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A Decision Tree-Based Data Mining Approach to Estimating Dental Tourists' Satisfaction State

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Abstract: *This study introduces a data mining approach to estimate dental tourists' satisfaction. In detail, the study combines statistical techniques and a decision tree model to ensure a complete estimation pipeline. The study was conducted using survey feedback from a total 314 dental tourists, who visited a private dental clinic in Kuşadası, in the Aydın province of Turkey. The collected data were analysed by using Pearson coefficient, Kolmogorov-Smirnov test, Mann-Whitney U test, and Kruskal-Wallis test. Next, factor analysis was used to identify various factors that established the input parameters of the decision tree model. In terms of statistical findings, it was found that there was no significant relationship between age and the satisfaction of the dental tourists. It was also found that there was a significant difference in satisfaction by gender, and dental tourists' satisfaction levels differed significantly based on citizenship, education level, and income status as these differences varied across relevant demographic classes. At the data mining application stage, a total of four factors determined through factor analysis were used to train a decision tree model and the model achieved respectively 96%, and 80% accuracy rates for during training and testing data. The study concludes that various demographic data and factors influence dental tourists' service satisfaction, and data mining can help in effectively estimating satisfaction levels for potential dental tourists.*

Keywords: *health tourism; dental tourism; service satisfaction; data mining; decision tree.*

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1. Introduction

Health tourism has grown in popularity because of the expansion of global collaborations, human activities, information exchange, and, undoubtedly, travel. Health tourism, which generally involves tourism-focused activities in which individuals travel to other countries to receive healthcare services (Edinsel & Adıgüzel, 2014; Gan, 2025; Reisman, 2010), has evolved in response to desires such as vacationing while receiving healthcare services, engaging in cultural and touristic interactions, receiving services at lower prices than in their home country, or accessing underdeveloped healthcare services in other countries more effectively (Hofer et al., 2012; Smith and Puczko, 2015; Smith and Puczko, 2016). Health tourism activities have become a significant potential for countries with prominent cultural and touristic characteristics, and the prevalence of health tourism has accelerated due to the ever-evolving communication and travel opportunities between countries. This field, which focuses on people and tourism, is further divided into various types based on the individuals it targets and the services it offers. Types of health tourism, such as medical tourism (Buzcu and Birdir, 2019), which primarily involves medical services (treatment and surgery), thermal tourism (Şengül & Bulut, 2019), which emphasises relaxation and rehabilitation, senior tourism focusing on older individuals, and disability tourism targeting individuals with disabilities (Doğan et al., 2020), have all contributed to the intensification of health tourism research. When examined in detail, it can be stated that specific service areas within the health sector have also led to the emergence of alternative approaches within health tourism. One of these alternative approaches is known as dental tourism.

Dental tourism is a form of health tourism that has emerged in the area of dental healthcare and associated care services (Conti et al., 2014). Factors such as the high cost of dental health services in different countries and the lack of desired services have led to the emergence of dental tourism interactions within health tourism. The more practical nature of dental services compared to other health services and the relatively faster healing processes have led to the acceleration of activities focused on dental tourism. Furthermore, the inclusion of aesthetic and beauty-focused solutions in addition to oral health in dental services has served as a catalyst for dental tourism, aesthetic dental services have played a key role in the rise of this field within the integration of health and tourism. In recent years, dental tourism activities have been rapidly increasing not only internationally but also within Turkey (Gönül & İçöz, 2020). Turkey, with its highly trained specialists in dental health solutions, has also rapidly adapted to dental tourism activities. However, ultimately, dental tourism, which includes commercial value and customer interaction within its tourism focus, is subject to issues such as health tourists' satisfaction and loyalty, just like other health tourism-focused activities. When considered within the focus of health tourism, it can be easily seen that the relevant literature evaluates satisfaction and loyalty phenomena in different locations, individuals, and health services, and contributes to the development of the field of health tourism with various outcomes (Akdu, 2014; Baş & Karaca, 2021; Campon-Cerro et al., 2020; Demirci, 2018; Esen & Bahar, 2019; Göker & Öztürk, 2022; Karagöz et al., 2022; Li et al., 2022). Similar issues are also addressed within the scope of dental tourism; various studies have been put forward within the framework of both dental services and tourism interaction (Akbar et al., 2020a; Gönül & İçöz, 2020; Lwin et al., 2021). This demonstrates that the relationship between the areas of activity within health tourism and dynamics such as business processes, management and planning, marketing, and customer relations effectively facilitates dental tourism. Dental tourism, within the broader health tourism framework, has achieved a synergy compatible with the 21st century, which envisions and requires collaboration between different disciplines. This synergy is also important for human-centered assessments and satisfaction and loyalty-oriented research.

A closer look at the literature reveals that health tourism is closely intertwined with information technologies. Accordingly, individuals seeking services in distant regions can access relevant service points and receive services through specialised web platforms or mobile environments (Budakkıran & Mercan, 2021; Oduncuoğlu et al., 2023; Tsonev & Basmadzhieva, 2023; Yılmaz & Yılmaz, 2022). Similar functions have become essential for a globally dynamic

field like health tourism. For health tourists, information technologies significantly facilitate steps such as searching for and finding health tourism services, accessing and receiving treatment, and even making post-visit evaluations. These facilitating effects apply not only to health tourists but also to healthcare professionals, service providers, and agencies. Information technologies not only facilitate access to and communication of information but also create added value in activities by processing it quickly and effectively. The interactions between health tourists, healthcare professionals, and service providers within a technological ecosystem can yield a variety of data regarding these interactions when appropriate tools are used. Analysing data related to health tourism activities facilitates service providers' assessment and forecasting. This also opens the door to academic research on these interactions between service providers and recipients. For example, data collected on health tourists can be used to better assess a service provider's global reputation or to understand health tourists' interest in and satisfaction with their services. Just as individuals seek to determine which country, agency, clinic or doctor, they may prefer to receive the most appropriate health tourism service, service providers also seek to understand individual service satisfaction and obtain effective findings to improve service quality and implement effective marketing strategies. However, the diverse dynamics within health tourism can, at some stages, enable more effective outcomes to be achieved through solutions that go beyond traditional numerical methods. At this point, one alternative and effective solution is known as data mining. Data mining encompasses different methods and algorithms within these methods that enable the design of effective solutions for deriving (discovering) new information from available data and using it in decision-making processes (Cleve & Lammel, 2020; Yu & Lovric, 2025). Data mining algorithms are built on structures that identify patterns in available sample datasets through various mathematical and logical steps. Data mining has been frequently used in problem areas where decision support mechanisms are required, especially because it enables consistent determinations to be obtained quickly over a wide variety of data sets (Kantardzic, 2011; Li et al., 2022).

Based on the explanations so far, the objective of this study is to introduce a data mining-based approach, which helps in estimating the satisfaction states of dental tourists (health tourists). In this context, the study sought to answer the main research question: "*Can the satisfaction of dental tourists receiving services be estimated using a data mining approach?*". In order to achieve this, the scope of the study firstly included collecting feedback data on the satisfaction levels of dental tourists, who have previously received dental health services in Kuşadası province in Turkey. After that, the study moved forward by validating the data through statistical analyses and tests. Following that, the exact satisfaction factors were shaped by using factor analysis, which determined the most important parameters (inputs) for a typical data mining algorithm. Here, a decision tree, which is an interpretable and effective data mining technique, was used to establish a trained model. In the context of this study, it is thought that the development of a data mining tool estimating dental tourists' satisfaction will provide numerous benefits, from identifying potential tourists to ensure service effectiveness, developing further marketing strategies, and eventually creating an effective direction for the literature of health tourism.

2. Literature Review

Based on the scope of the study, a general review of the literature can be done by examining some studies targeting the satisfaction factor in health and dental tourism, and the studies with data mining usage. In this context the following sub-sections provide both perspectives accordingly.

2.1. Research on Health Tourists' and Dental Tourists' Satisfaction

Satisfaction in health tourism has become an important focus for researchers. Health tourists' satisfaction with the services they receive increases their likelihood of revisiting the same destinations, and they are also likely to recommend the destination and service provider to others. From the service provider's perspective, positive feedback indicates that many components,

including physicians and healthcare professionals, travel services, accommodation services, and tourism activities, are generally found to be satisfactory.

A study conducted by Ünal & Demirel (2011), based on quantitative analyses conducted on 54 health tourists in Bolu province (Turkey), found that health tourists had positive opinions about the attitudes, hygiene approaches, and prices of service providers. Gender and education levels did not affect their satisfaction. Karagöz & Öztürk (2019) conducted a study on health tourism activities in the provinces of Sivas and Samsun (Turkey), finding that health tourists' satisfaction with the relevant service providers was positive. They also concluded that there were significant differences between the city of stay and factors such as enthusiasm, empathy, and overall satisfaction. A comprehensive study by Zengingönül et al. (2012) evaluated health tourism practices in Istanbul, specifically focusing on hospitals. Surveys conducted with both health tourists and their relatives revealed positive levels of satisfaction with the hospitals' accommodation and food and beverage offerings, services, overall quality, and physicians and staff. A study by Yavuz (2018) analysed 216 health tourists, considering service providers operating in Central Anatolia. The findings indicated that consulting services, housekeeping, trust in staff, the service provider's attitudes, and pricing policies all influenced satisfaction. In a qualitative study conducted by Salman & Esen (2023) with 37 Iraqi health tourists, the overall satisfaction level in Turkey regarding the general condition of hospitals, staff, medical devices, and equipment was found to be positive. However, they also found that communication difficulties could arise due to language differences. In a study conducted by Gündüz (2015) within the scope of thermal tourism, thermal hotels in Pamukkale, Denizli (Turkey), were considered as destinations and satisfaction analyses were conducted based on health tourists' online comments. The findings showed that the opinions of health tourists were predominantly positive, with a total of 2,850 comments (64% positive reviews). However, a detailed examination of the data revealed that some negative opinions, particularly regarding physical facilities and pricing, were also prominent. Another study on thermal tourism analysed thermal service providers in Balçova, Izmir (Turkey), revealing a positive correlation between destination image and satisfaction with the destination, and even destination loyalty (Sancar, 2023). In another study focusing on thermal tourism in the Bolu province, analysis of survey data obtained from 33 individuals found that the overall satisfaction level with thermal tourism processes in Bolu was moderate (Çilginoğlu & Aytuğar, 2021). Haque et al. (2018) conducted a study on health tourism services in Malaysia based on data collected from 225 individuals and concluded that price, service quality, and motivation significantly impact satisfaction. In a study focusing on medical tourism practices in South Korea, a quantitative assessment conducted with 407 medical tourists concluded that price positively influenced satisfaction, but individuals' awareness of their health status did not have a significant impact on satisfaction (Park et al., 2017). In a study by Markovic et al. (2014), based on data from 104 health tourists who received health tourism services in Croatia, a positive correlation was found between service quality and satisfaction, and this even led to loyalty to the hospital where they received healthcare services. Studies evaluating satisfaction factors in China, a country particularly prominent for its wellness-oriented health tourism activities, are also noteworthy. The research conducted by Zeng et al. (2021) evaluated practices involving mountain and nature excursions. The findings showed that personal intentions and competition between destinations influence satisfaction. In another study with similar destinations, Mi et al. (2019) found that factors such as environmental quality, service quality, food, facility amenities, and convenience have positive effects on satisfaction.

