022	0.0022	0.0393
15	0.0023	0.0098	0.0470	0.0021	0.0022	0.0393
16	0.0075	0.0147	0.0267	0.0110	0.0053	0.0393
17	0.0020	0.0134	0.0437	0.0047	0.0033	0.0393
18	0.0077	0.0103	0.0231	0.0018	0.0012	0.0393
19	0.0130	0.0169	0.0329	0.0031	0.0012	0.0391
20	0.0037	0.0165	0.0373	0.0057	0.0035	0.0393
21	0.0066	0.0207	0.0134	0.0056	0.0020	0.0392
22	0.0009	0.0084	0.0412	0.0040	0.0028	0.0393
23	0.0086	0.0128	0.0280	0.0040	0.0028	0.0391
24	0.0175	0.0161	0.0254	0.0032	0.0016	0.0393
25	0.0302	0.0341	0.0225	0.0069	0.0047	0.0392
26	0.0022	0.0190	0.0221	0.0066	0.0048	0.0393
27	0.0031	0.0093	0.0193	0.0064	0.0037	0.0391
28	0.0229	0.0096	0.0335	0.0029	0.0018	0.0392
29	0.0085	0.0091	0.0259	0.0016	0.0014	0.0393
30	0.0044	0.0097	0.0159	0.0018	0.0002	0.0393
31	0.0070	0.0075	0.0280	0.0044	0.0026	0.0393
32	0.0029	0.0122	0.0316	0.0026	0.0047	0.0393
33	0.0098	0.0218	0.0288	0.0077	0.0034	0.0393
34	0.0022	0.0074	0.0172	0.0532	0.0561	0.0393
35	0.0054	0.0162	0.0293	0.0193	0.0121	0.0393
36	0.0069	0.0139	0.0209	0.0028	0.0013	0.0393
37	0.0178	0.0178	0.0371	0.0028	0.0019	0.0393
38	0.0163	0.0231	0.0222	0.0095	0.0053	0.0391
39	0.0004	0.0088	0.0386	0.0036	0.0016	0.0393
40	0.0014	0.0090	0.0304	0.0019	0.0013	0.0393
41	0.0033	0.0046	0.0213	0.0080	0.0054	0.0393
42	0.0051	0.0556	0.0265	0.0103	0.0086	0.0392
43	0.0026	0.0158	0.0293	0.0033	0.0035	0.0393
44	0.0175	0.0167	0.0263	0.0045	0.0027	0.0393
45	0.0043	0.0182	0.0367	0.0063	0.0032	0.0392
46	0.0126	0.0198	0.0229	0.0046	0.0025	0.0393
47	0.0017	0.0120	0.0169	0.0032	0.0009	0.0393
48	0.0022	0.0172	0.0447	0.0081	0.0030	0.0393
49	0.0058	0.0118	0.0188	0.0014	0.0007	0.0393
50	0.0052	0.0075	0.0394	0.0022	0.0018	0.0393
51	0.0037	0.0099	0.0323	0.0026	0.0017	0.0393
52	0.0092	0.0080	0.0325	0.0033	0.0012	0.0393
53	0.0298	0.0052	0.0331	0.0020	0.0012	0.0393
54	0.0040	0.0066	0.0315	0.0045	0.0049	0.0393
55	0.0101	0.0132	0.0306	0.0064	0.0036	0.0393
56	0.0056	0.0078	0.0148	0.0017	0.0011	0.0393
57	0.0096	0.0078	0.0352	0.0014	0.0009	0.0393
58	0.0211	0.0384	0.0244	0.0056	0.0032	0.0392
59	0.0009	0.0084	0.0306	0.0055	0.0019	0.0393
60	0.0106	0.0137	0.0288	0.0031	0.0021	0.0393
61	0.0396	0.0063	0.0348	0.0041	0.0034	0.0393
62	0.0158	0.0103	0.0303	0.0014	0.0004	0.0393
63	0.0026	0.0262	0.0191	0.0049	0.0018	0.0393
64	0.0010	0.0076	0.0392	0.0022	0.0020	0.0393
65	0.0121	0.0285	0.0162	0.0045	0.0018	0.0393
66	0.0067	0.0186	0.0337	0.0027	0.0014	0.0393
67	0.0125	0.0046	0.0283	0.0022	0.0024	0.0392
68	0.0035	0.0104	0.0300	0.0025	0.0015	0.0393
69	0.0040	0.0051	0.0266	0.0011	0.0009	0.0393
70	0.0042	0.0118	0.0297	0.0019	0.0012	0.0393
71	0.0030	0.0065	0.0273	0.0019	0.0024	0.0393
72	0.0022	0.0061	0.0113	0.0020	0.0009	0.0393
73	0.0017	0.0096	0.0101	0.0021	0.0003	0.0393
74	0.0094	0.0032	0.0330	0.0013	0.0013	0.0393
75	0.0019	0.0067	0.0281	0.0012	0.0004	0.0393
76	0.0036	0.0050	0.0192	0.0012	0.0007	0.0393
77	0.0023	0.0011	0.0321	0.0015	0.0010	0.0393
78	0.0104	0.0056	0.0334	0.0017	0.0032	0.0393
79	0.0007	0.0019	0.0310	0.0008	0.0007	0.0393
80	0.0035	0.0045	0.0276	0.0020	0.0009	0.0393
81	0.0045	0.0034	0.0319	0.0019	0.0020	0.0393

APPENDIX 4-Table 4 in the table 4.8. matrix is subtracted from the ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each criterion alternative. All data are in appendix 4. It includes the operations in the Saaty Method part.

	K1	K2	K3	K4	K5	K6
S_{30}^*	0.0016	0.0074	0.0965	0.2644	0.3126	0.0000
S_{31}^*	0.0044	0.0041	0.0363	0.2377	0.2863	0.0000
S_{32}^*	0.0006	0.0123	0.0238	0.2558	0.2645	0.0000
S_{33}^*	0.0089	0.0429	0.0332	0.2064	0.2782	0.0000
S_{34}^*	0.0003	0.0040	0.0889	-	-	0.0000
S_{35}^*	0.0025	0.0228	0.0313	0.1145	0.1935	0.0000
S_{36}^*	0.0042	0.0164	0.0681	0.2539	0.2998	0.0000
S_{37}^*	0.0303	0.0279	0.0099	0.2542	0.2938	0.0000
S_{38}^*	0.0252	0.0485	0.0618	0.1907	0.2585	0.0000
S_{39}^*	-	0.0059	0.0070	0.2456	0.2971	0.0000
S_{40}^*	0.0001	0.0062	0.0274	0.2632	0.3002	0.0000
S_{41}^*	0.0008	0.0013	0.0659	0.2045	0.2575	0.0000
S_{42}^*	0.0023	0.2974	0.0420	0.1835	0.2260	0.0000
S_{43}^*	0.0005	0.0218	0.0313	0.2487	0.2768	0.0000
S_{44}^*	0.0291	0.0244	0.0429	0.2371	0.2854	0.0000
S_{45}^*	0.0015	0.0292	0.0107	0.2194	0.2800	0.0000
S_{46}^*	0.0149	0.0349	0.0582	0.2361	0.2878	0.0000
S_{47}^*	0.0002	0.0118	0.0908	0.2499	0.3046	0.0000
S_{48}^*	0.0003	0.0261	0.0005	0.2035	0.2822	0.0000
S_{49}^*	0.0029	0.0114	0.0793	0.2684	0.3073	0.0000
S_{50}^*	0.0023	0.0041	0.0057	0.2597	0.2946	0.0000
S_{51}^*	0.0011	0.0077	0.0216	0.2563	0.2957	0.0000
S_{52}^*	0.0078	0.0048	0.0210	0.2492	0.3018	0.0000
S_{53}^*	0.0862	0.0017	0.0193	0.2615	0.3013	0.0000
S_{54}^*	0.0013	0.0030	0.0241	0.2369	0.2624	0.0000
S_{55}^*	0.0094	0.0148	0.0268	0.2191	0.2758	0.0000
S_{56}^*	0.0027	0.0045	0.1037	0.2648	0.3025	0.0000
S_{57}^*	0.0085	0.0045	0.0139	0.2676	0.3052	0.0000
S_{58}^*	0.0427	0.1389	0.0510	0.2262	0.2796	0.0000

