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"A Decision Support System for Evaluating Hotels from a Sustainability Perspective"

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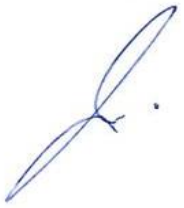

Table of Contents

Table of Contents (Tables)

Table of Contents (Figures)

Abstract

This thesis develops a practical two-stage approach to evaluate hotels from the sustainability perspective by integrating a multi-criteria decision-making method and a fuzzy inference system. The first step of the proposed approach deals with determining the score of hotels for each sustainability dimension. In this regard, in this stage, the economic, environmental, and social criteria are identified, and by applying the fuzzy step-wise weight assessment ratio analysis (SWARA) method, the scores of the hotels are calculated separately for the economic, social, and environmental aspects. Then, in the second stage, using the knowledge of experts, a fuzzy inference system including 343 fuzzy inference rules is structured to calculate the final score of hotels from a sustainability perspective. In the designed system, economic, social, and environmental aspects are considered input variables and sustainability score as output variables. The applicability of the proposed approach is examined through its implementation in two hotels, one in Iran and the other in Italy. The results denote that the developed approach is efficient and its outputs are reliable.

***Keywords*:** sustainability principles; hotel evaluation; multi-criteria decision-making; fuzzy theory; fuzzy inference system

Chapter 1:

Introduction

1.1. Introduction

In recent decades, with the emergence of the concept of sustainability, important theoretical discussions have been raised in this field. Although governments, non-profit organizations, and academics have not reached a common definition of sustainability, they all agree that this concept is a viable solution to deal with some economic, environmental, and social challenges. Early definitions of sustainability-focused more on environmental principles, but recent definitions emphasize all three dimensions of sustainability and establish a fair balance on all three dimensions of sustainability considering human needs. Over time, interest in sustainability has grown within businesses, making it one of the essential requirements for them. Businesses are under increasing pressure to promote the "triple bottom line" approach, in which economic, environmental, and social sustainability are incorporated into business strategies and practices (Han and Hyun, 2018).

Although the application of the concept of sustainability in the hotel industry has been neglected in the past decades, the implementation of sustainability principles in this industry has received much attention in recent years. The application of sustainability principles in hotels has significant effects on the environment and local communities, leading to increased demand for hotels. The increase in awareness of consumers has made hotels' sustainability practices more important, influencing consumer behaviors, attitudes, satisfaction, and loyalty. Therefore, a growing and substantial body of academic literature has emerged, investigating consumer attitudes, perceptions, and behaviors concerning sustainable practices of hotels (Olya et al., 2021).

Considering that the hotel evaluation problem is one of the multi-criteria decision-making (MCDM) problems, in this thesis, we will use the combination of an MCDM method with a fuzzy inference system for the evaluation of hotels from a sustainability perspective. In this vein, in the following, we will present the problem statement and the research importance. Then research objectives, questions, and methodology will be stated, respectively. Finally, definitions are provided for keywords.

1.2. Problem statement

The literature review indicates that there are different approaches and methods to evaluate hotels. MCDM-based approaches are among the most well-known and widely used approaches in this field. Because the hotel evaluation problem is a decision-making problem with conflicting and multiple criteria. Recently, with the prominence of environmental issues and social concerns, many researchers have tilted their research towards sustainability. For this end, some researchers in the field of tourism and hospitality have also applied the sustainability

concept in their research. Hence, designing a decision support system (DSS) to evaluate hotels from the sustainability perspective can help improve the economic, social and environmental performance of hotels. Therefore, this thesis presents for the first time a new two-step approach to evaluate hotels from the sustainability perspective. In the first stage, hotel performance is measured for each sustainability dimension separately using the fuzzy step-wise weight assessment ratio analysis (SWARA) method. Then, in the second stage, a fuzzy inference system is developed to calculate the final score of hotels from the perspective of sustainability.

1.3. Research Importance

The evaluation of hotels from the sustainability perspective is important from different aspects. By evaluating hotels from the sustainability perspective, it is possible to measure the performance of hotels in terms of waste production, water and energy consumption, etc., and provide strategies to improve their performance. On the other hand, evaluating hotels from the sustainability perspective can help the development of communities. To strengthen their social dimension, sustainable hotels implement activities such as creating jobs for local people, serving local food, promoting local customs and traditions, etc. The evaluation of hotels from the perspective of sustainability helps to identify the weaknesses of hotels in social criteria and provide strategies to strengthen them. In addition, the implementation of sustainable practices in hotels leads to a reduction in costs in the long term. For example, the use of renewable energy, efficient energy systems, and waste management measures, in addition to being beneficial to the environment, will lead to lower costs in the long run. In general, the evaluation of hotels from the perspective of sustainability can lead to the improvement of the economic, social, and environmental performance of hotels.

1.4. Research objectives

In general, the objectives of this research are:

- Identifying a comprehensive set of economic, social, and environmental criteria to evaluate hotels from the sustainability perspective;
- Development of a DSS by combining MCDM methods and a fuzzy inference system to evaluate hotels from the sustainability perspective;
- Validation of the proposed DSS using data from two hotels, one in Iran and the other in Italy.

1.5. Research questions

Generally, this research aims to answer the following questions:

- What are the most appropriate criteria for evaluating hotels from the sustainability perspective?
- What are the most efficient methods for structuring an approach to evaluate hotels from the sustainability perspective?
- How to examine the applicability of the presented approach in the real world?

1.6. Research methodology

This research applies a combination of two techniques to evaluate hotels from the sustainability perspective. First, it uses the fuzzy SWARA method to calculate the weight of economic, environmental, and social criteria. This method was created through the integration of fuzzy theory and the SWARA method. SWARA method is one of the MCDM methods which is used to calculate the weight of factors. This method is popular due to its computational simplicity, user-friendliness, and low number of pairwise comparisons. Finally, the sustainability score of the hotels is determined through the development of a fuzzy inference system. A fuzzy inference system is an expert-based method that can easily formulate nonlinear relationships between variables. In this thesis, the fuzzy inference system is employed to create a relationship between the sustainability score of hotels and the scores of hotels in each of the sustainability dimensions.

1.7. Definition of the keywords

In this section, some keywords are defined, which are given below:

- Performance evaluation: It is a process in which the performance of one or more organizations (systems) is assessed based on a set of criteria. In general, the evaluation process consists of two main stages, including identifying the effective criteria and applying the appropriate evaluation method. The purpose of performance evaluation is to know the state of the system and extract its strengths and weaknesses.
- Sustainable hotels: Sustainable hotels are hotels that focus on social and environmental dimensions in addition to the economic dimension, and their goal is to reduce the harmful environmental effects and increase the positive social effects. Sustainable hotels attempt to operate in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- SWARA method: SWARA is one of the MCDM methods that calculates the relative weight of factors in decision-making problems. This method prioritizes factors first. Then, it compares each sorted factor with the previous factor and finally calculates the relative weights of the factors.

- Fuzzy inference system: A fuzzy inference system is a control system that uses fuzzy logic to establish a relationship between input and output variables. In this system, the relationship between input and output variables is established by fuzzy inference rules.

The remainder of the thesis is organized as follows. The second chapter deals with the literature review. In the third chapter, the proposed approach is described. In the fourth chapter, the implementation of the proposed approach in two hotels is presented step by step. Finally, the fifth chapter provides a summary of the results and suggestions for future research.

Chapter 2:

Literature Review

2.1. Introduction

The assessment of hotel performance has received a lot of attention lately, especially when it comes to sustainability. Effective techniques to evaluate and analyze hotels' sustainability performance are becoming more and more necessary as the hospitality sector comes under greater pressure to implement sustainable practices. Multi-criteria decision-making (MCDM) techniques have become useful instruments for assessing and prioritizing sustainable hotels according to several criteria.

MCDM techniques offer a methodical approach to decision-making by taking into account the opinions of different stakeholders and taking into account multiple criteria at once. In the context of MCDM methods, considering the opinions of various stakeholders entails gathering and incorporating the diverse preferences, perspectives, and priorities of individuals or groups involved in the decision-making process. This ensures that the decision reflects a comprehensive understanding of the needs and viewpoints of all relevant parties. Simultaneously, accounting for multiple criteria involves evaluating and weighing numerous factors or considerations, allowing for a more holistic and nuanced assessment that captures the complexity of decision contexts. These methods make it possible to integrate a variety of sustainability-related elements that are often conflicting, including social responsibility, water conservation, waste management, energy efficiency, and environmental impact. Hotel managers, investors, and legislators may make well-informed decisions and pinpoint opportunities for sustainable hotel practice improvement by utilizing MCDM approaches.

In the following, first, the role of sustainability in the hotel industry is examined. Then, the relationship between sustainable hotels and customer loyalty is discussed. Finally, the relevant literature will be reviewed.

2.2. Hotel industry and sustainability

The hotel industry has key role in the economic boom, development, and progress of nations (Abdou et al., 2020). The outcomes of hotel activity are such positive phenomena as employment, foreign exchange earnings, profitability, infrastructure development, and tourism development (Nepal et al., 2019). When this industry is actively operating in an area, different jobs are created and the employment rate increases. Managers, cooks, repairmen, maintenance staff, and the like are among the variety of direct jobs that are created as a result of hotel industry development. The creation of job opportunities in this light exert a cascading effect on the economy of that society since some expenses are spent on different services and goods (Dogru et al., 2020; Melián-González and Bulchand-Gidumal, 2020).

Another important outcome of the development of this industry is foreign exchange earnings as international travelers and tourists need accommodation when visiting tourist attractions in that country. In addition to the hotel industry, the entrance of tourists into a country activates the food-providing sector, tourism centers, transportation, etc. which can greatly help with revenue generation. This contributes to the development of that region (Bhattarai et al., 2021).

In the same way, the hotel industry promotes development and investment infrastructure as hotels must provide sound infrastructure such as desired transportation, communication networks, and utilities to meet the needs of their customers, especially foreign tourists (Moise et al., 2021; Provotorina et al., 2020). In this regard, stakeholders in the steersmen and private sectors also bolster the hotel industry, subsequently enhancing sectors such as transportation systems, utilities, and connectivity.

Hotels provide a safe environment for tourists and act as a catalyst in the tourism chain. This is so because hotels support tourists and provide them with comfort and convenience. High-quality hotels in a country can be regarded as an attraction for tourists to visit the country and promote the economy of that country. In consequence, local businesses, including restaurants, gift shops, and tour operators benefit from this situation, according, the entire tourism ecosystem gets actively promoted and developed (García-Gómez et al., 2023; Ezzaouia and Bulchand-Gidumal, 2020).

The development of hotel industry can also make a considerable contribution to the promotion of sustainability (Khalil et al., 2022). When it comes to the economic aspect, sustainability results in the creation of job opportunities and the engagement of the whole economy of that society in a positive manner. On the other hand, the local economy is supported by tourist attraction and revenue generation when rural areas and recreational centers are to serve food and accommodate tourists for a day or some hours. Thus, local businesses are supported besides the hotels. Other job opportunities are also created that leads to the mitigation of poverty, stability of the whole economy, and income generation (El-Said and Aziz, 2022).

In terms of the social dimension, hotels should accept social responsibilities and develop inclusivity during their operations (Farmaki, 2019). This involves the participation of corporate social responsibility initiatives in supporting local charities, community events, and social sectors. As hotels help with investment in the promotion and enhancement of local communities, a great contribution is made towards social sustainability. In addition, the cultural sector is also engaged as hotels provide a special opportunity for presenting the cultural heritage. Craftsmen and industrialists have the opportunity to showcase their craftsmanship and products. Traditions, souvenirs, artworks, cultural exchange and appreciation, cultural

diversity, and social cohesion are all upgraded and fostered (Lee et al., 2023; Gürlek and Tuna, 2019).

When it comes to the environmental aspect, again hotels have an enormous part in protecting natural resources and mitigating the consequent environmental effects. Various sustainability practices and policies can be adopted by hotels to save energy consumption and enhance efficiency in the energy sector. For example, hotels can provide their lighting using ultra-low consumption lamps. Also, to conserve water, they can use low-flow fixtures and faucets with an electronic eye. In this vein, appropriate devices and tools are put into operation, smart technologies are applied, renewable energy sources are put into practice. Another area in this dimension is water conservation. In this regard, hotels can provide the conditions for the activation of water-saving measures, including guest education programs, water recycling tools, and low-flow fixtures to go for a developed system of responsible water consumption. The other element that may largely help with environmental sustainability is waste management wherein hotels can have a crucial role. Hotels can decrease the generation of waste by adopting proper policies such as recycling programs and sustainable procurement practices (Kuo et al., 2022; Okumus et al., 2019).

Hotels should integrate these three sustainability dimensions, namely economic, social, and environmental to be able to contribute to sustainability. In this way, no element of sustainability is overlooked and all the components and practices are assigned credit and value. In doing so, stakeholders must develop cooperation and collaboration among themselves. These stakeholders include hotel owners, employees, guests, government bodies, and local communities. They should set common goals and objectives, observe sustainability rules and standards, take appropriate initiatives, and adopt sustainable policies and practices (Pereira et al., 2021).

In terms of the economic dimension, hotels contribute to the local economy by increasing the employment rate and supporting local businesses by their operations. For example, hotels create job opportunities ranging from housekeeping to managerial positions, thereby boosting employment levels within the community. Additionally, hotels often source products and services locally, thereby fostering economic growth within the region.

From a social dimension, hotels have the potential to engage with the community and promote cultural heritage through various initiatives. This can involve collaborating with local artisans, organizing cultural events, or supporting community projects that preserve and celebrate the area's heritage. By actively participating in community engagement and cultural preservation, hotels can become integral parts of the social fabric of the region.

Environmental sustainability in hotels can be achieved through various practices such as waste management, energy efficiency, and responsible procurement. Hotels can implement recycling waste, and energy-saving measures, and source eco-friendly products to decrease their environmental footprint. By focusing on these areas, hotels can minimize their impact on the environment and contribute to a more sustainable future.

2.3. Sustainable hotels and customers' loyalty

Researchers, scholars, and decision-makers have recognized the significance of the link between customer loyalty and eco-friendly hotels within the hospitality sector. The significant role of sustainability has been identified as crucial due to its considerable impact on customer actions and allegiance. The hotels practically involved in sustainability are the ones that reduce the possible detrimental effects and make a great contribution to local communities by bringing environmentally friendly practices, social responsibility, and economic viability into their practices (Han et al., 2019; Chen, 2015).

