Mersin University Journal of Maritime Faculty of Engineering

Mersin University Journal of Maritime Faculty (MEUJMAF)
Vol. 2, Issue 1, pp.14-24, June 2020
ISSN 2687-6612, Turkey
Research Article

MARINA SELECTION OF YACHTSMEN USING AHP-TOPSIS AND AHP-PROMETHEE

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Received: 12/11/2019 Accepted: 01/04/2020

ABSTRACT
In the scope of the research, determination of preference criteria of yacht owners, applicability of the most suitable marina and selected methods to the marina selection problem were evaluated and findings obtained by different methods were compared and to what extent these methods contributed to the decision-making process and how consistent they were. In this study, the criteria of yacht owners to prefer marinas of our country are tried to be determined by using Analytic Hierarchy Process (AHP) which is one of the multi criteria decision making methods. Weight input values obtained by AHP were used in TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and PROMETHEE methods, which are multi-criteria decision-making methods, to evaluate yacht owners to determine the most suitable marina alternative for themselves. As a result of the study, consistent and real-life results were obtained, it was concluded that AHP, TOPSIS and PROMETHEE methods could be used for decision support during selection.

Keywords: *Marina Selection, Analytic Hierarchy Process, TOPSIS, PROMETHEE, Tourism of Marine*

1. INTRODUCTION

Marine tourism, which is one of the building blocks of tourism sector, has made great progress in our country in recent years as in the whole world. An important part of this progress is the modernization of newly built marinas and existing marina technologies that can serve all types of boats.

As a result of the incentives and investments made, especially the North Aegean and Western Mediterranean coasts, natural texture, climate, safe and sheltered bays attract attention with suitable sea rotations and cultural heritage for both foreign and domestic yachtsmen. The marinas are spread over the Mediterranean, Marmara and Aegean coasts of our country, surrounded by inland seas and are concentrated in Istanbul, North Aegean, South Aegean and Western Mediterranean regions.

According to the yachting statistics published by the Ministry of Culture and Tourism, the number of foreign private yachts coming to Bodrum Port in 2007 for example increased from 816 to 3691 in 2016 and increased by 452% (Ministry of Culture and Tourism, 2019).

In this study, the problem of marina selection in accordance with the individual expectations and boat characteristics of private yacht owners who intend to visit Turkey permanently or in transit is examined. Since yachts and yacht harbor profiles vary with many elements, 3 yachts with motor yachts of 25 m² and above, 5 anchors certified, blue flags and a full occupancy rate of 85% in 2019 summer period were included in the study.

2. AIM AND SCOPE OF THE RESEARCH

This study examines the usability of multi-criteria decision-making methods in marina selection. Additionally, evaluates the different results of the quantitative and qualitative criteria at the decision stage of foreign and domestic yacht owners who want to visit the coasts of Turkey with yachts, as well as the superiority of marinas to each other and handicaps in order to handle them in a healthy way.

The decision alternatives, which are one of the three basic components of Multi-Criteria Decision-Making methods, consist of 3 private marina enterprises in Muğla province, all with 5 anchors certified, owned blue flags and occupancy rate of 85 percent and above in summer season. The decision makers are the owners of yachts which has 25 m² area or more, in which the Ministry of Culture and Tourism deals with the status of foreign and domestic yachtsmen. Selection criteria were determined as location, capacity, prestige, security, superstructure, infrastructure and mooring fee by using the available literature and expert opinion.

3. YACHTS AND MARINAS

There are two basic elements of yacht tourism. These are yachts and marinas where they are moored. The marinas in marine tourism can be defined as the structures where private and commercial yachts can safely approach, professional mooring services are provided, the safety of the yacht and yachtsmen are provided, and there are various boat handling and maintenance equipment and also social facilities and various cultural activities are carried out (Işık and Cerit, 2008). When we look at the official definitions of the word “yacht”: “not to be more than twenty miles away from the nearest land with a cabin, toilet, washbasin, kitchen, used commercially or non-commercially for sightseeing and sports purposes, not in the nature of cargo, passengers and fishing vessels, the number of passengers carried shall not exceed twelve or the cabotage is limited to one hundred miles (Tourism Incentive Law No. 2634). And “suitable for use in sea tourism trade with the purpose of travel, sports and entertainment, the number of passengers carried by the ship shall not exceed twelve” (Marine Tourism Regulation, 2009) seen as definitions.

Yachts are classified according to propulsion system, hull structure and construction methods in traditional classification. Other than these, motor yachts, sailing yachts, sports and recreational vehicles are classified as private yachts and commercial yachts. Private yachts; refers to boats used for recreational and sporting purposes, which are limited to 12 persons. Commercial yachts mean boats that do not have cargo, passenger or fishing vessel status, can travel up to 20 nautical miles away from the nearest land or do not make more than 100 miles in cabotage and who do not exceed 36 people (Kan and Nas, 2014).