	K1	K2	K3	K4	K5	K6
S_1^*	0.0111	0.0316	0.0548	0.1935	0.2745	0.0000
S_2^*	0.0150	0.0079	0.0408	0.2574	0.3001	0.0000
S_3^*	0.0023	0.0324	0.0248	0.2360	0.2852	0.0000
S_4^*	0.0064	0.0197	0.1077	0.2536	0.3051	0.0000
S_5^*	0.0058	0.0043	0.0193	0.2629	0.3036	0.0000
S_6^*	0.0174	0.1144	0.0742	0.0761	0.1165	0.0000
S_7^*	0.0019	0.0697	0.0089	0.1641	0.2507	0.0000
S_8^*	0.0318	0.0081	0.0028	0.2607	0.3065	0.0000
S_9^*	0.0021	0.0099	0.0053	0.2274	0.2772	0.0000
S_{10}^*	0.0014	0.0352	0.0064	0.2141	0.2799	0.0000
S_{11}^*	0.0001	0.0021	0.0359	0.2642	0.3022	0.0000
S_{12}^*	0.0559	0.0096	0.0871	0.2633	0.3025	0.0000
S_{13}^*	0.0355	0.0104	0.0692	0.2626	0.3074	0.0000
S_{14}^*	0.0012	0.0105	0.0344	0.2593	0.2901	0.0000
S_{15}^*	0.0004	0.0075	-	0.2609	0.2904	0.0000
S_{16}^*	0.0051	0.0186	0.0412	0.1780	0.2585	0.0000
S_{17}^*	0.0003	0.0151	0.0011	0.2345	0.2791	0.0000
S_{18}^*	0.0054	0.0084	0.0572	0.2638	0.3009	0.0000
S_{19}^*	0.0159	0.0251	0.0198	0.2504	0.3018	0.0000
S_{20}^*	0.0011	0.0238	0.0095	0.2252	0.2767	0.0000
S_{21}^*	0.0039	0.0383	0.1132	0.2260	0.2923	0.0000
S_{22}^*	0.0000	0.0053	0.0034	0.2413	0.2837	0.0000
S_{23}^*	0.0067	0.0137	0.0363	0.2415	0.2844	0.0000
S_{24}^*	0.0291	0.0225	0.0468	0.2493	0.2967	0.0000
S_{25}^*	0.0890	0.1087	0.0602	0.2143	0.2637	0.0000
S_{26}^*	0.0003	0.0321	0.0623	0.2165	0.2631	0.0000
S_{27}^*	0.0007	0.0067	0.0770	0.2192	0.2744	0.0000
S_{28}^*	0.0507	0.0072	0.0181	0.2533	0.2945	0.0000
S_{29}^*	0.0066	0.0064	0.0446	0.2665	0.2998	0.0000

	K1	K2	K3	K4	K5	K6
S_{59}^*	0.0000	0.0054	0.0268	0.2272	0.2942	0.0000
S_{60}^*	0.0104	0.0159	0.0332	0.2505	0.2921	0.0000
S_{61}^*	0.1535	0.0027	0.0149	0.2413	0.2774	0.0000
S_{62}^*	0.0239	0.0085	0.0278	0.2684	0.3099	0.0000
S_{63}^*	0.0005	0.0631	0.0782	0.2326	0.2945	-
S_{64}^*	0.0000	0.0042	0.0060	0.2602	0.2928	0.0000
S_{65}^*	0.0138	0.0751	0.0952	0.2366	0.2947	0.0000
S_{66}^*	0.0039	0.0308	0.0178	0.2550	0.2992	0.0000
S_{67}^*	0.0147	0.0012	0.0351	0.2599	0.2887	0.0000
S_{68}^*	0.0010	0.0087	0.0288	0.2568	0.2985	0.0000
S_{69}^*	0.0013	0.0016	0.0416	0.2707	0.3046	0.0000
S_{70}^*	0.0014	0.0115	0.0299	0.2632	0.3012	0.0000
S_{71}^*	0.0007	0.0030	0.0387	0.2624	0.2888	0.0000
S_{72}^*	0.0003	0.0025	0.1276	0.2623	0.3049	0.0000
S_{73}^*	0.0002	0.0073	0.1359	0.2610	0.3116	0.0000
S_{74}^*	0.0081	0.0004	0.0195	0.2690	0.3006	0.0000
S_{75}^*	0.0002	0.0032	0.0359	0.2701	0.3104	0.0000
S_{76}^*	0.0010	0.0015	0.0776	0.2696	0.3070	0.0000
S_{77}^*	0.0004	-	0.0222	0.2666	0.3038	0.0000
S_{78}^*	0.0101	0.0021	0.0184	0.2655	0.2803	0.0000
S_{79}^*	0.0000	0.0001	0.0258	0.2746	0.3074	0.0000
S_{80}^*	0.0009	0.0012	0.0375	0.2617	0.3053	0.0000
S_{81}^*	0.0016	0.0005	0.0229	0.2631	0.2929	0.0000

APPENDIX 5-Table 5, the value in the table 4.8. is subtracted from the negative ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria. All data are in appendix 5. It includes the operations in the Saaty Method part.

	K1	K2	K3	K4	K5	K6
S_{1}'	0.0820	0.1352	0.0181	0.0071	0.0012	0.0000
S_{2}'	0.0724	0.2082	0.0278	0.0003	0.0001	0.0000
S_{3}'	0.1184	0.1334	0.0446	0.0015	0.0006	0.0000
S_{4}'	0.0971	0.1640	0.0016	0.0004	0.0000	0.0000
S_{5}'	0.0997	0.2300	0.0528	0.0001	0.0001	0.0000
S_{6}'	0.0676	0.0429	0.0093	0.0616	0.0474	0.0000
S_{7}'	0.1211	0.0792	0.0753	0.0141	0.0034	0.0000
S_{8}'	0.0456	0.2075	0.0997	0.0002	0.0000	0.0000
S_{9}'	0.1197	0.1986	0.0877	0.0022	0.0011	0.0000
S_{10}'	0.1252	0.1279	0.0835	0.0038	0.0009	0.0000
S_{11}'	0.1443	0.2493	0.0321	0.0001	0.0001	0.0000
S_{12}'	0.0241	0.2000	0.0054	0.0001	0.0001	0.0000
S_{13}'	0.0413	0.1965	0.0112	0.0001	0.0000	0.0000
S_{14}'	0.1273	0.1962	0.0336	0.0002	0.0004	0.0000
S_{15}'	0.1390	0.2102	0.1359	0.0002	0.0004	0.0000
S_{16}'	0.1026	0.1672	0.0274	0.0104	0.0026	0.0000
S_{17}'	0.1412	0.1785	0.1125	0.0016	0.0010	0.0000
S_{18}'	0.1014	0.2056	0.0168	0.0001	0.0001	0.0000
S_{19}'	0.0706	0.1497	0.0519	0.0006	0.0001	0.0000
S_{20}'	0.1285	0.1528	0.0736	0.0024	0.0011	0.0000
S_{21}'	0.1087	0.1222	0.0010	0.0024	0.0003	0.0000
S_{22}'	0.1496	0.2233	0.0965	0.0011	0.0007	0.0000
S_{23}'	0.0960	0.1835	0.0317	0.0011	0.0007	-
S_{24}'	0.0489	0.1562	0.0232	0.0006	0.0002	0.0000
S_{25}'	0.0087	0.0465	0.0152	0.0037	0.0021	0.0000
S_{26}'	0.1395	0.1340	0.0142	0.0034	0.0021	0.0000
S_{27}'	0.1332	0.2149	0.0083	0.0031	0.0012	0.0000
S_{28}'	0.0278	0.2121	0.0548	0.0004	0.0003	0.0000
S_{29}'	0.0966	0.2166	0.0248	0.0001	0.0001	0.0000
S_{30}'	0.1236	0.2112	0.0034	0.0001	-	0.0000
S_{31}'	0.1058	0.2313	0.0317	0.0013	0.0006	0.0000
S_{32}'	0.1345	0.1887	0.0459	0.0003	0.0020	0.0000
S_{33}'	0.0885	0.1143	0.0347	0.0049	0.0010	0.0000
S_{34}'	0.1398	0.2321	0.0050	0.2746	0.3126	0.0000
S_{35}'	0.1170	0.1554	0.0367	0.0345	0.0142	0.0000
S_{36}'	0.1071	0.1742	0.0116	0.0004	0.0001	0.0000
S_{37}'	0.0474	0.1431	0.0725	0.0004	0.0003	0.0000
S_{38}'	0.0543	0.1057	0.0144	0.0076	0.0026	0.0000
S_{39}'	0.1535	0.2192	0.0811	0.0008	0.0002	0.0000
S_{40}'	0.1459	0.2176	0.0412	0.0001	0.0001	0.0000
S_{41}'	0.1316	0.2600	0.0125	0.0052	0.0027	0.0000
S_{42}'	0.1185	-	0.0268	0.0091	0.0070	0.0000
S_{43}'	0.1364	0.1582	0.0367	0.0006	0.0011	0.0000
S_{44}'	0.0489	0.1515	0.0261	0.0014	0.0006	0.0000
S_{45}'	0.1243	0.1403	0.0703	0.0031	0.0009	0.0000
S_{46}'	0.0726	0.1285	0.0162	0.0015	0.0005	0.0000
S_{47}'	0.1431	0.1906	0.0045	0.0006	0.0001	0.0000
S_{48}'	0.1398	0.1473	0.1196	0.0053	0.0008	0.0000
S_{49}'	0.1143	0.1922	0.0076	0.0000	0.0000	0.0000
S_{50}'	0.1181	0.2318	0.0859	0.0002	0.0003	0.0000
S_{51}'	0.1286	0.2095	0.0491	0.0003	0.0002	0.0000
S_{52}'	0.0922	0.2269	0.0500	0.0006	0.0001	0.0000
S_{53}'	0.0096	0.2540	0.0528	0.0002	0.0001	0.0000
S_{54}'	0.1268	0.2406	0.0455	0.0014	0.0022	0.0000
S_{55}'	0.0869	0.1796	0.0420	0.0031	0.0012	0.0000
S_{56}'	0.1155	0.2288	0.0022	0.0001	0.0001	0.0000
S_{57}'	0.0897	0.2288	0.0628	0.0000	0.0000	0.0000
S_{58}'	0.0343	0.0298	0.0204	0.0023	0.0009	0.0000
S_{59}'	0.1494	0.2227	0.0420	0.0022	0.0003	0.0000
S_{60}'	0.0839	0.1759	0.0347	0.0006	0.0004	0.0000
S_{61}'	-	0.2432	0.0607	0.0011	0.0011	0.0000
S_{62}'	0.0563	0.2051	0.0408	0.0000	0.0000	0.0000
S_{63}'	0.1367	0.0865	0.0079	0.0017	0.0003	0.0000
S_{64}'	0.1491	0.2309	0.0847	0.0002	0.0003	0.0000
S_{65}'	0.0754	0.0736	0.0036	0.0014	0.0003	0.0000
S_{66}'	0.1083	0.1367	0.0552	0.0004	0.0001	0.0000
S_{67}'	0.0731	0.2608	0.0328	0.0002	0.0005	0.0000
S_{68}'	0.1301	0.2042	0.0395	0.0003	0.0002	0.0000
S_{69}'	0.1267	0.2552	0.0271	0.0000	0.0001	0.0000
S_{70}'	0.1254	0.1918	0.0383	0.0001	0.0001	0.0000
S_{71}'	0.1335	0.2410	0.0295	0.0001	0.0005	0.0000
S_{72}'	0.1398	0.2452	0.0001	0.0001	0.0000	0.0000
S_{73}'	0.1437	0.2114	-	0.0002	0.0000	0.0000
S_{74}'	0.0910	0.2751	0.0524	0.0000	0.0001	0.0000
S_{75}'	0.1423	0.2391	0.0321	0.0000	0.0000	0.0000
S_{76}'	0.1297	0.2563	0.0081	0.0000	0.0000	0.0000
S_{77}'	0.1388	0.2974	0.0482	0.0001	0.0001	0.0000
S_{78}'	0.0849	0.2498	0.0543	0.0001	0.0009	0.0000
S_{79}'	0.1507	0.2883	0.0433	-	0.0000	0.0000
S_{80}'	0.1304	0.2611	0.0306	0.0002	0.0000	0.0000
S_{81}'	0.1233	0.2727	0.0473	0.0001	0.0003	0.0000

