Koc. J. Sci. Eng., 5(1): (2022) 84-96 https://doi.org/10.34088/kojose.890327

Kocaeli University

Kocaeli Journal of Science and Engineering

http://dergipark.org.tr/kojose

Evaluation of Seaway Passenger Transportation in Kocaeli Bay, By Using the Methods of Analytic Hierarchy Process and Analytic Network Process

Zafer AYDIN [1,*], Güler ALKAN [2]

[1] *Kocaeli Metropolitan Municipalıty, Kocaeli, 41040, Turkey,* ***ORCID:*** *0000-0002-8155-0674*
[2] *İskenderun Technical University, Hatay, 31200, Turkey,* ***ORCID:*** *0000-0001-6809-0784*

Article Info

Review paper

Received : *May 05, 2021*
Accepted : *March 08, 2022*

Keywords

AHP
ANP
Public Transport
Seaway Passenger Transport

Abstract

Municipalities are in charge of running and managing public transport activities. This study aims to identify the factors affecting seaway passenger transportation via scheduled high-speed sea buses, motorboats, and cityline from 11 points in Kocaeli Bay. To provide sea transportation service in Kocaeli at a sustainable cost, which is the legal obligation of Metropolitan Municipalities, framing the current transportation system as a whole in the light of these factors is another objective.
In today's rapidly changing world, the criteria may quickly change over time. Many primary and secondary criteria affect public transportation systems. Therefore, it would be appropriate to use multi-criteria decision-making methods while dealing with Public Transport systems. In addition to the Analytic Hierarchy Process (AHP) method, it would be appropriate to use the Analytic Network Process (ANP) method, which is a structure that examines the interaction between criteria and allows systematic revealing of all types of dependencies and feedback between factors and sub-factors affecting the decision-making process. In the study, the results obtained by AHP and ANP methods were compared and evaluated, in order to determine the optimal alternative for the seaway passenger transportation in Kocaeli Bay to be economical, sustainable and continuous.

1. Introduction

By considering Kocaeli Bay as a whole, this study is prepared to determine the most suitable alternative or option in order to make seaway passenger transportation in Kocaeli Bay at a sustainable cost carried out by Kocaeli Metropolitan Municipality from 12 different piers as a component of public transportation activities.

Kocaeli Bay is a natural port and the farthest point that can be reached by sea in the Marmara Region as the industrial center of Turkey, a country where energy pipelines, rail system, and Ro-Ro lines which are the integration point of Trans-European highways with the seaway and intersect as a transfer center for long-distance flights.

The seaway passenger transportation in Kocaeli Bay is carried out by the Seaway Transportation Directorate of Kocaeli Metropolitan Municipality. Urban public transport activities are among the main duties of the municipalities. The sea transportation directorate is an organization affiliated with the metropolitan municipality, and the metropolitan municipal council approves its budget. Damage arising from the seaway passenger transport activity is covered by the municipal budget. In this respect, there is no resource problem for seaway passenger transportation in Kocaeli Bay, but the fact that the income obtained is very low due to the fact that the resource spent for this activity is very high and the number of passengers is very low, it appears to be the biggest obstacle to the sustainable sea transport in Kocaeli Bay.

By examining the operations of the Seaway Transportation Directorate, it has been observed that the personnel structure is multifaceted and that it is subject to various regimes (permanent, contracted, subcontractor), resulting in ineffectiveness in personnel productivity. It is observed that there seem personnel subject to different working regimes, and the service produced is high in terms

* Corresponding Author: zfraydin61@gmail.com

of personnel costs. It has been determined that the professional competence and education level of the personnel of the Seaway Transportation Directorate is above the average and the average age is at the middle level. The Seaway Transportation Directorate has a mixed fleet structure and has four sea buses, three leased passenger motorboats and two city line ferries. The average age of the ships is above the economic life of 20 years, excluding leased passenger motorboats. The conditions and types of the ships are different from each other, which causes inefficiency in terms of management and operation.

There are 12 piers under the Seaway Transportation Directorate. Eight of these piers are open during summer and winter, and four of them are open only in summer. There is no integrity in the structures of the piers. All piers have separate technical features. The pier, which is suitable for berthing for a ship type, is not suitable for another ship type. This situation causes problems in berthing and departure maneuvers of ships and pier management. It has been determined that the number of piers is high on the Kocaeli Bay scale. There are four piers in the same district.

In Kocaeli Bay, except Kocaeli Metropolitan Municipality Directorate of Seaway Transportation, it has been determined that three maritime companies, namely Istanbul Sea Buses (İDO), İstanbullines A.Ş., Dentur Avrasya A.Ş., are operating in the field of passenger and vehicle transportation, and that there is no integration between these companies, and that each company operates independently.

Urban public transportation is a tool that is needed in every moment of our daily city life when traveling from point A to B, to go to work, school and any intercity transfer. Considering that the majority of people today live in cities, public transport is an integral part of city life. Intelligent transportation systems (electronic fare collection systems, smart stops, passenger information, etc.) are part of the public transportation system. Intelligent transportation systems play an important role in determining the urban public transportation fee policies and the implementation of these policies (single ticket, transfer, fare payment by distance, subscription). In the Seaway Transportation Directorate, money is collected according to the distance. A smart ticket system is used as a fare collection system, but transfers with other transport systems are not available. It is seen that the transfer is valid only between municipal vehicles. This situation is considered to be a factor in not achieving the desired increase in the number of passengers.

The only institution authorized to determine the local public transport ticket prices and fare policies is the Transport Coordination Center (UKOME), which is affiliated with the metropolitan municipalities. Since the decision-making mechanism of the Transportation Coordination Centers depends on the public, the increase in the ticket prices of the vehicles (metro, tram, sea bus, ferry, etc.) connected to the urban public transport modes is limited, and the management costs are determined in market conditions, this situation creates a serious problem for companies whose only item of income is ticket prices in terms of income-expenditure balance.

When the legal regulations on public transportation in the city are examined, there are basically three different passenger profiles (Adult, Student, 60 years and over). When Kocaeli Metropolitan Municipality's travel cards regulation is examined, it is stated that there are types of passengers transported free of charge in 14 different items (municipal officers, police, municipal employees, etc.), and, according to the Ministry of Family and Social Policies regulation, citizens aged 65 and over will benefit from public transportation free of charge. There is no government subsidy for passengers carried free of charge. The high number of passengers carried free of charge causes the income to be low and, this situation causes the number of resources to increase spent to perform the service.

The population is estimated to be 2.500.000 people in the 2025 projection of the Turkey Statistical Institution for Kocaeli province. With the impact of the 17 August 1999 earthquake, settlements tended to move away from the seashore and tended to be established on high mountain slopes. This trend continues. In addition, it is considered that the demand for sea transportation will not change much for the next ten years due to the lack of attraction centers between the opposite shores of the Kocaeli Bay that will increase urban population mobility. When planning transportation, the current and future population and zoning projections of the city should be taken into account.

