SELECTION OF THE BEST YACHT CATEGORY WITH

ANALYTICAL HIERARCHY PROCESS

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Bornova – IZMIR

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YAŞAR UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

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This study titled "SELECTION OF THE BEST YACHT CATEGORY WITH ANALYTICAL HIERARCHY PROCESS" and presented as MSc Thesis by Ahter ALTAY has been evaluated in compliance with the relevant provisions of Y.U. Graduate Education and Training Regulation and Y.U. Institute of Science Education and Training Direction and jury members written below have decided for the defence of this thesis and it has been declared by consensus / majority of votes that the candidate has succeeded in thesis defense examination dated December 17,2013.

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Head   **:**………………   …………….

Rapporteur Member **:** ……………….   …………….

Member   **:** ……………….   …………….

ÖZET

EN İYİ YAT KATEGORİSİNİN
ANALİTİK HİYERARŞİ YÖNTEMİYLE SEÇİMİ

ALTAY, Ahter

Yüksek Lisans Tezi, Endüstri Mühendisliği Programı

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Aralık 2013, 58 sayfa

Bu tezin amacı, turizm endüstrisinde hizmet veren bir acentenin sezon içinde müşterilerinin taleplerine uygun yat seçeneği sunabilmesi için portföyünde kullanacağı en iyi yat kategorisini belirlemektir. Yat kategorilerinin önceliklendirilmesi çok kriterli karar verme yöntemlerinden biri olan Analitik Hiyerarşi Süreci (AHP) yöntemiyle belirlenmiştir. Analitik hiyerarşi modeli klasik yapıda amaç, ana-kriterler, alt-kriterler ve alternatifler olmak üzere dört seviyeli bir hiyerarşi halinde yapılandırılmıştır. Ekonomi, standart, lüks ve delüks olmak üzere toplam dört adet alternatif yat kategorisi belirlenmiştir. Değerlendirme yapabilmek için de çeşitli ana ve alt-kriterler belirlenmiştir. Kriterlerin ve hiyerarşik yapılarının belirlenmesinde sektörde tecrübe sahibi operatörler ile müşterilerin görüşlerine başvurulmuştur.

Anahtar Kelimeler: Analitik Hiyerarşi Süreci (AHP), turizm, yatlar

ABSTRACT

SELECTION OF THE BEST YACHT CATEGORY WITH ANALYTICAL HIERARCHY PROCESS

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MSc in Industrial Engineering

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Some travel agencies offer blue cruise for their customers in Turkey. However, they generally do not have own yachts, instead, they hold a portfolio that consists of commercial yachts in charter. A portfolio should include appropriate numbers of yachts in different categories. The problem is to decide the composition of yachts in the portfolio.

The goal of this study is to evaluate the categories of yachts and ranking them in order to help the agency. The yachts are divided into four categories in general. Those categories are: "economy", "standard", "luxury" and "deluxe" yachts. Classification of the yachts depends on the size and variety of utilities that they have. These categories have been evaluated using Analytical Hierarchy Process (AHP) since the study is a multi-criteria decision-making problem in which intangible criteria are involved in decision process. The criteria and their hierarchical structure are determined by a group of people consisting of professionals from the sector and the customers.

Keywords: Analytic Hierarchy Process (AHP), tourism, yacht

ACKNOWLEDGEMENTS

TEXT OF OATH

I declare and honestly confirm that my study titled "SELECTION OF THE BEST YACHT CATEGORY WITH ANALYTICAL HIERARCHY PROCESS", and presented as Master's Thesis has been written without applying to any assistance inconsistent with scientific ethics and traditions and all sources I have benefited from are listed in bibliography and I have benefited from these sources by means of making references.

02 / 12/ 2013
Ahter ALTAY

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<u>SYMBOLS</u>

n	Number of compared components
A	Pairwise Comparison Matrix
a_{ij}	Elements in Pairwise Comparison Matrix
B	Normalized Matrix
b_{ij}	Elements in Normalized Matrix
w_i	Eigenvector
λ_{max}	Maximum Eigenvalue
CI	Consistency Index
CR	Consistency Ratio
RI	Random Consistency Index
w	Preference (weight) vector
C	The columns are the eigenvectors of the pairwise comparisons of the alternatives
x	The final preference vector

INDEX OF SYMBOLS AND ABBREVIATIONS (continued)

ABBREVIATION

AHP	Analytic Hierarchy Process
TURSAB	Association of Turkish Travel Agency
OP	Operation
UNC	Unconfirmed
ANP	Analytic Network Process
TOPSIS	Technique for the Order of Prioritization by Similarity to Ideal Solution
DEA	Data Envelopment Analysis
w.r.t.	with respect to

1. INTRODUCTION

Tourism industry in Turkey became more popular and expanded day by day because of Turkey is surrounded by sea on three sides that is the advantage of geographical location and the availability of climate has an important role in the development of the tourism industry. In recent years, approximately 31.5 million foreign tourists travelled in Turkey. Tourism industry consists of different service components. These service components include accommodation facilities (hotels, resorts, motels, boutique hotels, etc.), travel agencies and tour operators, food and beverage companies, transportation companies etc.

Travel agencies coordinate details of transportation, accommodation and itineraries for their customers. With the Law No.1618, travel agencies are established upon the issue of an operation License by the Ministry of Tourism, and they are obliged to become members of the Association of Turkish Travel Agencies (TURSAB)

Travel agencies are divided into three groups depending on the type of service carried:

• Group (A) agencies offer and perform all services specified in article 1 of the Law No.1618

• Group (B) agencies sell tickets for international land, sea and air transport and tours arranged by (A) group travel agencies.

• Group (C) agencies organize and sell domestic tours for Turkish citizens.

Group (B) and (C) agencies can also carry out the services which are entrusted to them by (A) group travel agencies. The services offered by the agencies include organizing tours, transfers, reservations, information, incentives, organizing congresses and conferences, individual vehicles renting out for tour purposes, selling tickets for transporting vehicles, selling the products of travel

agencies. Table 1.1 shows that numbers of travel agencies in Turkey (Strateji Geliştirme Başkanlığı, 2013).

Table 1.1 Numbers of Travel Agencies in Turkey

NUMBER OF TRAVEL AGENCIES	
YEAR	NUMBER
2007	5.268
2008	5.519
2009	5.787
2010	6.045
2011	6.366
2012	6.877

In tourism industry, agencies try to carry best service for their customers to be ahead of the competition in this sector. Travel agencies are the retailers of the industry which are in competition with newer intermediaries, communicating with customers via the internet, telephone, digital cable television, or a combination thereof (Beaver, 2005). Thus, alternatives to the requests are made to the customer will be allowed to decide.

One of the services that provided by tourism agencies is the famous "blue cruise". Blue cruise is taken its name from Turkish turquoise waters. Yachts in blue cruise are called gullet, as Turkish name which are constructed in ship yards that have traditional design and also made kind of wooden.

In 1970s, the first samples of the gullets were providing seating area only at aft deck. Those gullets were primarily used for fishing in those years. With changing commercial conditions, gullets began to serve for transportation of passengers with accommodation and eventually they became the primary vessels used for blue cruise. In addition to traditional gullets, the sailboats are also used for blue cruise with or without crew. Throughout this study, we will concern only with the gullets. In order to comply in international terminology, we use the term

"yacht" instead of gullet. Table 1.2 shows that registered yachts in southern Aegean coast in Turkey (Deniz Ticareti Genel Müdürlüğü, 2013:a)

Table 1.2 Numbers of Registered Yachts in Southern Aegean Coast in Turkey

REGISTERED YACHTS IN SOUTHERN AEGEAN COAST PORT AUTHORITY	
PORT AUTHORITY	NUMBER
Bodrum	920
Fethiye	561
Datça	306
Güllük	542
Kuşadası	487
Marmaris	875
TOTAL	3691

Figure 1.1 A typical yacht (wooden gullet) used for blue cruise

The coast line of Turkey is 8,333 kilometers range with coves, bays and numerous beaches. Sailing in Turkey combines great experience with sea and various cruise itineraries. According to Tourism portal of Turkey (Go Turkey, 2013) Turkey's most established marinas lie on the southern Aegean and Mediterranean coasts at Izmir, Çeşme, Kuşadası, Bodrum, Ayvalık, Mersin, Datça, Bozburun, Marmaris, Göcek, Fethiye, Kalkan, Kaş, Finike, Kernel and Antalya.

The coast line from Bodrum to Antalya (see Figure 1.2) is consisted of different itineraries available for blue cruise between period of May and October. There are lots of possible itineraries for a weekly blue cruises, the most widely known itinerary is departure from Bodrum to gulf of Gökova or gulf of Hisarönü itinerary (Anderson, 1989).

Figure 1.2 Coast line from Bodrum to Antalya

The organization of this study is explained as follows: chapter one contains a brief description of tourism industry, blue cruise and tourism agencies. Information and reservation system of the tourism agency and formal statement of the problem is given in chapter two. Chapter three includes literature survey. Chapter four is devoted to a brief explanation of Analytical Hierarchy Process (AHP) methodology. Chapter five contains application of analytic hierarchy process in evaluating the yacht categories. All numerical details and computations are presented in that chapter. Chapter six is consisted of results and discussions.