Numerous research findings imply that sustainability practices can increase the degree of customer loyalty in hotels (Preziosi et al., 2019). Customers who prioritize the environment and sustainability tend to choose hotels repeatedly when needed, as this aligns with their values. Such hotels are perceived by these customers to be more reliable and responsible. This results in high levels of satisfaction and loyalty. Different sustainable practices, including waste management, community engagement, employment of renewable resources, and energy and water conservation create a good mental image in customers' minds (Olya et al., 2021).

The literature review shows that it is related to the sustainability of hotels and customer loyalty. Guests' concerns concerning the environment direct them to go for sustainable hotels that mainly remain committed to the practices and prove it by different means such as certifications, eco-labels, and transparent reporting of environmental initiatives. In addition, hotels can engage customers and guests in sustainable practices and, in this way, they feel engaged and responsible, which finally leads to enhanced loyalty. Another effective factor in this domain is the sense of satisfaction that customers may have with sustainable hotel experiences (Zhou, 2022; Kim and Hall, 2020). This also boosts customer loyalty. In fact, those customers who are interested in sustainability will be inclined to return to the hotel with such practices and even recommend it to other people, as well.

A variety of factors like convenience, service quality, price, and location play a significant role in sustainable hotel selection. Although sustainability is of great importance, customers take a look at different standards for hotel selection. Accordingly, it is required that hotels establish a

trade-off between sustainability and other factors that may contribute to customer loyalty and satisfaction.

It is noteworthy that there is a multifaceted relationship between customer loyalty and sustainable hotel selection. Indeed, sustainable practices can move in line with customers' tastes in terms of environmental factors, and, thereby, customers' trust and perception are enhanced. The provision of desirable experiences for customers along with an inner sense of satisfaction with the hotel practices can also improve this relationship. These points are highly important for officials and decision-makers in the hotel industry because they can accordingly improve customer loyalty and competitiveness in this industry (Abdou et al., 2022; Khalil et al., 2022).

2.4. Literature review

The purpose of this section is to identify suitable factors from the sustainability perspective and to examine MCDM-based methods in the hotel evaluation and selection process. Therefore, in the following articles are reviewed:

have used MCDM methods in the hotel industry;

deal with hotel evaluation factors;

provide sustainability factors in the evaluation of hotels.

In the following, we have reviewed the articles published between 2016 and 2023 that have at least one of the mentioned items.

By integrating MCDM-based methods, a hybrid framework for hotel prioritization was developed by Işık and Adalı (2016). They used five factors including "staff and service", "comfort", "price", "cleanliness", and "facilities" to evaluate six hotels in Pamukkale. First, they calculated the weight of the mentioned factors by employing the step-wise weight assessment ratio analysis (SWARA). Then they prioritized the hotels through the operational competitiveness ratings analysis (OCRA) technique. The results demonstrated that the two factors cleanliness and price have the most weight in the evaluation process of hotels, respectively.

Mardani et al. (2016) presented a hybrid MCDM-oriented framework to evaluate the practices of quality management in the hotel industry. They identified and extracted a large number of criteria through a comprehensive and thorough review of the literature. Then, they selected the most effective criteria using the fuzzy Delphi method. They classified the identified criteria into four groups including organizational, people, technological, and external environmental. They utilized the fuzzy analytic hierarchy process (AHP) method to determine the weights of the criteria, and prioritized the hotels by the Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) and technique for order of preference by similarity to ideal solution

(TOPSIS) methods. The results showed that both VIKOR and TOPSIS methods provide the same ranking.

The evaluation of hotels from the quality management perspective can lead to identifying the Weaknesses and strengths of hotels of hotels, and help managers in adopting appropriate strategies to improve the performance of hotels. Hence, Yeng et al. (2016) presented a theoretical evaluation approach for ranking hotels by integrating the concept of quality management and MCDM methods. They believed that evaluation criteria should be derived from the quality management perspective. After identifying the criteria, the less important criteria are removed by the gray relational analysis method and the causal relationship among the criteria is analyzed by the decision-making trial and evaluation laboratory (DEMATEL) technique. In their approach, the weights of criteria are calculated by the analytical network process (ANP) method.

Abokhamis Mousavi et al. (2017) developed a model for evaluating sustainable hotels by applying cultural, social, environmental, and economic criteria. This model was validated using data from six hotels in Northern Cyprus. The authors believe that due to environmental limitations, lack of skills in the field of sustainable hotel management, lack of attention to cultural aspects, and lack of job opportunities, it is important to develop a model to move hotels towards sustainability. They considered indicators such as energy consumption, employee training, investment rate, safety, comfort, local job creation, air quality, etc. as evaluation indicators of sustainable hotels. The results of their research demonstrated that big hotels should be sustainable from an environmental perspective, while sustainability in small hotels should be from a cultural-social perspective.

The purpose of the paper presented by Reid et al. (2017) is to identify a set of sustainability practices for evaluating hotels. To this end, they examined the sustainable practices implemented in hotels and coastal accommodations and extracted and identified more than 594 sustainability activities. The results showed that the highest number of sustainability practices are related to urban hotels. It should be noted that they identified sustainable practices from the aspects of efficiency of water, priority of region, atmosphere and energy, pollution, waste, management, innovation, use of sustainable sites, and health.

Zolfani et al. (2018) presented a practical MCDM-oriented framework to evaluate and prioritize construction projects in the sustainable hotel industry. Their framework included two parts. In the first part, the weight of the evaluation criteria was determined using the SWARA method. Then, in the second part, the options were prioritized using the complex proportional assessment (COPRAS) method. The authors used energy consumption, environmental, social,

and financial criteria to prioritize projects and applied the data of a five-star hotel construction project in Tehran to validate their proposed approach.

As mentioned, the hotel evaluation problem is one of the MCDM problems. In this regard, Gürbüz and Erdinç (2018) suggested an efficient approach under uncertainty to prioritize hotels and select the best hotel by applying the fuzzy MOORA method. To this end, they considered six criteria including "reliability", "tangibles", "responsiveness", "price", "understanding customer needs", and "assurance combining competence, courtesy, communication, credibility, and security". It should be noted that they used a numerical example to demonstrate the performance of their proposed approach.

Using the online comments of reviewers helps customers to choose the proper hotel. Many researchers have worked on this topic and designed many practical decisions support systems (DSSs) to help customers choose the right hotel. In this regard, Yu et al. (2018) have presented a new MCDM method to evaluate and rank hotels. They used six criteria including sleep quality, rooms, location, cleanliness, value, and service to prioritize hotels. The results showed that their approach is sufficiently effective, and has high flexibility so that it can be easily implemented in other fields.

To improve service quality in hotels, an MCDM-oriented approach was introduced by Mohaghar et al. (2019). By reviewing the articles related to this field, they identified 21 criteria for evaluating the quality of hotel services. It should be noted that they extracted these criteria from five dimensions "physical", "warranty services", "responding", "respect for empathy and human values", and "confidence". Because the evaluation criteria were intertwined, they utilized the fuzzy ANP method to weight the criteria. Then, they prioritized the hotels through the fuzzy TOPSIS technique. The results showed that "the modernity of hotel facilities", "the use of experienced and skilled employees", and "the respectful behavior of employees with customers" are three important criteria in the process of evaluating the quality of services in the hotel industry.

MCDM methods have many applications in the hotel industry. In addition to the evaluation of the hotels, these methods are also employed to evaluate hotels' websites. Ostovare and Shahraki (2019) proposed a comprehensive approach for hotel website evaluation by integrating MCDM methods. In this vein, first, criteria and their sub-criteria for evaluating websites were identified through the fuzzy Delphi method. The evaluation criteria included technology, marketing, security, and customer. Then the weights of these criteria and their sub-criteria were calculated by the Shannon entropy method. At the end, PROMETHEE and GAIA methods were used to prioritize hotels' websites. The results showed that the customer criterion is the most important

criterion in the evaluation of hotels' websites. Finally, the proposed approach was validated using the data related to several websites of five-star hotels in Mashhad.

Kwok and Lau (2019) believe that the design of a DSS for selecting a hotel leads to customers being able to choose their desired alternative with less time. They also stated that the provided DSS should be designed based on customers' preferences and should be user-friendly. In this vein, they presented a user-friendly DSS for hotel selection by applying a modified TOPSIS. They first evaluated the validity of their proposed DSS by using mathematical equations. Then they examined its efficiency through simulated data. Finally, they used the data of a case study to check the validity of the results obtained from their DSS.

By applying the concept of machine learning and combining it with MCDM methods, a hybrid approach was developed to evaluate green hotels by Nilashi et al. (2019). They stated that their research is the first research in the field of hospitality that segments customers through online customer analysis. After analyzing the reviewers' textual comments, they ranked the hotels' features by the TOPSIS technique and finally examined the level of customer satisfaction through the fuzzy-neuro method. The authors used "service", "value", "sleep quality", "location", "room", "check-in", and "cleanliness" criteria for evaluation. It should be noted that the validation of the approach was done by applying the data from 152 hotels in Malaysia. The obtained results made it possible for managers to strengthen their marketing strategies and improve their service quality.

Vahdat et al. (2019) believe that with the success of the hospitality industry, the demand for hotels increases, and tourists always look for hotels that have high service quality. There are two types of hotels in historical cities. Hotels that are located in historical regions and provide a traditional environment to introduce tourists to the local cuisine, culture, and architecture of the city. The second type are modern hotels that provide international cuisine and modern services. Vahdat et al. (2019) have examined which type of hotels are more proper for tourists using the evaluation process. It should be noted that they have employed the SERVQUAL model and MCDM methods for this purpose. Based on the five dimensions of the SERVQUAL model, namely "tangibility", "empathy", "responsiveness", "reliability", and "assurance", they identified and extracted evaluation criteria. Then, the weights of SERVQUAL model dimensions and evaluation criteria were calculated by the AHP method. Finally, by applying TOPSIS technique, hotels are ranked. The results showed that historical hotels are more suitable for tourists.

Ahani et al. (2019) stated that online customer comments can lead to the improvement of hotel performance and facilitate the hotel selection process for future customers. By reviewing the comments, hotel owners identify their weak points, and adopt strategies to improve them. In

this regard, the authors presented an approach for evaluating and prioritizing hotels using MCDM methods and clustering techniques. They evaluated the performance of hotels based on seven criteria including "value", "location", "cleanliness", "room", "service", "sleep quality", and "check-in/front desk" and ranked the hotels by the TOPSIS method. They used Canary Islands hotels as a case study and evaluated the effectiveness of their presented approach using their data. The findings emphasized that to improve hotel services and increase customer satisfaction, customer preferences should be segmented before data analysis.

A hybrid MCDM approach to assess online travel agencies to help hotel managers was structured by Liao et al. (2019). In the first stage of the proposed approach, evaluation criteria were determined through the fuzzy Delphi method, and a total of four criteria and 12 sub-criteria were identified. By applying the DEMATEL method, interdependencies among criteria were discovered, and then the weights of the criteria and their sub-criteria were calculated by the ANP method. Finally, the performance of the proposed approach was evaluated by real data, and the results confirmed its effectiveness.

Samanlioglu et al. (2020) presented an integrated approach to evaluate hotel website provider firms under uncertainty. They used the fuzzy best-worst method (BWM) to weight the criteria, and the fuzzy TOPSIS method to rank hotel website provider firms. They introduced nine criteria for evaluation and applied the knowledge of three experts to rank the firms. Finally, the effectiveness of their proposed approach was investigated through its implementation in a hotel in Turkey.

Wang et al. (2020) believed that the choice of hotel by different types of tourists is different. In their research, they considered five types of hotel customers, including family, friends, solo, couples, and business, and using factors such as "cleanliness", "location", "bed", "service", "breakfast", "bathroom", "close", "food", etc. were evaluated from the point of view of different customers. The results demonstrated that the weights of evaluation criteria are different from the different customer's points of view. In addition, the results revealed that families and friends have close preferences.

To assess peer-to-peer rental accommodations, a dynamic system based on MCDM methods was configured by Tavana et al. (2020). Their proposed DSS has an innovative insight into the hotel and hospitality industry, and for the first time, such a system has been presented for the evaluation of rental accommodations. They believe that the evaluation criteria and their weights are various from the point of view of different customers, and a set of fixed criteria with static weights should not be used to evaluate rental accommodations. They identified and extracted a comprehensive set of evaluation criteria by reviewing the literature and online platforms that provide rental accommodations. In the designed DSS, the weights of the criteria are determined

by fuzzy BWM, and no expert knowledge is needed to complete the pairwise comparison questionnaires. In the proposed DSS, customers choose their desired criteria and specify their priority in the system. In addition, customers can apply filters in the system to make the search process faster. Finally, the proposed DSS calculates the weight of the criteria under the highest compatibility and prioritizes rental accommodations for customers. It should be noted that fuzzy TOPSIS method was used to prioritize rental accommodations. They used data from a case study in the peer-to-peer rental accommodation industry to demonstrate the applicability of their proposed DSS.

To compare and rank sustainability practices in hotels, a structured approach based on MCDM methods was developed by Nasser et al. (2021). Their goal was to improve sustainability performance in the Yemeni hotel industry. They applied three methods including AHP, fuzzy AHP, and fuzzy Delphi method to weight the performance criteria. Although the results of the three methods were slightly different from each other, the water conservation criterion was chosen as the most important criterion in all three methods.

Nguyen (2021) provided an evaluation approach to measure the quality of services provided by hotels by integrating the SERVQUAL model and fuzzy AHP method. He used data from a five-star hotel to achieve this goal. In this vein, based on the five criteria of the SERVQUAL model, he identified and extracted 22 sub-criteria for evaluating the quality of hotel services. Then, using the fuzzy AHP method, the weights of the criteria and their sub-criteria were calculated. The research findings showed that the special attention of employees to customers is the most important sub-criteria in the evaluation process. He believes that hotels should focus on organized and important factors to provide better services.

A fuzzy PROMETHEE-based approach to evaluate the performance of green hotels was introduced by Kamalkhani et al. (2021). They identified eight criteria including "technology", "green architecture", "energy consumption", "green transportation", "green internal management", "economic performance", "pollution", and "environmental management" and 41 sub-criteria to evaluate green hotels. They used the data of 25 hotels in Tehran to examine the performance of their presented approach.

In hotel construction projects, it is important to evaluate the project from the economic, social, and environmental aspects. This problem is among MCDM problems. Hence, Popovic et al. (2021) presented a MCDM-oriented framework to assess hotel construction projects from the sustainability perspective. They evaluated five alternatives in Serbia using seven criteria including "investment", "environmental footprint", "economic prosperity", "social welfare", "accommodation fee per night", "area of accommodations", and "number of accommodations".