2. Literature Review

In the literature, it is observed that there are many studies in various fields in which the solution of AHP and ANP methods with fuzzy numbers are applied. Evaluation of the contribution of IT departments to the organizational development and strategic goals of companies using fuzzy AHP and balanced scorecards (BSC) methods (Lee et al., 2008). The fuzzy AHP method has been used in the selection of the most suitable bridge construction method in bridge construction projects where many criteria are effective (Pan, 2008). In the selection of the most suitable hospital location, a solution was sought by the fuzzy logic AHP method (Vahidnia et al., 2009). The fuzzy AHP method was used in the selection of enterprise resource

planning in the textile company (Cebeci, 2009). To evaluate the performance of the production company, the fuzzy ANP method and the balanced objective cards methods were used (Yuksel and Dağdeviren, 2010). The fuzzy ANP method and TOPSIS methods were used together as a decision-making method in evaluating the education system (Chen and Chen, 2010). The fuzzy AHP method was used to evaluate the uncontrolled landfill area (Promentilla et al., 2008). There are also studies in the literature in which AHP and ANP methods are used together. In these studies, The role of production performance measurement systems in success was evaluated using AHP/ANP methods (Yang et al., 2009). AHP/ANP methods were applied as a decision-making method according to different conditions depending on time. (Saaty, 2007). Comparisons are done by showing the parallels between the AHP/ANP methods (Garuti & Spencer, 2007).

3. Materials and Methods

3.1. Multi-Criteria Decision-Making

Every person is constantly faced with the situation of making decisions both in his/her own life and in his/her business life. In their own lives, they decide on issues such as which products to meet their individual needs by purchasing, where they will spend their holidays, how to evaluate their savings, while they decide on issues such as organizational structure of institutions, marketing strategies, production planning, financing, and investments in their business lives. Multi-criteria decision problems are problems where a choice must be made between at least two criteria. Generally, all multi-criteria decision-making problems involve many criteria. For the most appropriate decision, the criteria must be determined very well. In the next step, the most suitable alternative should be determined for the solution of the problem. After that, the problem should be solved by making the necessary calculations and determining the most suitable alternative. In today's competitive environment, it is very important to make the right decisions for the success of the business. Therefore, to make the right decisions, decisions are made not only subjectively based on experience, but also based on objective and subjective criteria using quantitative and qualitative data as well as experience. For this, numerical methods have been developed to make the right decision. In today's world, due to the rapid development of time and events, the criteria that affect the problem can also change during the period of time the event continues. When handling the problem, variable events should also be considered. (Ozden, 2009).

Because the criteria are based on people's experiences and that people's experiences are different in multi-criteria problems, criteria in multi-criteria problems often conflict with each other. Therefore, there is usually no optimal solution for such problems. So, none of the alternative solutions is the best solution according to all the specified criteria. In addition, the effect (weight) of the criteria taken into consideration by the decision maker when choosing among the alternatives is not the same. These weights can often vary depending on the decision maker. (Ozden, 2009).

Multi-criteria decision-making methods used in the literature are mentioned below. The multi-criteria decision-making methods in Chene and Hwang's classification are; Dominance method, Maximin, Maximax, Conjunctive Method, Disconjunctive Method, Lexicographic Method, Semi Order Lexicographic Method, Elimination By Aspects- EBA Method, Simple Additive Weighting Method, Weighted Product Method, Distance from Target Method, AHP-Analytic Hierarchy Process, ELECTRE-Elimination and Choice Translating Reality, TOPSIS-Technique for Order Preference by Similarity to Ideal Solution, VIKOR -Vise Kriterjumska Optimizacija I Kompromisno Resenje, UTADIS- Utilities Additives Discriminantes, PROMETHEE- Preference Ranking Organization Method For Enrichment Evaluation and ANP-Analytic Network Process method. (Chen et al., 1992).

3.2. Multi-Criteria Decision-Making

Analytic Hierarchy Process is a structure with the objective function at the top, criteria and sub-criteria under this function, and various alternatives under the criteria. The Analytic Hierarchy Process was developed in 1971 by Thomas L Saaty. Saaty transforms AHP into a model in 1977, making it easier to solve decision-making problems. (Rencber, 2010). The main purpose of AHP is to contribute to the solution of multi-criteria decision-making problem. Analytic Hierarchy Process (AHP) is one of the multi-criteria decision-making methods. It is not a magical method (or model) that provides the correct answer. However, it is a process that helps decision-makers to find the “best” answer. (Formen and Sally, 2002).

AHP is a powerful and easy-to-understand method that allows groups and individuals to combine qualitative and quantitative factors in the decision-making process. (Saaty, 1996). The AHP method is used in decision-making problems where there are one or more decision makers and in environments with certainty or uncertainty where there are too many alternatives and criteria. It is an easy-to-use method allowing the decision-maker to

incorporate his/her intuition and instincts into the solution process and to act together by consensus on different ideas. (Dogan, 2004). One of the most important functions of AHP is being able to synthesize many factors in a single hierarchy. (Power, 2003).

The AHP method aims to ensure that this decision-making process is completed most efficiently by placing the related priorities on a scale for a given set of options, taking into account the intuitive judgments of decision-makers and the comparison consistency of the options in the decision-making process. This approach supports the decision maker's judgments based on his/her knowledge and experience. The strength of the AHP method is that it systematically organizes countable and uncountable factors and offers a simple and effective solution in the decision-making process by taking all factors into account. (Ozyurek et al., 2008)

AHP is a measurement theory based on binary comparison of alternatives according to a common criterion. AHP provides important assistance to the decision-maker in solving multi-criteria and multi-choice problems. AHP poses a problem with a hierarchical structure that consists of more than one level. In the Analytic Hierarchy Process, a hierarchical structure consisting of purpose, criteria, possible sub-criteria levels, and alternatives is used for each problem. (Saaty, 1990). It is a general method for complex, difficult to understand or unstructured problems. It is based on three basic principles, namely the establishment of hierarchies, determination of advantages, and logical and numerical consistency. (Guner and Yucel, 2007).

In AHP, the problem is structured hierarchically. Figure 1 shows a three-level hierarchical structure. There is a purpose at the top of the hierarchy, and the structure is completed with the criteria below the purpose and, alternatives at the bottom. (Felek et al., 2007).

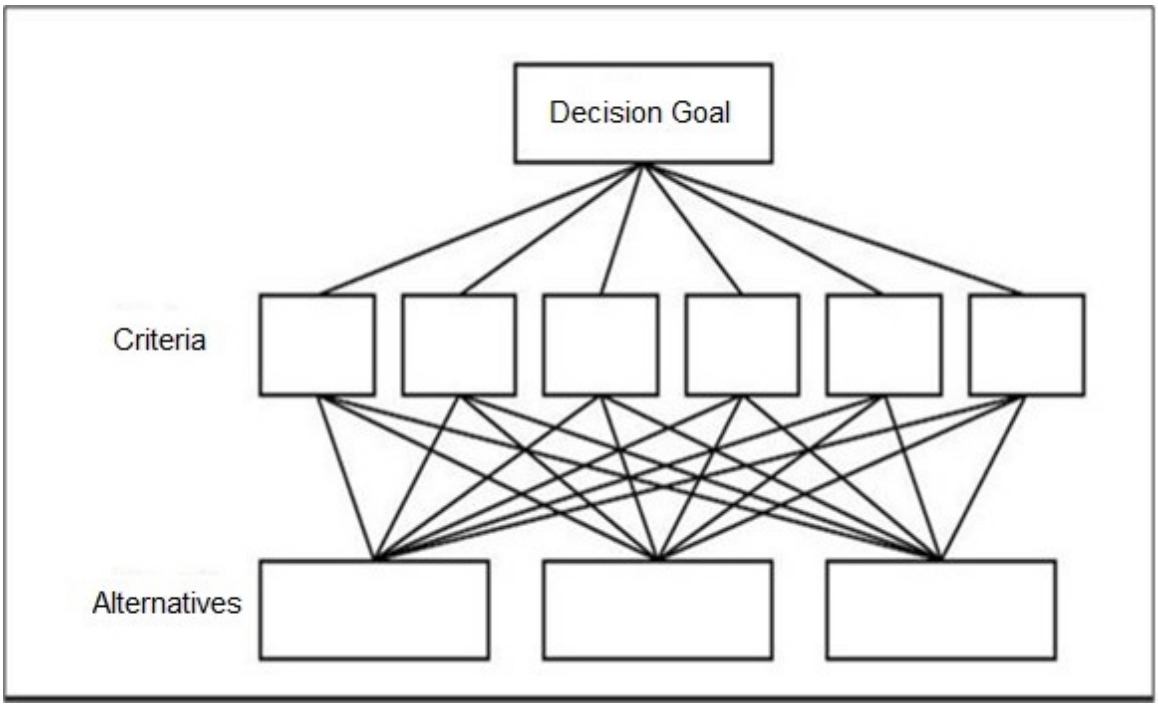

Figure 1. Three Level Analytic Hierarchy Model (Saaty and Vargas, 2001)