When the topic of this thesis is specifically considered in dental tourism, it is seen that various studies have been conducted to determine satisfaction levels. Akbar et al. (2020b) conducted a general review of the literature and found that service quality is highly effective in creating satisfaction in dental tourism practices, and that satisfaction even triggers loyalty towards the service provider and its employees. Aydın Kılınç (2023) conducted a study analysing dental tourism in the Antalya province and consulted 311 dentists and 250 dental tourists. The findings revealed positive correlations between destination image, city knowledge, perceived value, safety and

security, treatment quality, and cost savings factors, as well as satisfaction and loyalty. An analysis of dental tourism practices in Bangkok, Thailand, conducted on a total of 106 participants, found that participants who participated in services in Bangkok had a very high level of satisfaction, with treatment quality, accessibility to transportation, and destination attractiveness being the most influential factors (Lwin et al., 2021). Jaapar et al. (2017) analysed 196 dental tourists visiting Malaysia and found that the highest motivations for dental tourism were treatment quality, cost savings, and access to information. Considering the factors affecting satisfaction, treatment quality and access to information had positive effects, while cost savings and cultural familiarity had negative effects. In a second study analyzing the findings of the same study, Saub et al. (2019) commented that technical competence, clinical facilities and interpersonal factors have a highly positive effect on satisfaction.

2.2. Data Mining Research in Health Tourism

Reported studies conducted using data mining on health tourism reveals that the literature is quite open to new research. This relates to the recent integration of digital transformation processes in health tourism with analytical tools such as data mining. Some remarkable studies in this context can be expressed briefly as follows: In the study conducted by Panteli et al. (2021), data mining was used to match health tourists' health needs with potential service providers. Characteristic data related to both parties were used to ensure relevant matches. The study is particularly noteworthy because it is a decision support and recommendation solution. In their study, Koh & Gan (2009) applied a clustering method to understand the factors related to health tourists' hospital selection in Singapore. This approach targeted understanding the potential differences between initial expectations and post-hospital experiences. In a study conducted by Usta & Asan (2021), data mining-based tweet analysis and interpretive structural modeling were used to identify potential relationships between obstacles related to medical tourism during the COVID-19 pandemic. In a recent study by Molae Fard (2023), a recommendation system was developed for health tourists searching for service providers. The recommendation system, developed using data mining, achieved over 90% success rates in evaluations. Ridderstaat (2023), in a study focusing on health tourism practices in the United States, employed a different perspective by focusing on price development. He conducted various analyses using data mining within time-series data on price flows. These analyses yielded findings regarding the latent demand and price behaviors related to external health tourism expenditures. In a study by Nilashi et al. (2022), online reviews of health tourists were analysed and detailed analyses were conducted regarding health tourists' preferences for medical tourism using data mining and fuzzy logic techniques. The findings of the study demonstrated that the relevant solution system plays an effective role in obtaining practical outcomes regarding health tourist trends and patient satisfaction. Another study conducted by Janalipour Jenizeh & Ersöz (2022) used classification techniques to determine the satisfaction levels of health tourists within medical tourism. The study revealed that the most significant factors influencing health tourist satisfaction are low prices, advertising, highly educated doctors, trained staff, relatives living in Turkey, and high-tech medical equipment. In their study targeting health tourism activities in Iran, Sheikhhassan et al. (2021) analysed feedback obtained from health tourists using data mining and reached various findings indicating factors related to their satisfaction. In addition to these studies, examples of data mining applications are also seen in subject areas considered to include health and tourism phenomena, such as sports tourism and rural tourism. Rashid et al. (2023) examined the potential of data mining with a focus on Internet of Things technology in the context of Malaysia. In another study, Yu et al. (2022) used data mining algorithms to examine the spatial characteristics of sports tourism destinations, the determining factors about destinations, and individuals' preferences for sports tourism. Chen et al. (2022), in their research study within the framework of rural tourism, implemented a solution that evaluated potential factors for establishing a rural tourism ecosystem using a clustering method. Although not specifically addressing the application of data mining to a health tourism problem, two other studies

based on the relationship between health tourism and data mining are noteworthy. Accordingly, the study conducted by Awlaqi (2018) evaluated the potential of data mining for big data in medical tourism through a qualitative study, including interviews with hair transplantation centers. In another study, Yalçın Balçık and Demir (2018) analysed scientific publications on medical tourism using data mining.

Data mining and satisfaction in dental tourism

Although various studies have been conducted in the literature focusing on the satisfaction of medical tourists (Akdu, 2014; Baş & Karaca, 2021; Campon-Cerro et al., 2020; Demirci, 2018; Esen & Bahar, 2019; Göker & Öztürk, 2022; Karagöz et al., 2022; Li et al., 2022), research studies that directly evaluate their satisfaction using data mining are relatively few (Janalipour Jenizeh & Ersöz, 2022; Nilashi et al., 2022; Sheikh Hassan et al., 2021). Moreover, there is not any research study directly investigating dental tourists' satisfaction level by using a data mining solution. Furthermore, it is understood that there are relatively few graduate theses specifically on dental tourism, and in fact, no graduate theses that incorporate data mining have yet appeared in the literature. Therefore, considering the current state of the literature, assessing and estimating dental tourist satisfaction using data mining has been a unique motivation for this study.

3. Methodology

This section includes information about the applied methodology as well as the techniques and tools used during the study process.

3.1. Research Venue and Approach

The study was conducted as a quantitative investigation targeting dental tourists, who visited a private dental clinic in Kuşadası (Aydın, Turkey) during 2023. A quantitative approach was followed to obtain generalisable results, facilitate practical flow from statistical analyses to data mining, and ensure a more effective development phase for the targeted data mining system. Considering its active tourism potential and status in health tourism, Kuşadası was considered a representative sample for the research. Furthermore, the dynamic activities and interest in dental tourism strengthened the view that Kuşadası was suitable for the research processes in this study.

The research approach of the study was structured within a 4-step framework (Figure 1). Each step can be expressed briefly as follows:

- **Step 1- Collecting Data via Survey:** In the first step, the aim was to collect meaningful feedback from some dental tourists by using a satisfaction survey. This was done by adapting a satisfaction survey from the literature.
- **Step 2- Statistical Tests and Factor Identification:** In the second step, some statistical tests were applied to the data collected through the survey and the input parameters to be used for the data mining stage were determined through factor analysis. Factor analysis was used to determine the parameters that could be used for satisfaction estimation in the data mining model. In research studies with data mining perspective, this approach is also preferred in the context of feature selection steps (Chizi et al., 2009).
- **Step 3- Collecting Data According to the Factors:** In Step 3, the participating dental tourists were asked again their five-point scale satisfaction feedback to the defined factors and gave their final feedback according to three satisfaction categories: “No”, “Unsure”, or “Yes”. This resulted in a data set of 314 samples for the data mining step.
- **Step 4- Data Mining with Decision Tree:** In the final step, a decision tree model was trained using the dataset obtained in the previous step. In this way, a final data mining model was obtained to estimate satisfaction states or levels of potential dental tourists.

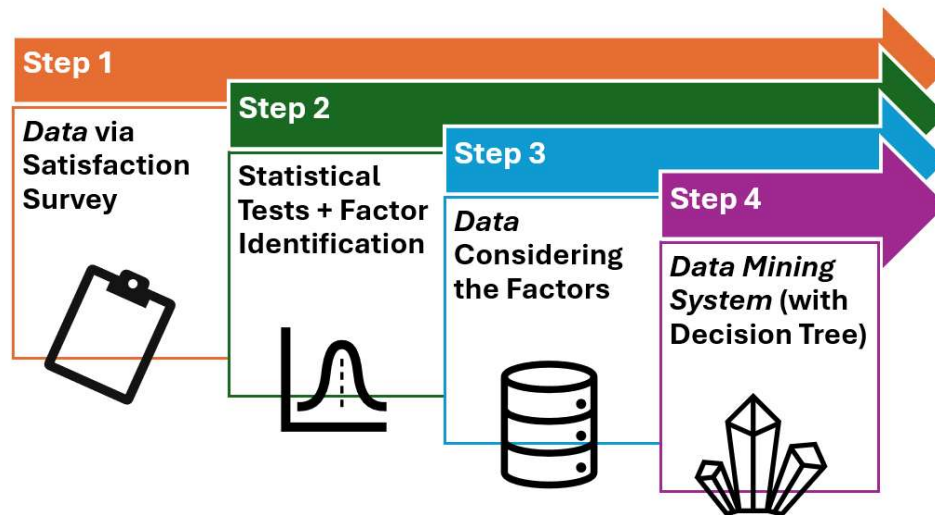


Figure 1. General research approach followed in the study.

3.2. Hypotheses

In the study, a total of six hypotheses were tested within the specified research approach. The first five hypotheses correspond to the statistical steps conducted on the survey data, whereas the sixth hypothesis relates to the overall evaluation of the data mining system created through a decision tree model:

- **Hypothesis 1:** *The age of dental tourists visiting Kuşadası has a significant impact on satisfaction.*
- **Hypothesis 2:** *The satisfaction levels of dental tourists visiting Kuşadası differ significantly by gender.*
- **Hypothesis 3:** *The satisfaction levels of dental tourists visiting Kuşadası differ significantly by citizenship.*
- **Hypothesis 4:** *The satisfaction levels of dental tourists visiting Kuşadası differ significantly by education level.*
- **Hypothesis 5:** *The satisfaction levels of dental tourists visiting Kuşadası differ significantly by income status.*
- **Hypothesis 6:** *Satisfaction levels of potential dental tourists visiting Kuşadası can be estimated using data mining techniques.*

3.3. Participants

In order to obtain reliable findings at the desired level within the scope of research, it is important to include a sufficient sample size (participants). In this context, the population of this study consists of foreign tourists, who come to Kuşadası, Aydın province, for dental health services and vacations. Based on various data obtained from Turkish institutions such as International Health Services Inc. (USHAŞ, 2024) and the Turkish Dental Association (TDB, 2024), as well as recent statistics on the number of health tourists visiting Turkey, the dental tourism contribution rate, the number of dentists in Kuşadası, and the density of dental tourism services provided by clinics, the annual average number of active dental tourists was estimated to be approximately 1,200–1,400. The research sample consisted of dental tourists visiting a private dental clinic in Kuşadası. This approach was followed because a single dental clinic ensures reliable data collection and active research, and also combination of a single clinic and the same service provides more reliability. This approach is consistent with research design solutions in reported literature (Creswell & Creswell, 2021). Random sampling (Haşiloğlu et al., 2015) was chosen for the data collection sample, and the acceptable sample table for specific populations (Çıngı, 1994) was used to determine the sample size. The sample size was targeted at 300 dental tourists with a 5% margin of error under a 95%

confidence interval. Feedback was collected from a total of 314 individuals to support the related target.