APPENDIX 6-Table 6 , contains ranked data for all alternatives. All data are in appendix 6. It includes the operations in the Saaty Method part.

S_i^*		S_i^-		C_i^*		Ranking
S_1^*	0.7520	S_1^-	0.493565437	C_1^*	0.3963	66
S_2^*	0.7882	S_2^-	0.555685403	C_2^*	0.4135	54
S_3^*	0.7620	S_3^-	0.546385517	C_3^*	0.4176	50
S_4^*	0.8322	S_4^-	0.513056653	C_4^*	0.3814	69
S_5^*	0.7719	S_5^-	0.618617804	C_5^*	0.4449	29
S_6^*	0.6313	S_6^-	0.47824192	C_6^*	0.4310	44
S_7^*	0.7037	S_7^-	0.541439373	C_7^*	0.4348	40
S_8^*	0.7809	S_8^-	0.594138389	C_8^*	0.4321	42
S_9^*	0.7224	S_9^-	0.639748015	C_9^*	0.4697	12
S_{10}^*	0.7328	S_{10}^-	0.584122652	C_{10}^*	0.4435	31
S_{11}^*	0.7776	S_{11}^-	0.652589606	C_{11}^*	0.4563	17
S_{12}^*	0.8476	S_{12}^-	0.479289957	C_{12}^*	0.3612	76
S_{13}^*	0.8277	S_{13}^-	0.499085769	C_{13}^*	0.3762	71
S_{14}^*	0.7717	S_{14}^-	0.598116655	C_{14}^*	0.4366	38
S_{15}^*	0.7478	S_{15}^-	0.696884792	C_{15}^*	0.4824	4
S_{16}^*	0.7081	S_{16}^-	0.557024854	C_{16}^*	0.4403	36
S_{17}^*	0.7280	S_{17}^-	0.659355427	C_{17}^*	0.4753	6
S_{18}^*	0.7973	S_{18}^-	0.569231433	C_{18}^*	0.4165	53
S_{19}^*	0.7830	S_{19}^-	0.522381094	C_{19}^*	0.4002	64
S_{20}^*	0.7324	S_{20}^-	0.598703746	C_{20}^*	0.4498	23
S_{21}^*	0.8208	S_{21}^-	0.484425486	C_{21}^*	0.3711	74
S_{22}^*	0.7306	S_{22}^-	0.686375543	C_{22}^*	0.4844	3
S_{23}^*	0.7633	S_{23}^-	0.559481971	C_{23}^*	0.4230	48
S_{24}^*	0.8028	S_{24}^-	0.478702865	C_{24}^*	0.3736	72
S_{25}^*	0.8579	S_{25}^-	0.2760936	C_{25}^*	0.2435	81
S_{26}^*	0.7578	S_{26}^-	0.541506561	C_{26}^*	0.4168	52
S_{27}^*	0.7603	S_{27}^-	0.60056639	C_{27}^*	0.4413	35
S_{28}^*	0.7898	S_{28}^-	0.543411369	C_{28}^*	0.4076	59
S_{29}^*	0.7898	S_{29}^-	0.581469678	C_{29}^*	0.4240	47
S_{30}^*	0.8261	S_{30}^-	0.581599659	C_{30}^*	0.4131	57
S_{31}^*	0.7542	S_{31}^-	0.608924067	C_{31}^*	0.4467	28
S_{32}^*	0.7464	S_{32}^-	0.609482728	C_{32}^*	0.4495	25
S_{33}^*	0.7547	S_{33}^-	0.493366369	C_{33}^*	0.3953	68
S_{34}^*	0.3054	S_{34}^-	0.981890289	C_{34}^*	0.7627	1
S_{35}^*	0.6039	S_{35}^-	0.598130405	C_{35}^*	0.4976	2
S_{36}^*	0.8014	S_{36}^-	0.541660247	C_{36}^*	0.4033	63
S_{37}^*	0.7850	S_{37}^-	0.513435669	C_{37}^*	0.3954	67
S_{38}^*	0.7647	S_{38}^-	0.429652318	C_{38}^*	0.3597	77
S_{39}^*	0.7454	S_{39}^-	0.674391364	C_{39}^*	0.4750	7
S_{40}^*	0.7727	S_{40}^-	0.636334288	C_{40}^*	0.4516	21
S_{41}^*	0.7280	S_{41}^-	0.641867705	C_{41}^*	0.4686	13
S_{42}^*	0.8667	S_{42}^-	0.401819105	C_{42}^*	0.3168	79
S_{43}^*	0.7611	S_{43}^-	0.577049078	C_{43}^*	0.4312	43
S_{44}^*	0.7867	S_{44}^-	0.478032151	C_{44}^*	0.3780	70
S_{45}^*	0.7355	S_{45}^-	0.582108058	C_{45}^*	0.4418	34
S_{46}^*	0.7949	S_{46}^-	0.468297026	C_{46}^*	0.3707	75
S_{47}^*	0.8108	S_{47}^-	0.58211043	C_{47}^*	0.4179	49
S_{48}^*	0.7159	S_{48}^-	0.642505806	C_{48}^*	0.4730	9
S_{49}^*	0.8181	S_{49}^-	0.560420064	C_{49}^*	0.4065	62
S_{50}^*	0.7526	S_{50}^-	0.660507695	C_{50}^*	0.4674	14
S_{51}^*	0.7631	S_{51}^-	0.622690017	C_{51}^*	0.4493	26
S_{52}^*	0.7645	S_{52}^-	0.608171725	C_{52}^*	0.4431	32
S_{53}^*	0.8186	S_{53}^-	0.562761005	C_{53}^*	0.4074	61
S_{54}^*	0.7264	S_{54}^-	0.645377612	C_{54}^*	0.4705	11
S_{55}^*	0.7389	S_{55}^-	0.559217089	C_{55}^*	0.4308	45
S_{56}^*	0.8235	S_{56}^-	0.588785274	C_{56}^*	0.4169	51
S_{57}^*	0.7744	S_{57}^-	0.617546551	C_{57}^*	0.4437	30
S_{58}^*	0.8593	S_{58}^-	0.296243302	C_{58}^*	0.2564	80
S_{59}^*	0.7440	S_{59}^-	0.64549736	C_{59}^*	0.4646	16
S_{60}^*	0.7759	S_{60}^-	0.543589111	C_{60}^*	0.4120	58
S_{61}^*	0.8305	S_{61}^-	0.553231576	C_{61}^*	0.3998	65
S_{62}^*	0.7990	S_{62}^-	0.549753858	C_{62}^*	0.4076	60
S_{63}^*	0.8179	S_{63}^-	0.482832498	C_{63}^*	0.3712	73
S_{64}^*	0.7505	S_{64}^-	0.682043906	C_{64}^*	0.4761	5
S_{65}^*	0.8458	S_{65}^-	0.392711883	C_{65}^*	0.3171	78
S_{66}^*	0.7790	S_{66}^-	0.548413146	C_{66}^*	0.4132	56
S_{67}^*	0.7743	S_{67}^-	0.606124514	C_{67}^*	0.4391	37
S_{68}^*	0.7706	S_{68}^-	0.611807171	C_{68}^*	0.4426	33
S_{69}^*	0.7873	S_{69}^-	0.63958294	C_{69}^*	0.4482	27
S_{70}^*	0.7793	S_{70}^-	0.596435894	C_{70}^*	0.4335	41
S_{71}^*	0.7704	S_{71}^-	0.636108751	C_{71}^*	0.4522	20
S_{72}^*	0.8353	S_{72}^-	0.620747243	C_{72}^*	0.4263	46
S_{73}^*	0.8462	S_{73}^-	0.596048029	C_{73}^*	0.4133	55
S_{74}^*	0.7731	S_{74}^-	0.646930779	C_{74}^*	0.4556	18
S_{75}^*	0.7873	S_{75}^-	0.643036488	C_{75}^*	0.4496	24
S_{76}^*	0.8104	S_{76}^-	0.627831631	C_{76}^*	0.4365	39
S_{77}^*	0.7701	S_{77}^-	0.696074577	C_{77}^*	0.4748	8
S_{78}^*	0.7592	S_{78}^-	0.624431782	C_{78}^*	0.4513	22
S_{79}^*	0.7796	S_{79}^-	0.694538235	C_{79}^*	0.4711	10
S_{80}^*	0.7788	S_{80}^-	0.649881035	C_{80}^*	0.4549	19
S_{81}^*	0.7623	S_{81}^-	0.66616788	C_{81}^*	0.4664	15

APPENDIX 7-Table 7 includes dividing the value of the alternative in each criterion by the square root of the total of the squares of whole alternatives in that criterion. All data are in appendix 7. It includes the operations in the Entropy Method part.