3.3. Analytic Network Process (ANP)

Analytic Network Process is a structure that examines the interaction between criteria. Making decisions quickly and effectively has been one of the most important goals of businesses in today's competitive environment. For businesses to quickly adapt to rapidly changing environmental conditions and take effective decisions in parallel with this change is possible by using scientific methods that can evaluate many qualitative and quantitative factors together in the decision process. Analytic Network Process (ANP) is a method that can be used in this process. (Dagdeviren et al., 2005) The AHP method is used in environments with certainty or uncertainty where one or more decision makers are present. Likewise, it is used in decision problems where there are too many alternatives and criteria. It provides the opportunity to make decisions individually and as a group, to include the intuition and instincts of the decision maker in the solution process, and to act together by reconciling different ideas (Dogan, 2004).

ANP is a new multi-purpose decision-making method which is an extension of the Analytic Hierarchy Process (AHP) method. ANP is the first technique that allows systematically revealing all kinds of dependencies and feedback among factors and sub-factors affecting the decision-making process. (Bayazıt, 2002).

Analytic Network Process is a structure established to determine dependencies between criteria rather than assumptions in decision making. (Yang et al., 2009).

A decision problem in ANP consists of clusters, factors, and connections between them. A Cluster is formed by the combination of suitable factors in a network. ANP is based on feedback and dependency within each cluster. Thus, ANP enables easy modeling of complex decision problems that cannot be modeled hierarchically. (Alptekin, 2010).

ANP consists of two subsections. The first section is the control hierarchy formed by the factors that control the interactions in the model. The second is subgroups formed by interactions between factors and sets of factors. In ANP, the decision-making problem is modeled as a network and at this stage, external dependencies between factor groups, feedback, and internal dependencies within the same factor group are taken into consideration. With this structure, ANP enables more effective decisions to be made. Figure 2 shows a sample network structure presenting the relationships between factor clusters (C) consisting of different numbers of factors.

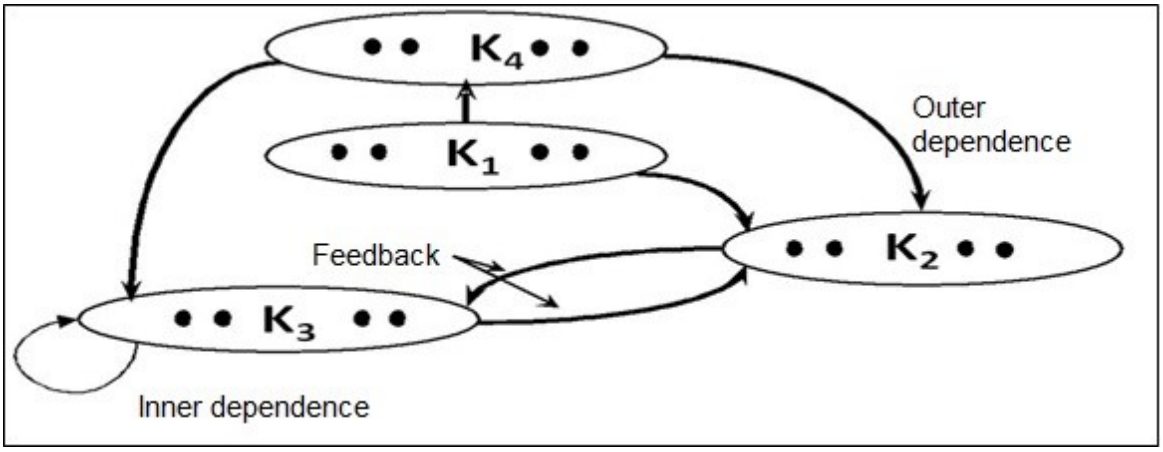

Figure 2. Example of a Network Model (Saaty, 1999)

The basic concept in ANP is the "effect". The fact that one component affects another component in a network structure indicates that there is an external dependency, the presence of two-way arrows between two components indicates that there is interdependence or feedback between those two components. If the elements in a component affect each other, it is said that there is an internal dependency in that component, and this situation is indicated by an arrow exported from the component and entering the same component. (Bayazıt and Yuzugullu, 2013). The difference between a hierarchical structure and a network structure is shown in Figure 3.

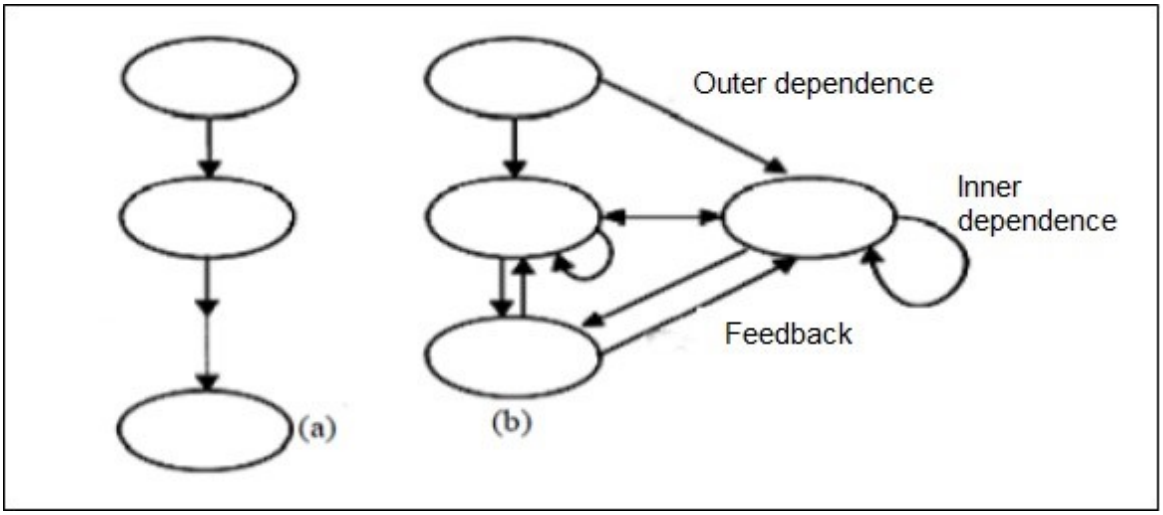

Figure 3. A Hierarchy and its Network Structure (Karsak et al., 2002).

4. Results

4.1. Description of the criteria and sub-criteria

It has been determined that 8 main criteria are evaluated as affecting maritime passenger means of transport in Kocaeli Bay, and additional 42 sub-criteria under these 8 main criteria have been identified. The determined criteria were evaluated together with the experts. Based on the expert opinions, the criteria were weighted in and the obtained data were finalized using the program called super decisions.