2. STATEMENT OF THE PROBLEM

"Sungulets" is the name of a tourism agency that operates in Bodrum. It is established at the beginning of 2011. It follows a high quality service approach and seeks the customer satisfaction above all.

The agency operates as shipping agency, deals with boat trading, as well as surveying, maintenance, repair and wintering services for all types of vessels. However, the primary service of the agency is blue cruise by gullets, motor-yachts and sailboats with or without a crew. Bodrum is the most favorable place or port for planning blue cruises and special organizations for individuals, larger groups, national and international associations.

The agency receives reservation requests by telephone or via e-mail from their potential customers. The customer is then contacted by a sales representative and he/she tries to collect all the details of request such as the number of travelers, embarking date, duration of the cruise, preference on the utilities of the yacht etc. The agency reservation process flow - chart shows that process of the operation (see Figure 2.1).

According to the flow - chart, upon receiving request from the customer, appropriate yachts are selected from the agency's yacht portfolio according to the details of customer's request. All available yachts, their characteristics and price information are prepared as an offer package and it is sent to the customer. The offer is evaluated by the customer and then he/she selects a specific yacht and responds as confirmed or unconfirmed via e-mail. Unconfirmed (UNC) offers are thrown into the discard and filed. Confirmed offers are classified into the customer's file.

If we have a confirmed offer, two distinct contracts have been prepared. The first one is signed by customer and the tourism agency. The other one is signed by the yacht owner and tourism agency. The contracts include all relevant information such as the name of the yacht, cruise dates, ports with itineraries and general conditions. A sample contract between the customer and the agency is

shown in Figure 2.2. The contract should be completed 10 days before the beginning of the cruise.

```
                    ┌──────────────────┐
                    │   Reservation    │
                    │     Request      │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │     Request      │
                    │      Form        │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │   Evaluation of  │
                    │ Request by agency│
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │ Preparation of offer │
                    │ and send via email to│
                    │   the customer   │
                    └──────────────────┘
                             │
                             ▼
                         ◇ Offer
                        Confir-
                         mation ◇ ─── no ──→ ┌──────────────┐
                             │               │  Unconfirmed │
                           yes               │     File     │
                             │               └──────────────┘
                             ▼
    ┌────────────┐   ┌──────────────────┐
    │ Operation  │───│ Confirmation mail│
    │   File     │   │   sent to the    │
    └────────────┘   │    customer      │
         ▲           └──────────────────┘
         │                    │
         │                    ▼
         │           ┌──────────────────┐   ┌──────────────┐
         │           │ Preparation of the│──│   Copy of    │
         │           │ customer and yacht│   │ contracts to │
         │           │  owner contract  │   │  accountant  │
         │           └──────────────────┘   └──────────────┘
         │                    │
         │                    ▼
         │           ┌──────────────────┐
         │           │ Sent the contract to│
         │           │ customer and yacht│
         │           │  owner via email │
         │           └──────────────────┘
         │                    │
         │                    ▼
         │           ┌──────────────────┐
         └───────────│  Received signed │
                     │    contracts     │
                     └──────────────────┘
```

Figure 2.1 The tourism agency reservation flow-chart

Dear...

1. **Yacht** : **D06 - 100** 32,00 m, 6 cabins, 12 pax, air conditioned
   Category : Deluxe
   Details : D06 - 100 PDF
   Period : **03.08.2013** Saturday 15:00 - **10.08.2013** Saturday 09:30
   Itinerary : **Bodrum** - **Bodrum**
   Daily Price : ... €

GENERAL CONDITIONS

1. Emberkation is on **Saturdays** at 15:00 & Disemberkation is on **Saturdays** at 09:30 (Standard regulation).
2. Especially during the high season (July - Aug) for Gulets reservations will usually be from Saturday to Saturday on weekly bases.
3. Motoryacht reservations are arranged according to customers offers.
4. The air-conditioning system is at service from 4 hours up to max. 6 hours a day in economy, standard and luxury class yachts.
5. Our yachts have third parties financial responsibility insurance (to have a personal travel insurance is recommended).
6. The yachts' passenger capacity is limited to max. 12 pax according to the licence of registration. (children are included)
7. Greek Island visits are limited to max. 12 people.
8. Schengen visa is needed for non EEC citizens for Greek Island visits.

INCLUDED IN THE RENTAL PRICE

1. Yacht rental fee.
2. Fuel for max. 4 hours (motoryachts excluded) cruising a day (may vary according to the daily itinerary)
3. Bed, Sheets, Towels.
4. Water for daily use.
5. Use of equipment on board (flippers, snorkel & fishing tackles, etc.)
6. Port taxes in the marinas in Turkish waters (private marinas are excluded)
7. Crew service.
8. Daily usage of water (shower and WC)

NOT INCLUDED IN THE RENTAL PRICE

1. Food and beverages, supermarket costs.
2. All fuel costs for motoryachts (we will inform you for estimated costs)
3. VAT tax 18%
4. Airport transfers.
5. Fuel for watersports that use the outboard dinghy on board.
6. Optional land tours, entrance fees for historical places and museums.
7. All port taxes and charges for Greek Island itineraries (Turkish & Greek) and private marinas.
8. Please ask for different reservation conditions.

Figure 2.2 A sample contract between agency and customer

The agencies offer blue cruise for their customers. However, they generally do not have own yachts for blue cruise. Instead, they hold a portfolio that consists of commercial yachts in charter. The agency should be in close contact with the yacht owners at the beginning of the season since a yacht owner may co-operate with other competing agencies. Therefore some tentative agreements are issued with the owners before the season starts.

The yachts are divided into four categories in general. Those categories are: "economy", "standard", "luxury" and "deluxe" yachts. Classification of the yachts depends on the size and variety of utilities that the yachts have. A portfolio should include appropriate numbers of yachts in different categories. The problem is to decide the composition of yachts in the portfolio. If the portfolio is not built efficiently, you may miss some customers demanding a specific category of yacht during the season. Historical data and experience shows that the demand is uncertain and fluctuating with respect to timing and category. It is nearly impossible to make efficient forecasts. Therefore "Sungulets" company, one of the tourism agencies in Bodrum, has decided to focus on the category of yacht and considers building a portfolio consisting of yachts only from one or two categories.

The goal of this study is to evaluate the categories of yachts and ranking them in order to help the agency. The Analytic Hierarchy Process (AHP) is a technique which is used in multi-criteria decision problems. The analytic hierarchy process is related with a model for evaluating and ranking several alternatives. Besides AHP method, there are lots of solutions for decision making such as; Analytic Network Process (ANP), Technique for the Order of Prioritization by Similarity to Ideal Solution (TOPSIS) and Data Envelopment Analysis (DEA). In this study AHP method will be used for evaluating categories.

3. LITERATURE REVIEW

Analytic Hierarchy Process (AHP) is a special technique, used in multi-criteria decision making problems. It is a technique that provides with a systematic structure for evaluating and ranking the alternatives under various criteria.

AHP is proven to be a useful tool especially when decision maker needs to evaluate the alternatives under both qualitative and quantitative criteria. AHP method was introduced by Saaty (1977, 1980), and it is used in a widespread area of applications. The typical application areas are reviewed below.

Evaluating and ranking of suppliers is a major issue in supply chain management for companies. Selecting appropriate supplier is a multi-criteria decision making problem that considers objectives such as cost, quality, delivery, product/services. There are many studies that explains how AHP may be used for selection of a supplier such as Akarte (2011), Chan and Chan (2004), Kahraman et al (2003), Çebi and Bayraktar (2003), Aissaoui (2006).

Evaluating and ranking of projects is another application area in which AHP is used as the primary decision tool. There may be many projects developed in a company. Since the resources are scarce, those projects should be ranked in order to decide the priorities. The projects usually have different aspects and originated from different departments of the company. Therefore they have to be evaluated under both qualitative and quantitative criteria such as contribution to the strategic goals, costs, benefits, urgency, risks etc. For example Pehlivanlı (2005) developed a AHP model to evaluate and decide the importance of the projects in Turkish Army. Some other applications are explained in Al Khalil (2002), Muralidhar et al (1990), Sarhan (2011), Hsing Hung Chen et al (2010).

Strategic Planning deals with developing effective strategies for the companies. AHP may be used for evaluating different alternatives as seen in Zaim et al (2012), Pedrycz (2011).

Employee performance evaluation is a major issue in Human Resources Department of every company / institution. AHP may be used to develop a systematic and effective structure for this problem. Hsin-Pin Fu and Sheng-Wei Lin (2009) investigate appropriate criteria of performance measurement on national energy promotion project. Rangone (1996) develop AHP model to measure and compare the performance of distinct manufacturing departments within the similar company.

In Cost-benefit Analysis, AHP method is used to analyze the appropriate alternative. Evaluation criteria consist of cost, characteristics, technical specifications, risks, safety and flexibility. Tuleda et al (2006) developed an AHP model to conduct cost-benefit analysis in a transport project.

There are not many studies in literature about tourism agencies. Majority of them involve in improvement of service quality in tourism services. Chen (2006) studied convention sector in tourism industry and developed an AHP model for convention site selection problem. Ku and Fan Yiwen (2009) studied on a AHP model to explore the relative weights of the nine proposed fundamental travel products from an Internet perspective. The study comprised customers who had purchased room products from travel agencies websites, with data collected using a questionnaire survey.