The “marina” is defined as the facility that contains the equipment and materials that can accommodate all kinds of yachts' accommodation (TDK, 2019). In other words, marinas, due to their special activities should be on the sea shore, small boats and yachts sheltered for shelter, maintenance and attitude for boats and yachts, services such as wintering, electricity, water, telephone, internet, bilge, fuel. In addition, these facilities are open to tourism where yachts and yachts' needs are met such as catering, eating, drinking, and shopping (Dikeç and Töz, 2016).

The number of certified tourism businesses coastal marinas in Turkey is 27; the total capacity is 11.715't. Number of yacht berths with tourism operation certificate is 6 and total mooring capacity is 967. The number of marinas with a tourism investment certificate is 8 and the total mooring capacity is 3530. The cruise ship port with a tourism investment certificate is 1 and the overall total of all maritime tourism facilities is 42 and the total mooring capacity is 16.212 (Marine Tourism Report, Maritime Trade Magazine, 2019).

As the inland yacht tourism, which is an inland sea, has recently increased in demand, the Mediterranean has become one of the important regions for yachting globally. Local tourists realized the availability of yachting, which was discovered by foreign tourists in the 1960s with the intention of visiting the bays where no land transportation was available, in time, thus the marina and yachting activities in Bodrum, Marmaris gained momentum (Sezer, 2012). While yacht tourism has been addressed to the upper income group in the past, the middle-income group today has demanded it (Sarıışık et al, 2011). When the coastal sea traffic on the coasts of our country is analyzed, it is seen that the yachts descend from the Western Mediterranean - Greek Ports - Marmaris - Bodrum to the South West Mediterranean coast. The other is a rotation Israel - Cyprus Island - the island of Rhodes over South South Aegean coasts of Turkey and Greece constitutes stopover at the passing boats. According to the yachting statistics published by the Ministry of Culture and Tourism, every year until 2016, the most intensive region in terms of yacht traffic and occupancy rate is between Bodrum and Finike (Tourism and Culture Ministry, 2019). The criteria underlying the concentration of yacht traffic and occupancy rates in this region are seen in the literature regarding the selection of facility location (Maglić, 2019; Tomovic, 2014). When the other publications in the literature are examined, it is seen that the factors that affect the service quality of marinas other than plant location selection, application of service quality factors to marina enterprises, sustainability in marinas and reduction of environmental impacts (Dikeç and Töz, 2016; Maglić, 2019; Paker and Altuntaş 2016; Maglić, 2019; Ritchie, et al, 2017; Sezer, 2012; Wilson et al, 2015). Although the service quality is a very important criteria for yachtsmen, when the occupancy rates of the marinas on our coasts are examined to include all marinas, more important technical criteria may be present. For example, in the marinas on the Eastern Mediterranean coast of Turkey where service quality is very high, it is thought that the effect of service quality on the preferability of the marina is lower compared to some quantitative criteria.

4. METODOLOGY

In the study, in order to define the weights of the criteria, Analytical Hierarchy Process (AHP) was used. The selection of criteria, which is one of the most important components of TOPSIS and PROMETHEE methods, was obtained through literature research and semi-structured interviews with 3 academicians and one senior marina manager. The relevant expert opinion was also applied to form and weight the pairwise comparison matrices of the criteria. In order to rank the decision alternatives for each criterion, the questionnaires prepared for the qualitative criteria were applied to 15 yacht owners whose total area is less than 25 m², preferring 3 different, 5 anchored and blue flagged private marinas operating in Muğla province. While scoring of criteria with quantitative values, data were obtained via internet and e-mail.

4.1. Analytic Hierarchy Process

Although the Analytic Hierarchy Process was first proposed by Myers and Alpert in 1968, Thomas Lorie Saaty developed it as a model in 1977 and made it available to decision-making processes (Yaralıoğlu, 2001). The Analytic Hierarchy Process allows decision makers to model problems, decision alternatives, criteria and sub-criteria, if any, and the relationship between them in a hierarchical structure. In the Analytic Hierarchy Process, the subjective interpretations and objective evaluations of the decision-maker at the decision stage are included together.

AHP has been applied in almost every field. Evaluation of information systems in the field of telecommunications (Liang, 2015), food industry supplier evaluation and selection (Rezaei and Ortt, 2013), supplier selection and evaluation in automotive sector (Kahraman et al., 2010), in state business, industrial technology development program selection and evaluation (Huang et al, 2008), thermal power maintenance strategy evaluation and selection (Wang et al, 2006), in the field of general production, supplier selection and evaluation (Chan and Kumar, 2007).

The first step in the Analytic Hierarchy Process is to establish a hierarchical model. The aim of the problem, respectively, the main criteria, if any sub-criteria, decision alternatives are listed in a hierarchical manner.