It is aimed to determine the factors affecting seaway passenger transportation in Kocaeli Bay and to make seaway passenger transportation in an economical and sustainable manner in line with these factors. For this, thirty-nine sub-criteria were determined under eight main criteria affecting the Kocaeli Bay seaway passenger means of transport. These criteria determined for the data were demonstrated practically using the Analytic Hierarchy Process and Analytic Network process methods, using the Super Decisions program. After examining these criteria and sub-criteria in detail, three different alternatives were determined for the most suitable alternative. These alternatives are:

Alternative 1 (X): Scheduled passenger transportation provided by the municipality, as an alternative to the service currently implemented by the Kocaeli Bay Seaway Transportation Directorate using the sea bus, passenger motorboat, and ferry,

Alternative 2 (Y): Scheduled passenger transportation service where this service is provided by the municipality using only passenger motorboats as an alternative to the mixed fleet of the passenger transportation service in Kocaeli Bay,

Alternative 3 (Z): Scheduled passenger transportation in Kocaeli Bay carried out using only passenger motorboats instead of a mixed fleet, is designated and named as an alternative to scheduled means of passenger transport where this service is provided by the private sector.

4.1.1. Operating Costs

Operating costs are among the most important cost items faced by businesses operating in the field of passenger transportation. Effectively managing the factors affecting operating costs leads to a reduction in operating costs, which makes the passenger means of transport service offered more economical.

Operating costs affecting Maritime Passenger means of transport in Kocaeli Bay consist of eight sub-criteria. These consist of personnel cost, fuel cost, maintenance and repair costs, class and certificate expenses, shipyard expenses, insurance costs, tax, drawing, and line permit costs, and SCT-free fuel costs. While personnel, insurance, tax, class, and certificate expenses are among the expenses that constitute the operating costs, fuel costs, maintenance, and repair costs, shipyard costs are variable costs that vary throughout the year and are determined according to market conditions.

4.1.2. Specifications of the Passenger Ships

The different types of passenger ships used in a seaway means of transport operation are an important factor affecting transportation costs. The different types of ships cause the type of the main engine used in passenger ships to be different, and the difference in the main engine type of passenger ships causes the speed of the ship to be high or low, the fuel consumption at the same distance to be different and the qualification of the personnel working on the ships to change. In the same type of passenger ships, the difference in age, machine condition, and sheet condition affects the number of resources spent on the operation of the ships.

Passenger ships consist of six sub-criteria such as the criteria of technical characteristics, different ship types, different ship's technical conditions, use of the high-speed main engine, ship passenger capacity incompatible with passenger frequency, and the average age of ships.

4.1.3. Passenger Schedule

The schedule includes the departure and arrival times, piers, and voyage times of passenger ships. The schedules are generally determined twice a year, taking into account the summer and winter times. The weekday schedules are determined according to working hours, and the number of voyages on weekdays is higher than the number of trips on weekends. The passenger schedule consists of six sub-criteria such as voyage times, voyage intervals, passenger safety, scheduled voyage, voyage cancellations, and seasonal effect.

4.1.4. Tariff System

In all modes of urban public transportation (bus, minibus, ferry, etc.), the right to determine the ticket price tariff belongs to the Municipalities. The Metropolitan Municipalities determine their tariffs through transportation coordination centers. While there are three

passenger types who pay (full, student, discounted) in urban public transportation, fourteen different passenger types do not pay any fees. There are no subsidies for passengers transported free of charge.

The wage system criterion consists of four sub-criteria such as fare collection system, ticket prices, transfer, and integration with other transportation systems.

4.1.5. Statutory Regulations

Statutory regulations determine how passenger means of transport (private transport, public transport, etc.) will be carried out, within which they will be performed, the rules and prohibitions, in short, they determine the legal framework of passenger transport. The implementation of every new rule introduced incurs a cost. Therefore, statutory responsibilities and obligations affect the unit transportation cost. The statutory regulation criterion consists of sub-criteria such as free transport passengers, UKOME effect, line permit, metropolitan municipality law, and financial structure.

4.1.6. Transportation Structure

Each transportation system has its unique features. When examining a transportation system, besides the features of the system, factors affecting other transportation systems should also be examined. When dealing with seaway transportation in Kocaeli Bay, besides the structure of seaway transportation, other factors affecting seaway transportation in Kocaeli Bay should be taken into consideration. These criteria consist of four sub-criteria such as the number of piers, the different types of pier structures, the presence of other seaway transport companies operating in Kocaeli Bay, and the bay passage bridge.

4.1.7. Seaway Transportation Directorate

The Seaway Transportation Directorate is a directorate that has been carrying passengers at twelve different piers since 1998 in Kocaeli Bay affiliated with Kocaeli Metropolitan Municipality Public Transportation Department. The Seaway Transportation Directorate criterion consists of sub-criteria such as the difference of personnel regime, administrative structure, and age of the personnel, their professional and educational status, and previous planning studies.

4.1.8. Spatial Distribution of Kocaeli Bay

Each city has a specific spatial distribution. The topographic features of a city are one of the most important aspects affecting the transportation infrastructure. When examining the transportation structures of cities, there is a necessity to consider the spatial distribution of that city. Therefore, since the spatial distribution of each city is different, the solution for one city may not be the same for another. The Kocaeli Bay Spatial Distribution criterion consists of sub-criteria such as the settlement characteristic of Kocaeli, restricted areas, anchorage areas, and Kocaeli Bay traffic separation scheme, the absence of attraction centers between the opposite coasts, and the population structure of Kocaeli province.