	K1	K2	K3	K4	K5
1	0.110	0.133	0.089	0.124	0.056
2	0.127	0.070	0.101	0.033	0.020
3	0.052	0.134	0.118	0.062	0.041
4	0.084	0.106	0.054	0.038	0.013
5	0.080	0.054	0.125	0.026	0.015
6	0.136	0.246	0.075	0.346	0.332
7	0.048	0.193	0.142	0.171	0.091
8	0.183	0.071	0.158	0.029	0.011
9	0.050	0.078	0.150	0.074	0.052
10	0.042	0.140	0.147	0.093	0.048
11	0.016	0.040	0.106	0.024	0.017
12	0.241	0.077	0.066	0.025	0.017
13	0.193	0.080	0.078	0.026	0.010
14	0.039	0.080	0.108	0.030	0.034
15	0.023	0.069	0.178	0.028	0.034
16	0.076	0.104	0.101	0.148	0.080
17	0.020	0.094	0.165	0.064	0.050
18	0.077	0.072	0.087	0.025	0.019
19	0.130	0.119	0.124	0.042	0.018
20	0.037	0.116	0.141	0.077	0.053
21	0.066	0.145	0.050	0.076	0.031
22	0.009	0.059	0.156	0.055	0.043
23	0.086	0.090	0.106	0.054	0.042
24	0.175	0.113	0.096	0.044	0.025
25	0.303	0.240	0.085	0.093	0.072
26	0.022	0.134	0.083	0.090	0.073
27	0.031	0.065	0.073	0.086	0.056
28	0.230	0.067	0.127	0.038	0.028
29	0.085	0.064	0.098	0.021	0.020
30	0.044	0.068	0.060	0.024	0.003
31	0.071	0.053	0.106	0.060	0.039
32	0.029	0.086	0.119	0.035	0.071
33	0.099	0.153	0.109	0.105	0.051
34	0.022	0.052	0.065	0.718	0.849
35	0.054	0.114	0.111	0.261	0.183
36	0.069	0.098	0.079	0.038	0.020
37	0.179	0.125	0.140	0.037	0.029
38	0.163	0.163	0.084	0.128	0.080
39	0.004	0.062	0.146	0.049	0.024
40	0.014	0.063	0.115	0.025	0.020
41	0.033	0.033	0.081	0.107	0.081
42	0.052	0.392	0.100	0.140	0.130
43	0.027	0.112	0.111	0.045	0.053
44	0.175	0.118	0.099	0.061	0.041
45	0.043	0.128	0.138	0.085	0.048
46	0.127	0.139	0.086	0.062	0.037
47	0.018	0.084	0.064	0.043	0.014
48	0.022	0.121	0.169	0.109	0.045
49	0.058	0.083	0.071	0.018	0.010
50	0.052	0.053	0.149	0.030	0.028
51	0.037	0.069	0.122	0.034	0.026
52	0.092	0.056	0.123	0.044	0.018
53	0.298	0.037	0.125	0.028	0.018
54	0.040	0.046	0.119	0.061	0.074
55	0.101	0.093	0.116	0.086	0.054
56	0.056	0.055	0.056	0.023	0.017
57	0.096	0.055	0.133	0.020	0.013
58	0.211	0.270	0.092	0.076	0.049
59	0.009	0.059	0.116	0.074	0.028
60	0.106	0.096	0.109	0.042	0.031
61	0.397	0.044	0.131	0.055	0.052
62	0.159	0.073	0.115	0.018	0.007
63	0.026	0.184	0.072	0.067	0.028
64	0.010	0.053	0.148	0.029	0.030
65	0.122	0.201	0.061	0.061	0.027
66	0.067	0.131	0.127	0.036	0.021
67	0.126	0.032	0.107	0.030	0.036
68	0.035	0.073	0.113	0.034	0.022
69	0.040	0.036	0.100	0.015	0.014
70	0.042	0.083	0.112	0.025	0.018
71	0.030	0.046	0.103	0.026	0.036
72	0.022	0.043	0.043	0.026	0.013
73	0.017	0.068	0.038	0.028	0.004
74	0.094	0.022	0.125	0.018	0.019
75	0.019	0.047	0.106	0.016	0.006
76	0.036	0.035	0.072	0.017	0.011
77	0.023	0.008	0.121	0.021	0.015
78	0.105	0.040	0.126	0.022	0.048
79	0.008	0.014	0.117	0.010	0.010
80	0.035	0.032	0.104	0.027	0.013
81	0.045	0.024	0.120	0.025	0.030

APPENDIX 8-Table 8 shows all the results of the operations in table 4.17. All data are in appendix 8. It includes the operations in the Entropy Method part.

	K1	K2	K3	K4	K5
1	0.0222	0.0143	0.0021	0.0327	0.0226
2	0.0257	0.0076	0.0024	0.0087	0.0081
3	0.0105	0.0145	0.0028	0.0164	0.0164
4	0.0171	0.0115	0.0013	0.0100	0.0053
5	0.0162	0.0058	0.0030	0.0068	0.0061
6	0.0276	0.0265	0.0018	0.0911	0.1337
7	0.0097	0.0208	0.0034	0.0451	0.0367
8	0.0370	0.0076	0.0038	0.0075	0.0045
9	0.0101	0.0084	0.0036	0.0196	0.0210
10	0.0085	0.0151	0.0035	0.0246	0.0195
11	0.0032	0.0043	0.0026	0.0063	0.0069
12	0.0488	0.0083	0.0016	0.0066	0.0067
13	0.0391	0.0086	0.0019	0.0069	0.0040
14	0.0079	0.0086	0.0026	0.0080	0.0136
15	0.0047	0.0074	0.0043	0.0075	0.0135
16	0.0153	0.0112	0.0024	0.0391	0.0320
17	0.0041	0.0101	0.0040	0.0169	0.0200
18	0.0157	0.0078	0.0021	0.0065	0.0076
19	0.0264	0.0128	0.0030	0.0112	0.0071
20	0.0076	0.0125	0.0034	0.0204	0.0213
21	0.0134	0.0157	0.0012	0.0201	0.0124
22	0.0018	0.0063	0.0037	0.0144	0.0173
23	0.0174	0.0097	0.0025	0.0144	0.0169
24	0.0354	0.0122	0.0023	0.0116	0.0099
25	0.0613	0.0258	0.0020	0.0245	0.0289
26	0.0045	0.0144	0.0020	0.0237	0.0293
27	0.0063	0.0070	0.0018	0.0226	0.0226
28	0.0465	0.0073	0.0030	0.0102	0.0112
29	0.0172	0.0069	0.0024	0.0055	0.0082
30	0.0090	0.0073	0.0014	0.0062	0.0012
31	0.0143	0.0057	0.0025	0.0158	0.0158
32	0.0059	0.0092	0.0029	0.0093	0.0284
33	0.0200	0.0165	0.0026	0.0276	0.0205
34	0.0044	0.0056	0.0016	0.1894	0.3414
35	0.0109	0.0123	0.0027	0.0689	0.0737
36	0.0139	0.0105	0.0019	0.0099	0.0082
37	0.0361	0.0135	0.0034	0.0098	0.0116
38	0.0330	0.0175	0.0020	0.0338	0.0320
39	0.0008	0.0067	0.0035	0.0129	0.0097
40	0.0028	0.0068	0.0028	0.0067	0.0080
41	0.0067	0.0035	0.0019	0.0283	0.0326
42	0.0104	0.0422	0.0024	0.0368	0.0521
43	0.0054	0.0120	0.0027	0.0118	0.0212
44	0.0354	0.0127	0.0024	0.0160	0.0163
45	0.0088	0.0138	0.0033	0.0225	0.0194
46	0.0256	0.0150	0.0021	0.0163	0.0150
47	0.0036	0.0091	0.0015	0.0113	0.0055
48	0.0044	0.0131	0.0041	0.0287	0.0182