Said et al. (2021) identified and prioritized the effective factors in the implementation of sustainability practices in hotels. They identified and introduced a set of effective factors in the implementation of sustainable practices by applying the knowledge of 13 experts. They used fuzzy Delphi method to rank these factors. It should be noted that a total of 42 factors were identified, of which 10 factors were selected as principal factors. These factors are: "sustainability management system", "destination engagement", "legal compliance", "interpretation and information", "communication and reporting", "infrastructure and buildings", "land water and property rights", "staff engagement", "accurate promotion", and "customer experience". They used the information and data of a hotel in Yemen to demonstrate the effectiveness of their proposed approach.

A DSS based on MCDM methods was designed to select the best hotel by Wu et al. (2022). They prioritized eight hotels in Shanghai city with the help of six criteria including "comfort", "position", "cleanliness", "service", "food", and "facility". They used BWM and TOPSIS to calculate the weight of criteria and prioritize hotels, respectively.

Piya et al. (2022) believe that the implementation of green practices in the hospitality industry can lead to the reduction of environmental destructive effects. In this regard, they identified factors that introduce green practices. Then, they formed an integrated approach to measure the green score of hotels by applying MCDM methods. They first identified 26 factors, and classified these factors into six groups including "reuse and recycling", "green incentives and training", "energy conservation and efficiency", "water conservation and efficiency", "transportation", and "commitment to eco-practices". They calculated the weight of factors and their groups by the fuzzy AHP method, and utilized the fuzzy TOPSIS method to determine the green score of hotels and rank them. The findings of their research indicated that "reuse and recycling" and "green incentives and training" have the highest and lowest weight, respectively. Finally, they used data from 13 four-star and five-star hotels in Oman to validate their approach.

By integrating BWM and fuzzy TOPSIS, an evaluation approach for ranking hotels from the sustainability perspective was introduced by Wang and Nguyen (2022). They introduced six main criteria for evaluating sustainable hotels, which each criterion includes five sub-criteria. The main criteria include "green infrastructure and building", "green transportation and operation", "local green culture protection", "green regulations and policies", "environmental and monitoring control", and "green training of employees". They used BWM and fuzzy TOPSIS to weight factors (main criteria and sub-criteria) and rank hotels, respectively. Finally, the authors stated that sub-criteria such as "forming a biodiversity-focused commission to assess hotel operations' impact on the local environment", "applying eco-tourism strategies",

and "use of a green vehicle for transportation" have the greatest impact on the performance of sustainable hotels.

Rodríguez-García et al. (2023) analyzed the content of sustainability certificates in the hospitality industry and identified a set of sustainability criteria. Some of these criteria include "sustainability management system", "staff engagement", "interpretation and information", "sustainable materials and practices", "local livelihoods", "equal opportunity", "cultural interactions", "community support", "energy and water conservation", "transport", and "pollution control".

Recently, the hotel industry in India has focused on sustainable practices and has pushed the hospitality industry towards sustainable development. In this vein, Prakash et al. (2023) have investigated which of the sustainability practices has a greater impact on the sustainability of the hotels. They considered five sustainability practices including "increasing water conservation", "minimizing air pollution", "effective waste management", "reducing noise pollution", and "preserving energy" and ranked these practices through the AHP method. It should be noted that they used "hotel image", "cost", "local community pressure", and "government regulations" criteria for this purpose. The results showed that increasing water conservation is more effective than other practices in the sustainability of hotels.

In Table 2.1, a summary of the reviewed articles is presented so that the readers can be informed about the content of the articles with a glance and see the research gap.

Table 2.1. A summary of reviewed articles

Author(s)	Year	Technique/ approach/method	Purpose	Sustainability	Uncertainty	Case study
Abokhamis Mousavi et al.	2017	A questionnaire-based model	Applying a model to assess sustainable hotels using cultural, social, environmental, and economic criteria	Yes	No	Northern Cyprus
Reid et al.	2017	Survey	Identifying a set of sustainability practices for evaluating hotels	Yes	No	Asia-Pacific
Zolfani et al.	2018	SWARA and COPRAS	Evaluating and prioritizing the construction projects in the sustainable hotel industry	Yes	No	Iran (Tehran city)
Gürbüz and Erdinç	2018	Fuzzy MOORA	Prioritizing hotels to identify the best hotel	No	Yes (fuzzy)	Turkey (Kayseri city)
Yu et al.	2018	Novel MCDM method based on VIKOR	Developing a DSS to evaluate and rank hotels using online comments of reviewers and MCDM methods	No	No	China (Shanghai city)
Mohaghar et al.	2019	Fuzzy ANP and fuzzy TOPSIS	Evaluating the quality of hotel services	No	Yes (fuzzy)	Iran (Mashhad city)
Ostovare and Shahraki	2019	Fuzzy Delphi, PROMETHEE, and GAIA	Developing a comprehensive approach for hotel website evaluation	No	Yes (fuzzy)	Iran (Mashhad city)
Kwok and Lau	2019	Modified-TOPSIS	Structuring a user-friendly DSS for selecting the best hotel	No	Yes (fuzzy)	Hong Kong
Nilashi et al.	2019	Machine learning and TOPSIS	Developing a hybrid approach to evaluate the hotels	No	Yes (fuzzy)	Malaysia

Vahdat et al.	2019	SERVQUAL model, AHP, TOPSIS, fuzzy theory	Configuring a hybrid approach for selecting the proper hotel for tourists	No	Yes (fuzzy)	Iran (Yazd city)
Ahani et al.	2019	TOPICS	Developing an MCDM approach to evaluate the hotels	No	No	Canary Islands
Liao et al.	2019	Fuzzy Delphi, DEMATEL, and ANP	Proposing a hybrid MCDM approach to assess online travel agencies to help hotel managers	No	Yes (fuzzy)	Taiwan
Samanlioglu et al.	2020	Fuzzy BWM and fuzzy TOPSIS	Presenting an integrated approach to evaluate hotel website provider firms under uncertainty	No	Yes (fuzzy)	Turkey
Tavana et al.	2020	Fuzzy BWM and fuzzy TOPSIS	Developing a novel MCDM-based DSS for assessing the peer-to-peer rental accommodations	No	Yes (fuzzy)	Paris
Nasser et al.	2021	AHP, fuzzy Delphi, and fuzzy AHP	Structuring an MCDM-based framework to compare and rank sustainability practices in hotels	Yes	Yes (fuzzy)	Yemen
Nguyen	2021	SERVQUAL model and fuzzy AHP	Developing an evaluation approach to measure the quality of services provided by hotels	No	Yes (fuzzy)	Vietnam
Kamalkhani et al.	2021	fuzzy PROMETHEE	Providing an MCDM-oriented approach to evaluate the performance of green hotels	Yes	Yes (fuzzy)	Iran (Tehran city)
Popovic et al.	2021	Novel MCDM method	Developing an MCDM-oriented framework to assess hotel construction projects from the sustainability perspective	Yes	No	Serbia
Said et al.	2021	Fuzzy Delphi	Identifying and prioritizing the effective factors in the implementation of sustainability practices in hotels	Yes	Yes (fuzzy)	Yemen
Wu et al.	2022	BWM and TOPSIS	Designing an MCDM-oriented DSS to select the best hotel	No	No	Shanghai

Piya et al.	2022	Fuzzy AHP and fuzzy TOPSIS	forming an integrated approach to measure the green score of hotels	Yes	Yes (fuzzy)	Oman
Wang and Nguyen	2022	BWM and fuzzy TOPSIS	Developing an evaluation approach for ranking hotels from the sustainability perspective	Yes	Yes (fuzzy)	Vietnam
Rodríguez-García	2023	Survey and analysis	Analyzing the content of sustainability certificates in the hospitality industry to identify a set of sustainability criteria	No	No	-
Prakash et al.	2023	AHP	Identifying the most effective sustainability practices on the sustainability of the hotels	Yes	No	India

2.5. Summary of the chapter

The purpose of this research is to design a DSS to evaluate hotels from the sustainability perspective in order to increase the loyalty of sustainable customers. Therefore, in this section, we first examined the importance of sustainability in the hotel industry, and revealed that the use of sustainable practices in this industry can have a significant impact on reducing resource and energy consumption, increasing economic growth, reducing pollution, developing job opportunities, etc. Then we briefly discussed the relationship between sustainable hotels and customer loyalty. Finally, in the literature review sub-section, we examined a large number of articles from 2016 to 2023. The purpose of this sub-section was to identify the evaluation criteria and the MCDM method employed in the hotel industry. At the end of this sub-section, we presented a summary of the reviewed articles in the form of Table 2.1.

Chapter 3:

Proposed Approach

3.1. Introduction

In this chapter, by integrating MCDM methods and a fuzzy inference system, an efficient decision support system (DSS) is presented for evaluating hotels from the sustainability perspective. The proposed DSS consists of two stages. In the first stage, with the help of the fuzzy step-wise weight assessment ratio analysis (SWARA) method, the weights of the criteria are calculated and the score of hotels for each dimension are determined. In the second stage of the developed DSS, by using a fuzzy inference system, the relationship between the input variables (i.e., economic, environmental, and social dimensions) and the output variable (i.e., the final score of the hotel) is formulated by applying the rules defined by experts. Then, the final score of each hotel is calculated by the fuzzy inference system. In the following, the proposed approach is presented in three stages.

3.2. Fuzzy inference system

Fuzzy Logic and expert system technologies are used to create the non-linear fuzzy inference system (Govindan et al., 2020). Fuzzy logic is a method of reasoning that enables the processing of ambiguous or approximate information. The concept of fuzzy sets-classes of items with ambiguous boundaries-serves as its foundation. Variables in fuzzy logic can be defined and handled according to how much they belong to a fuzzy set, which is represented as a continuum of values ranging from 0 to 1. This makes it feasible to process different truth values using the same variable and to assign a value to an operation's result based on how true it is. Several ambiguous IF-THEN rules derived from professional judgment make up fuzzy inference system. These guidelines work well at simulating human thought processes. Tavana et al. (2019) provides readers with information on the benefits of fuzzy inference system and its adaptable regulations.

The two main types of fuzzy logic modeling are the Takagi-Sugeno-Kang (Sugeno, 1985) and Mamdani (Mamdani and Assilian, 1993) approaches. The elements of the Mamdani models are defined as a fuzzy collection of antecedents and their effects. The Takagi-Sugeno-Kang models have the same origins as the Mamdani models. It is interesting to observe that the Takagi-Sugeno-Kang models lead to linear equations. The primary focus of fuzzy relational equation models is to analyze fuzzy connection matrices based on input-output process data. The limitations of the Takagi-Sugeno-Kang fuzzy inference system become evident when conducting multi-parameter synthetic assessments, input weighting, and handling fuzzy rules. One way to summarize the advantages of the Mamdani model is its high level of understandability and legibility. According to Govindan et al. (2020), Mamdani fuzzy inference system is considered superior to comparable models in terms of output expression.

3.3. Proposed approach

An efficient evaluation approach is an approach that consists of appropriate evaluation criteria and proper evaluation method. In order to achieve a set of comprehensive and appropriate criteria, the literature should be carefully reviewed and the knowledge of experts should be employed to finalize the criteria. On the other hand, it is not possible to choose proper evaluation method(s) except by knowing the nature of the investigated problem. In this study, evaluation criteria are extracted from the economic, environmental, and social dimensions. The literature review shows that there is a linear relationship between each dimension of sustainability and its criteria (Tavana et al., 2023). Therefore, MCDM methods can be utilized to calculate the weights of the criteria of each dimension. In this research, we use the fuzzy SWARA developed by Zarbakhshnia et al (2018) to determine the weights of criteria. Fuzzy SWARA method is a method based on pairwise comparisons that can be easily implemented in various MCDM problems and does not require complex mathematical calculations. In addition, the review of the literature reveals that there is not necessarily a linear relationship between the final score of alternatives and sustainability dimensions (Tavana et al., 2023; Omair et al., 2021), and perhaps the good performance of one dimension cannot compensate for the unfavorable performance of another dimension. In such a situation, methods should be used to formulate the nonlinear relationship between input and output variables. Fuzzy inference system is one of these methods that applies the knowledge of experts to map logical relationships between input variables (i.e., economic, social, and environmental dimensions) and output variables (i.e., the final score of alternatives). In this vein, in this research, for the first time, by integrating fuzzy SWARA method and fuzzy inference system, a practical DSS is presented for evaluating hotels from a sustainability perspective. The proposed DSS consists of two stages, which are given below:

First stage: Fuzzy SWARA method to calculate the score of hotels for each dimension

In this stage, hotel evaluation criteria are extracted from the economic, social, and environmental perspectives and weighted by SWARA fuzzy method. The process of weighting the criteria using the fuzzy SWARA method is given below in nine steps:

Step 1.1: In this step, evaluation criteria are identified for each dimension. For this purpose, first a set of criteria are extracted from the literature and effective and suitable criteria are identified by applying the knowledge of experts.

Step 1.2: In this step, experts should prioritize the criteria from the most important to the least important. Note that this operation must be implemented separately for the criteria of each dimension.

Step 1.3: In this step, experts should compare criterion *j* with criterion (*j*-1) using the linguistic terms provided in Table 3.1. Note that the comparisons start from the second criterion and $\tilde{S}_j$ represents the relative importance ratio of criterion *j*.

Table 3.1. Linguistic terms for pairwise comparisons (Chang, 1996)

Linguistic terms	Fuzzy triangular numbers
Equally important	(1,1,1)
Slightly less important	(2/3,1,3/2)
Less important	(2/5,1/2,2/3)
Very less important	(2/7,1/3,2/5)
Absolutely less important	(2/9,1/4,2/7)

Step 1.4: In this step, we calculate the coefficient $\tilde{K}_j$ for criterion *j* through Eq. (3.1).

$$\tilde{K}_j = \begin{cases} \tilde{1} & j = 1 \\ \tilde{S}_j + \tilde{1} & j > 1 \end{cases} \tag{3.1}$$

where $\tilde{K}_j = (K_j^l, K_j^m, K_j^u)$ denotes the coefficient value of comparative importance for criterion *j*.

Step 1.5: In this step, we calculate the fuzzy recalculated weight of criterion *j* ($\tilde{Q}_j$) by applying Eq. (3.2).

$$\tilde{Q}_j = \begin{cases} \tilde{1} & j = 1 \\ \dfrac{\tilde{Q}_{j-1}}{\tilde{K}_j} & j > 1 \end{cases} \tag{3.2}$$

where; $\tilde{Q}_j = (Q_j^l, Q_j^m, Q_j^u)$.

Step 1.6: In this step, the relative fuzzy weight of criterion *j* ($\tilde{W}_j$) is calculated with the help of Eq. (3.3).

$$\tilde{W}_j = \frac{\tilde{Q}_j}{\sum_{j=1}^{n} \tilde{Q}_j} \tag{3.3}$$

where; $\tilde{W}_j = (W_j^l, W_j^m, W_j^u)$.