4.2. Analytic Hierarchy Process Analysis and Implementation

4.2.1. Analytic Hierarchy Process Super Decision Computer Program Application

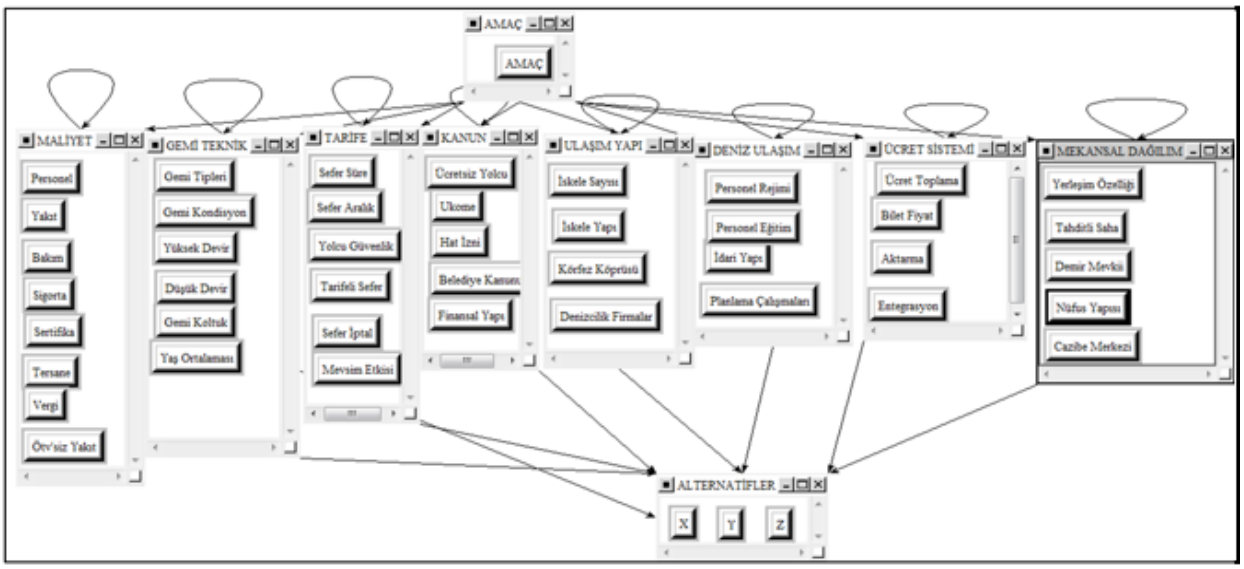

Figure 4: Analytic Hierarchy Process Purpose Function Display

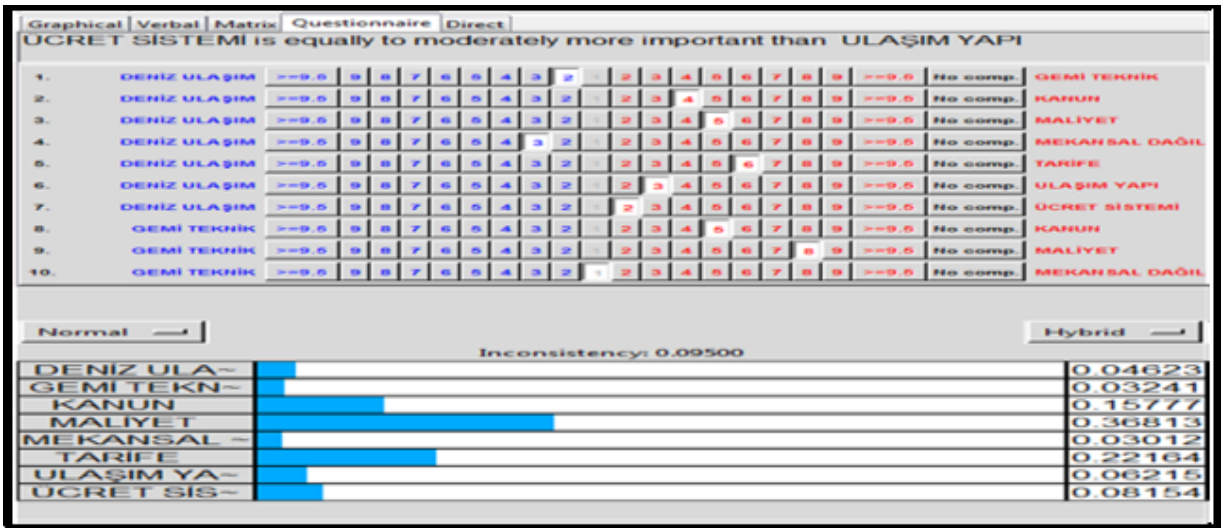

Figure 5: Analytic Hierarchy Process Key Criterion Paired Comparisons.

Analytic Hierarchy Process paired comparisons revealed that the main criterion Cost was 36%, Tariff 22%, Law 15%, Fee System 8%, Transport Structure 6%, Seaway Transportation 4% and Ship Technical key criterion 3%. Since the basis of the seaway passenger transportation service is determined by the announced tariff, it is of secondary importance in paired comparisons. As seen in paired comparisons, the main criterion of the cost came out of first importance. The tariff main criterion has emerged at the second level of importance. In this respect, the service planned and the tariff to be implemented should be determined well. When the tariff is announced, the announced tariff must be executed, regardless of whether there is a passenger or not.

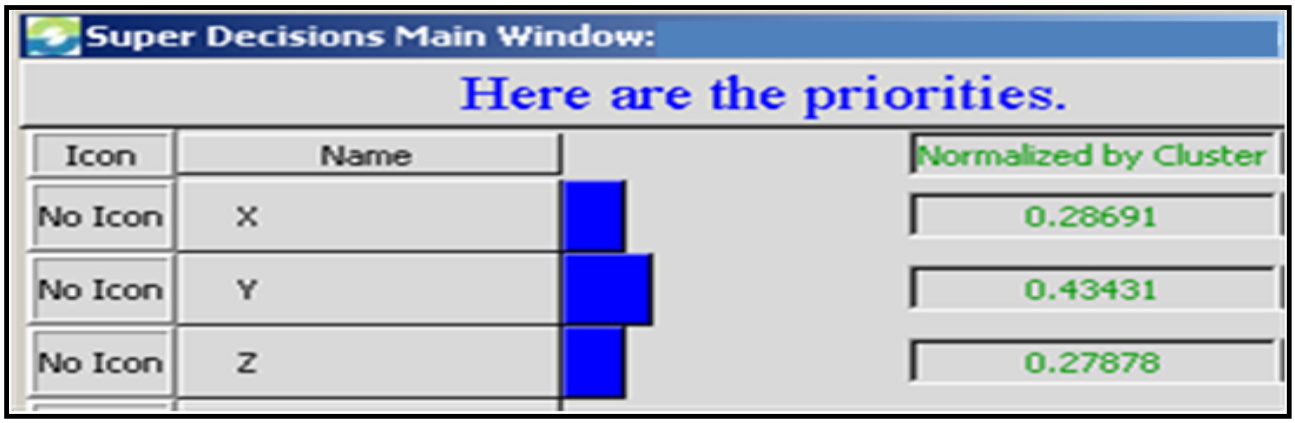

Figure 6: Analytic Hierarchy Process Purpose Function Displ

In the calculations made, it was determined that the best alternative among the three alternatives was the "Y" alternative. This alternative is considered appropriate to use the seaway passenger transportation in Kocaeli Bay not in the form of sea bus, passenger ferry, and passenger motorboat mixed fleet, but by leasing low-speed passenger engines. The most important reason for not choosing the "Z" alternative is that the nature of the Kocaeli Bay, the voyages are long and the number of miles is high, the frequency of passengers is low, the income is low and the number of trips is high, all are making it difficult to provide the current service by the private sector. Since the "X" alternative has a mixed fleet structure within itself, it is considered that its implementation is not suitable for the efficient use of resources.

4.3. Analytic Network Process Analysis and Implementation

4.3.1. Analytic Network Process Super Decision Computer Program Application

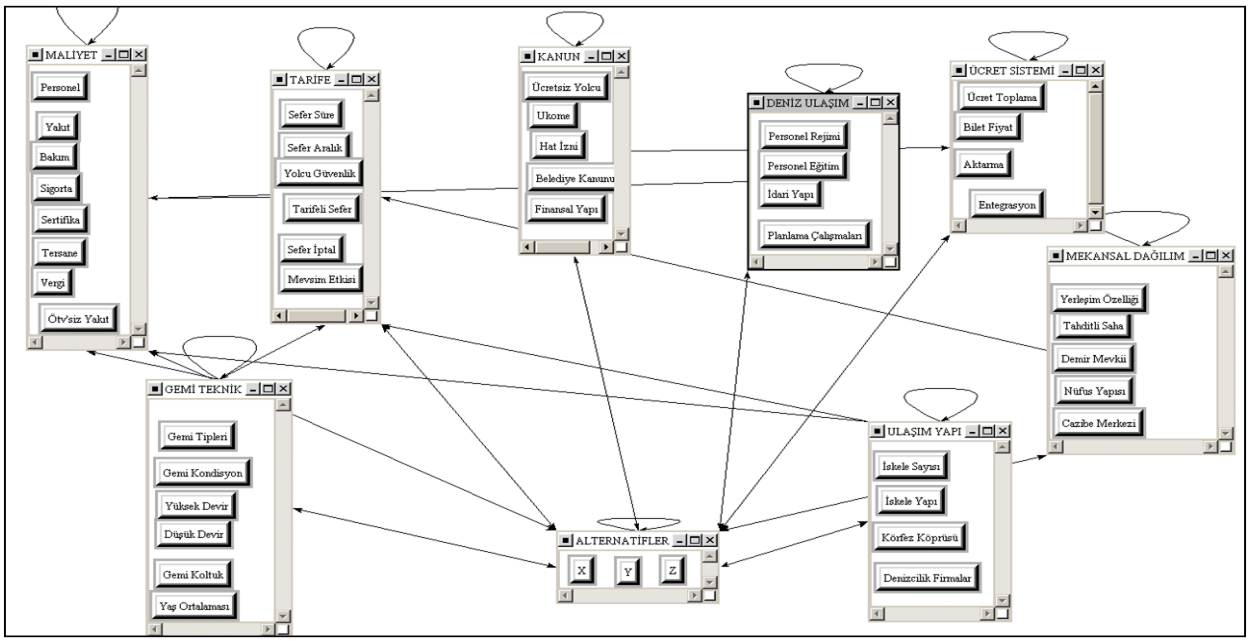

Figure 7: Analytic Network Process Function Display.