Wickramasinghe and Takano (2009) studied a systematic approach and analytical means for tourism revival strategic marketing planning with a combination of SWOT matrix and Analytic Hierarchy Process.

Curry and Moutinho (1992) propose an AHP model which is implemented in an computer software for comparative decisions for environmental issues in tourism management.

4. THE ANALYTICAL HIERARCHY PROCESS

Analytic Hierarchy Process (AHP) is a technique which is used in multi-criteria decision problems to make the best choice between alternatives. AHP is useful tool especially when decision maker needs to evaluate the alternatives under both qualitative and quantitative criteria. Essence of the technique depends on pairwise comparisons to choose the best alternative.

According to Saaty (1994) the analytic hierarchy process is an effective system for solving complex decision making problems, and may assist the decision maker to set priorities and make the best decision.

The analytic hierarchy process method consists of three levels of hierarchy. The first level of hierarchy is the objective of the decision making, the second level of hierarchy is how each of the existing criteria contributes to the achievement, and the last level of hierarchy is to find out how each of the alternatives contributes to each of the criteria. Main structure of hierarchy model is shown in Figure 4.1.

Taylor (2013) explains that the steps of decision making process using by the method are as follows:

- To determine the objective, main-criteria, sub-criteria, alternatives and construction of the hierarchy.
- Make pairwise comparisons of criteria
- Make pairwise comparisons of alternatives for each criteria
- Preparation of pairwise comparison with normalized matrices (each column by dividing the sum of the column)
- Calculation of priority vector (each line is obtained by the taking average)
- Determination of weights and alternative criterion of benchmark scores
- Calculate and check consistency ratio
- Analysis of the AHP scores

GOAL OF THE PROBLEM {

MAIN-CRITERIA {

SUB-CRITERIA {

ALTERNATIVES {
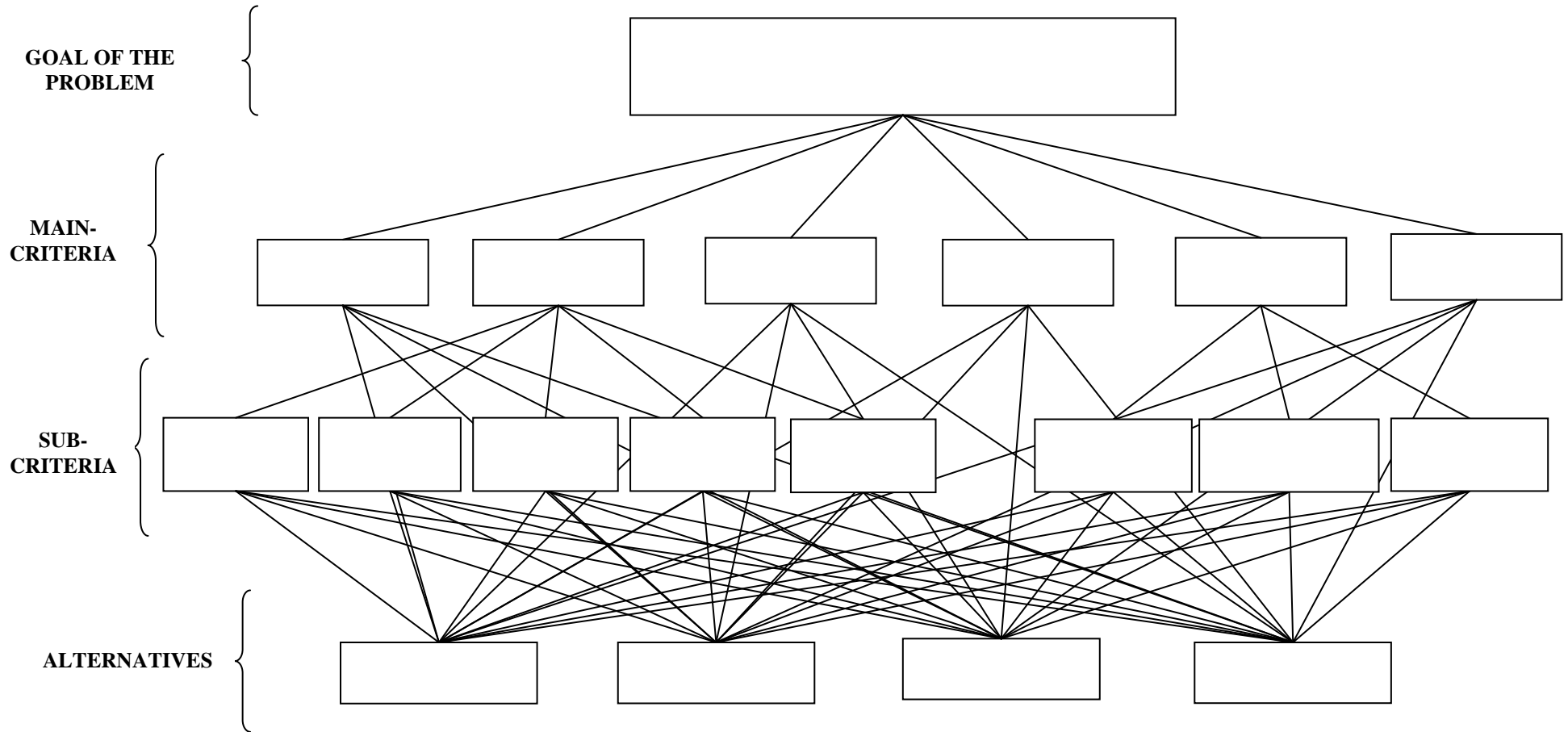
Figure 4.1 Sample Hierarchy Structure

4.1 Basic Principles of AHP Methodology

Saaty (1994) states that AHP method consists of three basic principles which are as defined below:

- Decomposition

The decision problem is decomposed into some hierarchical components such as the objective of the problem, performance criteria including sub-criteria and the solution alternatives. Those components are combined to form a hierarchical tree structure.

- Comparative Judgement

The essence of AHP method is to make pairwise comparisons between the components of the hierarchical structure. Those comparisons help us to evaluate the relative importance of the components. A special evaluation method is used through pairwise comparisons. The results can be observed in the form of Pairwise Comparison Matrices.

- Synthesis of Priority

Each pairwise comparison matrix is used to determine local priorities. The global priorities are then acquired by synthesizing those local priorities that is called weights.

A ratio-scale form is used in pairwise comparisons. It imposes subjective evaluation between the components. Actually it asks the decision maker to decide the relative importance of the components and express the subjective judgement in a numerical format. It shows the degree of preference of a component over the other one. Those values are then stored in the pairwise comparison matrix. The ratio-scale is limited in a range between 1–9. The standard preference scale of pairwise comparison is explained in Table 4.1.

Table 4.1 Preference scale of pairwise comparisons

Intensity of Importance	Definition	Explanation
1	Equally Preferred	Two components contribute equally to the objective
3	Moderate Preferred	Experience and judgement slightly favors one component over another
5	Strong Preferred	Experience and judgement strongly favors one component over another
7	Very Strong Preferred	An component is favored very strongly over another, its dominance demonstrated in practice
9	Extreme Preferred	The evidence favoring one component over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent scale values	-

4.2 Test of Consistency

AHP method checks the consistency of the pairwise comparisons in order to get a reliable solution. Inconsistency arises in different situations. Consider that there are 3 components (A, B and C) are the subject of pairwise comparisons. If the decision maker makes a pairwise comparison between A and B and decides A is moderately preferred over B by using preference intensity 3. Furthermore, consider he/she decides preference intensity is 2 when B compared to C and preference intensity is 2 when A compared to C. The decisions are then showed in a pairwise comparison matrix as shown below.

Table 4.2 Sample Pairwise Comparison Matrix

COMPONENT	A	B	C
A	1	3	2
B		1	2
C			1

There are some missing elements in comparison matrix in Table 4.2. Those missing elements are filled with appropriate reciprocal values. Resulting comparison matrix is shown in Table 4.3

Table 4.3 The Complete Sample Pairwise Comparison Matrix

COMPONENT	A	B	C
A	1	3	2
B	1/3	1	2
C	1/2	1/2	1

There is some inconsistency in Table 4.3 since the preference intensity should be 6 when A compared to C based on the two previous comparisons (A vs. B and B vs. C).

Let a_{ij} denote the elements in the pairwise comparison matrix. This matrix is consistent (consistency matrix) when the following equality is true for each i, j, and k

$$a_{ik}\, a_{kj} = a_{ij} \qquad \forall\, i, j\ and\ k \qquad (1)$$

This formula is an expression of the transitivity of preferences. The inconsistency in Table 4.3 may be revealed for i=1, j=2 and k=3:

Consistency requires $a_{13}\, a_{32} = a_{12}$

However, numerical values don't deliver it : $2 * \frac{1}{2} \neq 3$.

If $a_{13} = 6$ instead of 2, then consistency would be provided.