3.4. Satisfaction Survey

For data collection and data mining purposes, the study included a survey component aiming to collect feedback on the satisfaction levels of 314 dental tourists, and a decision tree algorithm, which corresponds to a classification-based estimation approach. To understand the satisfaction levels of participating dental tourists, a survey developed by Jaapar et al. (2017) was adapted to evaluate the general profile, motivation, and satisfaction levels. By considering the items in the survey, which was applied in Malaysia before, a total of 40 items were selected to be applied in this study. Some adjustments were made to the survey questions to improve their clarity in Turkish and adapt them to the venue, Kuşadası. The first five items of the survey collected information on age, gender (male, female), citizenship, education level (no formal education, primary or secondary school, high school, pre-bachelor (associate) degree, undergraduate degree, graduate degree), and income status (low, medium, high, very high). The remaining thirty-five items included statements for analysing satisfaction with the dental tourism process and the corresponding components. Responses were rated on a five-point Likert scale, where 1 = very low, 2 = low, 3 = moderate, 4 = good, and 5 = very good. The responses given to the survey data were used to test the study hypotheses and perform factor analysis to determine the input parameters for the decision tree model.

3.5. Decision Tree Algorithm

The study included the decision tree algorithm as a data mining tool for estimating dental tourists' satisfaction states according to some input parameters. As a typical classification technique, the decision tree is often used in research studies due to its ease of use and clarity. Briefly, a typical decision tree algorithm is used to process a sample dataset related to the target problem and creates a tree structure that best represents the cause-and-effect flow in the related problem (Suthaharan, 2016). Accordingly, the most appropriate decision paths connecting input parameters to outputs can be identified and defined thanks to the used sample dataset (De Ville, 2013). This allows for a generalised flow representing the problem's decision process in cases with a large amount of sample data.

In this study, the decision tree model was the final component of the research methodology. The data mining system, created using the decision tree, was designed to estimate whether a potential dental tourist would be satisfied based on specific parameters associated with them.

3.6. Software Tools

The study employed SPSS 23 software for the statistical analyses throughout the research process. SPSS is widely used for analysing the data provided and subjecting it to a wide variety of statistical tests (Field, 2024). Therefore, it was one of the preferred software options during the thesis process.

On the other hand, the data mining step of the study was conducted using the WEKA software. As developed by researchers at the University of Waikato in New Zealand, the simple interface of WEKA allows applications to be developed using different data mining techniques and algorithms (Kalua, 2013). Therefore, WEKA software was chosen for modelling the decision tree used in the study process.

3.7. Limitations and Ethical Aspects

In terms of health tourism research, this study targeted only dental tourists. The process included only individuals who visited the dental clinic participating in the study; other dental tourism-focused clinics, and therefore dental tourists visiting them, were not included in the study. The individuals included in the study sample also resulted in country-specific limitations; the study

specifically considered dental tourists from England, the Netherlands, and Ireland. This was because the dental clinic participating in the study had agreements to serve only dental tourists from these countries during the related period.

For establishing the data collection phase and Ethics Committee approval was obtained from the Adnan Menderes University, Social and Human Sciences Research Ethics Committee. The information of dental tourists visiting the clinic was used only for the study purposes, and the associated data privacy principles (KVKK: Turkish Personal Data Protection Law and GDPR: General Data Protection Regulation) were followed accordingly.

4. Applications and Findings

This section presents the findings obtained from the statistical analyses as well as the data mining-based applications conducted in the study.

4.1. Demographic Distribution

As indicated earlier, a total of 314 dental tourists participated in the survey phase of the study. In this context, the demographic distribution of the participants is presented in Table 1.

Table 1. Demographic characteristics of the participants.

Feature	Minimum	Maximum	Average
Age	39	61	49.15

Feature		Frequency	Rate
Gender	Male	179	57%
	Female	135	43%
Citizenship	England	169	54%
	Netherlands	82	26%
	Ireland	63	20%
Education Level	No Formal Education	10	3%
	Primary-Secondary	14	4%
	High School	59	19%
	Pre-bachelor (Associate) Degree	109	35%
	Undergraduate	72	23%
	Graduate	50	16%
Income Status	Low	10	3%
	Medium	30	10%
	High	51	16%
	Very High	223	71%

4.2. Reliability Analysis

A reliability analysis was conducted based on the responses from dental tourists to the satisfaction survey. A Cronbach's alpha (α) value of 0.972 was found and this value was higher than the reliability limit of 0.70, indicating that the 35 statements (survey items) effectively measured the intended phenomenon. Therefore, further steps were taken in the study.

4.3. Findings for the Satisfaction Survey

Table 2 presents the Likert scale-based results derived from the survey data analysing dental tourists' satisfaction levels; the statements start from item 6, as the previous items covered demographic information

Table 2. Findings for the satisfaction survey.

Statement	Point (1: very low, 2: low, 3: moderate, 4: good, 5: very good)					Average	Std. Deviation
	1	2	3	4	5		
S6: Providing information about dental tourism services via relevant communication platforms, websites...etc.	0	0	26	139	149	4.39	0.637
S7: Communication with dental tourism service providers from my home country.	0	2	14	110	188	4.54	0.614
S8: Choosing a dentist for the service I need.	0	2	18	109	185	4.52	0.635
S9: Appointment availability.	0	0	13	93	208	4.62	0.565
S10: Health tourism-focused travel services (airway, roadway...etc.).	0	0	3	83	228	4.72	0.472
S11: Reaching to the dental clinic (in terms of location, transportation).	0	0	9	68	237	4.73	0.507
S12: General visibility of the dental clinic.	0	0	8	91	215	4.66	0.526
S13: Attitude/behaviour of dental clinic personnel.	0	0	0	70	244	4.78	0.417
S14: Remote registration / approval processes for services and appointments.	0	0	9	88	217	4.67	0.531
S15: Informative materials in the waiting room / area.	0	0	1	77	236	4.75	0.442
S16: Waiting room situation.	0	0	0	68	246	4.79	0.413
S17: Waiting time.	0	0	8	94	212	4.65	0.529
S18: The quality of the equipment in the treatment room.	0	0	0	50	264	4.84	0.367
S19: The competence of the dentist.	0	0	0	58	256	4.82	0.389
S20: Professionalism of the dentist.	0	0	2	55	257	4.81	0.407
S21: Meticulousness in the treatment process.	0	0	2	62	250	4.79	0.423
S22: Dentist's information provided about treatment processes.	0	0	4	68	242	4.76	0.458
S23: The dentist's answers to my questions.	0	0	5	67	242	4.75	0.467
S24: Informing me about the price before starting the treatment.	0	0	3	42	269	4.85	0.386
S25: Dentist's hygiene status.	0	0	0	51	263	4.84	0.369
S26: Dentist's recommendations for oral and dental health.	0	0	1	59	254	4.81	0.404
S27: The dentist's success in solving my problems.	0	0	2	68	244	4.77	0.436
S28: Cleanliness of the dental clinic.	0	0	0	38	276	4.88	0.327
S29: Decoration / design of the dental clinic.	0	0	5	72	237	4.74	0.475
S30: Crowd status of the dental clinic.	0	0	0	69	245	4.78	0.415
S31: Noise level in the dental clinic.	0	0	1	49	264	4.84	0.378
S32: Security level at the dental clinic.	0	2	5	96	211	4.64	0.548
S33: Clinic facilities for individuals with disabilities / special needs.	0	5	30	148	131	4.29	0.702
S34: Cleanliness of the restrooms and care rooms in the dental clinic.	0	0	1	44	269	4.85	0.363
S35: General pricing for the service I received.	0	0	0	45	269	4.86	0.351
S36: My satisfaction with the dental services I received.	0	0	1	46	267	4.85	0.369
S37: My likelihood of returning to Kuşadası for dental services.	0	0	0	52	262	4.83	0.372
S38: My likelihood of recommending Kuşadası to my relatives for dental services.	0	0	3	60	251	4.79	0.431
S39: My likelihood of recommending Kuşadası to my friends for dental services.	0	0	1	53	260	4.82	0.389
S40: My likelihood of recommending Kuşadası to others for dental services.	0	0	1	64	249	4.79	0.416

Findings for the satisfaction survey reveal that the satisfaction feedback received from dental tourists had a minimum mean score of 4.29. This finding suggests that dental tourists generally have a high level of satisfaction. The lowest mean value was obtained for the statement “Clinic facilities for individuals with disabilities/special needs”, while the highest average value was observed for the statement “Cleanliness of the dental clinic”. Dental tourists did not rate any statement with 1 point (very low). Only the following statements received 2 (low) points including “Communication with dental tourism service providers from my home country”, “Choosing a dentist for the service I need”, “Security level at the dental clinic”, and “Clinic facilities for individuals with disabilities/special needs”. A high frequency of 3 (moderate) points is also remarkable for these statements. It is important that the points in these statements greatly contribute to satisfaction within the context of dental tourism. Efforts to improve facilities for individuals with disabilities and special needs appear to be a top priority. Additionally, the 3-point (medium) frequency in the statement “Providing information about dental tourism services via relevant communication platforms and websites.” is also significant. Therefore, information activities on communication platforms and websites, such as these, need to be monitored and improved accordingly.

4.4. Satisfaction Analyses Based on Demographic Findings

Based on the demographic findings, some hypothesis tests were conducted to see the effects of demographic differences on satisfaction states. In this way, the first five hypotheses of the study were tested accordingly. The Pearson correlation coefficient was used to determine the relationship between age and satisfaction. Tests for the effects of gender, citizenship, education level, and income status on satisfaction were selected due to the nonparametric nature of the data and the absence of normal distribution. To determine the normal distribution of the satisfaction averages, the Kolmogorov–Smirnov test was applied because of the sample size exceeding 30 (Kul, 2014). The test revealed that the data were not normally distributed ($p < 0.05$). Consequently, the Mann-Whitney U Test was applied for two-group data, and the Kruskal-Wallis Test was applied for nonparametric data with more than two groups.

Hypothesis 1: In order to test Hypothesis 1 regarding the relationship between dental tourists’ age and satisfaction, Pearson’s coefficient was determined. The findings are presented in Table 3.