	K1	K2	K3	K4	K5
49	0.0117	0.0089	0.0017	0.0049	0.0041
50	0.0106	0.0057	0.0036	0.0079	0.0111
51	0.0075	0.0075	0.0029	0.0091	0.0105
52	0.0187	0.0061	0.0030	0.0116	0.0071
53	0.0604	0.0040	0.0030	0.0073	0.0074
54	0.0080	0.0050	0.0029	0.0160	0.0297
55	0.0205	0.0100	0.0028	0.0227	0.0218
56	0.0113	0.0059	0.0013	0.0061	0.0067
57	0.0195	0.0059	0.0032	0.0052	0.0052
58	0.0427	0.0291	0.0022	0.0200	0.0196
59	0.0019	0.0064	0.0028	0.0196	0.0114
60	0.0215	0.0104	0.0026	0.0111	0.0125
61	0.0803	0.0048	0.0032	0.0144	0.0209
62	0.0322	0.0078	0.0028	0.0049	0.0027
63	0.0053	0.0199	0.0017	0.0176	0.0112
64	0.0019	0.0057	0.0036	0.0077	0.0121
65	0.0246	0.0216	0.0015	0.0161	0.0110
66	0.0135	0.0141	0.0031	0.0095	0.0086
67	0.0255	0.0035	0.0026	0.0078	0.0145
68	0.0071	0.0079	0.0027	0.0089	0.0089
69	0.0081	0.0039	0.0024	0.0041	0.0055
70	0.0085	0.0090	0.0027	0.0067	0.0074
71	0.0062	0.0049	0.0025	0.0069	0.0144
72	0.0044	0.0046	0.0010	0.0070	0.0054
73	0.0034	0.0073	0.0009	0.0074	0.0017
74	0.0191	0.0024	0.0030	0.0047	0.0078
75	0.0038	0.0051	0.0026	0.0043	0.0024
76	0.0072	0.0038	0.0017	0.0045	0.0043
77	0.0047	0.0008	0.0029	0.0055	0.0060
78	0.0212	0.0043	0.0030	0.0059	0.0192
79	0.0015	0.0015	0.0028	0.0028	0.0040
80	0.0070	0.0034	0.0025	0.0072	0.0052
81	0.0090	0.0026	0.0029	0.0067	0.0121

APPENDIX 9-Table 9 in the table 4.17. matrix is subtracted from the ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each criterion alternative. All data are in appendix 9. It includes the operations in the Entropy Method part.

	K1	K2	K3	K4	K5
S_{1}^{*}	0.0458	0.0181	0.0005	2.4548	10.1633
S_{2}^{*}	0.0620	0.0046	0.0003	3.2655	11.1093
S_{3}^{*}	0.0094	0.0186	0.0002	2.9942	10.5592
S_{4}^{*}	0.0265	0.0113	0.0009	3.2173	11.2935
S_{5}^{*}	0.0238	0.0025	0.0002	3.3349	11.2380
S_{6}^{*}	0.0716	0.0658	0.0006	0.9656	4.3143
S_{7}^{*}	0.0079	0.0400	0.0001	2.0816	9.2812
S_{8}^{*}	0.1310	0.0046	0.0000	3.3073	11.3457
S_{9}^{*}	0.0087	0.0057	0.0000	2.8841	10.2615
S_{10}^{*}	0.0059	0.0203	0.0001	2.7160	10.3627
S_{11}^{*}	0.0006	0.0012	0.0003	3.3518	11.1882
S_{12}^{*}	0.2303	0.0055	0.0007	3.3400	11.1993
S_{13}^{*}	0.1464	0.0060	0.0006	3.3312	11.3805
S_{14}^{*}	0.0050	0.0060	0.0003	3.2900	10.7400
S_{15}^{*}	0.0015	0.0043	-	3.3091	10.7506
S_{16}^{*}	0.0210	0.0107	0.0003	2.2580	9.5698
S_{17}^{*}	0.0011	0.0087	0.0000	2.9752	10.3307
S_{18}^{*}	0.0221	0.0048	0.0005	3.3461	11.1413
S_{19}^{*}	0.0654	0.0144	0.0002	3.1770	11.1724
S_{20}^{*}	0.0046	0.0137	0.0001	2.8573	10.2439
S_{21}^{*}	0.0159	0.0220	0.0009	2.8671	10.8208
S_{22}^{*}	0.0001	0.0030	0.0000	3.0616	10.5028
S_{23}^{*}	0.0276	0.0079	0.0003	3.0638	10.5274
S_{24}^{*}	0.1199	0.0129	0.0004	3.1626	10.9842
S_{25}^{*}	0.3665	0.0625	0.0005	2.7188	9.7639
S_{26}^{*}	0.0014	0.0185	0.0005	2.7463	9.7386
S_{27}^{*}	0.0030	0.0038	0.0006	2.7810	10.1595
S_{28}^{*}	0.2089	0.0041	0.0001	3.2128	10.9007
S_{29}^{*}	0.0270	0.0037	0.0004	3.3802	11.0981
S_{30}^{*}	0.0067	0.0042	0.0008	3.3542	11.5742
S_{31}^{*}	0.0182	0.0024	0.0003	3.0152	10.5976
S_{32}^{*}	0.0026	0.0071	0.0002	3.2448	9.7924
S_{33}^{*}	0.0367	0.0247	0.0003	2.6177	10.2974
S_{34}^{*}	0.0013	0.0023	0.0007	-	-
S_{35}^{*}	0.0102	0.0131	0.0003	1.4525	7.1639
S_{36}^{*}	0.0172	0.0094	0.0006	3.2205	11.0993
S_{37}^{*}	0.1249	0.0160	0.0001	3.2253	10.8764
S_{38}^{*}	0.1038	0.0279	0.0005	2.4197	9.5697
S_{39}^{*}	-	0.0034	0.0001	3.1150	10.9982
S_{40}^{*}	0.0004	0.0036	0.0002	3.3386	11.1125
S_{41}^{*}	0.0035	0.0007	0.0005	2.5946	9.5316
S_{42}^{*}	0.0093	0.1709	0.0003	2.3283	8.3650

	K1	K2	K3	K4	K5
S_{43}^{*}	0.0021	0.0125	0.0003	3.1554	10.2482
S_{44}^{*}	0.1199	0.0140	0.0004	3.0076	10.5651
S_{45}^{*}	0.0063	0.0168	0.0001	2.7838	10.3664
S_{46}^{*}	0.0616	0.0201	0.0005	2.9953	10.6527
S_{47}^{*}	0.0008	0.0068	0.0007	3.1704	11.2782
S_{48}^{*}	0.0013	0.0150	0.0000	2.5810	10.4462
S_{49}^{*}	0.0119	0.0066	0.0007	3.4048	11.3756
S_{50}^{*}	0.0095	0.0023	0.0000	3.2941	10.9071
S_{51}^{*}	0.0045	0.0044	0.0002	3.2510	10.9467
S_{52}^{*}	0.0320	0.0027	0.0002	3.1612	11.1711
S_{53}^{*}	0.3554	0.0010	0.0002	3.3175	11.1545
S_{54}^{*}	0.0052	0.0017	0.0002	3.0052	9.7149
S_{55}^{*}	0.0388	0.0085	0.0002	2.7796	10.2110
S_{56}^{*}	0.0111	0.0026	0.0009	3.3588	11.1971
S_{57}^{*}	0.0351	0.0026	0.0001	3.3946	11.2976
S_{58}^{*}	0.1759	0.0798	0.0004	2.8697	10.3524
S_{59}^{*}	0.0001	0.0031	0.0002	2.8817	10.8900
S_{60}^{*}	0.0429	0.0091	0.0003	3.1783	10.8122
S_{61}^{*}	0.6324	0.0016	0.0001	3.0610	10.2682
S_{62}^{*}	0.0984	0.0049	0.0002	3.4049	11.4711
S_{63}^{*}	0.0020	0.0363	0.0006	2.9507	10.9040
S_{64}^{*}	0.0001	0.0024	0.0000	3.3006	10.8385
S_{65}^{*}	0.0567	0.0432	0.0008	3.0015	10.9113
S_{66}^{*}	0.0162	0.0177	0.0001	3.2349	11.0757
S_{67}^{*}	0.0608	0.0007	0.0003	3.2965	10.6865
S_{68}^{*}	0.0040	0.0050	0.0002	3.2580	11.0522
S_{69}^{*}	0.0053	0.0009	0.0003	3.4340	11.2774
S_{70}^{*}	0.0059	0.0066	0.0002	3.3387	11.1522
S_{71}^{*}	0.0029	0.0017	0.0003	3.3293	10.6902
S_{72}^{*}	0.0013	0.0014	0.0011	3.3278	11.2892
S_{73}^{*}	0.0007	0.0042	0.0011	3.3110	11.5371
S_{74}^{*}	0.0335	0.0003	0.0002	3.4120	11.1268
S_{75}^{*}	0.0009	0.0018	0.0003	3.4263	11.4909
S_{76}^{*}	0.0041	0.0009	0.0006	3.4204	11.3636
S_{77}^{*}	0.0015	-	0.0002	3.3820	11.2462
S_{78}^{*}	0.0415	0.0012	0.0002	3.3678	10.3773
S_{79}^{*}	0.0001	0.0000	0.0002	3.4834	11.3806
S_{80}^{*}	0.0039	0.0007	0.0003	3.3199	11.3005
S_{81}^{*}	0.0068	0.0003	0.0002	3.3379	10.8435

APPENDIX 10-Table 10, the value in the table 4.17. matrix is subtracted from the negative ideal solution set. The value is squared. It is then multiplied by 100. This process is repeated for each alternative of criteria. All data are in appendix 10. It includes the operations in the Entropy Method part.