However, the consistency check is made in a different way in practice. Taylor (2013) defines how a special formula and a "consistency index" is calculated for each pairwise comparison matrix as follows:

n : number of compared components

A : pairwise comparison matrix (for example shown in Table 4.3)

a_{ij} : elements in matrix A (i= 1,..,n; j=1,..,n)

The comparison matrix A is "normalized" in order to get matrix B. Normalization process is conducted simply by dividing each element of a_{ij} by the column totals. Therefore b_{ij}, the elements of matrix B can be found as follows:

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (2)$$

The details of finding matrix B is illustrated in the following two tables.

Table 4.4 Column Totals of Pairwise Comparison Matrix

COMPONENT	A	B	C
A	1	3	2
B	1/3	1	2
C	1/2	1/2	1
SUM OF THE COLUMN	$1 + \frac{1}{3} + \frac{1}{2}$	$3 + 1 + \frac{1}{2}$	$2 + 2 + 1$

Table 4.5 Normalized Matrix

COMPONENT	A	B	C
A	$\frac{1}{1 + \frac{1}{3} + \frac{1}{2}}$	0,67	0,40
B	0,18	0,22	0,40
C	0,27	0,11	0,20

Then, the eigenvector **w** : (w_1, w_2, ... , w_n) of the matrix B is found as follows:

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \tag{3}$$

Table 4.6 Sample Eigenvector

COMPONENT	w_i
A	$\dfrac{0,55 + 0,18 + 0,27}{3}$
B	0,27
C	0,19

Then maximum eigenvalue, λ_{max}, is calculated as follows:

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Aw)_i}{w_i} \tag{4}$$

Numerical calculation is shown below based on the sample above;

$$\lambda_{max} = \frac{1}{3} \left(\frac{Aw_1}{w_1} + \frac{Aw_2}{w_2} + \frac{Aw_3}{w_3} \right) = 3.13$$

After that, the Consistency Index (CI) is defined as follows:

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{5}$$

Numerical calculation is shown below based on the sample above:

$$CI = \frac{3,13 - 3}{3 - 1} = 0,068$$

After that, Consistency Ratio (CR) formula is defined as follows:

$$CR = \frac{CI}{RI} \qquad \text{where RI is Random Consistency Index} \tag{6}$$

Random Consistency Index (RI) values are calculated as a function of the number of components, n. The methodology of calculation is given in Saaty (1994). Those values are shown in Table 4.7.

Table 4.7 Random Consistency Indices

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,52	0,89	1,11	1,25	1,35	1,40	1,45	1,49

Numerical calculation is shown below based on the sample above;

$$CR = \frac{0,068}{0,52} = 0,13$$

The test of consistency is completed when the CR is numerically calculated. The decision of consistency is made depending on the numerical value of CR.

If CR ≥ 10%, achieved data is inconsistent

If CR < 10%, achieved data is consistent

If we are to evaluate the consistency of the sample comparison matrix given in Table 4.3, we need to decide that comparisons are not consistent since CR value is $0.13 \geq 0.10$.

5. APPLICATION OF THE AHP MODEL IN TOURISM AGENCY

The goal of this study is to evaluate the categories of yachts and ranking them in order to help the agency. The Analytic Hierarchy Process will be used for evaluating the categories. AHP is related with a model for evaluating and ranking several alternatives.

5.1 General AHP Model

Generally, there are three main components in AHP hierarchy (see Figure 4.1). They are: the goal of the model, comparison criteria and the alternatives to be ranked.

The goal of the model is defined as "Selection of the Best Yacht Category". The alternatives are the yacht categories "economy", "standard", "luxury" and "deluxe".

The criteria and their hierarchical structure, the comparison criteria of the model are determined by a group meeting consensus of people consisting of professionals from the sector and the customers.

The main-criteria and sub-criteria are defined as follows:

Main-Criteria;

- Price
- Comfort   (it has some sub-criteria)
- Length
- Cruise Speed
- Generator   (it has some sub-criteria)
- Entertainment Equipment

Sub-criteria of Comfort;

- Cabin
- Bathroom
- Outdoor Area
- Indoor Area
- Galley

Sub-criteria of Generator;

- Air condition
- Electronics
- Freezer

Therefore the structure of the hierarchy may be shown below in Figure 5.1.
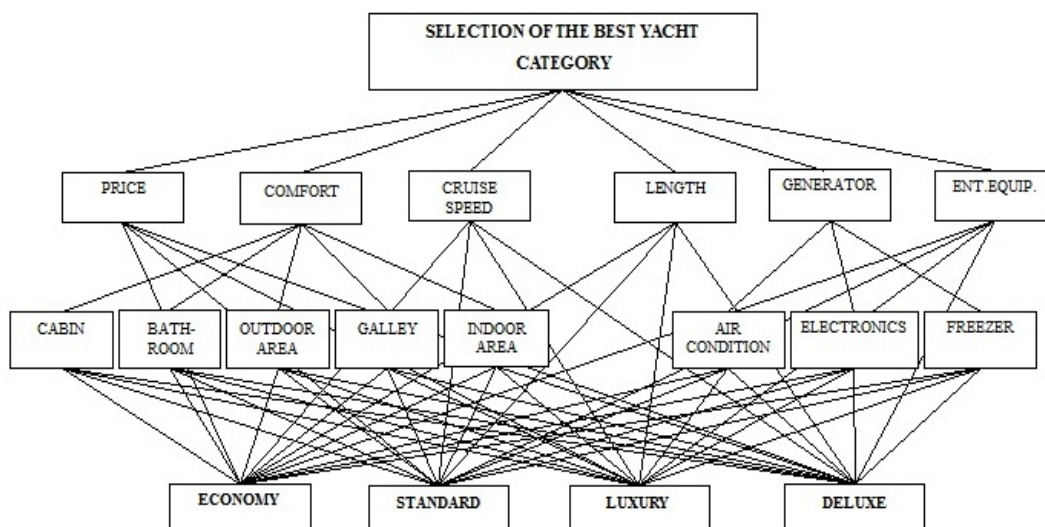
Figure 5.1 Hierarchical Model

5.2 The Details of Comparison Criteria

In this section, the details of the comparison criteria will be presented. Each criterion will be explained in detail and the reason why it is included in the model will be discussed.

5.2.1   Main Criterion : Price

The price criterion is naturally one of the important factors to evaluate the ranking of alternatives since the customers consider the price as one of major factor for their decision.

Price ranges for the alternatives are given below:

- Economy   : daily price 450 €to 750 €, average is 600 €
- Standard   : daily price 500 €to 1500 €, average is 1000 €
- Luxury   : daily price 500 €to 2500 €, average is 1500 €
- Deluxe   : daily price +3000 €, average is 3000 €

The average values are used in the model. Since price criterion consists of numerical values, we don't need to make subjective comparisons. The model takes the numerical values and uses them directly in the synthesis. An alternative is preferred over the other one if its price is lower. The degree of preference changes depending on the difference of the prices. Therefore an alternative gets higher priority as its price decrease.

5.2.2. Main Criterion : Comfort

Another factor that the customers consider is the comfort of the yacht. They demand some facilities in the boat which they can enjoy. The "comfort" criterion is defined as the combination of five sub-criteria which are: cabin, bathroom, outdoor area, indoor area and galley (see Figure 5.2).
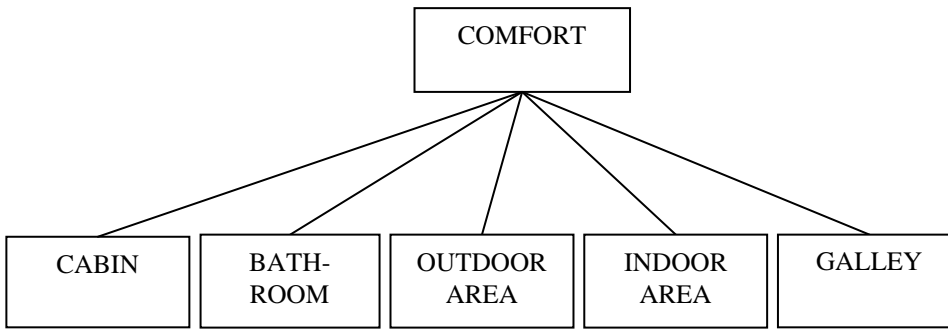
Figure 5.2 Sub-criteria for the main criterion "Comfort"

The sub-criterion "Cabin" refers to the rooms in the yacht. The numbers and sizes of cabins play important role on the decision of the customers. The cabins included in the alternatives are presented in Table below.

- Economy : 4 cabins
- Standard : 6 cabins
- Luxury : 8 cabins
- Deluxe : 6 cabins

Since this sub-criterion consists of numerical values, we don't need to make subjective comparisons. An alternative is preferred over the other one if the number of cabins is more than that of the other one. The degree of preference changes depending on the difference of number of cabins. Therefore an alternative gets higher priority as the number of cabins increases.

Figure 5.3 Sample of standard alternative yacht cabins

Another sub-criterion is the user friendliness of "Bathroom" in the yacht. The type and operating characteristics of bathroom equipment differ in different

alternatives. Economy yachts generally have pump and marine type toilets which are not pleasant to use. Standard yachts have electrically operated and/or home type toilets. Luxury and deluxe yachts have classical home type toilets which are much more preferred. Subjective comparisons should be made to evaluate the user friendliness of the bathrooms.