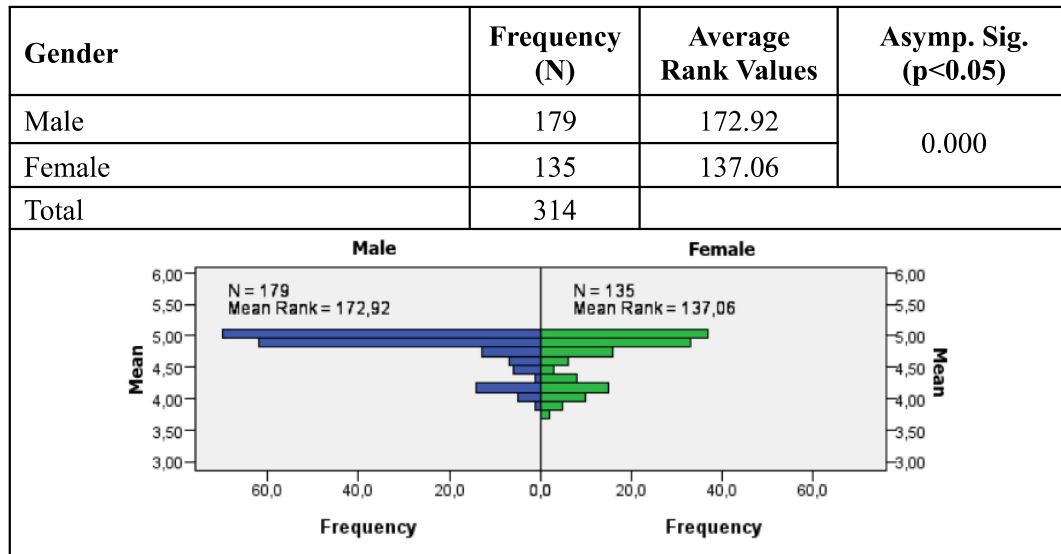
Table 3. The relationship between age and satisfaction among dental tourists visiting Kuşadası, Turkey

Pearson Correlation	Sig. ($p < 0.05$)	Frequency(N)
-0.104	0.066	314

The findings in Table 3 reveal a negative relationship between age and satisfaction. However, the findings also indicate that there is no significant relationship between age and satisfaction ($p = 0.066 > 0.05$). Therefore, Hypothesis 1, which posited that the age of dental tourists visiting Kuşadası had a significant impact on satisfaction, was rejected. Regardless of this finding, the age distribution between 39 and 61 was attributed to the interest in dental tourism among older individuals seeking emergency treatment and younger individuals focusing on aesthetic services such as smile design.

Hypothesis 2: The Mann-Whitney U Test was applied to Hypothesis 2 regarding the satisfaction status of dental tourists by gender. Table 4 shows the findings obtained with the related test.

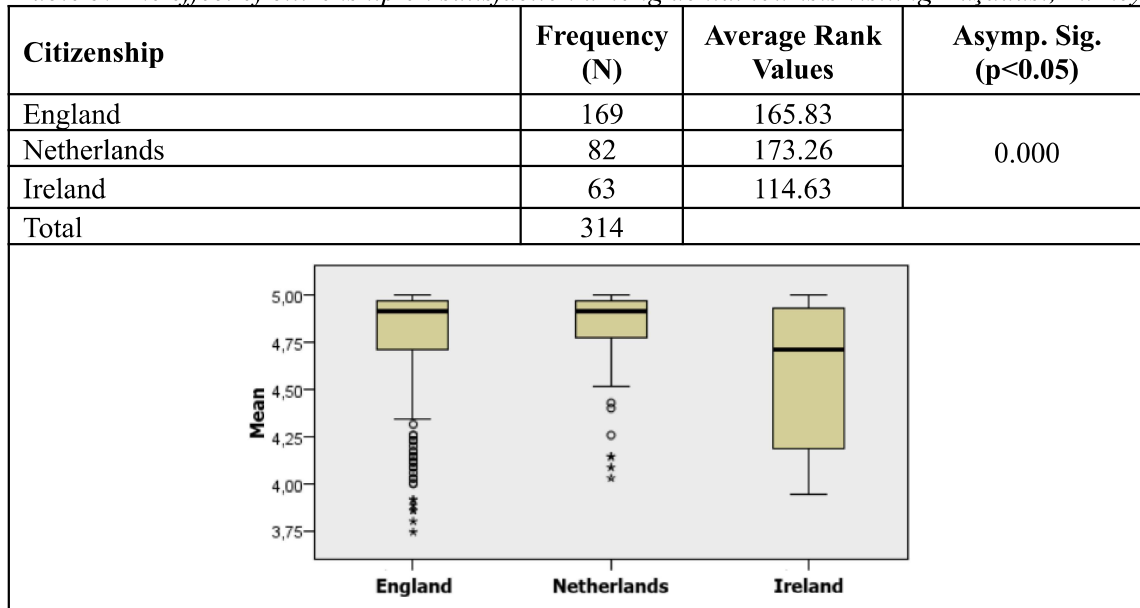
Table 4. The relationship between gender and satisfaction among dental tourists visiting Kuşadası, Turkey



The findings in Table 4 show that the satisfaction levels of dental tourists visiting Kuşadası differed significantly according to gender within the scope of Hypothesis 2 ($p < 0.05$). Therefore, Hypothesis 2 was supported. Accordingly, it can be concluded that male dental tourists were more satisfied than female dental tourists.

Hypothesis 3: The Kruskal-Wallis Test was applied for Hypothesis 3 to evaluate the satisfaction levels of dental tourists according to their citizenship. Table 5 shows the findings obtained with the test.

Table 5. The effect of citizenship on satisfaction among dental tourists visiting Kuşadası, Turkey



The findings in Table 5 indicate that the satisfaction levels of dental tourists visiting Kuşadası differed significantly by citizenship ($p < 0.05$), as within the scope of Hypothesis 3. Therefore, Hypothesis 3 was supported, and the analyses were continued with the Mann-Whitney U Test in pairwise groups. Furthermore, according to the box plots, while there is a close relationship between England and the Netherlands, Ireland presents a broader cluster in terms of different satisfaction levels. Outliers in England and the Netherlands are also notable. Table 6 shows the findings of the Mann-Whitney U Test, applied separately to pairwise groups of dental tourists visiting Kuşadası from England, Netherlands, and Ireland.

Table 6. Pairwise findings on dental tourist citizenship visiting Kuşadası, Turkey

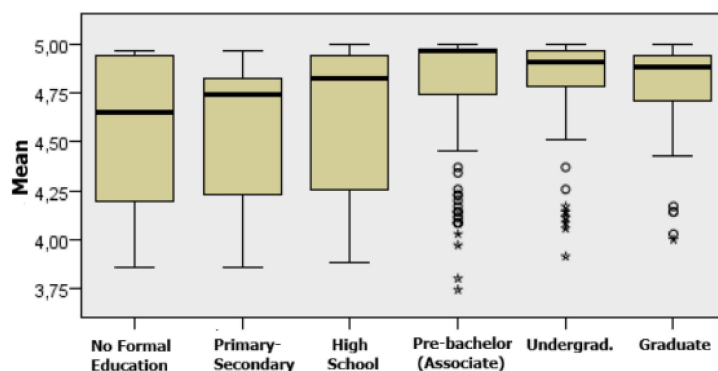
Citizenship	Frequency (N)	Average Rank Values	Asymp. Sig. (p<0.05)
England	169	124.43	0.620
Netherlands	82	129.23	
England	169	126.40	0.000
Ireland	63	89.94	
Netherlands	82	85.53	0.000
Ireland	63	56.69	

As seen from the findings in Table 6, there was no significant difference in dental tourist satisfaction between England and the Netherlands ($p = 0.620 > 0.05$). Although there was a significant difference between England and Ireland ($p = 0.000 < 0.05$), it may be concluded that England dental tourists are more satisfied than Irish dental tourists. Although there was also a significant difference between the Netherlands and Ireland ($p = 0.000 < 0.05$), Dutch dental tourists were also more satisfied than Irish dental tourists.

Hypothesis 4: The Kruskal–Wallis Test was applied to Hypothesis 4 about the satisfaction levels of dental tourists according to their education level. The findings of the test are shown in Table 7.

Table 7. Education level of dental tourists visiting Kuşadası, Turkey and its effect on satisfaction.

Education Level	Frequency (N)	Average Rank Values	Asymp. Sig. (p<0.05)
No Formal Education	10	110.65	0.003
Primary-Secondary	14	107.39	
High School	59	132.75	
Pre-bachelor (Associate) Degree	109	176.89	
Undergraduate	72	169.12	
Graduate	50	151.10	
Total	314		



The findings in Table 7 indicate that the satisfaction levels of dental tourists visiting Kuşadası differed significantly according to education level ($p = 0.003 < 0.05$). At this stage, analyses were conducted using the Mann–Whitney U Test in pairwise groups. An examination of the box plots revealed that the satisfaction levels of dental tourists with pre-bachelor (associate), undergraduate, and graduate degrees were similar, although there are some slight outliers. Dental tourists with other educational levels exhibited a wider distribution in terms of satisfaction, and initially, a similarity was suggested between those with no formal education and those with primary-secondary and high school degrees. Table 8 shows the findings of the Mann–Whitney U

Test, applied separately to pairwise groups of dental tourists visiting Kuşadası based on their education level.

Table 8. Pairwise findings regarding the education level of dental tourists visiting Kuşadası, Turkey

Education Level	Frequency (N)	Average Rank Values	Asymp. Sig. (p<0.05)
No Formal Education	10	12.65	0.930
Primary-Secondary	14	12.39	
No Formal Education	10	30.45	0.436
High School	59	35.77	
No Formal Education	10	37.75	0.030
Pre-bachelor (Associate) Degree	109	62.04	
No Formal Education	10	28.10	0.056
Undergraduate	72	43.36	
No Formal Education	10	23.70	0.176
Graduate	50	31.86	
Primary-Secondary	14	32.86	0.415
High School	59	37.98	
Primary-Secondary	14	39.36	0.010
Pre-bachelor (Associate) Degree	109	64.91	
Primary-Secondary	14	28.86	0.016
Undergraduate	72	46.35	
Primary-Secondary	14	23.93	0.051
Graduate	50	34.90	
High School	59	69.88	0.004
Pre-bachelor (Associate) Degree	109	92.41	
High School	59	57.64	0.022
Undergraduate	72	72.85	
High School	59	51.47	0.205
Graduate	50	59.16	
Pre-bachelor (Associate) Degree	109	93.28	0.466
Undergraduate	72	87.55	
Pre-bachelor (Associate) Degree	109	84.24	0.083
Graduate	50	70.75	
Undergraduate	72	65.02	0.184
Graduate	50	56.43	

Considering the findings in Table 8, it was observed that there were no significant differences between some education level groups. Accordingly, there were no significant differences between those with no formal education and the graduates of primary-secondary school ($p = 0.930 > 0.05$), high school ($p = 0.436 > 0.05$), undergraduate level ($p = 0.056 > 0.05$) and graduate level ($p = 0.176 > 0.05$). Similarly, there were no significant differences between primary-secondary school graduates and the graduates of high school ($p = 0.415 > 0.05$) and graduate level ($p = 0.051 > 0.05$). On the other hand, it was observed that there was no significant difference between (1) graduates of high school and graduate level ($p = 0.205 > 0.05$), (2) between pre-bachelor (associate) degree graduates and graduates of undergraduate level ($p = 0.466 > 0.05$) and graduate level ($p = 0.083 > 0.05$), and (3) between graduates of undergraduate level and graduate level ($p = 0.184 > 0.05$). The groups with statistically significant differences were (1) those with no formal education and pre-bachelor (associate) degree graduates ($p = 0.030 < 0.05$), (2) primary-secondary school graduates and pre-bachelor (associate) degree graduates ($p = 0.010 < 0.05$), (3) primary-secondary school graduates and undergraduate-level graduates ($p = 0.016 < 0.05$), (4) high school graduates

and pre-bachelor (associate) degree graduates ($p = 0.004 < 0.05$), and (5) high school graduates and undergraduate-level graduates ($p = 0.022 < 0.05$).