	K1	K2	K3	K4	K5
S_1^-	0.3379	0.0777	0.0001	0.0898	0.0458
S_2^-	0.2984	0.1197	0.0002	0.0035	0.0048
S_3^-	0.4878	0.0767	0.0004	0.0185	0.0233
S_4^-	0.4000	0.0943	0.0000	0.0053	0.0017
S_5^-	0.4108	0.1322	0.0004	0.0016	0.0025
S_6^-	0.2784	0.0247	0.0001	0.7810	1.7556
S_7^-	0.4991	0.0455	0.0006	0.1794	0.1264
S_8^-	0.1878	0.1193	0.0008	0.0023	0.0011
S_9^-	0.4931	0.1142	0.0007	0.0283	0.0395
S_{10}^-	0.5160	0.0735	0.0007	0.0477	0.0335
S_{11}^-	0.5947	0.1433	0.0003	0.0013	0.0033
S_{12}^-	0.0995	0.1149	0.0000	0.0015	0.0031
S_{13}^-	0.1703	0.1129	0.0001	0.0017	0.0008
S_{14}^-	0.5245	0.1128	0.0003	0.0028	0.0156
S_{15}^-	0.5727	0.1208	0.0011	0.0022	0.0152
S_{16}^-	0.4228	0.0961	0.0002	0.1323	0.0952
S_{17}^-	0.5817	0.1026	0.0009	0.0200	0.0353
S_{18}^-	0.4179	0.1182	0.0001	0.0014	0.0041
S_{19}^-	0.2910	0.0861	0.0004	0.0070	0.0035
S_{20}^-	0.5294	0.0878	0.0006	0.0310	0.0406
S_{21}^-	0.4479	0.0703	0.0000	0.0300	0.0127
S_{22}^-	0.6164	0.1283	0.0008	0.0136	0.0260
S_{23}^-	0.3958	0.1055	0.0003	0.0135	0.0248
S_{24}^-	0.2016	0.0898	0.0002	0.0077	0.0077
S_{25}^-	0.0360	0.0267	0.0001	0.0473	0.0769
S_{26}^-	0.5746	0.0770	0.0001	0.0438	0.0792
S_{27}^-	0.5486	0.1235	0.0001	0.0395	0.0461
S_{28}^-	0.1144	0.1219	0.0005	0.0055	0.0101
S_{29}^-	0.3979	0.1245	0.0002	0.0008	0.0050
S_{30}^-	0.5093	0.1214	0.0000	0.0012	-
S_{31}^-	0.4361	0.1330	0.0003	0.0169	0.0215
S_{32}^-	0.5543	0.1084	0.0004	0.0042	0.0744
S_{33}^-	0.3645	0.0657	0.0003	0.0617	0.0373
S_{34}^-	0.5759	0.1334	0.0000	3.4834	11.5742
S_{35}^-	0.4819	0.0893	0.0003	0.4371	0.5264
S_{36}^-	0.4411	0.1001	0.0001	0.0052	0.0050
S_{37}^-	0.1952	0.0822	0.0006	0.0050	0.0108
S_{38}^-	0.2238	0.0607	0.0001	0.0966	0.0952
S_{39}^-	0.6324	0.1260	0.0007	0.0103	0.0074
S_{40}^-	0.6012	0.1251	0.0003	0.0015	0.0047
S_{41}^-	0.5424	0.1495	0.0001	0.0653	0.0991
S_{42}^-	0.4884	-	0.0002	0.1159	0.2599
S_{43}^-	0.5619	0.0909	0.0003	0.0081	0.0403

	K1	K2	K3	K4	K5
S_{44}^-	0.2016	0.0871	0.0002	0.0175	0.0230
S_{45}^-	0.5123	0.0806	0.0006	0.0392	0.0333
S_{46}^-	0.2993	0.0738	0.0001	0.0184	0.0191
S_{47}^-	0.5895	0.1096	0.0000	0.0074	0.0019
S_{48}^-	0.5759	0.0847	0.0010	0.0675	0.0289
S_{49}^-	0.4708	0.1105	0.0001	0.0004	0.0009
S_{50}^-	0.4866	0.1333	0.0007	0.0026	0.0099
S_{51}^-	0.5300	0.1204	0.0004	0.0040	0.0087
S_{52}^-	0.3800	0.1304	0.0004	0.0078	0.0036
S_{53}^-	0.0397	0.1460	0.0004	0.0020	0.0039
S_{54}^-	0.5227	0.1383	0.0004	0.0176	0.0813
S_{55}^-	0.3579	0.1032	0.0003	0.0397	0.0427
S_{56}^-	0.4761	0.1315	0.0000	0.0011	0.0031
S_{57}^-	0.3696	0.1315	0.0005	0.0006	0.0017
S_{58}^-	0.1413	0.0171	0.0002	0.0297	0.0341
S_{59}^-	0.6157	0.1280	0.0003	0.0285	0.0104
S_{60}^-	0.3458	0.1011	0.0003	0.0070	0.0130
S_{61}^-	-	0.1398	0.0005	0.0136	0.0391
S_{62}^-	0.2319	0.1179	0.0003	0.0004	0.0002
S_{63}^-	0.5631	0.0497	0.0001	0.0221	0.0100
S_{64}^-	0.6144	0.1327	0.0007	0.0025	0.0121
S_{65}^-	0.3105	0.0423	0.0000	0.0179	0.0098
S_{66}^-	0.4462	0.0786	0.0005	0.0046	0.0055
S_{67}^-	0.3011	0.1499	0.0003	0.0026	0.0177
S_{68}^-	0.5362	0.1174	0.0003	0.0038	0.0060
S_{69}^-	0.5220	0.1467	0.0002	0.0002	0.0019
S_{70}^-	0.5166	0.1103	0.0003	0.0015	0.0039
S_{71}^-	0.5499	0.1385	0.0002	0.0017	0.0176
S_{72}^-	0.5759	0.1410	0.0000	0.0018	0.0018
S_{73}^-	0.5921	0.1215	-	0.0022	0.0000
S_{74}^-	0.3748	0.1581	0.0004	0.0004	0.0044
S_{75}^-	0.5862	0.1374	0.0003	0.0002	0.0002
S_{76}^-	0.5343	0.1473	0.0001	0.0003	0.0010
S_{77}^-	0.5721	0.1709	0.0004	0.0007	0.0024
S_{78}^-	0.3498	0.1436	0.0004	0.0010	0.0327
S_{79}^-	0.6210	0.1657	0.0004	-	0.0008
S_{80}^-	0.5374	0.1501	0.0003	0.0020	0.0016
S_{81}^-	0.5081	0.1568	0.0004	0.0016	0.0119

APPENDIX 11-Table 11, contains ranked data for all alternatives. All data are in appendix 11. It includes the operations in the Entropy Method part.

S_i^+		S_i^-		C_i^+		Ranking
S_1^+	3.5613	S_1^-	0.742536698	C_1^+	0.1725	45
S_2^+	3.8002	S_2^-	0.653098734	C_2^+	0.1467	67
S_3^+	3.6853	S_3^-	0.778884611	C_3^+	0.1745	41
S_4^+	3.8144	S_4^-	0.708054541	C_4^+	0.1566	62
S_5^+	3.8209	S_5^-	0.739935187	C_5^+	0.1622	56
S_6^+	2.3276	S_6^-	1.685143521	C_6^+	0.4199	2
S_7^+	3.3780	S_7^-	0.922557987	C_7^+	0.2145	5
S_8^+	3.8456	S_8^-	0.557938821	C_8^+	0.1267	73
S_9^+	3.6277	S_9^-	0.822052329	C_9^+	0.1847	21
S_{10}^+	3.6201	S_{10}^-	0.819328298	C_{10}^+	0.1846	22
S_{11}^+	3.8134	S_{11}^-	0.861832042	C_{11}^+	0.1843	23
S_{12}^+	3.8439	S_{12}^-	0.468028328	C_{12}^+	0.1085	78
S_{13}^+	3.8555	S_{13}^-	0.534596247	C_{13}^+	0.1218	75
S_{14}^+	3.7472	S_{14}^-	0.80988967	C_{14}^+	0.1777	35
S_{15}^+	3.7504	S_{15}^-	0.843848913	C_{15}^+	0.1837	26
S_{16}^+	3.4438	S_{16}^-	0.864084582	C_{16}^+	0.2006	7
S_{17}^+	3.6491	S_{17}^-	0.860568739	C_{17}^+	0.1908	15
S_{18}^+	3.8098	S_{18}^-	0.736011881	C_{18}^+	0.1619	57
S_{19}^+	3.7986	S_{19}^-	0.622980746	C_{19}^+	0.1409	69
S_{20}^+	3.6221	S_{20}^-	0.830325288	C_{20}^+	0.1865	19
S_{21}^+	3.7050	S_{21}^-	0.748880123	C_{21}^+	0.1681	49
S_{22}^+	3.6834	S_{22}^-	0.886068711	C_{22}^+	0.1939	12
S_{23}^+	3.6915	S_{23}^-	0.734692996	C_{23}^+	0.1660	51
S_{24}^+	3.7789	S_{24}^-	0.554126911	C_{24}^+	0.1279	72
S_{25}^+	3.5934	S_{25}^-	0.432576274	C_{25}^+	0.1074	79
S_{26}^+	3.5363	S_{26}^-	0.880179865	C_{26}^+	0.1993	8
S_{27}^+	3.5983	S_{27}^-	0.870528095	C_{27}^+	0.1948	10
S_{28}^+	3.7851	S_{28}^-	0.502301433	C_{28}^+	0.1172	76