The third sub-criterion related to the comfort is the convenience of "Outdoor Areas" in the boat. Generally, gullet's outdoor area consists of fore and aft deck open space areas which are customers can enjoy for sunbathing and dining activities. On the aft deck, rounded sofa and behind dining table, while on the spacious aft deck there are sunbathing mattresses and generally another seating area on board. The degree of convenience and the size of outdoor areas differ depending on the type of the yacht. Subjective comparisons should be made to evaluate the convenience of outdoor areas.

Figure 5.4 Outdoor area of the gullets; fore and aft deck

The fourth sub-criterion related to the comfort is the convenience of "Indoor Areas" in the boat. The alternative yacht types are evaluated with subjective judgements considering the size of living area inside, facilities included such as saloon with seating equipment, electrical gadgets, american bar etc.

Figure 5.5 Indoor areas of the gullets

The fifth sub-criterion related to the comfort is the "Galley" which refers to kitchen in the boat. The alternative yacht types are evaluated with subjective judgements considering design and size of the kitchen. Some kitchens are very small and at the lower deck of the boat, whereas some other kitchens are wide, comfortable and have windows.

Figure 5.6 Sample of gullets galley

5.2.3. Main Criterion: Length

Gullets have all limited and restricted area, customers who live in this limited area during the blue cruise. Therefore gullet length is an important factor for the customers. If gullet is bigger, then the customers will have more leisure area and they feel more comfortable.

The lengths are naturally different depending on the type of the yacht. However, the average lengths of each type has been calculated and presented as follows:

- Economy   : 18.12 meter
- Standard   : 22.63 meter
- Luxury   : 27.23 meter
- Deluxe   : 30.66 meter

Since this sub-criterion consists of numerical values, we don't need to make subjective comparisons. An alternative is preferred over the other one if its length is bigger than of the other one. The degree of preference changes depending on the difference of lengths. Therefore an alternative gets higher priority as the length increases.

5.2.4. Main Criterion: Cruise Speed

The cruise speed of the yacht is another important factor for renting decisions. Normally customers would like to prefer the yacht with higher speed. However, the nature of the blue cruise and the structure of the gullets lead the customers to prefer a boat with lower speed. Because it is better to cruise slowly for better sight-seeing. Furthermore, if the cruise speed is low, the noise and vibrations on the boat structure gets decrease, and it provides more comfortable travel for the customers. The average speeds of alternative yacht types are determined and used in evaluation.

The average speeds for the alternatives are given below:

- Economy   : 6.5 knots
- Standard   : 7.5 knots
- Luxury   : 9.5 knots
- Deluxe   : 9.5 knots

Since this criterion consists of numerical values, we don't need to make subjective comparisons. An alternative is preferred over the other one if its speed is lower than of the other one. The degree of preference changes depending on the difference of speeds. Therefore an alternative gets higher priority as the speed decreases.

5.2.5. Main Criterion: Generator

All yachts have generators that provide electricity supply for some equipment and gadgets. Therefore generator provides convenience for life in the boat. The convenience is defined as a combination of three sub-criteria which are: air condition, electronics and freezer (see Figure 5.7).
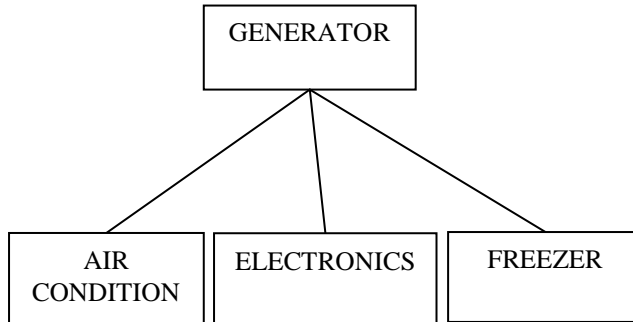
Figure 5.7 Sub-criteria for main criterion "Generator"

The existence of "Air Condition" is especially important since the summer season is very hot at blue cruise season. Yachts with air condition systems are naturally preferred over the others which don't have air conditioning.

It is a specific case for each yacht having air conditioning system, and it is generally independent of the yacht type. An economy yacht may have air conditioning system while a standard yacht may not. It is detected that 15% of economy class and 80% of standard class yachts have air conditioning system. Luxury and Deluxe categories all have air conditioning systems. Those numerical values are used in evaluating the alternatives and we don't need subjective judgements here.

Another sub-criterion is "Electronics". There are lots of electronic equipment in yachts that provide convenience for customers. The term electronics refers to whether equipment such as TV, DVD player and audio system exist on the boat. The comparisons are made using subjective judgements depending on the coverage of those systems

The third sub-criterion is the existence of "Freezer" in the boat. The term "freezer" includes the equipment such as refrigerator, deep freezer and ice maker. They provide great convenience for the customers during the cruise.

5.2.6. Main Criterion: Entertainment Equipment

Blue cruise yachts provide lots of entertainment equipment on board for the customer's leisure times such as fishing and snorkeling equipment, canoe, water-ski, windsurf, ringo, banana, kneeboard, jet-ski, wake-skate, wake-board, mono-ski.

Economy yachts generally have only fishing and snorkeling equipment. Standard yachts have some additional equipment used for water-sports like canoes, water-ski or wind-surf. The number and quality of equipment is higher in luxury yachts. Deluxe yachts have all kind of such entertainment equipment onboard.

The comparisons with respect to this criterion are made using subjective judgements depending on the coverage of this equipment.
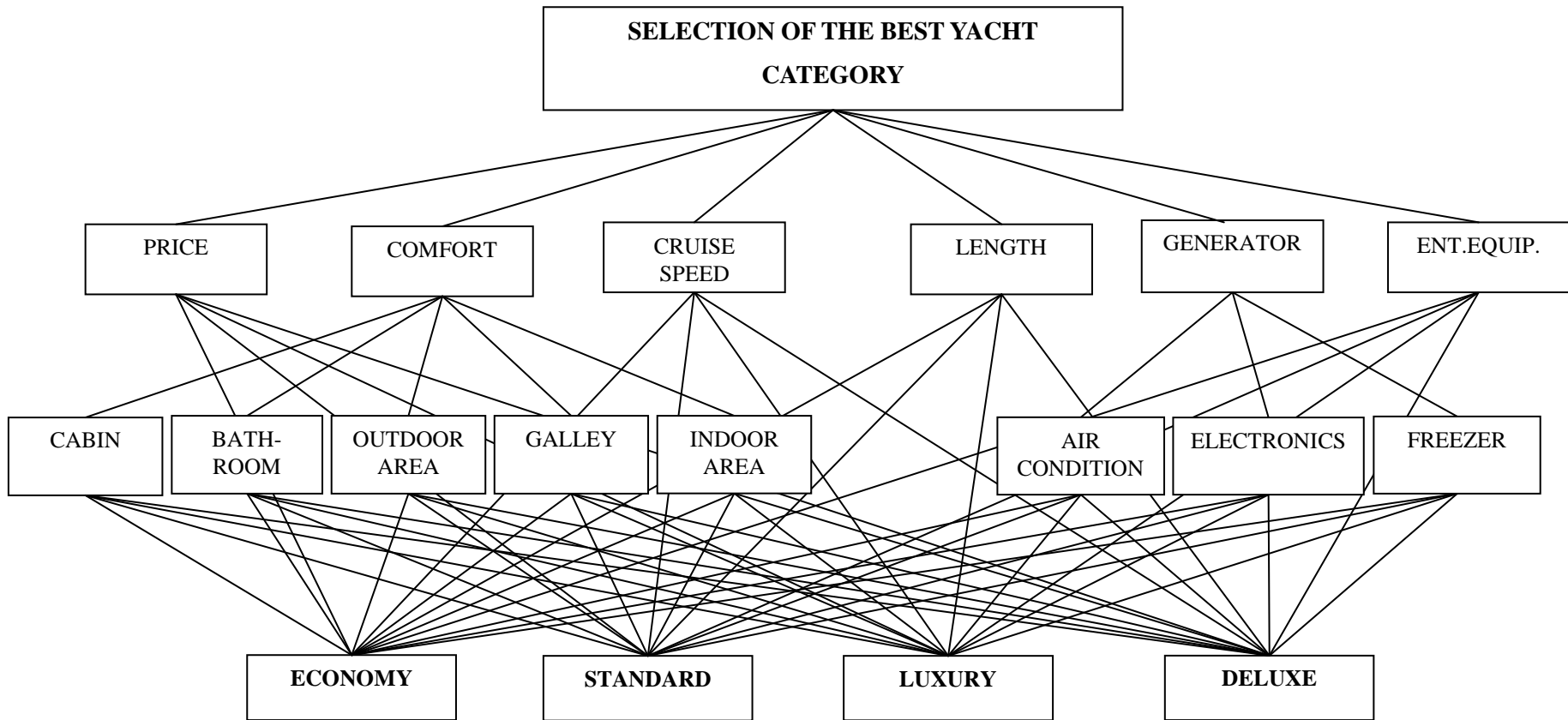
Figure 5.8 AHP model

5.3 Evaluation of the Hierarchy

As stated before, the essence of AHP is pairwise comparisons. The synthesis of AHP model is then made by manipulating pairwise comparison matrices. The comparison matrices may have subjective judgements or some direct numerical values. All the subjective judgements are made five people who are the managing partners of the tourism agency.