Hypothesis 5: The Kruskal–Wallis Test was applied to test Hypothesis 5, which concerned the satisfaction of dental tourists in terms of their income status. Table 9 shows the findings of the test.

The initial findings shown in Table 9 indicate that the satisfaction levels of dental tourists visiting Kuşadası differed statistically significantly based on their income levels ($p = 0.000 < 0.05$). Therefore, the analyses were conducted using the Mann–Whitney U Test in pairwise groups. An examination of the box plots revealed that those with very high incomes differed statistically significantly from those with low, medium, and high incomes.

Furthermore, there were outliers among very high-income dental tourists. Table 10 shows the findings of the Mann–Whitney U Test, applied separately to pairwise groups.

Table 9. The relationship between income status and satisfaction among dental tourists visiting Kuşadası, Turkey

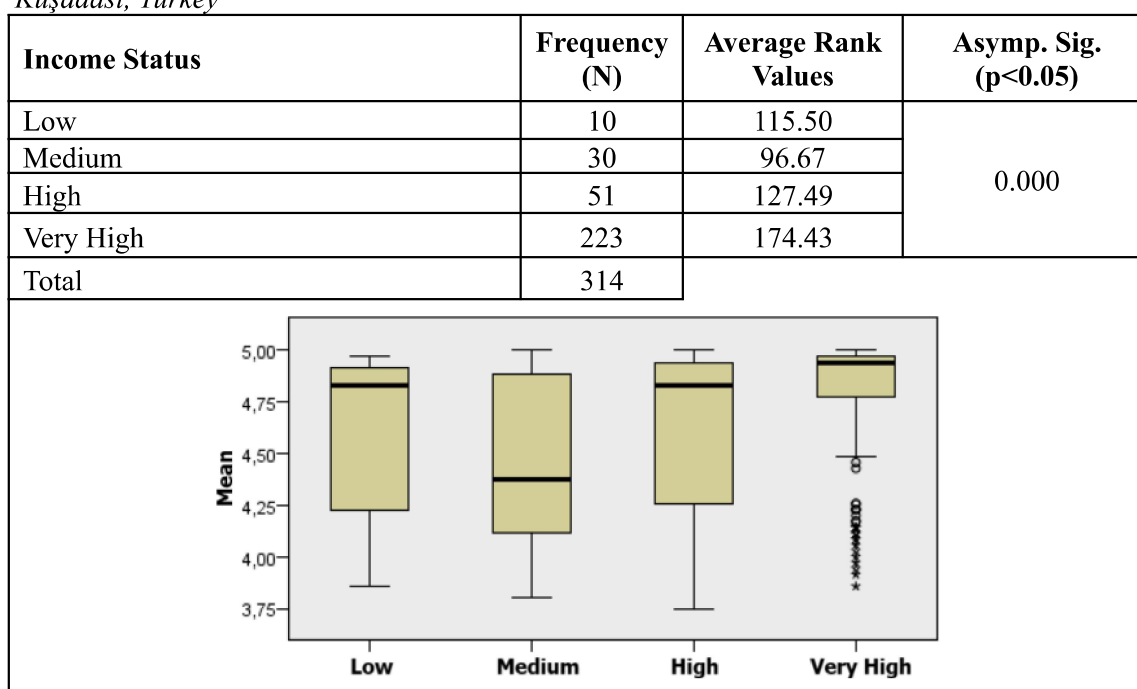


Table 10. Pairwise findings regarding the income status for dental tourists.

Income Status	Frequency (N)	Average Rank Values	Asymp. Sig. (p<0.05)
Low	10	23.60	0.332
Medium	30	19.47	
Low	10	29.65	0.792
High	51	31.26	
Low	10	73.25	0.034
Very High	223	118.96	
Medium	30	34.68	0.063
High	51	44.72	
Medium	30	73.52	0.000
Very High	223	134.20	
High	51	103.51	0.001
Very High	223	145.27	

Considering the findings in Table 10, it was observed that very high-income dental tourists differed statistically significantly from the other groups: low-income ($p = 0.034 < 0.05$), medium-income ($p = 0.000 < 0.05$), and high-income ($p = 0.001 < 0.05$). On the other hand, there were no significant differences (1) between low-income and medium-income ($p = 0.332 > 0.05$) and high-income ($p = 0.792 > 0.05$) dental tourists, and (2) between medium-income and high-income ($p = 0.063 > 0.05$) dental tourists.

The findings for the tests conducted for the first five hypotheses showed that the first hypothesis was rejected while the other associated hypotheses were supported (Table 11).

Table 11. Results for the first five hypotheses in this study.

Hypothesis	Result
Hypothesis 1: The age of dental tourists visiting Kuşadası has a significant impact on satisfaction.	Rejected
Hypothesis 2: The satisfaction levels of dental tourists visiting Kuşadası differ significantly by gender.	Accepted
Hypothesis 3: The satisfaction levels of dental tourists visiting Kuşadası differ significantly by citizenship.	Accepted
Hypothesis 4: The satisfaction levels of dental tourists visiting Kuşadası differ significantly by education level.	Accepted
Hypothesis 5: The satisfaction levels of dental tourists visiting Kuşadası differ significantly by income status.	Accepted

4.5. Factor Analysis

The results obtained so far indicated that demographic information, excluding age, could be used in a data mining-based approach due to their multifaceted effects on dental tourists' satisfaction. Furthermore, reducing the large number of survey questions to a smaller number of representations would also be a significant contribution from a data mining perspective. Therefore, factor analysis was used to determine whether factors that could be incorporated into the data mining system could be obtained by considering dental tourist feedback. This effort led the research to test the remaining hypothesis (Hypothesis 6) and answer the main research question, which were both related to the use of data mining for estimating the satisfaction levels of potential dental tourists.

In order to determine the suitability of the Satisfaction Survey for factor analysis, correlations between survey items were examined, and all were found to have statistically significant correlations. Furthermore, suitability for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) Test and Bartlett's Test of Sphericity. Table 12 shows the KMO and Bartlett Test findings.

Table 12. Findings for KMO Test and Bartlett Test of sphericity

KMO Sampling Adequacy	0.965	
Bartlett Test of Sphericity	Approximate Chi-Square	9830.725
	df	595
	Sig.	0.000

According to Table 12, the KMO value (0.965) was greater than the goodness-of-fit value: 0.60, and also the Bartlett's Test of Sphericity values were found to be significant ($p = 0.000 < 0.05$). Therefore, the Satisfaction Survey findings were found appropriate for a factor analysis. The factor analysis was performed using the Varimax rotation technique (Abdi, 2003), which makes inference more understandable. The process reached the optimal point after a total of six rotation cycles, and a total of four factors were identified. In this context, the total variance was explained by

67.425%. Details regarding the inference are presented in Table 13 (items after 10 are not shown in the table).

Table 13. Factor analysis variance findings

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative (%)	Total	% of Variance	Cumulative (%)
1	19.188	54.823	54.823	7.028	20.079	20.079
2	2.155	6.158	60.981	6.073	17.351	37.430
3	1.177	3.364	64.345	5.658	16.167	53.598
4	1.078	3.080	67.425	4.840	13.828	67.425
5	0.950	2.714	70.139			
6	0.765	2.187	72.326			
7	0.716	2.045	74.371			
8	0.673	1.924	76.294			
9	0.619	1.770	78.064			
10	0.562	1.607	79.671			
...	...	...	...			

The findings demonstrating the inter-factor activity of the survey items are shown in Table 14. Items with factor loadings below 0.40 were discarded (considering Shrestha, 2021), and the remaining items were sufficient for naming the factors. The identified factors were respectively named as **Dental Tourism Services**, **Dental Clinic**, **Dental Clinic Personnel**, and **Dental Tourism in Kuşadası, Turkey**.

Table 14. Satisfaction Survey statements (items) and their distributions under the determined factors.

Factor 1: Dental Tourism Services	Factor Loading
S6: Providing information about dental tourism services via relevant communication platforms, websites...etc.	0.730
S7: Communication with dental tourism service providers from my home country.	0.708
S8: Choosing a dentist for the service I need.	0.739
S9: Appointment availability.	0.745
S10: Health tourism-focused travel services (airway, roadway...etc.).	0.644
S11: Reaching to the dental clinic (in terms of location, transportation).	0.675
S12: General visibility of the dental clinic.	0.663
S14: Remote registration / approval processes for services and appointments.	0.684
S17: Waiting time.	0.638
Factor 2: Dental Clinic	Factor Loading
S28: Cleanliness of the dental clinic.	0.564
S29: Decoration/design of the dental clinic.	0.713
S30: Crowd status of the dental clinic.	0.666
S31: Noise level in the dental clinic.	0.520
S32: Security level at the dental clinic.	0.680
S33: Clinic facilities for individuals with disabilities/special needs.	0.664
S34: Cleanliness of the restrooms and care rooms in the dental clinic.	0.528
S35: General pricing for the service I received.	0.502

Factor 3: Dental Clinic Personnel	Factor Loading
S22: Dentist's information provided about treatment processes.	0.403
S25: Dentist's hygiene status.	0.456
S26: Dentist's recommendations for oral and dental health.	0.444
Factor 4: Dental Tourism in Kuşadası, Turkey	Factor Loading
S36: My satisfaction with the dental services I received.	0.618
S37: My likelihood of returning to Kuşadası for dental services.	0.727
S38: My likelihood of recommending Kuşadası to my relatives for dental services.	0.713
S39: My likelihood of recommending Kuşadası to my friends for dental services.	0.752
S40: My likelihood of recommending Kuşadası to others for dental services.	0.600

The four factors identified through factor analysis were combined with dental tourists' gender, citizenship, level of education and income status, resulting in a total of eight input parameters used to construct a data-mining system capable of estimating overall satisfaction (represented by a single output parameter). To prepare the dataset required for training this data-mining model, the 314 participating dental tourists were asked once again to rate each of the four factors on a scale from 1 to 5.

Also, based on these factors, they were asked to answer the question: **“Were you satisfied with your dental tourism experience in Kuşadası?”** with one of three responses: **“No”**, **“Not Sure”**, or **“Yes”**. Considering the feedback gathered, the dataset for the data mining system was established.

4.6. Decision Tree-Based Data Mining Solution

The data mining system design was initiated by using the decision tree algorithm in the WEKA software environment. In order to train the decision tree algorithm and enable it to learn the relationships among satisfaction decisions in the dataset, the dataset was divided into training and test sets. At this point, a common practice in the literature was to use 60% of the dataset for training and the remaining 40% for testing (Joseph, 2022). Therefore, 220 observations in the dataset were used for training, and the remaining 94 cases were used for testing.

One of the important problems in data mining was related to the memorisation of training patterns, a phenomenon called overfitting (Pham & Triantaphyllou, 2008). For preventing this, the training and test datasets were randomly selected from 314 samples. Figure 2 illustrates screenshots from training and testing steps done in the WEKA environment.