Note that this operation must be implemented for each dimension. Therefore, at the end of this step, relative fuzzy weight of criterion *j* related to dimension *i* is calculated, which is indicated

by $\tilde{W}_{ij} = (W_{ij}^{l}, W_{ij}^{m}, W_{ij}^{u})$.

Step 1.7: In this step, using the linguistic terms shown in Table 3.2, the performance of each alternative (hotel) is evaluated for each criterion. If *E* represents the number of customers, the average fuzzy score of alternative *h* in criterion *j* related to dimension *i* is calculated as follows:

$$\tilde{\theta}_{ijh} = \frac{\sum_{e=1}^{E} \tilde{\mu}_{ijhe}}{E} \tag{3.4}$$

where $\tilde{\mu}_{ijhe} = (\mu_{ijhe}^{l}, \mu_{ijhe}^{m}, \mu_{ijhe}^{u})$ and $\tilde{\theta}_{ijh} = (\theta_{ijh}^{l}, \theta_{ijh}^{m}, \theta_{ijh}^{u})$ represent the fuzzy score of alternative *h* in criterion *j* related to dimension *i* based on opinion of customer *e* and the average fuzzy score of alternative *h* in criterion *j* related to dimension *i*, respectively.

Table 3.2. Linguistic terms for evaluating alternatives

Linguistic terms	Fuzzy triangular numbers
Absolutely low (AL)	(0,0,0)
Very low (VL)	(0,0.1,0.2)
Low (L)	(0.1,0.2,0.3)
Slightly low (SL)	(0.2,0.3,0.4)
Mid-low (ML)	(0.3,0.4,0.5)
Mid (M)	(0.4,0.5,0.6)
Mid-high (MH)	(0.5,0.6,0.7)
Slightly high (SH)	(0.6,0.7,0.8)
High (H)	(0.7,0.8,0.9)
Very high (VH)	(0.8,0.9,1)
Absolutely high (AH)	(1,1,1)

Step 1.8: In this step, the fuzzy score of alternative *h* for dimension *i* is calculated using Eq. (3.5).

$$\tilde{\vartheta}_{ih} = \sum_{j=1}^{n} \tilde{\theta}_{ijh} \times \tilde{W}_{ij} \tag{3.5}$$

where $\tilde{\vartheta}_{ih} = (\vartheta_{ih}^{l}, \vartheta_{ih}^{m}, \vartheta_{ih}^{u})$ shows the fuzzy score of alternative *h* for dimension *i*.

Step 1.9: In this step, the fuzzy score obtained from the previous step is defuzzified via Eq. (3.6).

$$\varphi_{ih} = \frac{\vartheta_{ih}^{l} + 4 \times \vartheta_{ih}^{m} + \vartheta_{ih}^{u}}{6} \tag{3.6}$$

where φ_{ih} denotes the final score of alternative *h* in dimension *i*.

Second stage: Fuzzy inference system to calculate the final score of alternatives

In this stage, a fuzzy inference system is structured to calculate the final score of the alternatives. The proposed fuzzy inference system is given below in four steps:

Step 2.1: In this step, the input and output variables of the fuzzy inference system are first determined. Then, membership functions are defined for these variables. The accuracy of fuzzy inference system is influenced by the number of membership functions defined for input and output variables. On the other hand, if the number of membership functions of the input variables is large, the number of fuzzy inference rules increases exponentially. Note that the number of rolls is equal to the product of the number of membership functions of the input variables. This means that if the number of input variables of the fuzzy inference system was large, we should not consider the number of their membership functions to be large; because in this case, the number of fuzzy inference rules increases and this leads to fatigue and confusion of experts and increases the possibility of mistakes. Literature review shows that for systems that have less than four input variables, five or seven membership functions are considered. Here, to design an accurate fuzzy inference system, we consider seven membership functions for the input and output variables. These membership functions are presented in Table 3.3 and Figure 3.1.

Table 3.3. Membership functions of input and output variables

Linguistic terms	Fuzzy triangular numbers
Very low	(0,0,0.167)
Low	(0,0.167,0.333)
Mid-low	(0.167,0.333,0.5)
Mid	(0.333,0.5,0.667)
Mid-high	(0.5,0.667,0.833)
High	(0.667,0.833,1)
Very high	(0.833,1,1)

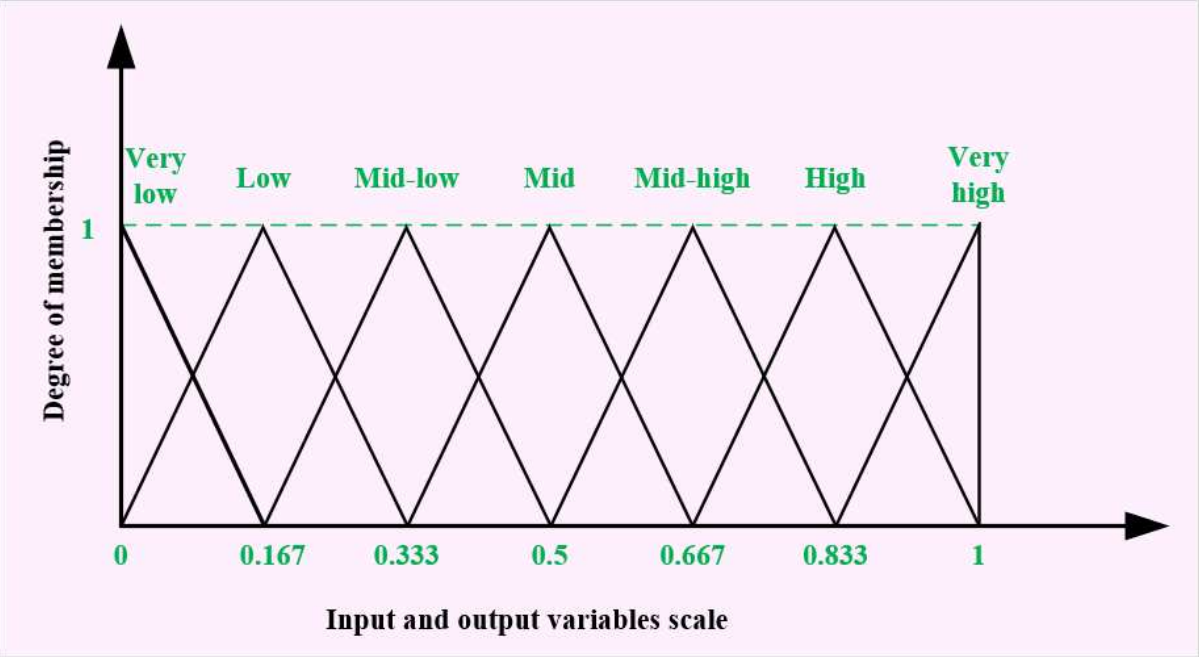

Figure 3.1. Membership functions of input and output variables

Step 2.2: In this step, fuzzy inference rules are determined. For this purpose, the experts are asked to establish a relationship between the input and output variables using the membership functions defined in the previous step. Figure 3.2 shows the general structure of the questionnaire required for extracting fuzzy inference rules.

1. If economic is very low, environmental is very low, and social is very low, then final score is ...
2. If economic is very low, environmental is very low, and social is low, then final score is ...
3. If economic is very low, environmental is very low, and social is mid-low, then final score is ...
.
.
.
341. If economic is very high, environmental is very high, and social is mid-high, then final score is ...
342. If economic is very high, environmental is very high, and social is high, then final score is ...
343. If economic is very high, environmental is very high, and social is very high, then final score is ...

Figure 3.2. The general structure of the questionnaire required for extracting fuzzy inference rules

Note that the developed fuzzy inference system includes three input variables, each of which has seven membership functions. Therefore, the number of fuzzy inference rules is $7 \times 7 \times 7 = 343$, which is shown in Figure 3.2.

Step 2.3: In this step, the final score of the alternatives is calculated. For this purpose, the calculated scores of the alternatives in step 1.9 are given as input to the fuzzy inference system and the system calculates the final score of the alternatives.

For a better understanding of the proposed approach, we have presented its steps in Figure 3.3.

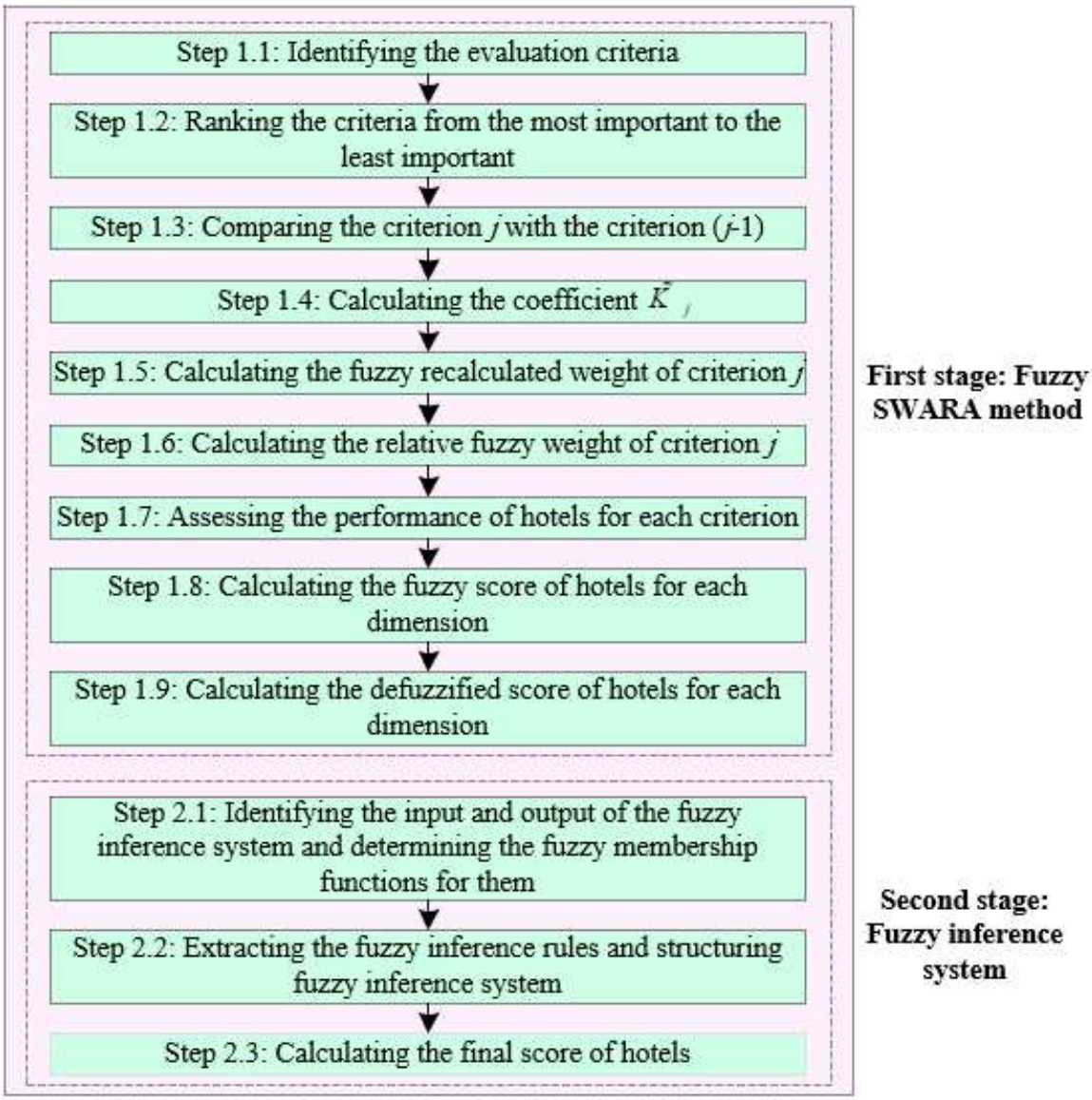

Figure 3.3. Proposed DSS

3.4. Summary of the chapter

In this chapter, by combining the fuzzy SWARA method and fuzzy inference system, a practical DSS was configured to evaluate hotels from the sustainability perspective. Presented DSS consists of two steps. The first stage deals with the weighting of the evaluation criteria and calculating the score of hotels for each dimension (i.e., economic, social, and environmental) and, uses fuzzy SWARA for this purpose. The second stage of the proposed DSS is based on a fuzzy inference system. This system consists of three inputs, including the hotel's economic score, the hotel's environmental score, and the hotel's social score, and one output, including the hotel's final score. The number of membership functions of input and output variables is considered to be seven, and a total of 343 fuzzy inference rules must be determined by experts

to establish relationships between input and output variables. In the next chapter, these rules are identified and the effectiveness of the proposed DSS in the real world is investigated.

Chapter 4:

Case study

4.1. Introduction

This chapter deals with the validation of the approach presented in Chapter 3. In this regard, the efficiency of the developed approach is evaluated using the data from two hotels, one in Iran and the other in Italy. It should be noted that questionnaires related to the fuzzy SWARA method and fuzzy inference system are completed by experts, but questionnaires related to hotel evaluation are filled by customers (guests). In the following, the hotel evaluation process using the developed DSS is presented step by step.

4.2. Case study

In this section, we use the data and knowledge of the experts of Hotel X[1] in Iran and Hotel Y[1] in Italy to investigate the application of the developed DSS. It should be noted that to validate our DSS, we intended to select several hotels with similar performance from developed and developing countries. For this purpose, we contacted several hotels and only these two hotels agreed with us. Note that an effective approach is one that can evaluate and rank hotels with similar performance levels, as hotels with significantly different performances can be ranked without the need for a specific approach. The evaluation process of the two mentioned hotels is as follows:

First stage: Calculating the score of hotels for each dimension

In this step, the fuzzy SWARA method is used to calculate the weight of the criteria and determine the score of the hotels for each dimension. This stage consists of nine steps as follows:

Step 1.1: By carefully studying the literature and holding meetings with experts, 20 evaluation criteria including seven economic criteria, seven environmental criteria, and six social criteria were identified, which are listed below (Prakash et al., 2023; Piya et al., 2022; Wu et al., 2022; Tavana et al., 2020; Wang et al., 2020):

- **Economic**
    - Amenities/facilities
    - Price Value
    - Food
    - Cleanliness
    - Service and staff
    - Location
    - Check-in

[1] The hotels prefer to maintain their anonymity.

- **Environmental**
  - Eco-friendly architecture
  - Using renewable energy
  - Using mechanisms to conserve energy and water
  - Food waste reduction and management
  - Easy access to bicycles, electric vehicles, and public transportation
  - Use of the eco-friendly cleaning products
  - Environmental certifications
- **Social**
  - Adapting to the needs of guests with disabilities
  - Staff training
  - Transparency and communication
  - Supporting charities and local development projects
  - Job creation for local people
  - Promoting local customs and traditions

Step 1.2: In this step, the experts prioritized the identified criteria from the most important to the least important. Tables 4.1 to 4.3 show the ordered economic, environmental, and social criteria.