After the hierarchy table is created, in the second step, the criteria are compared between each other and sub-criteria, if any, and their importance levels and weights are determined. In pairwise comparison, the square matrix is obtained by using the scale which developed by Saaty graded between 1-9. The effectiveness of the 1-9 comparison scale was determined by comparisons with other scales and the use of the scale in different research areas (Kuruüzüm and Atsan, 2001).

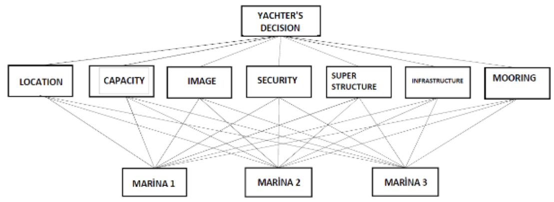


Fig.1: Marina Selection Problem – AHP Hierarchy Model

Normalisation : $$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} aij} \quad (1)$$

Definition of Normality Vector: $$w_i = \frac{\sum_{j=1}^{n} Cij}{n} \quad (2)$$

In step 4, the consistency of the criteria is determined and matrix consistency is determined. For a matrix to be consistent, its maximum eigenvalue (λmax) must be equal to the matrix size (n). To find λmax, each column element in the comparison matrix is divided by the sum of the column. Thus, the matrix is normalized. Then, each row is averaged for the priorities vector calculation. The "All Priorities Vector Matrix" is calculated by multiplying the priority vector and initial matrix. The values obtained are divided by the Priority Vector values. λmax the average of these values is determined to calculate. This is the average λmax value (Long and Kazan, 2016). This should be done after finding the value; As stated above, the consistency of the hierarchical table is determined by calculating the consistency ratio. The consistency ratio is calculated to prevent the expert from making mistakes when performing pairwise comparisons. If this value is greater than 0.1, the comparison should be reviewed. To calculate consistency, the consistency index (CI) is first calculated as below written equation.

$$CI = \frac{\lambda \max - n}{n-1} \quad (3)$$

Once CI is calculated, the consistency ratio (CR) is calculated by the following Eq. 4.

$$CR = \frac{CI}{RI} \tag{4}$$

RI represents the randomness index. The randomness index is determined by selecting the appropriate value from Randomness Index table.

Table 1: Randomness Index

Matrix size	Random Consistency index (RI)
1	0,00
2	0,00
3	0,58
4	0,90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49

If the obtained consistency ratio is less than 10%, the criteria weighting and / or decision-making process is consistent. The decision is applied.

4.2. TOPSIS

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is widely used in Multi Criteria Decision Making processes in the literature. Developed by Hwang and Yoon in 1981, this method allows for the best choice decision by ranking among alternatives (Hwang and Yoon, 1981).

In the field of management and organization in the selection of mid-level managers in the Greek IT firm (Kelemenis et al, 2011), determination of the most appropriate system analysis engineer (Mahdavi et al, 2008), in the field of engineering, in determining the optimal scheme for the maintenance of bridge structures (Wang and Elhag, 2006) (Wahdani and Tavakkoli, 2010) and the selection and evaluation of marine pollution control equipment in the maritime field are some of the TOPSIS applications in the literature.

The reasons for preference of the TOPSIS method are simplicity, rationality, understandability, good computing efficiency and the ability to measure the relative performance of each alternative in a simple mathematical form.

While the alternative chosen in the TOPSIS method, solution is expected to be close to the ideal solution, it is expected to be far from the negative ideal solution. The objective return means maximizing the return to the ideal solution and the distance to the negative ideal solution means minimizing the cost. In the selection phase between decision alternatives, the one, which is close to the ideal solution, and the one that is far from the negative ideal solution should be chosen.

The TOPSIS method is completed in seven steps. In the first step, the decision matrix is created. The criteria for the row elements of the decision matrix and the evaluation elements for the column elements. The decision matrix, which consists of *m* alternative and *n* criteria, is also referred to as the initial matrix (see table 2).

Table 2: Initial matrix

$$\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ \vdots & & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

In step 2, the decision matrix is normalized. Data obtained using different scales are made comparable using normalization process. This is achieved by dividing the square root of the sum of the squares of all elements of the decision matrix elements. In step 3, a weighted normalized decision matrix is created. The weight of the evaluation factors is calculated first. The Analytical Hierarchy Process is used to calculate these weights. The weighted evaluation factor values (w_{ij}) are multiplied by each normalized matrix element (r_{ij}).