Weka is an open-source machine-learning workbench distributed under the GNU General Public License. It provides users with everything they need to begin working with data-driven methods, including system requirements, download options, documentation, courses, and a helpful FAQ section.

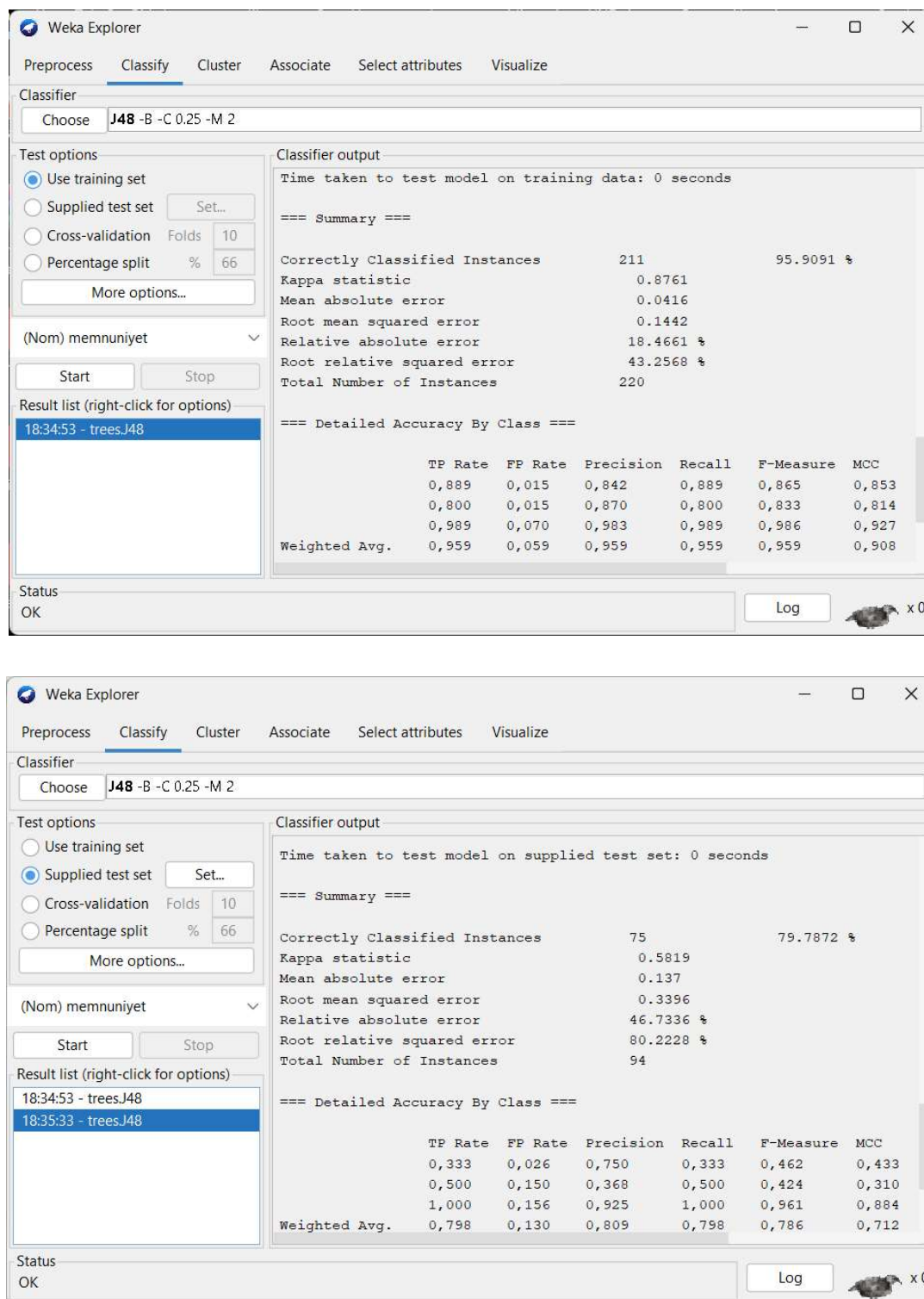


Figure 2. Training (up) and testing (down) steps for the decision tree algorithm in the WEKA environment.

As shown in Figure 2, the training process conducted using the decision tree algorithm resulted in an accuracy rate of 96%. Furthermore, precision, recall and F-measure values also reached 96%. On the other hand, the accuracy rate for the testing dataset was 80% whereas precision was 81%, recall was 80%, and F-measure was 79%. The tree structure obtained with the training process is presented in Figure 3. This tree structure is interpretable and easy-to-understand the general estimation flow (also decision process) for the dental tourists' satisfaction states.

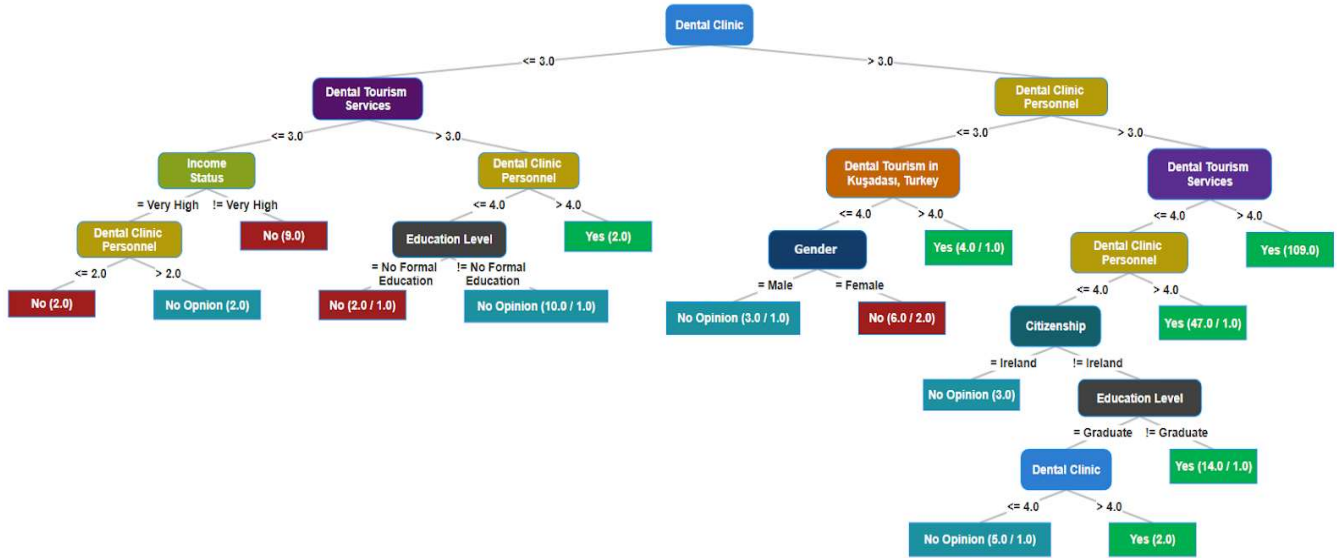


Figure 3. Obtained tree structure after training the decision tree model

According to the tree structure obtained (Figure 3), the first factor in terms of dental tourists' satisfaction is the Dental Clinic, and the other factors shape the path to satisfaction according to different situations. At this point, it becomes clear that only certain demographic information is effective in determining satisfaction, depending on the propensity for different factors. This makes the decision-making process more practical. By considering this tree structure, potential dental tourists can be asked to rate their interests, previous experiences, or perceived importance of other factors, in addition to their demographic information, on a scale of 1 to 5. This can help predict their satisfaction potential, enabling the service provider to take different actions.

Considering the findings for the data mining phase, it was concluded that the developed system based on a decision tree model showed high predictive performance in estimating dental tourist satisfaction. Thus, the **Hypothesis 6** (*Satisfaction levels of potential dental tourists visiting Kuşadası can be estimated by using data mining.*) of the study was accepted. With the acceptance of Hypothesis 6, the main research question, "Can the satisfaction of dental tourists receiving services be estimated using a data mining approach?" was also answered "Yes".

As the trained decision tree model (resulting data mining system) is capable of giving estimations for satisfaction, Table 15 presents some examples of estimations according to different input parameters out of the samples in the dataset. The sections marked with a "—" character in Table 15 indicate that no input is required for the relevant parameters for satisfaction estimation.

Table 15. Some examples of estimations given by the trained system

Input Parameters								Output (Satisfaction)
Gender	Citizenship	Education Level	Income Status	Dental Tourism Services	Dental Clinic	Dental Clinic Personnel	Dental Tourism in Kuşadası, Turkey	
—	—	—	—	5	4	5	—	Yes
—	—	No Formal Education	—	4	3	4	—	No
—	—	—	Very High	2	2	2	—	No

–	–	–	–	5	3	5	–	Yes
Male	–	–	–	–	5	3	4	No Opinion
–	Ireland	–	–	3	4	4	–	No Opinion
–	–	–	–	4	5	5	–	Yes
–	Netherlands	High School	–	4	5	4	–	Yes

5. Discussion

The findings of the research yielded several important conclusions regarding the examination of dental tourism activities in terms of service satisfaction. Data collected through survey responses from 314 dental tourists, specifically in Kuşadası, Turkey, revealed that age was not associated with satisfaction. This could be attributed to the participation of individuals over a certain age in the process, as well as the fact that oral and dental health is a crucial necessity regardless of age. Factors other than age, including gender, citizenship, education level, and income status, were also factors in influencing satisfaction. Male dental tourists were more satisfied than females, while dental tourists with English and Dutch citizenship –although some exceptions– were more satisfied than those with Irish citizenship. It was also concluded that service satisfaction tended to be more with higher levels of education, although there were exceptions. In terms of income status, while low, medium, and high-income groups were similar, the average satisfaction among medium-income groups is lower. Furthermore, although very high-income dental tourists have many exceptional cases, they stand out from other income groups and tend to score higher.

Feedback collected from dental tourists also demonstrated that service satisfaction can be analyzed under four factors: Dental Tourism Services, Dental Clinic, Dental Clinic Personnel, and Dental Tourism in Kuşadası, Turkey. By combining these factors with gender, citizenship, education level, and income status, a data mining-based estimation system was developed effectively. With such a data mining approach, potential dental tourists can be rated based on their past experiences, perceived importance, or level of interest, in addition to their demographic information. The obtained data mining system can be used to estimate potential satisfaction levels. The decision tree algorithm used for this purpose gave the following findings regarding estimation of satisfaction:

- The primary factor influencing satisfaction is the Dental Clinic. Whether this factor scores above or below the average creates two divergences in estimating satisfaction.
- If the Dental Clinic and Dental Clinic Personnel factors score 4 or above, and Dental Tourism Services receive the highest score (5), there is no need to consider other demographic information or the Dental Tourism in Kuşadası, Turkey; the dental tourist can be concluded to be satisfied with the service.
- If the Dental Clinic and Dental Tourism Services factors score below average (≤ 3), the dental tourist is unlikely to be satisfied; at best, they have ‘no opinion’.
- If the Dental Tourism Services score above average (> 3) in service satisfaction, but the Dental Clinic and Dental Clinic Personnel factors tend to score low, the best possibility for satisfaction is ‘no opinion’, depending on education level.
- In cases where the Dental Clinic factor scores above average (> 3) and the Dental Clinic Personnel factor scores 3 or 4, the dental tourist’s citizenship and education level become the determining factors. In such a scenario, it is remarkable that the Irish have ‘no opinion’. Generally, Irish dental tourists are more likely to report ‘no opinion’ or dissatisfaction in terms of satisfaction. This may be related to Ireland’s relatively greater distance from interaction with Turkey when compared to the other two countries, and it

can also be interpreted that more effective strategies are needed to reach Turkey's dental tourism potential in Ireland.