S_i^+		S_i^-		C_i^+		Ranking
S_{29}^+	3.8091	S_{29}^-	0.726881714	C_{29}^+	0.1602	60
S_{30}^+	3.8652	S_{30}^-	0.794945557	C_{30}^+	0.1706	46
S_{31}^+	3.6924	S_{31}^-	0.779569306	C_{31}^+	0.1743	42
S_{32}^+	3.6121	S_{32}^-	0.861265962	C_{32}^+	0.1925	13
S_{33}^+	3.6023	S_{33}^-	0.727680922	C_{33}^+	0.1681	50
S_{34}^+	0.0661	S_{34}^-	3.970763543	C_{34}^+	0.9836	1
S_{35}^+	2.9394	S_{35}^-	1.238994576	C_{35}^+	0.2965	3
S_{36}^+	3.7877	S_{36}^-	0.742625777	C_{36}^+	0.1639	54
S_{37}^+	3.7740	S_{37}^-	0.542075117	C_{37}^+	0.1256	74
S_{38}^+	3.4816	S_{38}^-	0.690302287	C_{38}^+	0.1655	53
S_{39}^+	3.7572	S_{39}^-	0.881329617	C_{39}^+	0.1900	16
S_{40}^+	3.8020	S_{40}^-	0.856064109	C_{40}^+	0.1838	25
S_{41}^+	3.4829	S_{41}^-	0.92540861	C_{41}^+	0.2099	6
S_{42}^+	3.2976	S_{42}^-	0.929791689	C_{42}^+	0.2199	4
S_{43}^+	3.6631	S_{43}^-	0.837582937	C_{43}^+	0.1861	20
S_{44}^+	3.7023	S_{44}^-	0.57389607	C_{44}^+	0.1342	70
S_{45}^+	3.6295	S_{45}^-	0.81606152	C_{45}^+	0.1836	27
S_{46}^+	3.7054	S_{46}^-	0.640932268	C_{46}^+	0.1475	66
S_{47}^+	3.8022	S_{47}^-	0.841640363	C_{47}^+	0.1812	30
S_{48}^+	3.6116	S_{48}^-	0.870634251	C_{48}^+	0.1942	11
S_{49}^+	3.8470	S_{49}^-	0.763323272	C_{49}^+	0.1656	52
S_{50}^+	3.7700	S_{50}^-	0.795695408	C_{50}^+	0.1743	43
S_{51}^+	3.7692	S_{51}^-	0.81460204	C_{51}^+	0.1777	36
S_{52}^+	3.7904	S_{52}^-	0.722634489	C_{52}^+	0.1601	61
S_{53}^+	3.8508	S_{53}^-	0.438144921	C_{53}^+	0.1022	81
S_{54}^+	3.5675	S_{54}^-	0.871953422	C_{54}^+	0.1964	9
S_{55}^+	3.6108	S_{55}^-	0.737422362	C_{55}^+	0.1696	48
S_{56}^+	3.8171	S_{56}^-	0.782204183	C_{56}^+	0.1701	47

S_i^+		S_i^-		C_i^+		Ranking
S_{57}^+	3.8380	S_{57}^-	0.70984373	C_{57}^+	0.1561	63
S_{58}^+	3.6713	S_{58}^-	0.471527727	C_{58}^+	0.1138	77
S_{59}^+	3.7115	S_{59}^-	0.884862671	C_{59}^+	0.1925	14
S_{60}^+	3.7474	S_{60}^-	0.683525971	C_{60}^+	0.1543	65
S_{61}^+	3.7368	S_{61}^-	0.439338269	C_{61}^+	0.1052	80
S_{62}^+	3.8703	S_{62}^-	0.592296331	C_{62}^+	0.1327	71
S_{63}^+	3.7274	S_{63}^-	0.803129826	C_{63}^+	0.1773	37
S_{64}^+	3.7606	S_{64}^-	0.873126685	C_{64}^+	0.1884	17
S_{65}^+	3.7434	S_{65}^-	0.6168646	C_{65}^+	0.1415	68
S_{66}^+	3.7874	S_{66}^-	0.731663649	C_{66}^+	0.1619	58
S_{67}^+	3.7476	S_{67}^-	0.686729209	C_{67}^+	0.1549	64
S_{68}^+	3.7841	S_{68}^-	0.814665469	C_{68}^+	0.1771	38
S_{69}^+	3.8364	S_{69}^-	0.819184002	C_{69}^+	0.1760	40
S_{70}^+	3.8084	S_{70}^-	0.795363458	C_{70}^+	0.1728	44
S_{71}^+	3.7449	S_{71}^-	0.841418374	C_{71}^+	0.1835	28
S_{72}^+	3.8237	S_{72}^-	0.848778783	C_{72}^+	0.1817	29
S_{73}^+	3.8541	S_{73}^-	0.84604845	C_{73}^+	0.1800	32
S_{74}^+	3.8174	S_{74}^-	0.733538965	C_{74}^+	0.1612	59
S_{75}^+	3.8627	S_{75}^-	0.851067344	C_{75}^+	0.1806	31
S_{76}^+	3.8457	S_{76}^-	0.826435107	C_{76}^+	0.1769	39
S_{77}^+	3.8249	S_{77}^-	0.864002749	C_{77}^+	0.1843	24
S_{78}^+	3.7132	S_{78}^-	0.72628018	C_{78}^+	0.1636	55
S_{79}^+	3.8554	S_{79}^-	0.887659668	C_{79}^+	0.1871	18
S_{80}^+	3.8243	S_{80}^-	0.831483012	C_{80}^+	0.1786	34
S_{81}^+	3.7668	S_{81}^-	0.823842239	C_{81}^+	0.1795	33

APPENDIX 12-Table 12, shows the set of each license plate code in the k-means algorithm. The table shows all the data for 4.22.

	K1	K2	K3	K4	K5	Cluster
1	525	13844	0.0228	9114	52606	6
2	608	7337	0.0259	2420	18793	4
3	248	14016	0.0302	4557	38272	4
4	404	11099	0.0137	2793	12378	1
5	384	5628	0.032	1888	14305	4
6	652	25632	0.0191	25387	311562	7
7	229	20177	0.0363	12569	85590	2
8	875	7393	0.0403	2099	10569	5
9	239	8116	0.0384	5451	49026	2
10	201	14583	0.0377	6851	45353	2
11	76	4179	0.0271	1759	16036	4
12	1154	8004	0.0169	1849	15650	6
13	924	8294	0.02	1916	9366	6
14	187	8313	0.0275	2232	31815	4
15	110	7175	0.0454	2085	31438	2
16	362	10813	0.0258	10900	74631	4
17	96	9817	0.0422	4710	46514	2
18	371	7542	0.0223	1803	17674	1
19	624	12428	0.0318	3107	16589	4
20	179	12134	0.036	5672	49667	2
21	317	15168	0.0129	5591	28947	1
22	43	6145	0.0398	4017	40296	2
23	412	9383	0.027	4000	39412	4
24	838	11815	0.0245	3220	23179	6
25	1451	25006	0.0217	6827	67357	7
26	107	13960	0.0213	6595	68301	1
27	148	6803	0.0186	6305	52747	1
28	1100	7025	0.0324	2828	26120	5

	K1	K2	K3	K4	K5	Cluster
29	408	6668	0.025	1544	19184	4
30	212	7095	0.0154	1741	2701	1
31	338	5524	0.027	4388	36895	4
32	139	8946	0.0305	2580	66295	4
33	472	16010	0.0278	7689	47722	6
34	105	5461	0.0166	52762	795738	3
35	258	11891	0.0283	19187	171826	4
36	329	10193	0.0202	2768	19142	1
37	855	13064	0.0358	2731	26978	5
38	781	16970	0.0214	9427	74637	6
39	19	6459	0.0373	3594	22687	2
40	66	6589	0.0294	1860	18680	4
41	158	3397	0.0206	7889	76073	1
42	247	40838	0.0256	10254	121549	7
43	127	11634	0.0283	3276	49511	4
44	838	12259	0.0254	4449	38059	6
45	207	13339	0.0354	6281	45220	2
46	606	14520	0.0221	4548	34925	6
47	84	8780	0.0163	3159	12908	1
48	105	12654	0.0432	8006	42336	2
49	277	8650	0.0182	1358	9534	1
50	250	5485	0.0381	2200	25895	2
51	178	7234	0.0312	2532	24500	4
52	442	5861	0.0314	3231	16634	4
53	1429	3835	0.032	2021	17213	5
54	190	4824	0.0304	4468	69184	4
55	485	9725	0.0296	6316	50866	4
56	268	5718	0.0143	1706	15727	1

	K1	K2	K3	K4	K5	Cluster
57	462	5718	0.034	1435	12233	4
58	1011	28164	0.0236	5570	45726	7
59	44	6190	0.0296	5471	26500	4
60	509	10042	0.0278	3097	29250	4
61	1900	4628	0.0336	4022	48782	5
62	761	7582	0.0293	1357	6240	4
63	125	19242	0.0184	4908	26004	1
64	46	5556	0.0379	2150	28319	2
65	582	20921	0.0156	4498	25747	6
66	320	13690	0.0325	2657	19969	4
67	602	3342	0.0273	2182	33718	4
68	168	7659	0.029	2478	20790	4
69	191	3746	0.0257	1138	12936	4
70	200	8678	0.0287	1859	17292	4
71	146	4791	0.0264	1931	33589	4
72	105	4477	0.0109	1942	12525	1
73	80	7078	0.0098	2071	3972	1
74	452	2330	0.0319	1303	18180	4
75	89	4934	0.0271	1196	5562	4
76	171	3664	0.0185	1240	9950	1
77	111	798	0.031	1530	14020	4
78	501	4142	0.0323	1638	44824	4
79	36	1412	0.0299	768	9362	4
80	166	3320	0.0267	2003	12134	4
81	214	2492	0.0308	1865	28142	4

APPENDIX 13-Table 13, shows the set of each license plate code in the k-means algorithm. The table shows all the data for 4.32.