The synthesis or the overall outcome of the model is found in two stages. The local priorities of main and sub-criteria are calculated in the first stage. In the second stage, the local priorities of alternatives are found with respect to each main or sub-criteria, and finally overall outcome is found using those local priorities.

The first stage starts with the comparisons at the first level which refer to pairwise comparisons of main criteria (see Table 5.2). The values represent subjective judgements.

Table 5.1 Pairwise Comparison Matrix for Main Criteria

MAIN CRITERIA	Price	Comfort	Length	Cruise Speed	Generator	Entertainment Equipment
Price	1,00	2,00	6,00	6,00	4,00	4,00
Comfort	0,50	1,00	5,00	5,00	4,00	3,00
Length	0,17	0,20	1,00	2,00	0,33	0,25
Cruise Speed	0,17	0,20	0,50	1,00	0,25	0,25
Generator	0,25	0,25	3,00	4,00	1,00	0,33
Entertainment Equipment	0,25	0,33	4,00	4,00	3,00	1,00
Sum	2,3333	3,9833	19,5000	22,0000	12,5833	8,8333

Pairwise comparison matrix is then normalized and consistency ratio is calculated as explained in section 4.2 and presented in Table 5.2.

Table 5.2 Normalized Matrix of Main Criteria

MAIN CRITERIA	Price	Comfort	Length	Cruise Speed	Generator	Entertainment Equipment
Price	0,4286	0,5021	0,3077	0,2727	0,3179	0,4528
Comfort	0,2143	0,2510	0,2564	0,2273	0,3179	0,3396
Length	0,0714	0,0502	0,0513	0,0909	0,0265	0,0283
Cruise Speed	0,0714	0,0502	0,0256	0,0455	0,0199	0,0283
Generator	0,1071	0,0628	0,1538	0,1818	0,0795	0,0377
Entertainment Equipment	0,1071	0,0837	0,2051	0,1818	0,2384	0,1132

Consistency Ratio (CR) of matrix =0,06

The relative importance, or weights, or the local priorities of main criteria are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.3.

Table 5.3 Weights of Main Criteria

WEIGHTS	
Price	0,3803
Comfort	0,2678
Entertainment Equipment.	0,1549
Generator	0,1038
Length	0,0531
Cruise Speed	0,0402

At the second level of the hierarchy, we need to make pairwise comparisons to find the local priorities of the sub-criteria. The first comparison matrix is developed for the sub-criteria of "Comfort". The pairwise comparison matrix is presented in Table 5.4.

Table 5.4 Pairwise Comparison Matrix for the sub-criteria of "Comfort"

MAIN CRITERION: COMFORT					
SUB-CRITERIA	Cabin	Bathroom	Outdoor Area	Indoor Area	Galley
Cabin	1,00	2,00	5,00	7,00	4,00
Bathroom	0,50	1,00	4,00	7,00	3,00
Outdoor Area	0,20	0,25	1,00	3,00	0,25
Indoor Area	0,14	0,14	0,33	1,00	0,20
Galley	0,25	0,33	4,00	5,00	1,00
Sum	2,0929	3,7262	14,3333	23,0000	8,4500

Pairwise comparison matrix is then normalized and consistency ratio is calculated as shown in Table 5.5.

Table 5.5 Normalized Matrix of the sub-criteria of "Comfort"

SUB-CRITERIA	Cabin	Bathroom	Outdoor Area	Indoor Area	Galley
Cabin	0,4778	0,5367	0,3488	0,3043	0,4734
Bathroom	0,2389	0,2684	0,2791	0,3043	0,3550
Outdoor Area	0,0956	0,0671	0,0698	0,1304	0,0296
Indoor Area	0,0683	0,0383	0,0233	0,0435	0,0237
Galley	0,1195	0,0895	0,2791	0,2174	0,1183

Consistency Ratio (CR) of matrix =0,06

The relative importance or the local priorities of these sub-criteria are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.6.

Table 5.6 Weights of the sub-criteria of "Comfort"

WEIGHTS	
Cabin	0,4282
Bathroom	0,2891
Outdoor Area	0,0785
Indoor Area	0,0394
Galley	0,1647

The other comparison matrix is developed for the sub-criteria of "Generator". The pairwise comparison matrix is presented in Table 5.7.

Table 5.7 Pairwise Comparison Matrix for the sub-criteria of "Generator"

MAIN CRITERION: GENERATOR			
SUB-CRITERIA	Freezer	Electronics	Air condition
Freezer	1,00	3,00	0,33
Electronics	0,33	1,00	0,20
Air condition	3,00	5,00	1,00
Sum	4,3333	9,0000	1,5333

Pairwise comparison matrix is then normalized and consistency ratio is calculated as shown in Table 5.8.

Table 5.8 Normalized matrix of the sub-criteria of "Generator"

SUB-CRITERIA	Freezer	Electronics	Air condition
Freezer	0,2308	0,3333	0,2174
Electronics	0,0769	0,1111	0,1304
Air condition	0,6923	0,5556	0,6522

Consistency Ratio (CR) of matrix =0,03

The relative importance or the local priorities of these sub-criteria are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.9.

Table 5.9 Weights of the sub-criteria of "Generator"

WEIGTH	
Freezer	0,2605
Electronics	0,1062
Air condition	0,6333

The calculations for the first stage are finished here. As a result of this first stage, the local priorities of main and sub-criteria are calculated. These priorities are summarized in Table 5.10 below. The entries in the last row of that table represent the preference (weight) vector **w** for the comparison criteria.

Table 5.10 Priority values of main-criteria and sub-criteria

Main-criteria	Price	Comfort					Entertainment Equipment	Generator			Length	Cruise Speed
Main-criteria Weights	0,3803	0,2678					0,1549	0,1038			0,0531	0,0402
Sub-criteria	▉	Cabin	Bathroom	Outdoor Area	Indoor Area	Galley	▉	Air condition	Electronics	Freezer	▉	
Sub-criteria Weights	▉	0,4282	0,2891	0,0785	0,0394	0,1647	▉	0,6333	0,1062	0,2605	▉	
Local Priorities (Weights)	0,3803	0,1147	0,0774	0,0210	0,0106	0,0441	0,1549	0,0657	0,0110	0,0270	0,0531	0,0401

w: preference (weight) vector

In the second stage, the local priorities of alternatives should be calculated with respect to each main or sub-criteria. The first comparison of alternatives is done with respect to main criterion "Price". The comparison matrix is given below in Table 5.11. The comparison matrix does not include any subjective judgement since this criterion is related with numerical values. The entries in this matrix are calculated by the actual prices of the alternatives explained in section 5.2.1.

Table 5.11 Pairwise Comparisons w.r.t. "Price"

Price	Economy	Standard	Luxury	Deluxe
Economy	1,00	**1000€/600€**	**1500€/600€**	**3000€/600€**
Standard	0,60	1,00	**1500€/1000€**	**3000€/1000€**
Luxury	0,40	0,67	1,00	**3000€/1500€**
Deluxe	0,20	0,33	0,50	1,00
Sum	2,2000	3,6667	5,5000	11,0000

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.12.

Table 5.12 Normalized Matrix w.r.t. "Price"

Price	Economy	Standard	Luxury	Deluxe
Economy	0,4545	0,4545	0,4545	0,4545
Standard	0,2727	0,2727	0,2727	0,2727
Luxury	0,1818	0,1818	0,1818	0,1818
Deluxe	0,0909	0,0909	0,0909	0,0909

Consistency Ratio (CR) of matrix =0,00

The relative importance or the local priorities of alternatives w.r.t. "Price" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.13.

Table 5.13 Local Priorities of Alternatives w.r.t. "Price"

WEIGHTS	
Economy	0,4545
Standard	0,2727
Luxury	0,1818
Deluxe	0,0909

The second comparison of alternatives is done with respect to sub criterion "Cabin". The comparison matrix is given below in Table 5.14. The comparison matrix does not include any subjective judgement since this criterion is related with numerical values. The entries in this matrix are calculated by the actual average cabin numbers of the alternatives explained in section 5.2.2.

Table 5.14 Pairwise Comparisons w.r.t. "Cabin"

Cabin	Economy	Standard	Luxury	Deluxe
Economy	1,00	4cabin/6cabin	4cabin/8cabin	4cabin/6cabin
Standard	1,50	1,00	6cabin/8cabin	6cabin/6cabin
Luxury	2,00	1,33	1,00	8cabin/6cabin
Deluxe	1,50	1,00	0,75	1,00
Sum	6,000	4,000	3,000	4,000

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.15.

Table 5.15 Normalized Matrix w.r.t. "Cabin"

Cabin	Economy	Standard	Luxury	Deluxe
Economy	0,1666	0,1666	0,1666	0,1666
Standard	0,2500	0,2500	0,2500	0,2500
Luxury	0,3333	0,3333	0,3333	0,3333
Deluxe	0,2500	0,2500	0,2500	0,2500

Consistency Ratio (CR) of matrix =0,00

The relative importance or the local priorities of alternatives w.r.t. "Cabin" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.16.