- In terms of education level, it is understood that other educational levels do not have a critical impact on satisfaction, except for the two extremes of 'no formal education' or a 'graduate' degree. A similar situation is observed for citizenship; England and the Netherlands do not create a critical difference. Regarding income status, no critical impact on satisfaction was observed except among those with very high incomes.
- The Dental Clinic factor scores above average (>3), while the Dental Clinic Personnel scores below average (≤ 3), triggers a key point where the Dental Tourism in Kuşadası, Turkey factor should be considered. If the Dental Tourism in Kuşadası, Turkey factor receives the highest score (5), it suggests that dental tourists will be satisfied with the service. Otherwise, the gender factor becomes a determinant between 'no opinion' and dissatisfaction (here, male dental tourists have 'no opinion', while female tourists are dissatisfied). The fact that the Dental Tourism in Kuşadası, Turkey factor is more specific compared to other factors and demographic information may be related to the still-developing recognition of dental tourism in Kuşadası.

It is also notable that estimating service satisfaction in three different classes: "Yes", "No Opinion", and "No" can facilitate decision-making processes for the following actions in terms of dental tourism services:

- Discounts, special packages, or similar advantages can be designed for potential dental tourists whose satisfaction potential is estimated as 'yes', and communication as well as interaction with such individuals can be done through information technologies.
- In order to encourage potential dental tourists whose satisfaction potential is estimated as 'no opinion' to transition to a 'yes' position, strategies can be developed that focus on the parameters that cause indecision. For example, in cases of negative clinic-related trends, options such as reviewing dental clinics based on dental tourist needs, investing more in negatively perceived components, or improving marketing activities can be considered.
- In the worst-case scenario with a 'no', options such as addressing the factors that cause this situation, shifting investments to relevant parameters, and increasing overall marketing, promotional, and communication/interaction activities can be considered.
- The solutions mentioned above can be applied to potential dental tourists individually in various ways or can be adapted to the service provider's overall dental tourism strategies on a mass scale. The authors think that effective use of information technologies is critical in this regard.

It is important that the decision tree used in the study ensures an interpretable structure. Interpretability of a tool used for healthcare and tourism related actions is a key necessity for decision makers, who need trustworthy software-based interfaces nowadays. Considering data mining-based operations, decision tree technique has a fast-running algorithmic flow so both advantages of trustworthiness and performance can be taken into consideration in similar applications. Furthermore, the study and its findings possess a cross-contextual nature, allowing them to be evaluated and adapted in alternative statistical and data mining research efforts beyond Kuşadası or Turkey.

6. Conclusion and Future Work

This study showed that a solution for estimating dental tourists' satisfaction states can be developed by using a data mining-based approach. Specifically, the first phase of the study was collecting survey data from 314 dental tourists, who previously visited Kuşadası, Turkey and received services from a private dental clinic. After that various analyses were conducted to reveal connections among demographic information and satisfaction states. Additionally, a factor analysis was done to determine the most important factors (input parameters) that can be used to develop a

data mining system capable of estimating dental tourists' satisfaction. The data mining system included a decision tree model, which can use a dental tourist's demographic information and feedback for a total of four factors (Dental Tourism Services, Dental Clinic, Dental Clinic Personnel, and Dental Tourism in Kuşadası, Turkey) to estimate potential satisfaction in three classes: "No", "Not Sure", and "Yes".

The study points out that various demographic and diverse factors influence a dental tourist's service satisfaction. Statistical tests performed showed that the age parameter in the study did not affect satisfaction. Therefore, all demographic parameters except age were used while developing the decision tree model. An accuracy rate of 96% for training and an 80% accuracy rate for the testing phase demonstrated that the data mining system running over a decision tree model was capable of estimating satisfaction based on feedback from dental tourists. Eventually, the results obtained in this study point to the potential for dental tourism in Kuşadası, Turkey, and highlight the importance of developing a data mining system for estimation purposes.

The results of the study also show that some more future work can be done accordingly. In this context, the study focused on Kuşadası and, based on the data obtained, included dental tourists from three different countries. Therefore, there is potential to contribute to literature by conducting new studies in different regions and covering different nationalities. Also, different data mining techniques can be applied for the same purpose of the study, to produce further findings. Service satisfaction was the focus of the current study. However, similar statistical processes and data mining steps can be used to examine different trends among dental tourists. It is also important that the study was conducted specifically for dental tourism, but the general research framework can be adapted to different health tourism fields based on target problems and detection scenarios.

In addition to the recommendations for future work, the authors also offer suggestions for health tourism and dental tourism service providers. These suggestions can be indicated as follows:

- The study highlights the advantages of data mining in decision support processes, particularly in health tourism and dental tourism. Based on this, health tourism and dental tourism service providers can leverage data mining-based insights into which individual parameters to consider when designing their services and which factors to consider during service development.
- Service providers can effectively utilise data mining solutions to support health tourism and dental tourism practices with more effective marketing strategies. Thus, they can also reach different countries in need of services and establish more targeted interactions with the individuals they plan to serve.
- Health tourism service providers, whose target audience is rapidly expanding and diversifying globally, will be better equipped to navigate the changing ecosystems they operate in by integrating with data-driven activities and leveraging data mining-based systems. Policymakers working specifically on health tourism can utilise data-based analysis to develop the necessary initiatives to ensure service satisfaction. In this regard, data mining can facilitate the acquisition of broader, more consistent findings and their application in decision-making processes.
- To ensure that health tourism activities continue to develop in Turkey and expand its global reach, the effectiveness of digitalised health tourism activities can be increased by leveraging data mining-based solutions. The potential inherent in health tourism and dental tourism can play a role in the development of globally exemplary practices through innovative approaches that incorporate data analysis and data mining. Here, dental clinics in Turkey and Kuşadası can also invest in data mining-based information technologies to ensure that dental tourism activities are technologically compatible and provide service satisfaction. Furthermore, they may allocate additional resources to support employment and training opportunities in data mining applications.

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References

- Abdi, H. (2003). Factor rotations in factor analyses. In *Encyclopedia for research methods for the social sciences* (pp. 792–795). Sage.
- Akbar, F. H., Rivai, F., Abdullah, A. Z., Awang, A. H., Faizah, N., Pasinringi, S. A., & Saleh, L. M. (2020a). Relation of access information with satisfaction and loyalty in medical (dental) tourism: Systematic review. *Systematic Reviews in Pharmacy*, 11(5).
- Akbar, F. H., Pasiga, B. D., Samad, R., Rivai, F., Abdullah, A. Z., Awang, A. H., & Pratiwi, D. (2020b). The relationship between service quality, culture similarity to satisfaction and loyalty of medical (dental) tourism. *Systematic Reviews in Pharmacy*, 11(12), 19–30.
- Akdu, U. (2014). *Evaluation of service quality, customer satisfaction and customer loyalty of medical tourism* [Doctoral dissertation, Akdeniz University, Turkey].
- Awlaqi, I. A. A. (2018). *A qualitative research on the applications of big data in the medical tourism sector* [Master's thesis, Süleyman Demirel University, Turkey].
- Aydın Kılınç, Z. (2023). *Dental tourism determinants in Antalya* [Master's thesis, Alanya Alaaddin Keykubat University, Turkey].
- Baş, C., & Karaca, Ş. (2021). The effect of service recovery strategies in health tourism enterprises on positive word-of-mouth communication and repurchase intention. *Journal of Current Marketing Approaches and Research*, 2(2), 110–122.
- Budakkıran, M., & Mercan, Ş. O. (2021). The evaluation of health tourism in the context of digitalization and digital marketing. In *Tourism studies and social sciences* (p. 327).
- Buzcu, Z., & Birdir, K. (2019). Review of medical tourism in Turkey: A study in private hospitals. *Gaziantep University Journal of Social Sciences*, 18(1), 311–327.
- Campon-Cerro, A. M., Di-Clemente, E., Hernandez-Mogollon, J. M., & Folgado-Fernandez, J. A. (2020). Healthy water-based tourism experiences: Their contribution to quality of life, satisfaction and loyalty. *International Journal of Environmental Research and Public Health*, 17(6), 1961.
- Chen, L., Hu, H., He, X., & Lyu, M. (2022). The development path and data mining mode of rural tourism under the background of big data. *Wireless Communications and Mobile Computing*, 2022, 1–13.
- Chizi, B., Rokach, L., & Maimon, O. (2009). A survey of feature selection techniques. In *Encyclopedia of data warehousing and mining* (2nd ed., pp. 1888–1895). IGI Global.
- Çılğınnoğlu, H., & Aytuğar, S. (2021). Health expectations and customer satisfaction: Bolu example in thermal tourism enterprises. *Journal of Turkish Tourism Research*, 5(2), 1088–1102.
- Çıngı, H. (1994). *Sampling theory*. Hacettepe University Press.
- Cleve, J., & Lammel, U. (2020). *Data mining*. Walter de Gruyter GmbH & Co KG.
- Conti, A., Delbon, P., Laffranchi, L., & Paganelli, C. (2014). What about the dentist–patient relationship in dental tourism? *Journal of Medical Ethics*, 40(3), 209–210.
- Creswell, J. W., & Creswell, J. D. (2021). *Research design* [In Turkish]. Nobel Press.
- De Ville, B. (2013). Decision trees. *Wiley Interdisciplinary Reviews: Computational Statistics*, 5(6), 448–455.
- Demirci, Ç. (2018). *The effect of perceived value on customer satisfaction and loyalty in health tourism: A research on health tourists* [Doctoral dissertation, Adnan Menderes University, Turkey].
- Doğan, T. G. B., Doğan, S., & Baynal, B. (2020). Bolu province health free zone design for elderly and disabled tourism target group [In Turkish]. *The Journal of Ankara Hacı Bayram Veli University Faculty of Tourism*, 23(2), 295–311.