In step 4, the positive and negative ideal solution values are calculated. The PROMETHEE method assumes that all evaluation factors have a monotonous increasing or decreasing tendency. For the ideal solution, the highest and lowest values in each column are selected among the values obtained in the previous step.

$$A^* = \{(maxV_{ij}|j \in J),\ (minV_{ij}|j \in J'^C)\}i = 1, 2, 3, \dots, m \tag{5}$$

$$A^- = \{(minV_{ij}|j \in J),\ (maxV_{ij}|j \in J'^C)\}i = 1, 2, 3, \dots, m \tag{6}$$

For the utility criteria, the highest value is considered and for the cost criterion the lowest value is considered. In the above equation, while A^* represents the most preferred alternative, A^- is the least preferred alternative. In step 5, the separation measures are determined. The deviation of the alternatives from the positive and negative ideal points is calculated using the Euclidian distance function. The values obtained from the calculation of the separation measures are called ideal separation (S_i^*) and negative ideal separation (S_i^-). In this case, J means the benefit criteria,J'means the cost criteria. The number obtained (S_i^*) and (S_i^-) should be equal to the number of alternatives.

$$(S_i^*) = \sqrt{\sum(v_{ij} - v_{j^*})^2}\ i = 1, 2, 3, \dots, m \tag{7}$$

$$(S_i^-) = \sqrt{\sum(v_{ij} - v_{j^-})^2}\ i = 1, 2, 3, \dots, m \tag{8}$$

In step 6, the relative priority is calculated according to the ideal solution. The proximity of the alternatives to the ideal solution is determined by using C_i^*ideal and negative ideal separation measures. The value used for this is the share of the negative discrimination measure in the total separation measure. Proximity to the ideal solution;

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-}; \qquad 0 \le C_i^* \le 1 \tag{9}$$

Finally, alternatives are listed by looking at the relative proximity values. Thus, among the alternatives, the one closest to the ideal solution, that is, the alternative having the largest C_i^* value, is determined as the best decision alternative. When the C_i^* values are sorted from large to small, the alternatives are prioritized.

4.3. PROMETHEE

In this method, alternatives are evaluated with different preference functions. Unlike other methods, this method is the determination of both partial and full priorities of alternatives. PROMETHEE (Preference Ranking Method for Enrichment Evaluation), which is one of the most widely used methods of multi-criteria decision-making methods, has been developed based on the difficulties of implementation of existing prioritization methods in the literature (Dağdeviren and Eraslan, 2008). It has been widely used in logistics and supply chain, theory, tourism and sustainability.

Among the reasons for choosing the PROMETHEE method in the solution of the problem are the fact that the differences between the criteria are more controllable, the decision-makers can easily come to the conclusion for decision modeling, the decision-makers are closer to the real decision problem, they better define the problem and make sensitivity analysis. In our country, which is surrounded by seas on three sides, there is no study using PROMETHEE (Mareschal, 2011).

Additionally, encryption algorithm sorting in engineering (Yılmaz and Ballı, 2016), sorting network components (Almoghathawi et al, 2017), telecommunication systems selection in communication (Sabri, 2016), mobile phone selection (Kecek and Yüksel, 2016), especially in the field of maritime transportation for selection of vessel's power plant (Uzun and Kazan, 2016) are some of the applications of PROMETHEE in the literature. Therefore, national or international researchers may be interested in the field of marine tourism in the future.

The PROMETHEE method consists of two main steps: PROMETHEE 1 and PROMETHEE 2. It was developed by J. P. Brans (Brans, 1982). This method is one of the other multi-criteria decision-making methods, considering the relationship between evaluation factors and each other's own internal relationship. This internal relationship is revealed by the distribution of the data set and due to this distribution, there are six different distributions. PROMETHEE method consists of a total of seven steps, in the first step; decision alternatives and criteria are determined.

In the second step, six preference functions are determined. PROMETHEE does not determine intrinsic absolute benefits on the basis of decision alternatives and neither on the whole nor on the basis of assessment factors. It makes the comparison of decision alternatives according to each criteria in pairs. Preference functions are as below:

First type, $P(d) = \begin{cases} 0 \\ 1 \end{cases} \quad d \leq 0, \text{d} > 0$ (10)

Parameter: ---

Second type, $P(d) = \begin{cases} 0 & d \leq q \\ 1 & \text{d} > q \end{cases}$ (11)

Parameter: q

Third type, $P(d) = \begin{cases} 0 & d \leq 0 \\ \frac{d}{p} & 0 < d \leq p \\ 1 & d > p \end{cases}$ (12)

Parameter: p

Forth type, $P(d) = \begin{cases} 0 & d \leq q \\ \frac{1}{2} & q < d \leq p \\ 1 & d > p \end{cases}$ (13)

Parameter: p,q

Fifth type, $P(d) = \begin{matrix} 0, & d \leq q \\ (d-s)/r, & q < d \leq p \\ 1 & d > p \end{matrix}$ (14)

Parameter: s,r

Sixth type, $p(d) = \begin{matrix} 0 & d \leq 0 \\ 1 - e^{-x^2/2\sigma^2}, & d \geq 0 \end{matrix}$ (15)