S_i^+		S_i^-		C_i^+		Ranking
S_1^+	1.2358	S_1^-	1.04251466	C_1^+	0.4576	62
S_2^+	1.3184	S_2^-	1.073761272	C_2^+	0.4489	64
S_3^+	1.2506	S_3^-	1.191644598	C_3^+	0.4879	44
S_4^+	1.3239	S_4^-	1.119168401	C_4^+	0.4581	61
S_5^+	1.2849	S_5^-	1.213106228	C_5^+	0.4856	46
S_6^+	1.0111	S_6^-	1.008042115	C_6^+	0.4992	39
S_7^+	1.1583	S_7^-	1.179634991	C_7^+	0.5046	33
S_8^+	1.3720	S_8^-	0.986929509	C_8^+	0.4184	69
S_9^+	1.2032	S_9^-	1.273573761	C_9^+	0.5142	21
S_{10}^+	1.2137	S_{10}^-	1.229518746	C_{10}^+	0.5032	36
S_{11}^+	1.2687	S_{11}^-	1.37846205	C_{11}^+	0.5207	14
S_{12}^+	1.4753	S_{12}^-	0.822435761	C_{12}^+	0.3579	77
S_{13}^+	1.4107	S_{13}^-	0.91054327	C_{13}^+	0.3923	75
S_{14}^+	1.2606	S_{14}^-	1.276186426	C_{14}^+	0.5031	37
S_{15}^+	1.2441	S_{15}^-	1.363803381	C_{15}^+	0.5230	13
S_{16}^+	1.1593	S_{16}^-	1.16918981	C_{16}^+	0.5021	38
S_{17}^+	1.2096	S_{17}^-	1.338592874	C_{17}^+	0.5253	11
S_{18}^+	1.2985	S_{18}^-	1.182830233	C_{18}^+	0.4767	52
S_{19}^+	1.3236	S_{19}^-	1.013576621	C_{19}^+	0.4337	66
S_{20}^+	1.2112	S_{20}^-	1.259283407	C_{20}^+	0.5097	24
S_{21}^+	1.2912	S_{21}^-	1.126280648	C_{21}^+	0.4659	58
S_{22}^+	1.2134	S_{22}^-	1.397306613	C_{22}^+	0.5352	4
S_{23}^+	1.2586	S_{23}^-	1.14819893	C_{23}^+	0.4771	51
S_{24}^+	1.3685	S_{24}^-	0.905406927	C_{24}^+	0.3982	74
S_{25}^+	1.5603	S_{25}^-	0.462690103	C_{25}^+	0.2287	81
S_{26}^+	1.2103	S_{26}^-	1.262396817	C_{26}^+	0.5105	23
S_{27}^+	1.2101	S_{27}^-	1.307914414	C_{27}^+	0.5194	15
S_{28}^+	1.4181	S_{28}^-	0.885015472	C_{28}^+	0.3843	76
S_{29}^+	1.2978	S_{29}^-	1.177816662	C_{29}^+	0.4758	53
S_{30}^+	1.3120	S_{30}^-	1.264846191	C_{30}^+	0.4909	42
S_{31}^+	1.2399	S_{31}^-	1.231074905	C_{31}^+	0.4982	40
S_{32}^+	1.2224	S_{32}^-	1.301260538	C_{32}^+	0.5156	17
S_{33}^+	1.2479	S_{33}^-	1.052078368	C_{33}^+	0.4574	63
S_{34}^+	0.3061	S_{34}^-	1.850104833	C_{34}^+	0.8580	1
S_{35}^+	0.9825	S_{35}^-	1.255174369	C_{35}^+	0.5609	2
S_{36}^+	1.2938	S_{36}^-	1.172684228	C_{36}^+	0.4755	55
S_{37}^+	1.3663	S_{37}^-	0.90602726	C_{37}^+	0.3987	73
S_{38}^+	1.2828	S_{38}^-	0.878264402	C_{38}^+	0.4064	70
S_{39}^+	1.2356	S_{39}^-	1.400815758	C_{39}^+	0.5313	5
S_{40}^+	1.2657	S_{40}^-	1.360637948	C_{40}^+	0.5181	16
S_{41}^+	1.1641	S_{41}^-	1.346265751	C_{41}^+	0.5363	3
S_{42}^+	1.3673	S_{42}^-	1.068521048	C_{42}^+	0.4387	65
S_{43}^+	1.2405	S_{43}^-	1.276967492	C_{43}^+	0.5072	29
S_{44}^+	1.3448	S_{44}^-	0.902729425	C_{44}^+	0.4017	72
S_{45}^+	1.2160	S_{45}^-	1.232029218	C_{45}^+	0.5033	35
S_{46}^+	1.3125	S_{46}^-	0.984004902	C_{46}^+	0.4285	67
S_{47}^+	1.2853	S_{47}^-	1.316015979	C_{47}^+	0.5059	31
S_{48}^+	1.1898	S_{48}^-	1.313166521	C_{48}^+	0.5246	12
S_{49}^+	1.3119	S_{49}^-	1.214942235	C_{49}^+	0.4808	48
S_{50}^+	1.2538	S_{50}^-	1.293659409	C_{50}^+	0.5078	27
S_{51}^+	1.2562	S_{51}^-	1.297957869	C_{51}^+	0.5082	26
S_{52}^+	1.2768	S_{52}^-	1.181447492	C_{52}^+	0.4806	49
S_{53}^+	1.5372	S_{53}^-	0.84315097	C_{53}^+	0.3542	78
S_{54}^+	1.1932	S_{54}^-	1.320657607	C_{54}^+	0.5253	10
S_{55}^+	1.2325	S_{55}^-	1.11465801	C_{55}^+	0.4749	56
S_{56}^+	1.3048	S_{56}^-	1.251304678	C_{56}^+	0.4895	43
S_{57}^+	1.2993	S_{57}^-	1.177864222	C_{57}^+	0.4755	54
S_{58}^+	1.4673	S_{58}^-	0.636601832	C_{58}^+	0.3026	80
S_{59}^+	1.2195	S_{59}^-	1.378961493	C_{59}^+	0.5307	6
S_{60}^+	1.2907	S_{60}^-	1.091791731	C_{60}^+	0.4583	60
S_{61}^+	1.6874	S_{61}^-	0.7822095	C_{61}^+	0.3167	79
S_{62}^+	1.3656	S_{62}^-	1.005482295	C_{62}^+	0.4241	68
S_{63}^+	1.2979	S_{63}^-	1.202223086	C_{63}^+	0.4809	47
S_{64}^+	1.2442	S_{64}^-	1.39682732	C_{64}^+	0.5289	7
S_{65}^+	1.3632	S_{65}^-	0.92535072	C_{65}^+	0.4043	71
S_{66}^+	1.2882	S_{66}^-	1.158243527	C_{66}^+	0.4734	57
S_{67}^+	1.2993	S_{67}^-	1.132933077	C_{67}^+	0.4658	59
S_{68}^+	1.2632	S_{68}^-	1.29510132	C_{68}^+	0.5062	30
S_{69}^+	1.2838	S_{69}^-	1.322546864	C_{69}^+	0.5074	28
S_{70}^+	1.2773	S_{70}^-	1.266679743	C_{70}^+	0.4979	41
S_{71}^+	1.2552	S_{71}^-	1.334928423	C_{71}^+	0.5154	18
S_{72}^+	1.3036	S_{72}^-	1.34924387	C_{72}^+	0.5086	25
S_{73}^+	1.3162	S_{73}^-	1.333880916	C_{73}^+	0.5033	34
S_{74}^+	1.2926	S_{74}^-	1.222280731	C_{74}^+	0.4860	45
S_{75}^+	1.2852	S_{75}^-	1.363142502	C_{75}^+	0.5147	20
S_{76}^+	1.2971	S_{76}^-	1.327098472	C_{76}^+	0.5057	32
S_{77}^+	1.2670	S_{77}^-	1.404966171	C_{77}^+	0.5258	9
S_{78}^+	1.2740	S_{78}^-	1.177334572	C_{78}^+	0.4803	50
S_{79}^+	1.2794	S_{79}^-	1.433972121	C_{79}^+	0.5285	8
S_{80}^+	1.2722	S_{80}^-	1.341580561	C_{80}^+	0.5133	22
S_{81}^+	1.2561	S_{81}^-	1.333328706	C_{81}^+	0.5149	19