- Edinsel, S., & Adıgüzel, O. (2014). Turkey's place and its developments in the world countries in terms of health tourism within the last five years [In Turkish]. *Çankırı Karatekin University Journal of the Faculty of Economics and Administrative Sciences*, 4(2), 167–190.
- Esen, F. Ö., & Bahar, O. (2019). Thermal tourism in Afyonkarahisar in terms of the relationship between destination image, tourist satisfaction and destination loyalty [In Turkish]. *Journal of Turkish Tourism Research*, 3(4), 949–963.
- Field, A. (2024). *Discovering statistics using IBM SPSS statistics* (6th ed.). SAGE Publications.
- Gan, L. (2025). *Medical tourism*. Bloomsbury Publishing USA.
- Göker, G., & Öztürk, Y. (2022). A research on thermal tourism experience, satisfaction, mood and behavioral intention [In Turkish]. *Journal of Travel and Hotel Business*, 19(3), 469–485.
- Gönül, E., & İçöz, O. (2020). Dental destination visit motivations of dental tourists and the case of Didim [In Turkish]. *Tourism Academic Journal*, 7(1), 195–208.
- Gündüz, H. (2015). *Assessment of Pamukkale thermal sources in the scope of health tourism and determining customer satisfaction in the Ministry of Health licensed hotels* [Master's thesis, İzmir Katip Çelebi University, Turkey].
- Haque, A., Yasmin, F., & Anwar, N. (2018). Factors determinant of patients' satisfaction towards health tourism in Malaysia. *International Tourism and Hospitality Journal*, 1(1), 1–18.
- Haşiloğlu, S. B., Baran, T., & Aydın, O. (2015). A study on the potential problems in marketing research: Convenience sampling and scale items with adverbs of frequency [In Turkish]. *Pamukkale University Journal of Business Research*, 2(1), 19–28.
- Hofer, S., Honegger, F., & Hubeli, J. (2012). Health tourism: Definition focused on the Swiss market and conceptualisation of health (i)ness. *Journal of Health Organization and Management*, 26(1), 60–80.
- International Health Services Inc. Turkey (USHAŞ). (2024). *Health tourism data* [In Turkish]. USHAŞ Statistics and Publications. <https://www.ushas.com.tr/saglik-turizmi-verileri/>
- Jaapar, M., Musa, G., Moghavvemi, S., & Saub, R. (2017). Dental tourism: Examining tourist profiles, motivation and satisfaction. *Tourism Management*, 61, 538–552.
- Janalipour Jenizeh, S., & Ersoz, F. (2023). Investigation of factors affecting choice of medical travel destination using data mining techniques. *International Journal of Travel Medicine and Global Health*, 11(1), 186–193.
- Joseph, V. R. (2022). Optimal ratio for data splitting. *Statistical Analysis and Data Mining: The ASA Data Science Journal*, 15(4), 531–538.
- Kalua, B. (2013). *Instant Weka how-to*. Packt Publishing.
- Kantardzic, M. (2011). *Data mining: Concepts, models, methods, and algorithms* (2nd ed.). John Wiley & Sons.
- Karagöz, N., & Öztürk, A. (2019). Customer satisfaction in health tourism business (comparison of Samsun and Sivas province) [In Turkish]. *Journal of Turkish Tourism Research*, 3(4), 1260–1273.
- Karagöz, Y., Yalman, F., & Karaşin, Y. (2022). The effect of service quality on patient satisfaction and patient loyalty in medical tourism: A study on the Turkish diaspora [In Turkish]. *Toros University FEASS Journal of Social Sciences*, 9(17), 1–13.
- Koh, H. C., & Gan, L. L. (2009). A data mining analysis of healthcare tourism in Singapore. *Advances on Information Processing and Management*, 26.
- Kul, S. (2014). Guideline for suitable statistical test selection [In Turkish]. *Pleural Bulletin*, 8(2), 26.
- Li, L., Ragavan, N. A., Patwary, A. K., & Baijun, W. (2022). Measuring patients' satisfaction toward health tourism in Malaysia through hospital environment, nutritional advice, and perceived value: A study on Chinese exchange students. *Frontiers in Public Health*, 10, 893439. <https://doi.org/10.3389/fpubh.2022.893439>

- Lwin, H. N. N., Punnakitkashem, P., & Thananusak, T. (2021). The level and determinants of international patient satisfaction with dental tourism in Bangkok, Thailand. *Cogent Business & Management*, 8(1), 1898316. <https://doi.org/10.1080/23311975.2021.1898316>
- Markovic, S., Loncaric, D., & Loncaric, D. (2014). Service quality and customer satisfaction in the health care industry: Towards health tourism market. *Tourism and Hospitality Management*, 20(2), 155–170.
- Mi, C., Chen, Y., Cheng, C. S., Uwanyirigira, J. L., & Lin, C. T. (2019). Exploring the determinants of hot spring tourism customer satisfaction: Causal relationships analysis using ISM. *Sustainability*, 11(9), 2613. <https://doi.org/10.3390/su11092613>
- Molae Fard, R. (2023). Developing a recommender system for the health tourism industry using data mining methods. *Engineering Management and Soft Computing*, 8(2), 125–142.
- Nilashi, M., Samad, S., Alghamdi, A., Ismail, M. Y., Alghamdi, O. A., Mehmood, S. S., ..., & Alhargan, A. (2022). A new method for analysis of customers' online review in medical tourism using fuzzy logic and text mining approaches. *International Journal of Information Technology & Decision Making*, 21(6), 1797–1820. <https://doi.org/10.1142/S0219622022500341>
- Oduncuoğlu, F., Köse, G., Doğan, O., & Deniz, E. (2023). Digital transformation current trends in health tourism: A theoretical study [In Turkish]. In *Proceedings of the ATLAS 10th International Social Sciences Congress* (pp. 116–126).
- Panteli, A., Kompothrekas, A., Halkiopoulos, C., & Boutsinas, B. (2021). An innovative recommender system for health tourism. In A. Kavoura, S. Kefallonitis, & A. Giovanis (Eds.), *Culture and tourism in a smart, globalized, and sustainable world: 7th International Conference of IACuDiT, Hydra, Greece, 2020* (pp. 649–658). Springer International Publishing. https://doi.org/10.1007/978-3-030-72469-6_42
- Park, J., Ahn, J., & Yoo, W. S. (2017). The effects of price and health consciousness and satisfaction on the medical tourism experience. *Journal of Healthcare Management*, 62(6), 405–417. <https://doi.org/10.1097/JHM-D-16-00016>
- Pham, H. N. A., & Triantaphyllou, E. (2008). The impact of overfitting and overgeneralization on the classification accuracy in data mining. In B. Maimon & L. Rokach (Eds.), *Soft computing for knowledge discovery and data mining* (pp. 391–431). Springer. https://doi.org/10.1007/978-0-387-69935-6_16
- Rashid, I. M. A., Rawabdeh, M., Qudah, A. A., Samah, I. H. A., Amlus, M. H., & Wan Husain, W. A. F. (2023). Analyzing the influence of internet of things (IoT) data mining in medical tourism industry. In *AIP Conference Proceedings* (Vol. 2608, No. 1). AIP Publishing. <https://doi.org/10.1063/5.0127928>
- Reisman, D. A. (2010). *Health tourism: Social welfare through international trade*. Edward Elgar Publishing. <https://doi.org/10.4337/9781849805537>
- Ridderstaat, J. (2023). Measuring hidden demand and price behavior from US outbound health tourism spending. *Tourism Economics*, 29(3), 759–787. <https://doi.org/10.1177/13548166211067925>
- Salman, E. H. S., & Esen, Ü. B. (2023). Perception of satisfaction with health tourism services in Türkiye: The case of Iraqi tourists [In Turkish]. *Journal of Humanities and Tourism Research*, 13(2), 410–430.
- Sancar, T. (2023). The relationships between destination image, destination satisfaction and destination loyalty in thermal health tourism [In Turkish]. *Journal of Turkish Tourism Research*, 7(3), 465–479.
- Saub, R., Jaapar, M., Musa, G., & Moghavvemi, S. (2019). Dental tourists' satisfaction and loyalty intention with dental care services in Malaysia. *Malaysian Dental Journal*, 1, 1–23.
- Şengül, H., & Bulut, A. (2019). Health tourism in Turkey under thermal tourism: A SWOT analysis study. *ESTUDAM Public Health Journal*, 4(1), 55–70.

- Sheikhhassan, M., Sadeghzadeh, M., & Faghihi, M. (2021). Application of data mining techniques to present model of tourist's health behavior analysis. *Razavi International Journal of Medicine*, 9(1), 27–31.
- Shrestha, N. (2021). Factor analysis as a tool for survey analysis. *American Journal of Applied Mathematics and Statistics*, 9(1), 4–11.
- Smith, M. K., & Puczko, L. (Eds.). (2016). *The Routledge handbook of health tourism*. Taylor & Francis.
- Smith, M., & Puczko, L. (2015). More than a special interest: Defining and determining the demand for health tourism. *Tourism Recreation Research*, 40(2), 205–219. <https://doi.org/10.1080/02508281.2015.1045364>
- Suthaharan, S. (2016). Decision tree learning. In *Machine learning models and algorithms for big data classification: Thinking with examples for effective learning* (pp. 237–269). Springer. https://doi.org/10.1007/978-1-4899-7641-3_10
- Tsonev, N., & Basmadzhieva, S. (2023). Opportunities for digitalization in marketing management of health tourism in Bulgaria. *Athens Journal of Tourism*, 10(1), 21–44. <https://doi.org/10.30958/ajt.10-1-2>
- Turkish Dental Association (TBD). (2024). *Statistics* [In Turkish]. Oral and Dental Health. https://www.tdb.org.tr/menu_goster.php?Id=10
- Ünal, A., & Demirel, G. (2011). A research related to the definition of the expectations of customers that utilize from the health tourism companies in Bolu city [In Turkish]. *Electronic Journal of Vocational Colleges*, 1(1), 106–115.
- Usta, S. K., & Asan, Ş. S. (2021). Analysis of barriers in medical tourism during the COVID-19 pandemic [In Turkish]. *Journal of Design Architecture Engineering*, 1(1), 10–20.
- Yalçın Balçık, P., & Demir, H. (2018). Analysis of scientific publications in the field of medical tourism using data mining [In Turkish]. In *Proceedings of the 8th International Health Tourism Congress, Turkey, 3–6 May 2018*.
- Yavuz, M. C. (2018). *Services of medical tourism in Turkey: The perception of the effect of the patient and customer satisfaction: Central Anatolia Region example* [Master's thesis, İstanbul Gelişim University, Turkey].
- Yılmaz, H., & Yılmaz, N. (2022). Digital health tourism applications in the world and in Turkey [In Turkish]. *Health Care Academician Journal*, 9(1), 64–72.
- Yu, C. H., & Lovric, M. (2025). Data science, data mining, machine learning, big data, and statistics. In the *International encyclopedia of statistical science* (pp. 623–627). Springer. https://doi.org/10.1007/978-3-662-69359-9_157
- Yu, S., Qiu, C., & Yang, R. (2022). Spatial characteristics of sports tourism destination system based on data fusion and data mining. *Mobile Information Systems*, 2022, 1–11. <https://doi.org/10.1155/2022/1897852>
- Zeng, L., Li, R. Y. M., & Huang, X. (2021). Sustainable mountain-based health and wellness tourist destinations: The interrelationships between tourists' satisfaction, behavioral intentions, and competitiveness. *Sustainability*, 13(23), 13314. <https://doi.org/10.3390/su132313314>
- Zengingönül, O., Emeç, H., İyilikçi, D. E., & Bingöl, P. (2012). *Health tourism: An assessment of Istanbul*. Economists Platform / İstanbul Development Agency.