Table 4.1. The prioritized economic criteria

Economic criteria	Rank
Price Value	1
Cleanliness	2
Location	3
Amenities/facilities	4
Service and staff	5
Check-in	6
Food	7

Table 4.2. The prioritized environmental criteria

Environmental criteria	Rank
Using renewable energy	1
Using mechanisms to conserve energy and water	2
Eco-friendly architecture	3

Easy access to bicycles, electric vehicles, and public transportation	4
Food waste reduction and management	5
Use of eco-friendly cleaning products	6
Environmental certifications	7

Table 4.3. The prioritized social criteria

Social criteria	Rank
Job creation for local people	1
Adapting to the needs of guests with disabilities	2
Staff training	3
Transparency and communication	4
Supporting charities and local development projects	5
Promoting local customs and traditions	6

Step 1.3: In this step, $\tilde{S}_j$ is determined for each criterion. For this purpose, criterion (j-1) is compared with criterion j using the linguistic terms denoted in Table 3.1. Tables 4.4 to 4.6 represent $\tilde{S}_j$ values for economic, environmental, and social criteria, respectively.

Table 4.4. $\tilde{S}_j$ values for economic criteria

Economic criteria	$\tilde{S}_j$
Price Value	-
Cleanliness	(2/3,1,3/2)
Location	(2/3,1,3/2)
Amenities/facilities	(2/3,1,3/2)
Service and staff	(2/3,1,3/2)
Check-in	(2/5,1/2,2/3)
Food	(2/3,1,3/2)

Table 4.5. $\tilde{S}_j$ values for environmental criteria

Environmental criteria	$\tilde{S}_j$
Using renewable energy	-
Using mechanisms to conserve energy and water	(2/3,1,3/2)
Eco-friendly architecture	(2/5,1/2,2/3)
Easy access to bicycles, electric vehicles, and public transportation	(2/3,1,3/2)
Food waste reduction and management	(2/3,1,3/2)
Use of eco-friendly cleaning products	(2/5,1/2,2/3)
Environmental certifications	(2/3,1,3/2)

Table 4.6. $\tilde{S}_j$ values for social criteria

Social criteria	$\tilde{S}_j$
Job creation for local people	-
Adapting to the needs of guests with disabilities	(2/3,1,3/2)
Staff training	(2/3,1,3/2)
Transparency and communication	(2/5,1/2,2/3)
Supporting charities and local development projects	(2/3,1,3/2)
Promoting local customs and traditions	(2/3,1,3/2)

Step 1.4: In this step, by employing Eq. (3.1), coefficient $\tilde{K}_j$ is calculated for each criterion, which is shown in Tables 4.7 to 4.9.

Table 4.7. $\tilde{K}_j$ values for economic criteria

Economic criteria	$\tilde{K}_j$
Price Value	(1,1,1)
Cleanliness	(5/3,2,5/2)
Location	(5/3,2,5/2)
Amenities/facilities	(5/3,2,5/2)
Service and staff	(5/3,2,5/2)
Check-in	(7/5,3/2,5/3)
Food	(5/3,2,5/2)

Table 4.8. $\tilde{K}_j$ values for environmental criteria

Environmental criteria	$\tilde{K}_j$
Using renewable energy	(1,1,1)
Using mechanisms to conserve energy and water	(5/3,2,5/2)
Eco-friendly architecture	(7/5,3/2,5/3)
Easy access to bicycles, electric vehicles, and public transportation	(5/3,2,5/2)
Food waste reduction and management	(5/3,2,5/2)
Use of eco-friendly cleaning products	(7/5,3/2,5/3)
Environmental certifications	(5/3,2,5/2)

Table 4.9. $\tilde{K}_j$ values for social criteria

Social criteria	$\tilde{K}_j$
Job creation for local people	(1,1,1)
Adapting to the needs of guests with disabilities	(5/3,2,5/2)
Staff training	(5/3,2,5/2)
Transparency and communication	(7/5,3/2,5/3)
Supporting charities and local development projects	(5/3,2,5/2)
Promoting local customs and traditions	(5/3,2,5/2)

Step 1.5: In this step, the fuzzy recalculated weight ($\tilde{Q}_j$) is calculated for each criterion using Eq. (3.2). Tables 4.10 to 4.12 show the fuzzy recalculated weights for economic, environmental, and social criteria, respectively.

Table 4.10. $\tilde{Q}_j$ values for economic criteria

Economic criteria	$\tilde{Q}_j$
Price Value	(1,1,1)
Cleanliness	(0.4,0.5,0.6)
Location	(0.16,0.25,0.36)
Amenities/facilities	(0.064,0.125,0.216)
Service and staff	(0.0256,0.0625,0.1296)
Check-in	(0.0154,0.0417,0.0926)
Food	(0.0061,0.0208,0.0555)

Table 4.11. $\tilde{Q}_j$ values for environmental criteria

Environmental criteria	$\tilde{Q}_j$
Using renewable energy	(1,1,1)
Using mechanisms to conserve energy and water	(0.4,0.5,0.6)
Eco-friendly architecture	(0.24,0.3333,0.4286)
Easy access to bicycles, electric vehicles, and public transportation	(0.096,0.1667,0.2571)
Food waste reduction and management	(0.0384,0.0833,0.1543)
Use of eco-friendly cleaning products	(0.023,0.0556,0.1102)
Environmental certifications	(0.0092,0.0278,0.0661)

Table 4.12. $\tilde{Q}_j$ values for social criteria

Social criteria	$\tilde{Q}_j$
Job creation for local people	(1,1,1)
Adapting to the needs of guests with disabilities	(0.4,0.5,0.6)
Staff training	(0.16,0.25,0.36)
Transparency and communication	(0.096,0.1667,0.2571)
Supporting charities and local development projects	(0.0384,0.0833,0.1543)
Promoting local customs and traditions	(0.0154,0.0417,0.0926)

Step 1.6: In this step, the relative fuzzy weight ($\tilde{W}_j$) is calculated for each criterion using Eq. (3.3). Tables 4.13 to 4.15 show the relative fuzzy weights for economic, environmental, and social criteria, respectively.

Table 4.13. $\tilde{W}_j$ values for economic criteria

Economic criteria	$\tilde{W}_j$
Price Value	(0.4075,0.5,0.5984)
Cleanliness	(0.163,0.25,0.359)
Location	(0.0652,0.125,0.2154)
Amenities/facilities	(0.0261,0.0625,0.1293)

Service and staff	(0.0104,0.0313,0.0776)
Check-in	(0.0063,0.0209,0.0554)
Food	(0.0025,0.0104,0.0332)

Table 4.14. $\tilde{W}_j$ values for environmental criteria

Environmental criteria	$\tilde{W}_j$
Using renewable energy	(0.3822,0.4615,0.5535)
Using mechanisms to conserve energy and water	(0.1529,0.2308,0.3321)
Eco-friendly architecture	(0.0917,0.1538,0.2372)
Easy access to bicycles, electric vehicles, and public transportation	(0.0367,0.0769,0.1423)
Food waste reduction and management	(0.0147,0.0384,0.0854)
Use of the eco-friendly cleaning products	(0.0088,0.0257,0.061)
Environmental certifications	(0.0035,0.0128,0.0366)

Table 4.15. $\tilde{W}_j$ values for social criteria

Social criteria	$\tilde{W}_j$
Job creation for local people	(0.4058,0.4898,0.5849)
Adapting to the needs of guests with disabilities	(0.1623,0.2449,0.3509)
Staff training	(0.0649,0.1224,0.2106)
Transparency and communication	(0.039,0.0816,0.1504)
Supporting charities and local development projects	(0.0156,0.0408,0.0902)
Promoting local customs and traditions	(0.0063,0.0204,0.0542)

Step 1.7: In this step, the performance of the two studied hotels is evaluated based on the opinion of the customers. For this purpose, evaluation questionnaires were delivered to the hotels and during two months, 29 and 20 questionnaires were completed by the customers of Hotel X in Iran and Hotel Y in Italy, respectively. The results of completed questionnaires for each customer in hotels X and Y are shown in Tables A1 and A2, respectively. Note that the linguistic terms provided in Table 3.2 are used to score the hotels. Finally, with the help of Eq. (3.4), the average fuzzy score of hotels for each criterion is calculated. Tables 4.16 and 4.17 show the average fuzzy scores of hotels X and Y for each criterion, respectively.

Table 4.16. The average score of Hotel X for each criterion

Criteria	Average fuzzy score
Amenities/facilities	(0.8207,0.8724,0.9241)
Price Value	(0.8034,0.8690,0.9345)
Food	(0.8276,0.8759,0.9241)
Cleanliness	(0.7724,0.8483,0.9241)
Service and staff	(0.8586,0.9034,0.9483)
Location	(0.8138,0.8724,0.9310)
Check in	(0.7414,0.8103,0.8793)
Eco-friendly architecture	(0.6621,0.7310,0.8000)
Using renewable energy	(0.5828,0.6793,0.7759)
Using mechanisms to conserve energy and water	(0.5414,0.6310,0.7207)
Food waste reduction and management	(0.5414,0.6310,0.7207)
Easy access to bicycles, electric vehicles, and public transportation	(0.5103,0.6069,0.7034)
Use of the eco-friendly cleaning products	(0.5828,0.6655,0.7483)
Environmental certifications	(0.4966,0.5897,0.6828)
Adapting to the needs of guests with disabilities	(0.5207,0.6103,0.7000)
Staff training	(0.5931,0.6793,0.7655)
Transparency and communication	(0.6690,0.7483,0.8276)
Supporting charities and local development projects	(0.8034,0.8655,0.9276)
Job creation for local people	(0.8448,0.8931,0.9414)
Promoting local customs and traditions	(0.9276,0.9517,0.9759)

Table 4.17. The average score of hotel Y for each criterion

Criteria	Average fuzzy score
Amenities/facilities	(0.9500,0.9700,0.9900)
Price value	(0.8850,0.9350,0.9850)
Food	(0.9050,0.9350,0.9650)
Cleanliness	(0.8950,0.9100,0.9250)
Service and staff	(0.7350,0.7850,0.8350)
Location	(0.4300,0.5100,0.5900)
Check in	(0.8100,0.8600,0.9100)
Eco-friendly architecture	(0.6100,0.6950,0.7800)
Using renewable energy	(0.5700,0.6550,0.7400)
Using mechanisms to conserve energy and water	(0.5600,0.6500,0.7400)
Food waste reduction and management	(0.5500,0.6250,0.7000)

Easy access to bicycles, electric vehicles, and public transportation	(0.5900,0.6750,0.7600)
Use of the eco-friendly cleaning products	(0.5350,0.6250,0.7150)
Environmental certifications	(0.5050,0.6000,0.6950)
Adapting to the needs of guests with disabilities	(0.4700,0.5450,0.6200)
Staff training	(0.8300,0.8650,0.9000)
Transparency and communication	(0.8500,0.8850,0.9200)
Supporting charities and local development projects	(0.9500,0.9700,0.9900)
Job creation for local people	(0.9500,0.9600,0.9700)
Promoting local customs and traditions	(0.8200,0.8600,0.9000)

Step 1.8: In this step, the fuzzy score of hotels is calculated for each dimension by applying Eq. (3.5), which is given in Table 4.18.

Table 4.18. The fuzzy score of hotels for each dimension

Dimension	Fuzzy score of	
	Hotel X	Hotel Y
Economic	(0.5434,0.8645,1.3640)	(0.5744,0.8716,1.3238)
Environmental	(0.3998,0.6671,1.0908)	(0.3956,0.6588,1.0773)
Social	(0.5103,0.7858,1.2185)	(0.5688,0.8389,1.2509)

Step 1.9: In this step, the fuzzy score obtained from the previous step is defuzzified by applying Eq. (3.6). Table 4.19 represents the defuzzified score of hotels for each dimension.

Table 4.19. The defuzzified score of hotels for each dimension

Dimension	Defuzzified score of	
	Hotel X	Hotel Y
Economic	0.8942	0.8974
Environmental	0.6932	0.6847
Social	0.812	0.8626

Second stage: Calculating the final score of hotels

In this step, the fuzzy inference system is utilized to calculate the final score of hotels. This stage consists of three steps as follows:

Step 2.1: In this step, we first introduce the input and output variables of the system and then determine their membership functions. Economic, environmental, and social dimensions are considered as input variables and the final score of the hotel is considered as an output variable. With the help of linguistic terms and triangular fuzzy numbers presented in Table 3.3, we define

seven membership functions for the input and output variables. To design the fuzzy inference system, we use the fuzzy toolbox in MATLAB R2019b software. For this purpose, we design a Mamdani system including three input variables and one output variable (see Figure 4.1). Then, we define seven membership functions for all input and output variables. For example, in Figure 4.2, the membership functions defined for the economic dimension are shown. Note that the membership functions of other variables are also in the same form.