Table 5.16 Local Priorities of Alternatives w.r.t. "Cabin"

WEIGHTS	
Economy	0,1666
Standard	0,2500
Luxury	0,3333
Deluxe	0,2500

The third comparison of alternatives is done with respect to sub criterion "Bathroom". The comparison matrix is given below in Table 5.17. The comparison matrix includes subjective judgement. The entries in this matrix are determined depending on the considerations explained in section 5.2.2.

Table 5.17 Pairwise Comparisons w.r.t. "Bathroom"

Bathroom	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,33	0,20	0,14
Standard	3,00	1,00	0,33	0,20
Luxury	5,00	3,00	1,00	0,33
Deluxe	7,00	5,00	3,00	1,00
Sum	16,0000	9,3333	4,5333	1,6762

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.18.

Table 5.18 Normalized Matrix w.r.t. "Bathroom"

Bathroom	Economy	Standard	Luxury	Deluxe
Economy	0,0625	0,0357	0,0441	0,0852
Standard	0,1875	0,1071	0,0735	0,1193
Luxury	0,3125	0,3214	0,2206	0,1989
Deluxe	0,4375	0,5357	0,6618	0,5966

Consistency Ratio (CR) of matrix =0,04

The relative importance or the local priorities of alternatives w.r.t. "Bathroom" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.19.

Table 5.19 Local Priorities of Alternatives w.r.t. "Bathroom"

WEIGHTS	
Economy	0,0569
Standard	0,1219
Luxury	0,2633
Deluxe	0,5579

The fourth comparison of alternatives is done with respect to sub criterion "Outdoor Area". The comparison matrix is given below in Table 5.20. The comparison matrix includes subjective judgement. The entries in this matrix are determined depending on the considerations explained in section 5.2.2.

Table 5.20 Pairwise Comparisons w.r.t. "Outdoor Area"

Outdoor Area	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,33	0,33	0,20
Standard	3,00	1,00	0,50	0,33
Luxury	3,00	2,00	1,00	0,50
Deluxe	5,00	3,00	2,00	1,00
Sum	12,0000	6,3333	3,8333	2,0333

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.21.

Table 5.21 Normalized Matrix w.r.t. "Outdoor Area"

Outdoor Area	Economy	Standard	Luxury	Deluxe
Economy	0,0833	0,0526	0,0870	0,0984
Standard	0,2500	0,1579	0,1304	0,1639
Luxury	0,2500	0,3158	0,2609	0,2459
Deluxe	0,4167	0,4737	0,5217	0,4918

Consistency Ratio (CR) of matrix =0,02

The relative importance or the local priorities of alternatives w.r.t. "Outdoor Area" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.22.

Table 5.22 Local Priorities of Alternatives w.r.t. "Outdoor Area"

WEIGHTS	
Economy	0,0803
Standard	0,1756
Luxury	0,2681
Deluxe	0,4760

The fifth comparison of alternatives is done with respect to sub criterion "Indoor Area". The comparison matrix is given below in Table 5.23. The comparison matrix includes subjective judgements. The entries in this matrix are determined depending on the considerations explained in section 5.2.2.

Table 5.23 Pairwise Comparisons w.r.t. "Indoor Area"

Indoor Area	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,33	0,20	0,14
Standard	3,00	1,00	0,33	0,20
Luxury	5,00	3,00	1,00	0,33
Deluxe	7,00	5,00	3,00	1,00
Sum	16,0000	9,3333	4,5333	1,6762

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.24.

Table 5.24 Normalized Matrix w.r.t. "Indoor Area"

Indoor Area	Economy	Standard	Luxury	Deluxe
Economy	0,0625	0,0357	0,0441	0,0852
Standard	0,1875	0,1071	0,0735	0,1193
Luxury	0,3125	0,3214	0,2206	0,1989
Deluxe	0,4375	0,5357	0,6618	0,5966

Consistency Ratio (CR) of matrix =0,04

The relative importance or the local priorities of alternatives w.r.t. "Indoor Area" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.25.

Table 5.25 Local Priorities of Alternatives w.r.t. "Indoor Area"

WEIGHTS	
Economy	0,0569
Standard	0,1219
Luxury	0,2633
Deluxe	0,5579

The sixth comparison of alternatives is done with respect to sub criterion "Galley". The comparison matrix is given below in Table 5.26. The comparison matrix includes subjective judgements. The entries in this matrix are determined depending on the considerations explained in section 5.2.2.

Table 5.26 Pairwise Comparisons w.r.t. "Galley"

Galley	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,50	0,20	0,20
Standard	2,00	1,00	0,33	0,20
Luxury	5,00	3,00	1,00	0,50
Deluxe	5,00	5,00	2,00	1,00
Sum	13,0000	9,5000	3,5333	1,9000

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.27.

Table 5.27 Normalized Matrix w.r.t. "Galley"

Galley	Economy	Standard	Luxury	Deluxe
Economy	0,0769	0,0526	0,0566	0,1053
Standard	0,1538	0,1053	0,0943	0,1053
Luxury	0,3846	0,3158	0,2830	0,2632
Deluxe	0,3846	0,5263	0,5660	0,5263

Consistency Ratio (CR) of matrix =0,02

The relative importance or the local priorities of alternatives w.r.t. "Galley" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.28.

Table 5.28 Local Priorities of Alternatives w.r.t. "Galley"

WEIGHTS	
Economy	0,0729
Standard	0,1147
Luxury	0,3116
Deluxe	0,5008

The seventh comparison of alternatives is done with respect to main criterion "Length". The comparison matrix is given below in Table 5.29. The comparison matrix does not include any subjective judgements since this criterion is related with numerical values. The entries in this matrix are calculated by the average lengths of each type of the alternatives explained in section 5.2.3.

Table 5.29 Pairwise Comparisons w.r.t. "Length"

Length	Economy	Standard	Luxury	Deluxe
Economy	1,00	**18,12m/22,63m**	**18,12m/27,23m**	**18,12m/30,66m**
Standard	1,25	1,00	**22,63m/27,23m**	**22,63m/30,66m**
Luxury	1,50	1,20	1,00	**27,23m/30,66m**
Deluxe	1,69	1,35	1,13	1,00
Sum	5,4437	4,3588	3,6225	3,2172

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.30.

Table 5.30 Normalized Matrix w.r.t. "Length"

Length	Economy	Standard	Luxury	Deluxe
Economy	0,1837	0,1837	0,1837	0,1837
Standard	0,2294	0,2294	0,2294	0,2294
Luxury	0,2761	0,2761	0,2761	0,2761
Deluxe	0,3108	0,3108	0,3108	0,3108

Consistency Ratio (CR) of matrix =0,00

The relative importance or the local priorities of alternatives w.r.t. "Length" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.31.

Table 5.31 Local Priorities of Alternatives w.r.t. "Length"

WEIGHTS	
Economy	0,1837
Standard	0,2294
Luxury	0,2761
Deluxe	0,3108

The eighth comparison of alternatives is done with respect to main criterion "Cruise Speed". The comparison matrix is given below in Table 5.32. The comparison matrix does not include any subjective judgement since this criterion is related with numerical values. The entries in this matrix are calculated by the average speeds of yacht types of the alternatives explained in section 5.2.4.

Table 5.32 Pairwise Comparisons w.r.t. "Cruise Speed"

Cruise Speed	Economy	Standard	Luxury	Deluxe
Economy	1,00	7,5knots/6,5knots	9,5knots/6,5knots	9,5knots/6,5knots
Standard	0,87	1,00	9,5knots/7,5knots	9,5knots/7,5knots
Luxury	0,68	0,79	1,00	9,5knots/9,5knots
Deluxe	0,68	0,79	1,00	1,00
Sum	3,2351	3,7328	4,7282	4,7282

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.33.

Table 5.33 Normalized Matrix w.r.t. "Cruise Speed"

Cruise Speed	Economy	Standard	Luxury	Deluxe
Economy	0,3091	0,3091	0,3091	0,3091
Standard	0,2679	0,2679	0,2679	0,2679
Luxury	0,2115	0,2115	0,2115	0,2115
Deluxe	0,2115	0,2115	0,2115	0,2115

Consistency Ratio (CR) of matrix =0,00

The relative importance or the local priorities of alternatives w.r.t. "Cruise Speed" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.34.

Table 5.34 Local Priorities of Alternatives w.r.t. "Cruise Speed"

WEIGHTS	
Economy	0,3091
Standard	0,2679
Luxury	0,2115
Deluxe	0,2115

The nineth comparison of alternatives is done with respect to sub criterion "Air Condition". The comparison matrix is given below in Table 5.35. The comparison matrix does not include any subjective judgements since this criterion is related with numerical values. The entries in this matrix are calculated by the existence of percentage values of yacht types of the alternatives explained in section 5.2.5.

Table 5.35 Pairwise Comparisons w.r.t. "Air Condition"

Air Condition	Economy	Standard	Luxury	Deluxe
Economy	1,00	**15%/80%**	**15%/100%**	**15%/100%**
Standard	5,33	1,00	**80%/100%**	**80%/100%**
Luxury	6,67	1,25	1,00	**100%/100%**
Deluxe	6,67	1,25	1,00	1,00
Sum	19,6667	3,6875	2,9500	2,9500

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.36.