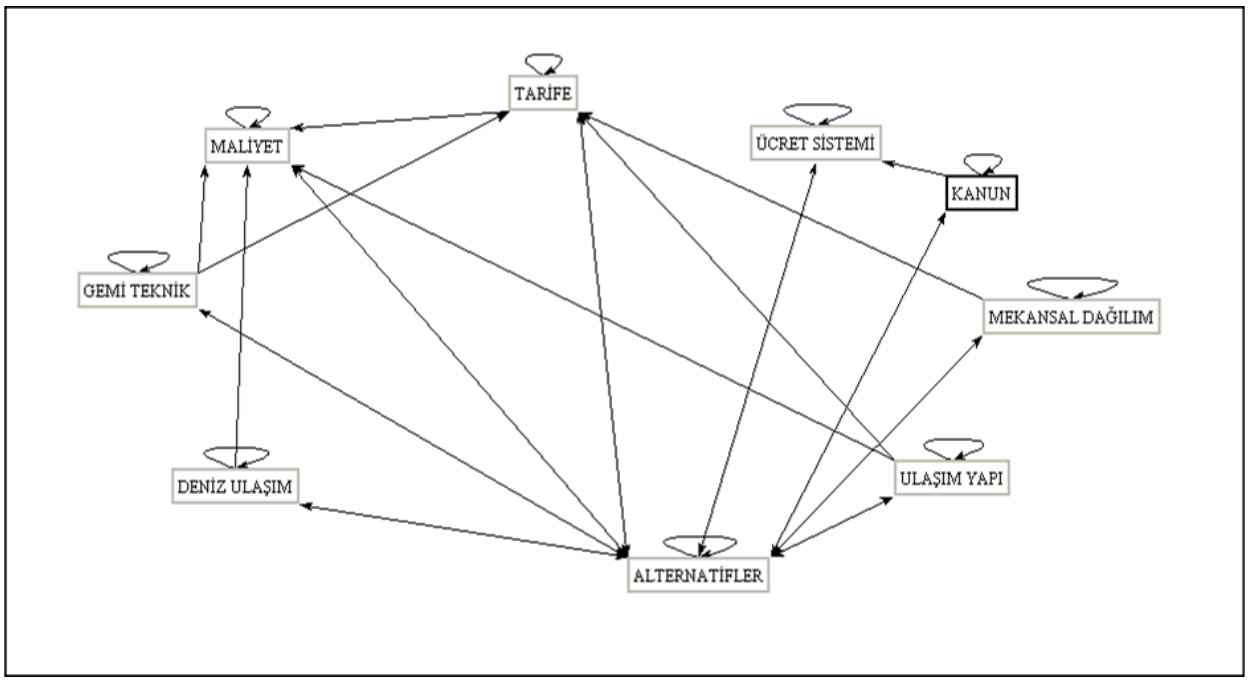

Figure 8: Analytic Network Process Network Function Display.

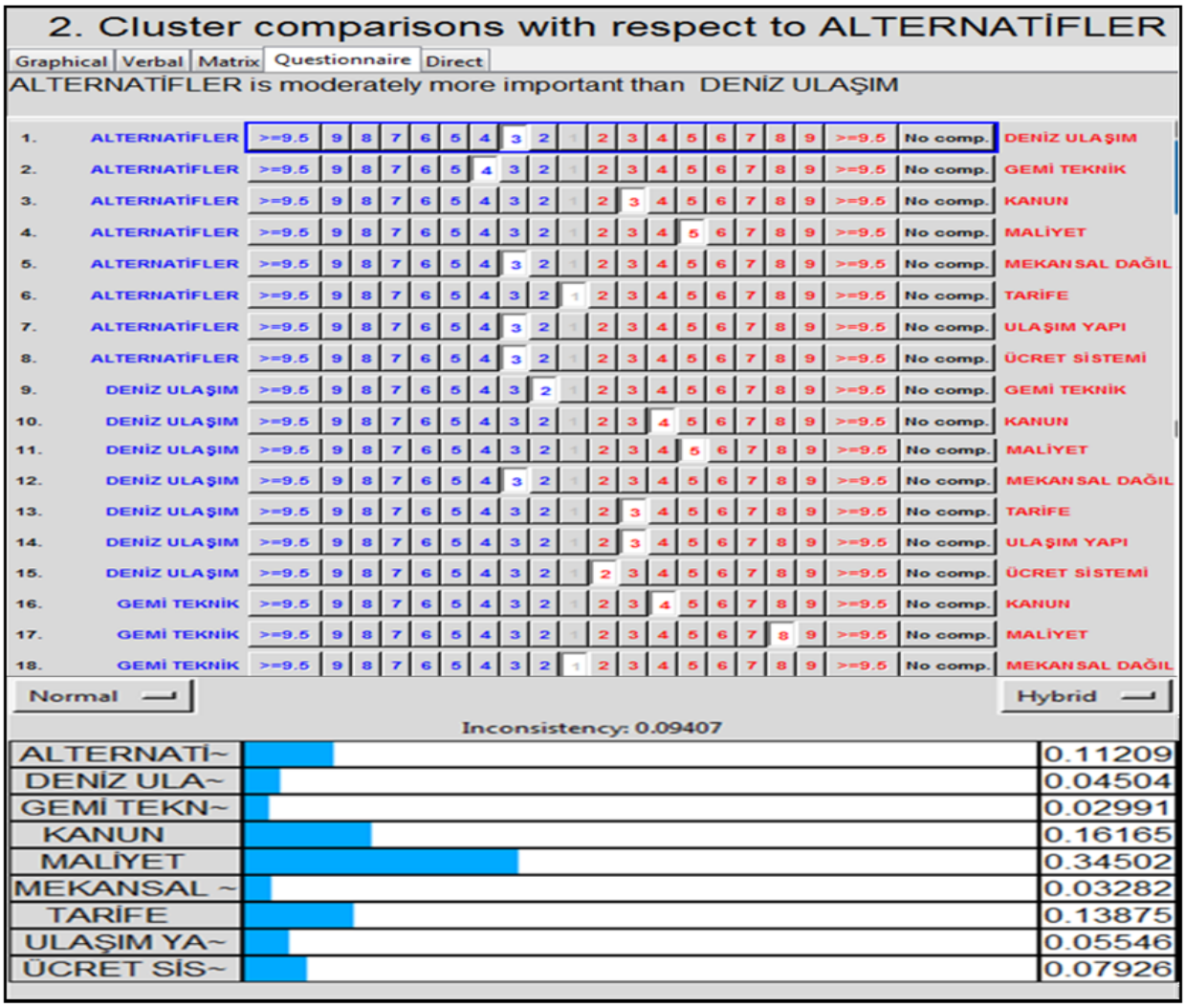

Figure 9: Analytic Network Process Alternatives and Criteria Comparisons.