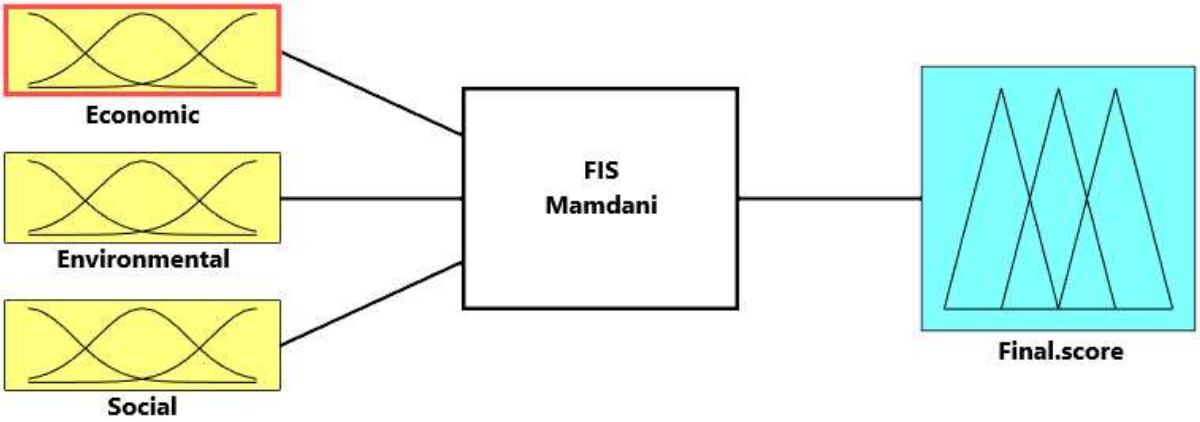

Figure 4.1. General structure of the fuzzy inference system

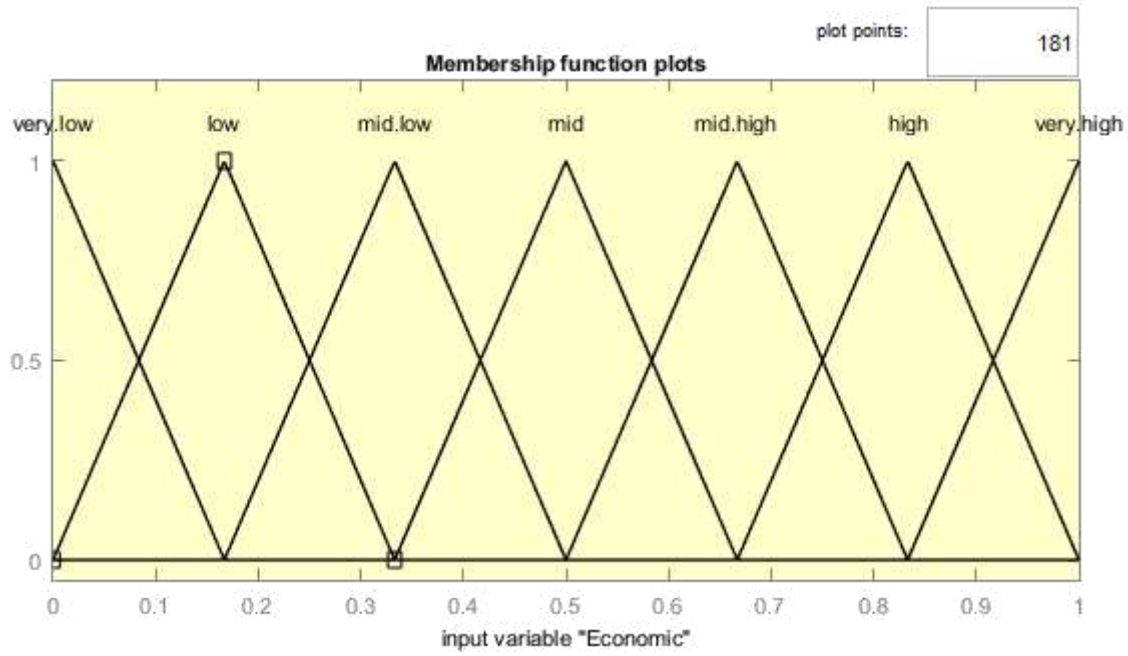

Figure 4.2. Membership functions for economic dimension

Step 2.2: After defining membership functions, in this step, fuzzy inference rules are provided by experts. Fuzzy inference rules are given in Appendix B. These rules are entered in the designed fuzzy inference system. Figure 4.3 shows the fuzzy inference rules defined in the system. In addition, the surface generated from fuzzy inference rules are shown in Figures 4.4

to 4.6.

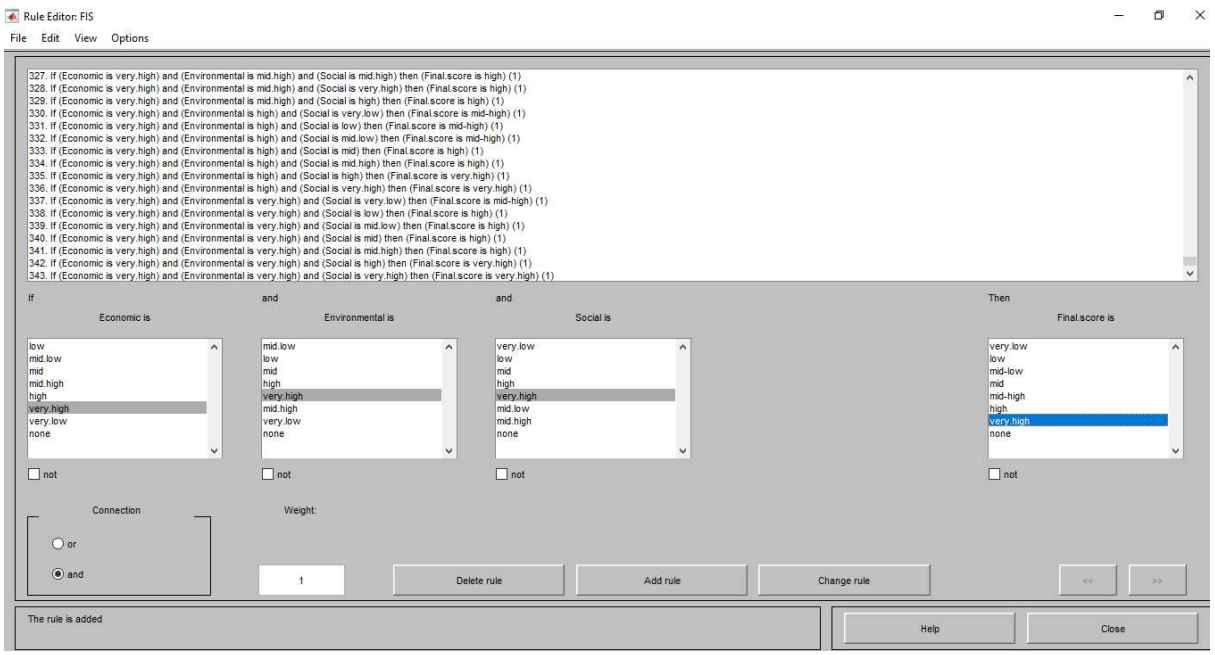

Figure 4.3. The fuzzy inference rules defined in system

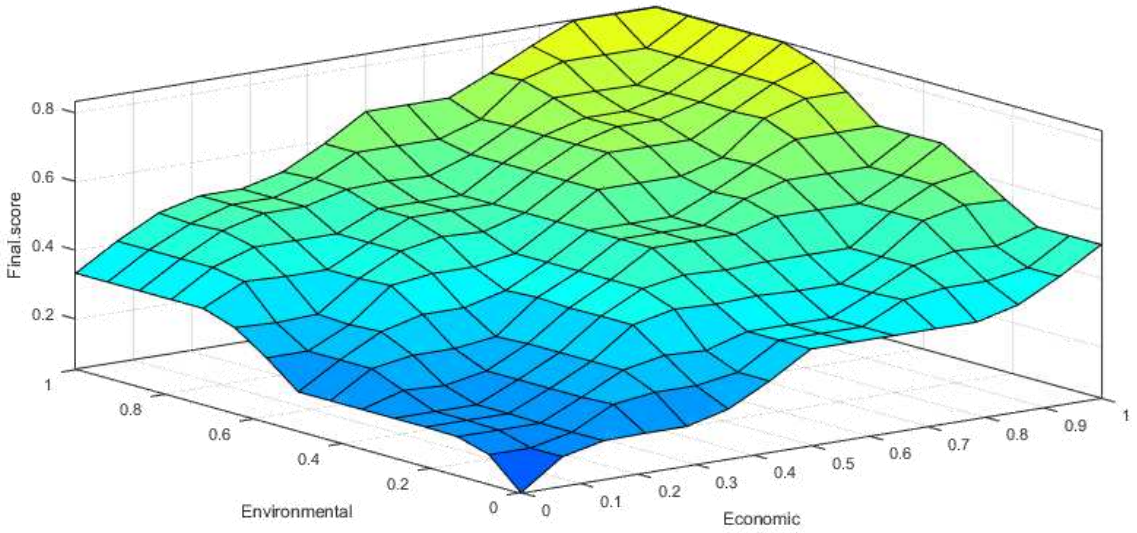

Figure 4.4. Surface caused by economic, environmental, and final score variables[2]

[2] The final score is the dependent variable, influenced by economic and environmental factors.

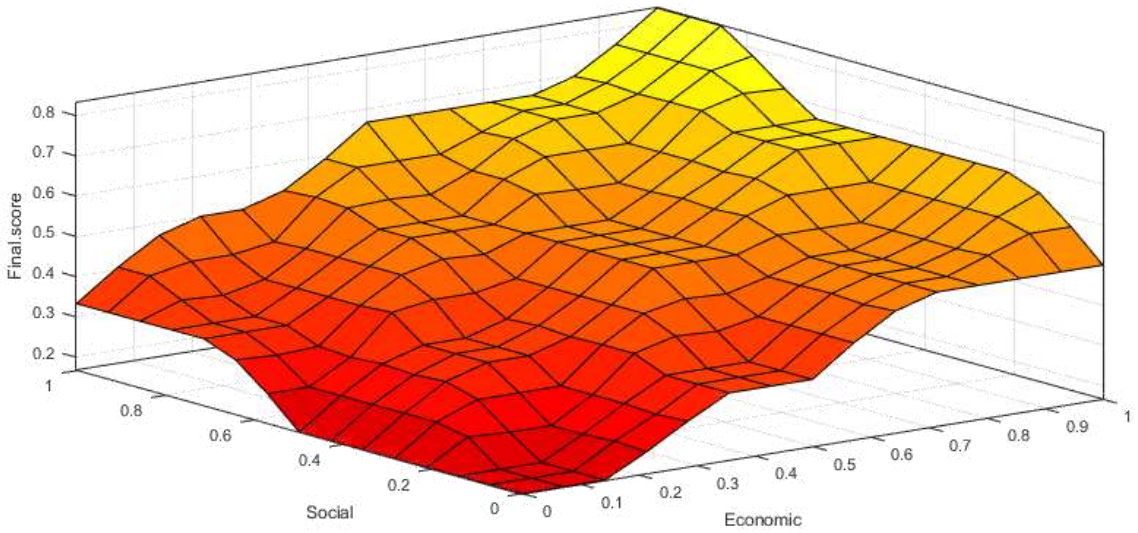

Figure 4.5. Surface caused by economic, social, and final score variables[3]

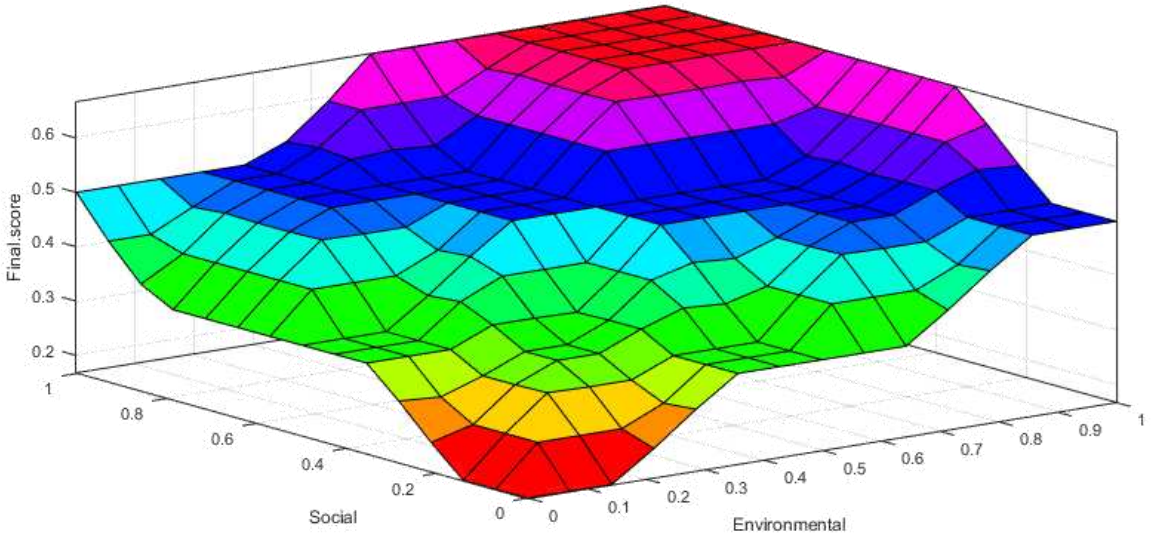

Figure 4.6. Surface caused by environmental, social, and final score variables[4]

Step 2.3: In this step, the final score of each hotel is calculated. For this purpose, the score calculated for the hotels per each dimension (see Table 4.19) is entered into the fuzzy inference system and the system calculates the final score of the hotels. Figures 4.7 and 4.8 show the process of calculating the final score of hotels X and Y in the designed fuzzy inference system, respectively.

[3] The final score is the dependent variable, influenced by economic and social factors.
[4] The final score is the dependent variable, influenced by environmental and social factors.