Parameter: σ

In the third step, common preference functions are determined by making pairwise comparisons between decision alternatives for each criterion according to the determined preference functions.

$$P(A,B) = \begin{cases} 0 \\ p[P(A) - P(B)] \end{cases} \begin{cases} F(A) \leq F(B) \\ F(A) > F(B) \end{cases} \quad (16)$$

In the fourth step, preference indices are determined.

$$\pi(A,B) = \sum_{i=1}^{k} (w_i P_i\,(A,B)) \quad (17)$$

In step 5, the positive and negative superiority values are determined.

$$\Phi^+ = \frac{1}{n-1} \sum \pi(A,x) \quad (18)$$

$$\phi^- = \frac{1}{n-1} \sum \pi(x,A) \quad (19)$$

In step six, partial sorting is created. In this stage where the positive and negative superiority values of decision alternatives are compared, three different situations can be encountered such as superiority of decision alternatives, indifference or inability to compare.

$$\begin{cases} \Phi^+(A) > \Phi^+(B)\ ve\ \phi^-(A) < \phi^-(B) \\ veya \\ \Phi^+(A) > \Phi^+(B) ve\ \phi^-(A) = \phi^-(B) \\ veya \\ \Phi^+(A) = \Phi^+(B) ve\ \phi^-(A) < \phi^-(B) \end{cases} \quad (20)$$

$superior\ to\ a - b$

$$\{\Phi^+(A) = \Phi^+(B)\ ve\ \phi^-(A) < \phi^-(B)\} \quad (21)$$

$equivalent\ to\ a - b$

$$\begin{cases} \Phi^{+}(A) > \Phi^{+}(B)\ ve\ \phi^{-}(A) > \phi^{-}(B) \\ veya \\ \Phi^{+}(A) < \Phi^{+}(B) ve\ \phi^{-}(A) < \phi^{-}(B) \end{cases} \quad (22)$$

$A\ and\ B\ non - compare$

In the seventh step, a complete ranking of decision alternatives is made with PROMETHEE 2. For each alternative, "full priority values" are determined by the following equation and sorted from small to large.

$$\Phi(A) = \Phi^{+}(A) - \phi^{-}(A) \quad (23)$$

5. APPLICATION

In the application stage of the marina selection problem, AHP method was used in the analysis of the problem and weighting of the criteria and decision alternatives were listed with TOPSIS and PROMETHEE methods.

The criteria that the yachtsmen will take into consideration in order to determine the most suitable marina for their own yacht from the marinas in Muğla are determined by the Analytic Hierarchy Process (AHP). Questionnaire forms were formed by using the scale that 1-9 graded by Saaty to be used in pairwise comparisons of criteria and evaluation of each alternative according to criteria (Saaty, 2003).

5.1. Definition of criteria

The criteria included in the study were obtained through a semi-structured face-to-face interview with three academicians and one marina official who were experts in their field through the literature survey. It has been concluded that the most effective criteria that the yacht owners take into consideration when choosing a marina are location, capacity, prestige, security, superstructure, infrastructure and mooring fee.

5.2. Weighting of criteria by using AHP

Criteria weights and alternatives were evaluated as a result of interviews with 3 academicians and 1 marina manager. In order to rank the decision alternatives for each criterion, questionnaire forms prepared for qualitative criteria were applied to 15 yachtsmen and data were collected via internet and e-mail for quantitative criteria.

Table 3: Weight of Criteria

Criteria's AHP score	Weight of Criteria
Location	0,283
Capacity	0,045
Prestige	0,105
Security	0,308
Superstructure	0,062
Infrastructure	0,062
Mooring Fees	0,136

According to the table, the criteria with the highest weight value were determined as position and safety respectively. Location and security criterias are followed by infrastructure, mooring fees, superstructure, capacity and prestige criteria.

Table 4: Comparison Matrix

Criteria	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Location	1	7	9	1	5	3	3
Capacity	1/7	1	1	1/9	1/3	1/5	1/3
Prestige	1/9	1	1	1/7	1/5	1/7	1/5
Security	1	9	7	1	5	1	3
Superstructure	1/5	3	5	1/5	1	1	1/3
Infrastructure	1/3	5	7	1	1	1	1
Mooring Fees	1/3	3	5	1/3	3	1	1

Table 5: Normalized Matrix

Criteria	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Location	0,30612	0,21739	0,25714	0,31914	0,27273	0,27272	0,33834
Capacity	0,06122	0,04347	0,08571	0,06382	0,01818	0,01818	0,02255
Prestige	0,10204	0,04347	0,08571	0,06382	0,16364	0,16363	0,11278
Security	0,30612	0,21739	0,42857	0,31914	0,27273	0,27272	0,33834
Superstructure	0,06122	0,13043	0,02857	0,06382	0,05454	0,05454	0,03759
Infrastructure	0,06122	0,13043	0,02857	0,06382	0,05454	0,05454	0,03759
Mooring Fees	0,10204	0,21739	0,08571	0,10138	0,16363	0,16363	0,11278