Table 5.36 Normalized Matrix w.r.t. "Air Condition"

Air Condition	Economy	Standard	Luxury	Deluxe
Economy	0,0508	0,0508	0,0508	0,0508
Standard	0,2712	0,2712	0,2712	0,2712
Luxury	0,3390	0,3390	0,3390	0,3390
Deluxe	0,3390	0,3390	0,3390	0,3390

Consistency Ratio (CR) of matrix =0,00

The relative importance or the local priorities of alternatives w.r.t. "Air Condition" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.37.

Table 5.37 Local Priorities of Alternatives w.r.t. "Air Condition"

WEIGHTS	
Economy	0,0508
Standard	0,2712
Luxury	0,3390
Deluxe	0,3390

The tenth comparison of alternatives is done with respect to sub criterion "Electronics". The comparison matrix is given below in Table 5.38. The comparison matrix includes subjective judgement. The entries in this matrix are determined depending on the considerations explained in section 5.2.5.

Table 5.38 Pairwise Comparisons w.r.t. "Electronics"

Electronics	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,33	0,33	0,20
Standard	3,00	1,00	0,50	0,25
Luxury	3,00	2,00	1,00	1,00
Deluxe	5,00	4,00	1,00	1,00
Sum	12,0000	7,3333	2,8333	2,4500

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.39.

Table 5.39 Normalized Matrix w.r.t. "Electronics"

Electronics	Economy	Standard	Luxury	Deluxe
Economy	0,0833	0,0455	0,1176	0,0816
Standard	0,2500	0,1364	0,1765	0,1020
Luxury	0,2500	0,2727	0,3529	0,4082
Deluxe	0,4167	0,5455	0,3529	0,4082

Consistency Ratio (CR) of matrix =0,04

The relative importance or the local priorities of alternatives w.r.t. "Electronics" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.40.

Table 5.40 Local Priorities of Alternatives w.r.t. "Electronics"

WEIGHT	
Economy	0,0820
Standard	0,1662
Luxury	0,3210
Deluxe	0,4308

The eleventh comparison of alternatives is done with respect to sub criterion "Freezer". The comparison matrix is given below in Table 5.41. The comparison

matrix includes subjective judgements. The entries in this matrix are determined depending on the considerations explained in section 5.2.5.

Table 5.41 Pairwise Comparisons w.r.t. "Freezer"

Freezer	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,50	0,50	0,33
Standard	2,00	1,00	0,50	0,50
Luxury	2,00	2,00	1,00	1,00
Deluxe	3,00	2,00	1,00	1,00
Sum	8,0000	5,5000	3,0000	2,8333

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.42.

Table 5.42 Normalized Matrix w.r.t. "Freezer"

Freezer	Economy	Standard	Luxury	Deluxe
Economy	0,1250	0,0909	0,1667	0,1176
Standard	0,2500	0,1818	0,1667	0,1765
Luxury	0,2500	0,3636	0,3333	0,3529
Deluxe	0,3750	0,3636	0,3333	0,3529

Consistency Ratio (CR) of matrix =0,01

The relative importance or the local priorities of alternatives w.r.t. "Freezer" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.43.

Table 5.43 Local Priorities of Alternatives w.r.t. "Freezer"

WEIGHT	
Economy	0,1251
Standard	0,1937
Luxury	0,3250
Deluxe	0,3562

The twelfth comparison of alternatives is done with respect to main criterion "Entertainment Equipment". The comparison matrix is given below in Table 5.44. The comparison matrix includes subjective judgements. The entries in this matrix are determined depending on the considerations explained in section 5.2.6.

Table 5.44 Pairwise Comparisons w.r.t. "Entertainment Equipment"

Entertainment Equipment	Economy	Standard	Luxury	Deluxe
Economy	1,00	0,50	0,33	0,14
Standard	2,00	1,00	1,00	0,20
Luxury	3,00	1,00	1,00	0,33
Deluxe	7,00	5,00	3,00	1,00
Sum	13,0000	7,5000	5,3333	1,6762

Pairwise comparison matrix is then normalized and consistency ratio is calculated and presented in Table 5.45.

Table 5.45 Normalized Matrix w.r.t. "Entertainment Equipment"

Entertainment Equipment	Economy	Standard	Luxury	Deluxe
Economy	0,0769	0,0667	0,0625	0,0852
Standard	0,1538	0,1333	0,1875	0,1193
Luxury	0,2308	0,1333	0,1875	0,1989
Deluxe	0,5385	0,6667	0,5625	0,5966

Consistency Ratio (CR) of matrix =0,01

The relative importance or the local priorities of alternatives w.r.t. "Entertainment Equipment" are then defined by the averages of each row in normalized matrix. These values are presented in Table 5.46.

Table 5.46 Local Priorities of Alternatives w.r.t. "Entertainment Equipment"

WEIGHT	
Economy	0,0728
Standard	0,1485
Luxury	0,1876
Deluxe	0,5911

The second stage of evaluation is completed here. At the end of this stage, the weights of pairwise comparisons of alternatives are summarized in the table 5.47 below. The entries in the shaded area represent the matrix **C** whose columns are the eigenvectors of the pairwise comparisons of the alternatives with respect to all the evaluation criteria placed above them in the hierarchy.

Table 5.47 Final Calculations

MAIN-CRITERIA	SUB-CRITERIA	EVALUATION CRITERIA	ECONOMY	STANDARD	LUXURY	DELUXE
Price	*	Price	0,4545	0,2727	0,1818	0,0909
Comfort	Cabin	Cabin	0,1666	0,2500	0,3333	0,2500
	Bathroom	Bathroom	0,0569	0,1219	0,2633	0,5579
	Outdoor Area	Outdoor Area	0,0803	0,1756	0,2681	0,4760
	Indoor Area	Indoor Area	0,0569	0,1219	0,2633	0,5579
	Galley	Galley	0,0729	0,1147	0,3116	0,5008
Length	*	Length	0,1837	0,2294	0,2761	0,3108
Cruise Speed	*	Cruise Speed	0,3091	0,2679	0,2115	0,2115
Generator	Air Condition	Air Condition	0,0508	0,2712	0,3390	0,3390
	Electronics	Electronics	0,0820	0,1662	0,3210	0,4308
	Freezer	Freezer	0,1251	0,1937	0,3250	0,3562
Entertainment Equipment	*	Entertainment Equipment	0,0728	0,1485	0,1876	0,5911

Matrix **C**:

The columns are the eigenvectors of the pairwise comparisons of the alternatives with respect to all the evaluation criteria placed above them in the hierarchy.

6. RESULTS

The goal of this study is to evaluate the categories of yachts and ranking them in order to help the agency. The yachts are divided into four categories in general. Classification of the yachts depends on the size and variety of utilities that the yachts have. A portfolio should include appropriate numbers of yachts in different categories. Therefore "Sungulets" company, one of the tourism agencies in Bodrum, has decided to focus on the category of yacht and considers building a portfolio consisting of yachts only from one or two categories. The model will be assisted to appropriate categories to get the portfolio for the season. In this section, overall outcomes of the AHP model will be presented.

In previous chapter, we have presented the preference vector **w** for comparison criteria (see Table 5.10), and the eigenvectors of the pairwise comparisons of alternatives. The eigenvectors form the matrix **C** (see Table 5.47)

The overall synthesis, or the outcomes of the AHP model is given by

$$x = C * w \text{ , where } \mathbf{x} \text{ is the final preference vector} \qquad (7)$$

The numerical values for calculations and details of matrix multiplication are shown in Figure 6.1. The results for the final preference or weights of the alternatives are given in the table below:

Table 6.1 Solution of the best yacht category alternatives

No	Alternatives	Priority
1	Deluxe	0,2982
2	Economy	0,2458
3	Luxury	0,2362
4	Standard	0,2197

This leads to a comment such that the best alternative is "Deluxe" whose final priority is calculated 29.82%. "Economy" alternative takes the second place with a priority of 24.58%.

According to these results, although deluxe and economy yacht alternatives are different from each other in terms of features, the agency would decide adding new yachts to its portfolio from these two alternatives. It is reasonable since the agency sells blue cruise with deluxe yacht alternative which has the highest profit margin. Economy yacht alternative is also desirable, because the number of demand for this alternative is higher than the other alternatives.

price	cabin	bathroom	outdoor	indoor	galley	length	cruise speed	air cond.	electronics	freezer	entertainment
0,4545	0,1666	0,0569	0,0803	0,0569	0,0729	0,1837	0,3091	0,0508	0,0820	0,1251	0,0728
0,2727	0,2500	0,1219	0,1756	0,1219	0,1147	0,2294	0,2679	0,2712	0,1662	0,1937	0,1485
0,1818	0,3333	0,2633	0,2681	0,2633	0,3116	0,2761	0,2115	0,3390	0,3210	0,3250	0,1876
0,0909	0,2500	0,5579	0,4760	0,5579	0,5008	0,3108	0,2115	0,3390	0,4308	0,3562	0,5911

x

0,3803
0,1147
0,0774
0,0210
0,0105
0,0441
0,0531
0,0402
0,0270
0,0110
0,0657
0,1549

=

0,2458	economy
0,2197	standard
0,2362	luxury
0,2982	deluxe

Figure 6.1 Calculations and Details of Matrix Multiplication

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