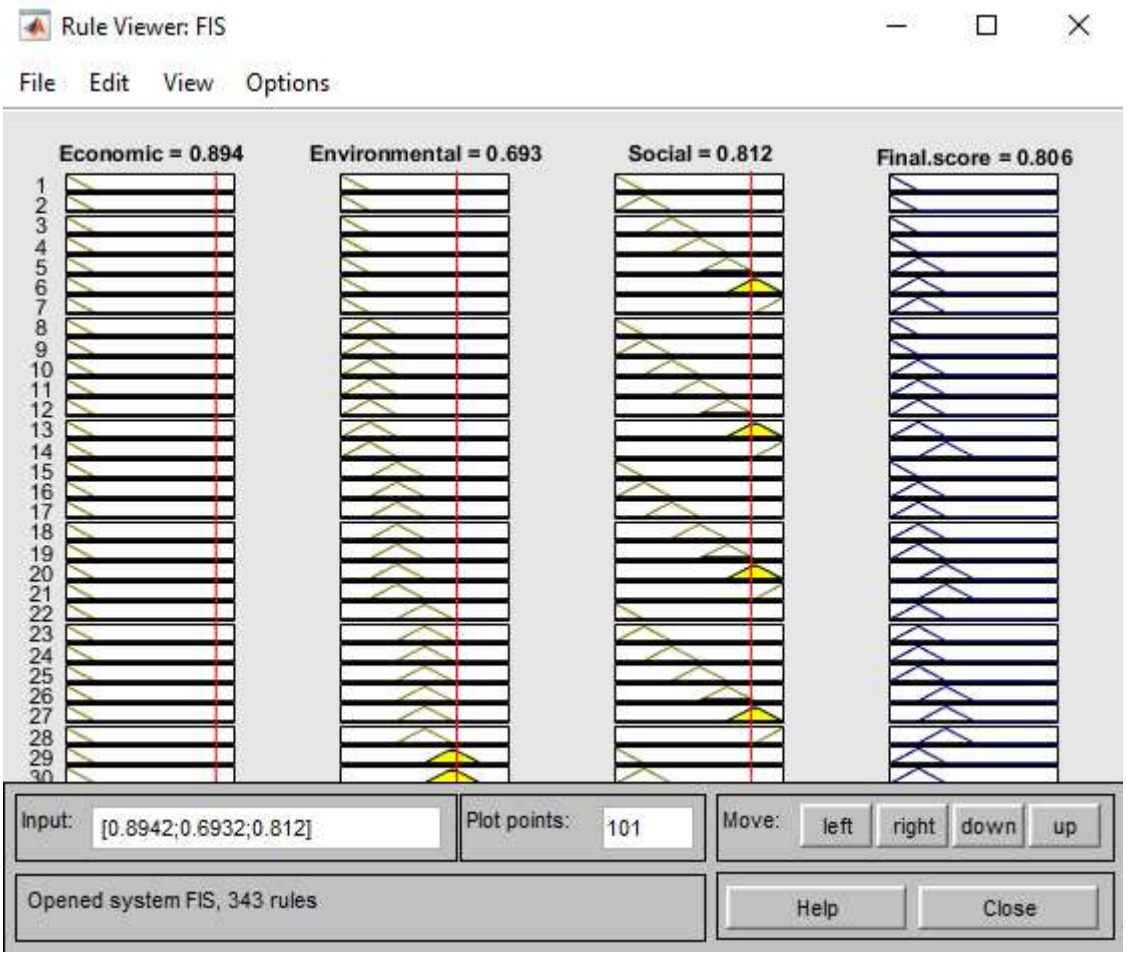

Figure 4.7. The process of calculating the final score of hotel X in the system

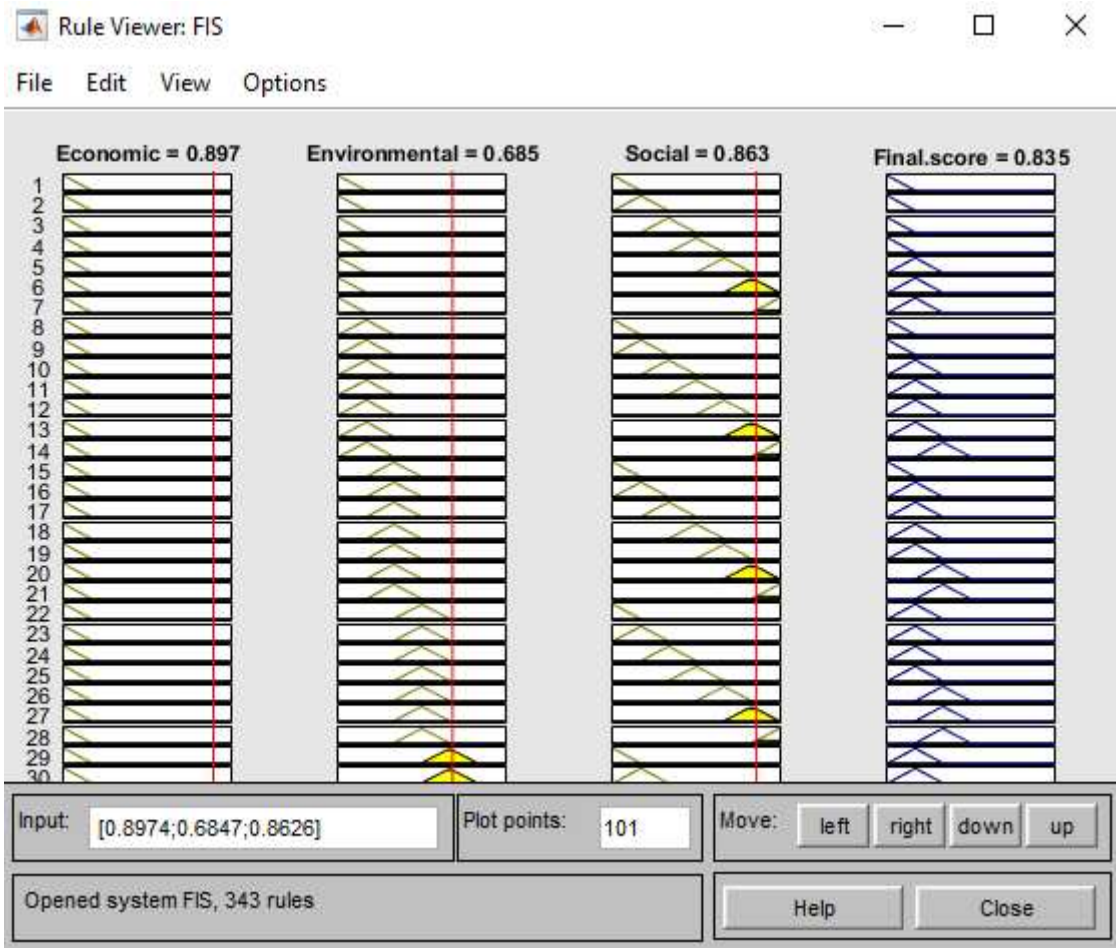

Figure 4.8. The process of calculating the final score of hotel Y in the system

As seen in Figures 4.7 and 4.8, hotels X and Y scored 0.806 and 0.835, respectively. This means that hotel Y has a better overall performance compared to hotel X. Thus, by applying the proposed approach, the performance of hotels can be evaluated from the perspective of sustainability.

4.3. Summary of the chapter

In the third chapter, by combining the fuzzy SWARA method and the fuzzy inference system, a holistic approach was presented to evaluate hotels from the perspective of sustainability. In this chapter, the performance of the proposed approach was examined using the data of two hotels, one in Iran and the other in Italy. For this purpose, hotel evaluation criteria were identified from the economic, environmental, and social perspectives and were weighted using the fuzzy SWARA method. Then the performance of the hotels was measured according to these criteria. In this vein, 29 customers evaluated the performance of Hotel X in Iran, and 20 customers evaluated the performance of Hotel Y in Italy. After that, the scores of hotels were calculated for economic, environmental, and social dimensions. Finally, a fuzzy inference

system including 343 rules was structured and calculated the final score of hotels from the perspective of sustainability.

Chapter 5:

Conclusions and suggestions

5.1. Introduction

In the third chapter, by integrating the fuzzy SWARA method and a fuzzy inference system, an approach was presented to evaluate hotels from the perspective of sustainability. The proposed approach consisted of two stages. In the first stage, by using the fuzzy SWARA method, the performance of hotels was measured according to economic, environmental, and social dimensions. In the second stage, the sustainability score of the hotels was determined with the help of a fuzzy inference system. In the fourth chapter, the data from two hotels were utilized to validate the developed approach. In this chapter, a summary of the results is presented first. Then, based on the obtained results, the research questions are answered. Finally, suggestions are provided for future researchers.

5.2. Summary of results

The hotel evaluation problem from the sustainability perspective is a decision-making problem with conflicting and multiple factors. Therefore, using the MCDM tool is an efficient tool for evaluating hotels. Although MCDM methods can efficiently calculate the performance of hotels for each sustainability dimension, these methods are ineffective in calculating the sustainability (final) score of hotels. The reason is that the final score of hotels is not a linear combination of the score of sustainability dimensions. Therefore, it is necessary to use a method that is able to establish a correct non-linear relationship between the dimensions of sustainability and the final score of hotels. The literature review shows that a fuzzy inference system can formulate the nonlinear relationship between these variables. For this purpose, seven economic criteria, seven environmental criteria, and six social criteria were identified and the fuzzy weights of these criteria were calculated by fuzzy SWARA method. Figures 5.1 to 5.3 show the fuzzy weights of economic, environmental, and social criteria, respectively.

Then, based on the opinions of 29 customers of Hotel X and 20 customers of Hotel Y, the performance of the hotels was evaluated. After that, the economic, environmental, and social performance of the hotels were calculated, which are shown in Figure 5. Finally, by employing the designed fuzzy inference system, the sustainability scores of both hotels were calculated. The results exposed that both hotels have almost similar performance. In addition, it was found that both hotels are weak in environmental criteria and should improve their environmental dimension by adopting appropriate strategies.