Table 6: Grading of criteria and percent consistency

%	*CA*	*Criteria*	*λmax*	*CI/RI*	*Consistency Percentage*
28,3%	0,92568	Location	7,60610	0,07653	%8 < %10
4,5%	1,02897	Capacity			
10,5%	1,22519	Prestige			
30,8%	0,96463	Security			
6,2%	1,12814	Superstructure			
6,2%	1,12814	Infrastructure			
13,60%	1,20534	Mooring Fees			

Consistency ratio (CR) is found to be 8% (0.07653), which is less than 0.1, which is the upper limit of consistency ratio. In this case, since 8% <10%, it can be said that experts make comparisons consistently.

5.3. Sorting alternatives with TOPSIS

In this section, decision alternatives are listed with TOPSIS method, based on the assumption that the yachters will choose the best alternative. The transactions are listed in below tables.

Table 7: 9-point scale for participants

Marina Alternatives	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Marina 1	Moderate Good	Good	Good	Moderate Good	Very Good	Extremely Good	Very High
Marina 2	Good	Moderate Good	Very Good	Good	Moderate Good	Moderate Good	Moderate High
Marina 3	Moderate Good	Very Good	Moderate Good	Good	Good	Good	Moderate High

Table 8: Scores of alternatives

Marina Alternatives	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Marina 1	5	3	3	5	7	9	7
Marina 2	3	5	7	3	5	5	5
Marina 3	3	7	5	3	3	3	5
Weights	0,283	0,045	0,105	0,308	0,062	0,062	0,136

Table 9: Normalized scores of alternatives

Marina Alternatives	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Marina 1	0,65094	0,32929	0,32929	0,76249	0,76834	0,83925	0,70352
Marina 2	0,39056	0,54882	0,768349	0,45749	0,54882	0,46625	0,50251
Marina 3	0,39056	0,76834	0,548821	0,45749	0,32929	0,27975	0,50251
Weights	0,283	0,045	0,105	0,308	0,062	0,062	0,136

Table 10: Weighted and normalized scores of alternatives

Marina Alternatives	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees
Marina 1	0,18421	0,01482	0,03458	0,23480	0,04760	0,05200	0,09567
Marina 2	0,11053	0,02470	0,08068	0,14090	0,03410	0,02890	0,06834
Marina 3	0,11053	0,03458	0,05763	0,14090	0,02040	0,01730	0,06834

Table 11: Values of positive and negative ideal solutions

Ideal Solution Value	0,18422	0,03458	0,08068	0,23484	0,04764	0,05203	0,06835
Negative Ideal Solution Value	0,11053	0,01482	0,03458	0,14090	0,02042	0,01735	0,09568

Table 12: Sorting of alternatives

Alternatives/ Criteria	Location	Capacity	Prestige	Security	Superstructure	Infrastructure	Mooring Fees	Total
Marina 1	0	0,00039	0,00212	0	0	0	0,00074	0,00326
Marina 2	0,00542	9,75904	0	0,00882	0,00018	0,00053	0	0,01507
Marina 3	0,00542	0	0,00053	0,00882	0,00074	0,00120	0	0,01673
Marina 1	0	0	0	0,00882	0,00074	0,00120	0	0,01619
Marina 2	0,00542	9,75904	0,00212	0	0,00018	0,00013	0,00074	0,00328
Marina 3	0	0,00039	0,00053	0	0	0	0,00074	0,00166

Alternatives	Si+	Si-	Ci
Marina 1	0,05712	0,12727	0,69022
Marina 2	0,12277	0,05735	0,31840
Marina 3	0,12934	0,04085	0,24003

5.4. Sorting alternatives with PROMETHEE

In this section, the criteria determined and weighted by AHP method were evaluated by scoring with a 9-scale scale for each marina as stated in TOPSIS method.

The application of the PROMETHEE method was carried out using the academic version of the “Visual PROMETHEE” software. “Visual PROMETHEE” application is a decision support software that is very easy to use.

The criteria weight inputs required for the application of PROMETHEE method were obtained by AHP method as in TOPSIS method.

Since the owners and experts think that the criteria should have a value above average for each selection alternative, the preference function to be used is determined as the “Fifth Type (linear) preference function” (Şenkayas and Hekimoğlu, 2013).