When the paired comparisons of alternatives and main criteria of the Analytic Network Process are calculated, it is seen that the main criterion of Cost is 38%, the main criterion of the Law is 16%, the main criterion of the Tariff is 13%, the alternatives is 11%, the main criterion of the Wage System is 7%, the main criterion of the Transport Structure is 5%, the criterion is 4%, the Spatial Distribution main criterion is 3% and that the Ship Tech main criterion is 2% effective.

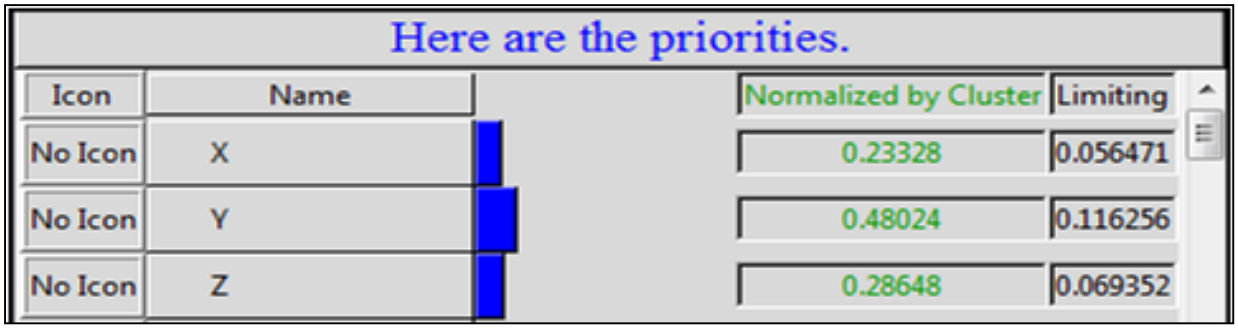

Figure 10: Analytic Network Process Display of Alternatives.

When the alternatives of the Analytic Network Process are evaluated, it is seen that the "Y" alternative is 48%, "Z" alternative is 28% and the "X" alternative is 23% effective. In the Analytic Hierarchy Process alternative evaluation, it was determined that the "Y" alternative was 43%, "X" alternative was 28%, and the "Z" alternative was 27% effective. In Analytic Network Process calculations, it was observed that the importance of "Y" and "Z" alternatives increased, and the importance of "X" alternatives decreased. The fact that the sub-criteria under the main criterion affect each other causes a change in the degree of importance among the alternatives. Another reason for the increasing importance of the "Y" alternative is that it is the most suitable model in terms of costs. The reason for the increase in the importance of the "Z" alternative and the decrease of the "X" alternative is that the "Z" alternative is similar to the "Y" alternative in terms of costs and, since the "X" alternative contains the sea bus option within itself, it is less likely to be preferred in terms of costs.

5. Discussion

By evaluating the Kocaeli Bay as a whole, this study was carried out to evaluate and determine the most suitable alternative or option for sea passenger transportation in Kocaeli Bay, which is carried out from 12 different piers as a component of public transportation activities by Kocaeli Metropolitan Municipality, at a sustainable cost.

To carry out at a sustainable cost the seaway passenger transportation in Kocaeli Bay, which is built in 12 different piers as a component of public transportation activities by Kocaeli Metropolitan Municipality, thirty-nine sub-criteria were determined under eight main criteria. Three different alternatives have been identified for these specified criteria. These alternatives are evaluated using analytic hierarchy and analytic network process methods.

When Analytic Hierarchy Process pair comparisons are made, it has been determined that the main criterion of cost is 36%, Tariff 22%, Law 15%, Wage System 8%, Transport Structure 6%, Maritime Transport 4%, and Ship Technical key criterion is 3%. As seen in the analytic network process pair of comparisons, the main criterion of the cost came out at the first level of importance. It has been seen that the best alternative in analytic network process calculations is the "Y" alternative. And, it has been determined that this is the scheduled passenger means of transport, the "Y" alternative in which sea passenger means of transport in Kocaeli Bay is provided by the metropolitan municipality using only a passenger motorboat as an alternative to the mixed fleet.

As a result of the pairwise comparisons of alternatives and main criteria of the Analytic Network Process are calculated, it can be seen the effectiveness of the criterion is as follow;

- Cost main criterion is 38%,
- Law main criterion is 16%,
- Tariff main criterion is 13%,
- Alternatives are 11%,
- Wage System main criterion is 7%,
- Transportation Structure main criterion is 5%,
- Main criterion of Maritime Transportation is 4%,
- Main criterion of Spatial Distribution is 3%
- Ship Technical key criteria is 2%.

When the alternatives of the Analytic Network Process are evaluated, it is seen that the "Y" alternative is 48%, the "Z" alternative is 28% and the "X" alternative is 23% effective. In the Analytic Hierarchy Process alternative evaluation, it was determined that the "Y" alternative was 43%, the "X" alternative was 28%, and the"Z" alternative was 27% effective. In Analytic Network Process calculations, it can be understood that the importance of "Y" and "Z" alternatives increased, and the "X" alternative decreased. By examining the analytic network process and the analytic hierarchy process together, it is concluded that the best alternative is the "Y" alternative in both methods.

6. Conclusions

It has been evaluated that it will be the most suitable solution at the scale of Kocaeli Bay to use the system in which passenger engines are supplied by leasing method and providing this service by the metropolitan municipality instead of the sea bus, ferry and passenger motorboat which are the current mixed sea fleet, and using low-speed passenger engines as marine vehicles, in order to ensure that the seaway passenger transportation service performed by the Kocaeli Metropolitan Municipality in the Kocaeli Bay is economical and sustainable, by considering seaway passenger transport as a component of urban public transport, by considering that the number of piers of Kocaeli Metropolitan Municipality Seaway Transportation Directorate is high and consequently the factors such as the high number of trips, the lack of attraction centers between the opposite coasts, the distancing of settlements from the coasts due to the earthquake, the low number of passengers, the lack of integration of urban public transport systems, the limited ticket increase price and ticket revenue and the absence of any other income than the ticket fee.

Declaration of Ethical Standards

The author(s) of this article declare that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Akman G., Atakan A., 2006. Tedarik Zinciri Yönetiminde Bulanık AHP Yöntemi Kullanılarak Tedarikçilerin Performansının Ölçülmesi: Otomotiv Yan Sanayinde Bir Uygulama. İstanbul Ticaret Üniversitesi, Fen Bilimleri Dergisi, **9**, pp. 23-46.

[2] Aksoy Y., Özkan E.M., Karanfil S., 2014. Bulanık Mantığa Giriş, 2.Baskı., Yıldız Teknik Üniversitesi Basın- Yayın Merkezi, İstanbul.

[3] Alptekin N., 2010. Analitik Ağ Süreci Yaklaşımı ile Türkiye'de Beyaz Eşya Sektörünün Pazar Payının Tahmini. Doğuş Üniversitesi Dergisi, **11**(1), pp. 18-27.

[4] Bayazıt O., 2002. A New Methodology in Multiple Crieria Decision- Making Systems: Analytic Network Process (ANP) and an Applications, Ankara Üniversitesi Siyasal Bilimler Fakültesi Dergisi, **57**(1), pp. 15-34.

[5] Baynal K., Yüzügüllü E., 2013. Tedarik Zinciri Yönetiminde Analitik Ağ Süreci ile Tedarikçi Seçimi ve Bir Uygulama. İstanbul Üniversitesi İşletme Fakültesi Dergisi, **42**(1), pp. 77-92.