5.4.1. PROMETHEE Partial Ranking

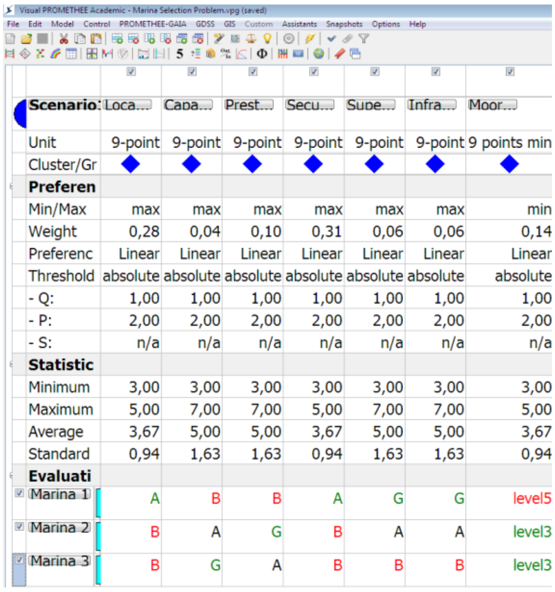
“PROMETHEE I” calculates values between +1 and -1 (Güney, 2017) for each marina alternative. The positive value indicates the positive superiority of each marina over the other marinas, and the negative value indicates how weak the marina is compared to other marinas as shown in pic 2.

5.4.2. PROMETHEE Complete Ranking

With PROMETHEE II, negative advantages are subtracted from positive advantages. Thus, it can be decided which marina to prefer by determining net advantages (Ömürbek and Şimşek., 2014). In the PROMETHEE II, the marina, which belongs to values between 0 and +1, takes the lead in the ranking (Şahin and Akkaya, 2013).

5.4.3. PROMETHEE Network

On the PROMETHEE Network screen, alternatives are shown with nodes and preferences with arrows (VP Solutions, 2013). In the study, while Marina 2 and Marina 3 are two close preferences, Marina 1 alternative seems to be the preferred alternative.



Scenario:	Loca...	Capa...	Prest...	Secu...	Supe...	Infra...	Moor...
Unit	9-point	9-point	9-point	9-point	9-point	9-point	9 points min
Cluster/Gr	◆	◆	◆	◆	◆	◆	◆
Preferen							
Min/Max	max	max	max	max	max	max	min
Weight	0,28	0,04	0,10	0,31	0,06	0,06	0,14
Preferenc	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Threshold	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q:	1,00	1,00	1,00	1,00	1,00	1,00	1,00
- P:	2,00	2,00	2,00	2,00	2,00	2,00	2,00
- S:	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistic							
Minimum	3,00	3,00	3,00	3,00	3,00	3,00	3,00
Maximum	5,00	7,00	7,00	5,00	7,00	7,00	5,00
Average	3,67	5,00	5,00	3,67	5,00	5,00	3,67
Standard	0,94	1,63	1,63	0,94	1,63	1,63	0,94
Evaluati							
Marina 1	A	B	B	A	G	G	level5
Marina 2	B	A	G	B	A	A	level3
Marina 3	B	G	A	B	B	B	level3

Fig.2: PROMETHEE data input screenshot

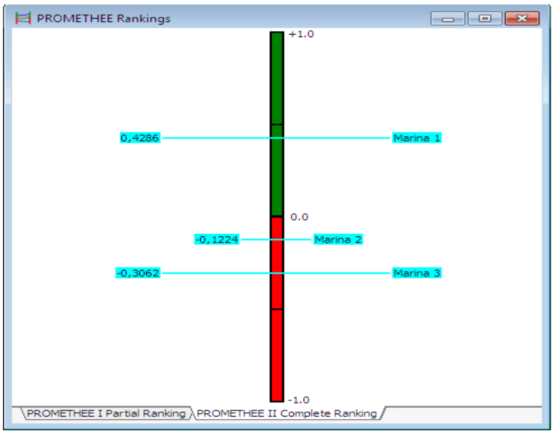


Fig. 4: PROMETHEE Complete Ranking

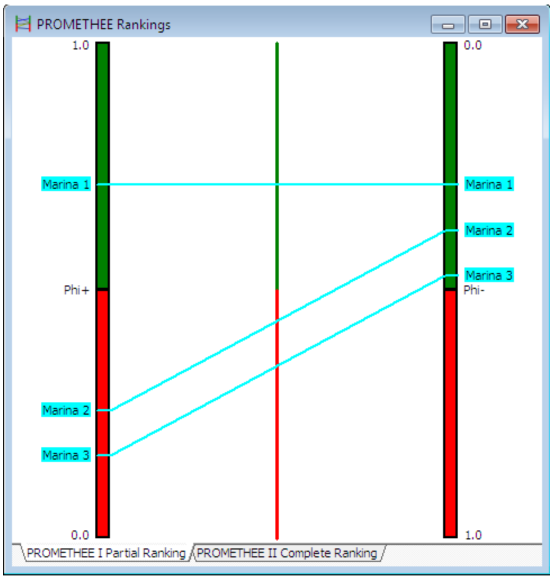


Fig. 3: PROMETHEE Partial Rankings

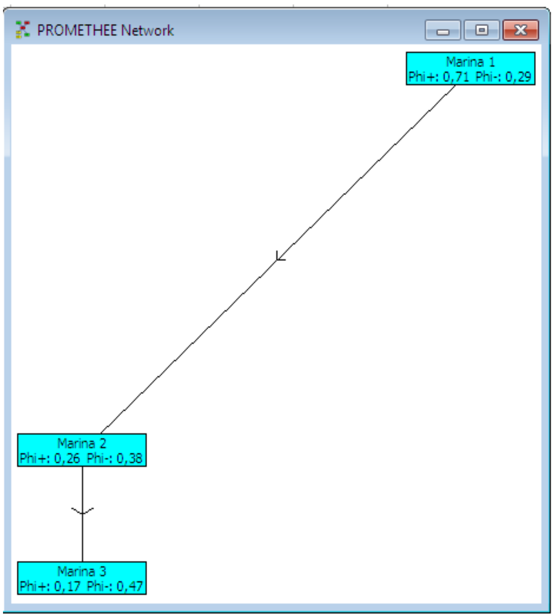
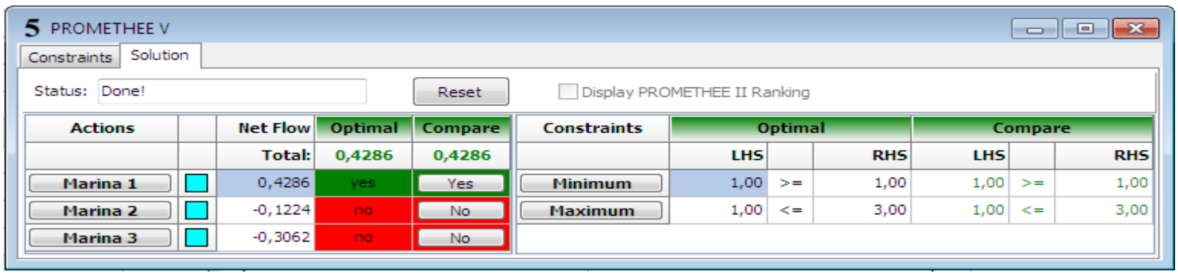


Fig. 5: PROMETHEE Network

5.4.4. PROMETHEE Solution Table

The "PROMETHEE V, Solution" tab of the application lists three alternative "net flow" values. In the study, it was seen that the net superiority values of Marina 1 were higher than the other two marinas.



PROMETHEE V — Constraints | Solution — Status: Done! — Reset — Display PROMETHEE II Ranking

Actions		Net Flow	Optimal	Compare
		Total:	0,4286	0,4286
Marina 1		0,4286	yes	Yes
Marina 2		-0,1224	no	No
Marina 3		-0,3062	no	No

Constraints	Optimal LHS		Optimal RHS	Compare LHS		Compare RHS
Minimum	1,00	>=	1,00	1,00	>=	1,00
Maximum	1,00	<=	3,00	1,00	<=	3,00

Fig. 6: PROMETHEE V – Solution Table

6. RESULTS AND DISCUSSION

In this study, determination of preference criteria of yacht owners, the most appropriate marina they can choose and the applicability of selected methods to marina selection problem were evaluated. In addition, by comparing the findings obtained with different methods, it was tried to determine to what extent these methods contributed to the decision-making process and how coherent they were.

According to the findings, the most important criterion of yacht owners when choosing the marinas of our country are security, location, mooring fees, prestige, infrastructure, superstructure and capacity respectively. Since all 3 marinas selected in the study were within the boundaries of Muğla, the effect of the security criterion on the selection was reasonable. Although the capacity criterion is closely related to the physical size or smallness of a marina; it is noteworthy that it has the least impact among the selected criterion affecting the choice of the yacht owner. As the capacity criterion has the least importance and the occupancy rate is high, it can be concluded that low capacity marinas may be preferable unexpectedly. TOPSIS and PROMETHEE methods have provided consistent results in the ranking of marina alternatives, and in both Marina 1, Marina 2 and Marina 3.

No studies using the MCDM method for marina selection have been found in the literature. Therefore, the usability of Multi Criteria Decision Making Methods in Marina Selection problem should be discussed.

In future studies, it will be beneficial for the sector and yachtsmen to determine the criteria by considering the socio-economic characteristics of each yachtsman, the purpose of use of the marina and the size of the yacht, and the use of multi-criteria decision-making methods that include other quantitative and qualitative criteria.

7. LIMITATIONS

In order to avoid subjective results, criteria must be chosen objectively. But in this study criteria have determined and scored by using expert opinions. This may cause a not sensitive result in our study. We can consider this issue as a limitation for our study.

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