[6] Chen S. C., Hwang C. L., Beckmann M.J., Krelle W., 1992. Fuzzy Multiple Attrıbute Decısıon Makıng: Methods and Applıcatıons, New York: Sprınger-Verlag.

[7] Cinemre N., 2004. Doğrusal Programlama, Üçüncü Baskı., Beta Basım Yayım Dağıtım A.Ş, İstanbul.

[8] Daft R. L., 1991. Management, 2nd Edition., The Dryden Press, USA.

[9] Dağdeviren M., Eraslan E., Kurt M., Dizdar E., 2005. Tedarikçi Seçimi Problemine Analitik Ağ Süreci ile Alternatif Bir Yaklaşım. Teknoloji Dergisi, **8**(2), pp. 115-122.

[10] Doğan B., 2004. Karar Vermede Çok Kriterli Bir Yaklaşım Modeli Olarak Analitik Hiyerarşi Süreci ve Mayın Avlama Gemisi Seçiminde Analitik Hiyerarşi Yönteminin Uygulanması. Deniz Harp Okulu, Deniz Bilimleri ve Mühendisliği Enstitüsü, Yüksek Lisans Tezi, İstanbul.

[11] Dokuz Eylül Üniversitesi, 2014 www.deu.edu.tr/userweb/k.yaralioglu/dosyalar/bul_man.doc [05 Ağustos 2014]

[12] Elmas C., 2011. Yapay Zeka Uygulamaları, Ankara: Seçkin Yayıncılık.

[13] Enea M., Piazza T., 2004. Project Selection by Constrained Fuzzy AHP. Fuzzy Optimization and Decision Making, **3**(1), pp. 39-62.

[14] Eren E., 2005. Stratejik yönetim ve işletme politikası, Beta Basım Yayın, İstanbul.

[15] Ergin A., 2011. Tedarik Zincir Yönetiminde Konteyner Taşıyıcı Firma Seçimi ve Türkiye'deki Uygulaması, Doktora Tezi, İstanbul Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

[16] Evren R., Ülengin F., 1992. Yönetiminde Çok Amaçlı Karar Verme, İstanbul Teknik Üniversite Matbaası, İstanbul.

[17] Felek S., Yuluğkural Y., Aladağ Z., 2007. Mobil İletişim Sektöründe Pazar Paylaşımının Tahmininde AHP ve ANP Yöntemlerinin Kıyaslanması. Makine Mühendisleri Odası Endüstri Mühendisliği Dergisi, **10**(1), pp. 211-233.

[18] Formen E., Selly M.A., 2002. Decision by Objectives, World Scientific Publishing, Singapore.

[19] Güner M., Yücel O., 2007. Konfeksiyon Üretiminde Temel Kriterlerin Hiyararşik Modellenmesi İle Üretilecek En Uygun Ürünün Belirlenmesi. Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi, **22**(1), pp. 73-79.

[20] Gürsoy M., Yardım M.S., Alçura G.A., 2012. İzmit Körfezi Feribot Taşımacılığı Taşıt ve Yolculuk Talebi ve Geleceğine İlişkin Teknik Rapor, Yıldız Teknik Üniversitesi, İstanbul, Türkiye.

[21] Harker P., Vargas L., 1987. The Teory of Ratio Scale Estimation, Saaty's Analytic Hierarchy Process Management. Management Science, **33**(11), pp. 1383-1403.

[22] Hwang C. L., Yoon K., 1981. Multiple Attribute Decision Making Methods and Applications, Springer Verlag, Berlin.

[23] İmrek M. K., 2003. Yöneticiler İçin Karar Verme Teknikleri El Kitabı,Beta Basım Yayım Dağıtım A.Ş, İstanbul.

[24] Jahanshahloo G. R., Lotfi F.H., İzadikhah M., 2006. An Algorithmic Method to Extend TOPSIS for Decision Making Problems with Interval Data. Applied Mathematics and Computation, **175**, pp. 1375-1384.

[25] Kahraman C., Demirel N. C., Ateş N. Y., 2008. A SWOT-AHP application using fuzzy concept: EGovernment in Turkey, Fuzzy Multi-Criteria Decision Making Book-Edited By Cengiz Kahraman, Springer Science-Business Media.

[26] Karsak E., Sözer S., Aladağ, Z., 2002. Product Plannig in Quality Function Deployment Using a Combined Analytic Network Process Goal Programming Approach. Computer& Industrial Engineering, **44**, pp. 171-190.

[27] Kocaeli Büyükşehir Belediyesi. 2012, Kocaeli Ulaşım Ana Planı Mevcut Bilgilerin Toplaması Çalışması 1. Ara Rapor. Kocaeli.

[28] Kocaeli Büyükşehir Belediyesi. 2012, Kocaeli Ulaşım Ana Planı Sonuç Raporu. Kocaeli.

[29] Kacakalay Ş., Özdemir M.S., Işık A., 2004. Analitik Serim Süreci Tekniği ile Pazar Payı Tahmini, Yöneylem Araştırması/Endüstri Mühendisliği Ulusal Kongresi, 15-18 Haziran 2004, Adana, 121-123.

[30] Koçel T., 2003. İşletme Yöneticiliği, Beta Basım Yayın Dağıtım A.Ş, İstanbul.

[31] Lin C., Tan B., Hsieh P.J., 2005. Application of the Fuzzy Weighted Average in Strategic Portfolio Management. Decision Sciences, **36**(3), pp. 489-511.

[32] Ömürbek T., Tunca M. Z., 2013. Analitik Hiyerarşi Süreci ve Analitik Ağ Süreci Yöntemlerinde Grup Kararı Verilmesi Aşamasına İlişkin Bir Örnek Uygulama. Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, **18**(3), pp. 47-70.

[33] Özden H.Ü., 2009. Türkiye'deki Mevduat Bankalarının Performansları, Detay Yayıncılık, Ankara.

[34] Özyürek B., Özcan C.E., 2008. Analitik Hiyerarşi Sürecinin Tedarikçi Seçiminde Uygulanması: Otomotiv Sektöründen Bir Örnek. Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, **13**(1) pp. 133-144.

[35] Power D.J., 2003. What is Analytic Hierarchy Proses (AHP)?, DSS News, 4, 13.

[36] Rençber Ö.F., 2010. Büyük Çaplı Projelerde Karar Verme: Analitik Hiyerarşi Süreci Uygulaması, Yüksek Lisans Tezi, Gebze Yüksek Teknoloji Enstitüsü, Sosyal Bilimler Enstitüsü, Gebze.

[37] Saaty T.L., 1990. How To Make A Decision: The Analytic Hierarchy Proses. European Journal of Operation Research, **48**, pp. 9-26.

[38] Saaty T.L., 1996. Decision Making with Dependence and Feedback: The Analytic Network Process, RWS Publications, Pittsburgh, PA.

[39] Saaty T.L., 1999. Fundamentals of The Analytic Network Process, ISAHP 1999, Kobe, Japan.

[40] Triantapjyllou E., 2000. Multi - Criteria Decision Making Methods: A Comparative Study, Kluwer Academic Publishers, 44, 1-3.

[41] Turanlı M., 1988. Pazarlama Yönetiminde Karar Alma, Beta Basım Yayım Dağıtım A.Ş, İstanbul.

[42] Yang C.L., Chuang S.P., Huang R.L., 2009. Manufacturing Evaluation System Based on AHP/ANP Approach for Water Fabricating Industry. Experts Systems with Applications, **36**, pp. 11369-11377.

[43] Yıldız Teknik Üniversitesi, 2014, http://www.enm.yildiz.edu.tr/~palcan/sistem_analizi.htm [7 Temmuz 2014]