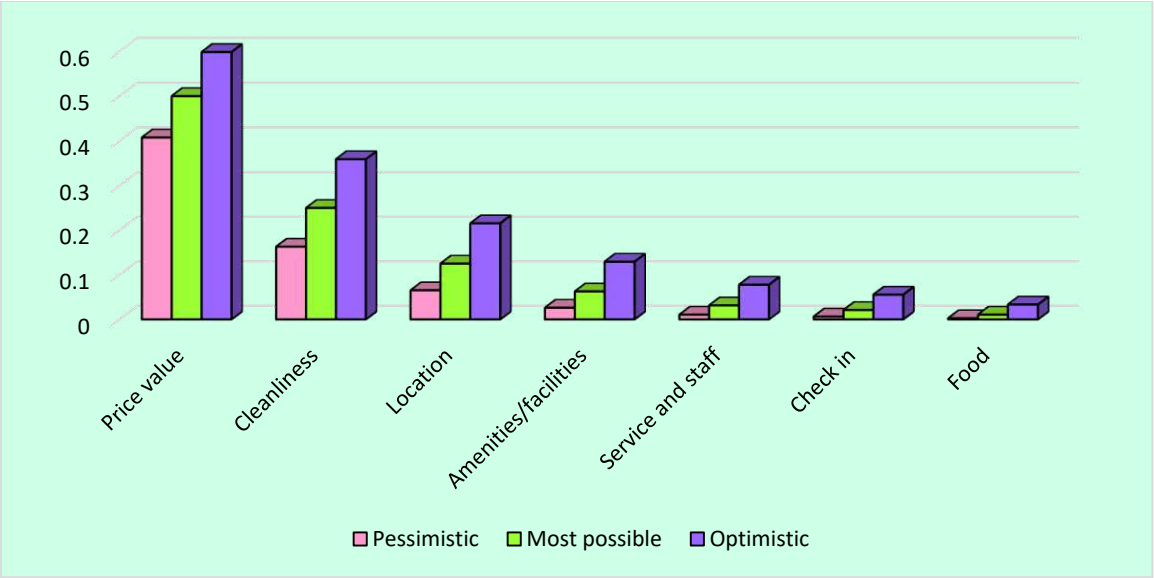

Figure 5.1. The fuzzy weights of economic criteria

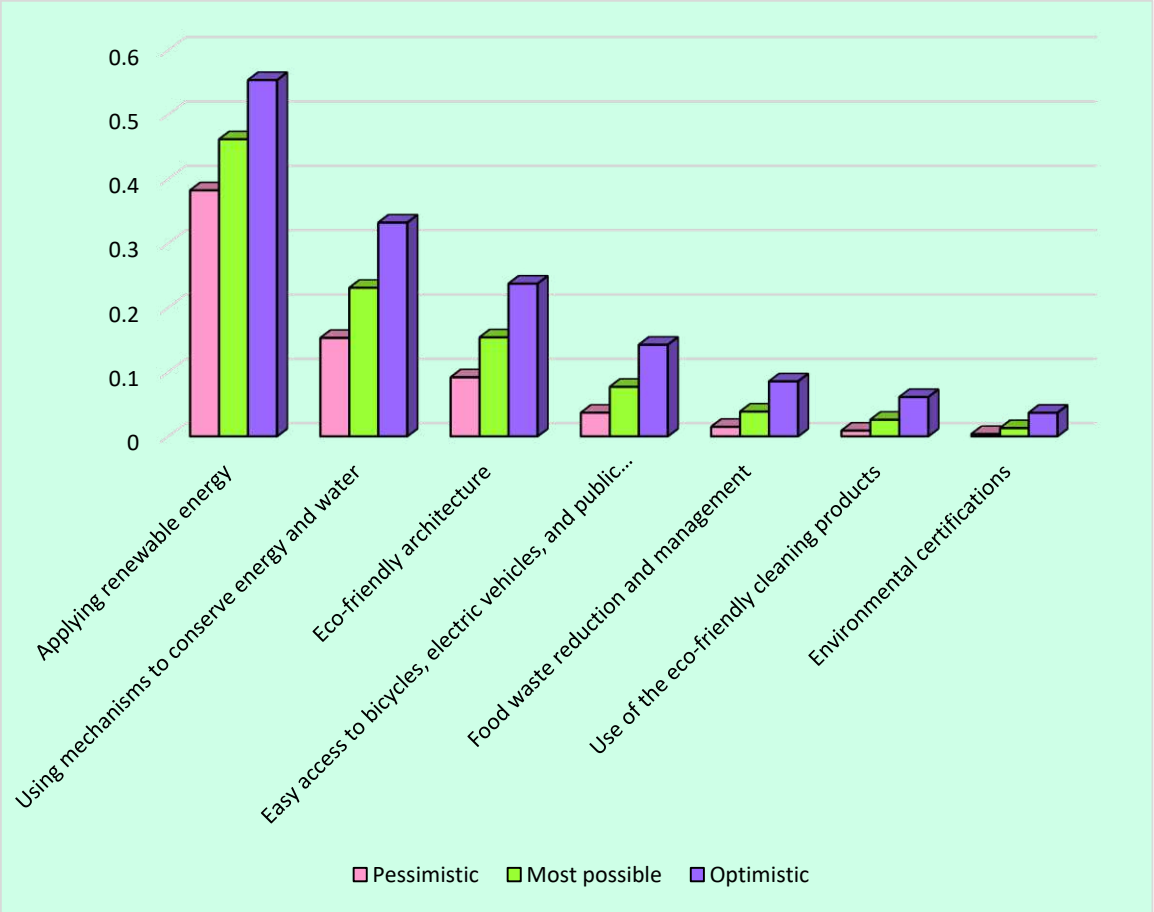

Figure 5.2. The fuzzy weights of environmental criteria

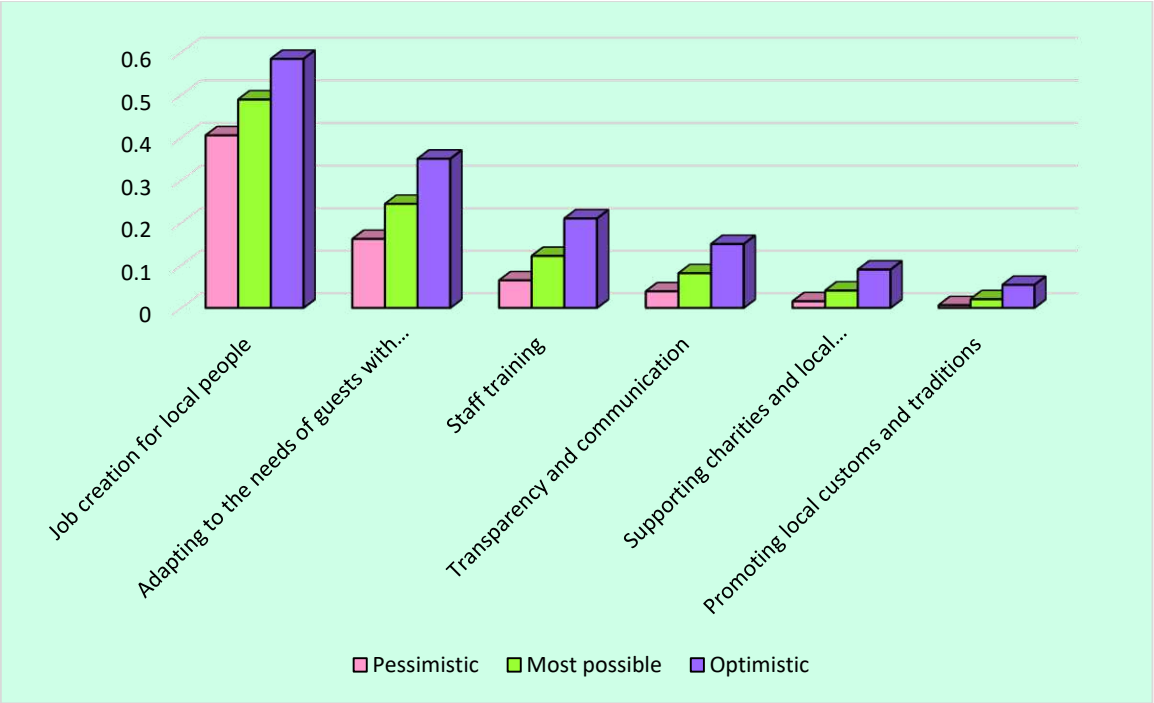

Figure 5.3. The fuzzy weights of social criteria

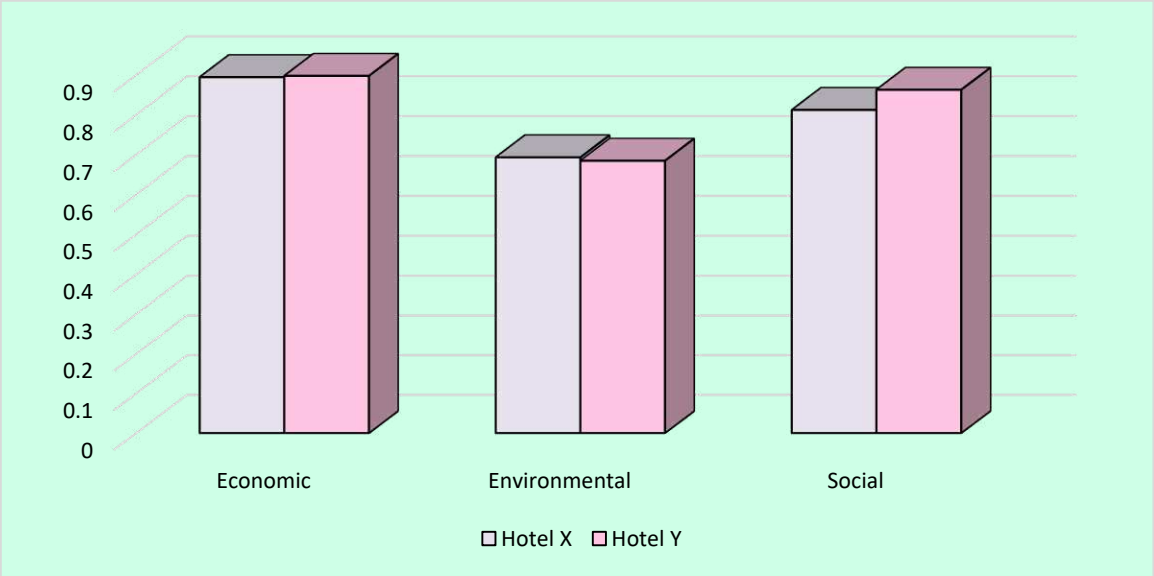

Figure 5.4. The economic, environmental, and social performance of hotels X and Y

5.3. Answering the research questions

In chapter 1, questions were raised in line with the research objectives. In this section, we are going to answer these questions based on the findings reported in chapters 2 to 4. The answers to the research questions are presented below:

1. What are the most appropriate criteria for evaluating hotels from the sustainability perspective?

By studying the literature in depth and taking advice from experts, seven economic criteria including "amenities/facilities", "price value", "food", "cleanliness", "service and staff",

"location", and "check-in", seven environmental criteria including "eco-friendly architecture", "using renewable energy", "using mechanisms to conserve energy and water", "food waste reduction and management", "easy access to bicycles, electric vehicles, and public transportation", "use of the eco-friendly cleaning products", and "environmental certifications", and six social criteria including "adapting to the needs of guests with disabilities", "staff training", "transparency and communication", "supporting charities and local development projects", "job creation for local people", and "promoting local customs and traditions" were identified.

2. What are the most efficient methods for structuring an approach to evaluate hotels from the sustainability perspective?

In this research, by integrating fuzzy SWARA and a fuzzy inference system, a two-stage approach was structured to evaluate hotels from the sustainability perspective. In the first stage, fuzzy SWARA method was used to calculate the score of hotels for each of the sustainability dimensions. This method was applied due to its user-friendliness, low computational complexity, and consideration of uncertainty in the evaluation process. The second stage dealt with the structuring of a fuzzy inference system. Because there was no linear relationship between the final score of the hotels and the score of the hotels in each dimension, the aforementioned fuzzy inference system was used to establish a non-linear relationship between them.

3. How to examine the applicability of the presented approach in the real world?

To examine the performance of the presented approach in the real world, the data of two hotels-one in Iran and the other in Italy- were used.

5.4. Suggestions for future studies

In this section, suggestions for future researchers are given as follows:

- In this research, the dependence between the criteria has been ignored in the calculation of the weights of the criteria. It is suggested to use a method like DEMATEL to calculate the dependence between the criteria and apply it to the weights of the criteria. Finally, instead of the independent weights of the criteria, their dependent weights should be used to evaluate the hotels from a sustainability perspective.
- With the emergence of the fourth industrial revolution, many businesses have moved towards digitalization. Considering digitalization criteria in evaluating hotels from the sustainability perspective is an idea that future researchers can focus on.
- In this research, the proposed approach was used to evaluate hotels from the sustainability perspective. It is suggested to use the proposed approach in other fields

such as third-party logistics evaluation, smart and sustainable cities evaluation, etc. in future research.

Appendix

Appendix A

Table A1. The results of the questionnaires completed by the customers of hotel X

Criteria	Customer																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Amenities/facilities	M	AH	SH	SH	H	AH	AH	AH	AH	AH	VH	SH	VH	L	VH	AH	AH	AH	VH	H	VH	AH	VH	SH	H	AH	AH	AH	AH
Price value	SH	VH	H	H	ML	VH	VH	AH	SH	VH	AH	MH	VH	H	AH	AH	AH	VH	H	SH	AH	AH	AH	H	VH	AH	AH	VH	VH
Food	H	AH	MH	AH	H	AH	AH	AH	VH	AH	SH	M	AH	VH	VH	VH	AH	ML	H	M	H	AH	AH	VH	AH	AH	AH	AH	AH
Cleanliness	VH	AH	VH	VH	VH	VH	AH	AH	MH	H	VH	M	VH	H	AH	H	AH	MH	SH	MH	VH	H	VH	AH	VH	SH	AH	H	VH
Service and staff	AH	MH	AH	AH	AH	AH	AH	AH	H	AH	MH	ML	VH	AH	AH	AH	VH	AH	VH	VH	AH	VH	AH	H	AH	H	AH	VH	H
Location	MH	AH	AH	AH	AH	H	AH	AH	AH	VH	H	MH	AH	AH	AH	H	H	AH	VH	VH	MH	SH	VH	SH	SH	VH	H	AH	VH
Check in	H	SH	M	AH	H	VH	AH	MH	AH	ML	AH	SH	AH	AH	VH	AH	VH	SL	MH	AH	H	VH	SH	H	H	AH	VH	MH	VH
Eco-friendly architecture	AH	M	H	M	VH	MH	AH	AH	AH	M	M	SL	SH	MH	M	H	AH	ML	SH	SL	ML	AH	VH	AH	VH	SH	AH	SH	AH
Using renewable energy	MH	H	ML	H	H	VH	H	AH	H	SL	SH	SL	M	M	ML	VH	VH	ML	H	M	M	ML	VH	H	H	SH	H	H	VH
Using mechanisms to conserve energy and water	H	MH	SH	SL	AH	M	AH	M	H	MH	VH	L	ML	SL	SL	SH	SH	SL	ML	SH	SL	ML	MH	AH	VH	H	VH	H	VH
Food waste reduction and management	VH	AH	L	SH	SH	MH	SH	SH	MH	L	M	L	SL	MH	M	VH	H	M	MH	ML	SH	SL	ML	VH	AH	VH	AH	SH	H
Easy access to bicycles, electric vehicles, and public transportation	MH	H	SL	VH	VH	ML	M	SH	MH	SL	MH	SL	SL	ML	ML	H	VH	SH	ML	MH	H	ML	SL	SH	VH	AH	VH	MH	MH
Use of the eco-	SH	VH	SH	AH	AH	MH	H	M	M	L	SH	SL	M	SH	ML	VH	AH	MH	SL	H	VH	M	L	M	AH	AH	VH	M	SH

friendly cleaning products																													
Environmental certifications	H	H	ML	VH	H	MH	H	SH	SH	MH	MH	VL	L	ML	ML	AH	H	ML	ML	ML	H	ML	SL	ML	H	AH	MH	MH	ML
Adapting to the needs of guests with disabilities	M	AH	H	AH	AH	SH	H	M	H	ML	MH	M	L	L	L	H	VH	SL	MH	VH	VH	M	L	ML	VH	VH	ML	SL	M
Staff training	H	SH	H	H	AH	M	VH	SH	MH	MH	MH	ML	VH	MH	AH	AH	AH	L	H	H	SH	MH	SL	SL	SH	H	M	M	MH
Transparency and communication	SH	VH	SH	AH	AH	SH	H	M	M	H	SH	SH	AH	H	AH	VH	VH	M	ML	AH	H	SH	SH	M	SH	AH	MH	M	SH
Supporting charities and local development projects	M	VH	AH	AH	AH	H	H	SH	SH	VH	SH	VH	VH	VH	AH	AH	AH	AH	H	VH	VH	AH	H	AH	AH	AH	SH	MH	SH
Job creation for local people	SH	VH	AH	AH	AH	VH	VH	M	VH	H	MH	AH	AH	H	AH	AH	VH	AH	VH	AH	AH	AH	H	AH	AH	AH	AH	MH	SH
Promoting local customs and traditions	VH	VH	AH	AH	AH	AH	AH	AH	AH	AH	SH	AH	AH	AH	AH	VH	AH	AH	AH	AH	AH	AH	H	AH	AH	AH	AH	SH	SH

Table A2. The results of the questionnaires completed by the customers of hotel Y

Criteria	Customer																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amenities/facilities	VH	AH	AH	AH	AH	AH	AH	VH	AH	AH	AH	SH	AH	AH	VH	AH	AH	AH	AH	AH
Price value	H	AH	VH	H	AH	VH	AH	AH	VH	AH	AH	VH	AH	AH	H	VH	AH	VH	AH	VH
Food	M	AH	AH	SH	AH	AH	AH	AH	AH	AH	AH	AH	VH	H	VH	VH	AH	AH	AH	AH
Cleanliness	MH	AH	AH	AH	AH	AL	AH	AH	VH	AH	AH	AH	AH	AH	SH	AH	AH	AH	AH	AH
Service and staff	VH	SL	AH	MH	AH	ML	AH	AH	AH	AH	VH	AH	AH	L	H	AH	SH	AH	ML	M
Location	SL	M	L	SL	VH	VL	VH	VH	VL	VL	VH	VL	AH	AH	L	SL	AH	L	AH	L
Check in	AH	MH	AH	VH	H	AH	AH	AH	AH	AH	AH	VH	MH	M	H	VH	MH	MH	AH	AH
Eco-friendly architecture	ML	ML	H	SH	VH	SH	AH	SH	SL	MH	M	H	H	H	MH	SH	M	SH	AH	AH
Using renewable energy	SL	MH	MH	VH	AH	ML	AH	ML	SL	AH	ML	MH	H	MH	SH	VH	MH	SH	MH	SH
Using mechanisms to conserve energy and water	ML	SH	AH	SH	AH	MH	SH	MH	SL	SH	SH	M	SH	ML	M	MH	H	SH	SH	SH
Food waste reduction and management	VL	ML	VH	AH	VH	AH	AH	M	SL	ML	SL	ML	VH	MH	SL	ML	ML	SH	AH	AH
Easy access to bicycles, electric vehicles, and public transportation	SH	H	SH	SH	AH	AH	H	VL	L	L	L	L	H	H	H	H	VH	VH	VH	AH
Use of the eco-friendly cleaning products	VH	VH	VH	M	SH	L	AH	SL	M	H	M	M	M	M	MH	SL	M	AH	MH	H
Environmental certifications	MH	M	ML	SH	AH	SL	MH	SH	M	MH	ML	MH	VH	SH	ML	M	ML	M	H	VH
Adapting to the needs of guests with disabilities	L	VH	M	H	MH	VL	AH	L	L	VL	VL	ML	SH	ML	SL	ML	AH	AH	AH	AH

Staff training	AH	AH	ML	VH	SH	AL	VH	AH	AH	H	AH	AH	AH	SH	AH	AH	AH	VH	AH	AH
Transparency and communication	VH	VH	AH	AH	M	M	AH	AH	AH	M	AH	VH	AH	M	AH	AH	AH	AH	AH	AH
Supporting charities and local development projects	AH	AH	AH	AH	VH	AH	AH	VH	AH	AH	AH	AH	AH	VH	AH	SH	AH	AH	AH	AH
Job creation for local people	AH	AH	AH	AH	AH	AH	AH	AH	AH	H	AH	AH	AH	ML	AH	AH	AH	AH	AH	AH
Promoting local customs and traditions	VH	SH	H	AH	AH	L	AH	AH	AH	AH	AH	SH	VH	H	AH	L	AH	AH	AH	AH

Appendix B

Fuzzy inference rules:

1. If Economic is very low, Environmental is very low, and Social is very low, then final score is very low.
2. If Economic is very low, Environmental is very low, and Social is low, then final score is very low.
3. If Economic is very low, Environmental is very low, and Social is mid-low, then final score is very low.
4. If Economic is very low, Environmental is very low, and Social is mid, then final score is very low.
5. If Economic is very low, Environmental is very low, and Social is mid-high, then final score is low.
6. If Economic is very low, Environmental is very low, and Social is high, then final score is low.
7. If Economic is very low, Environmental is very low, and Social is very high, then final score is low.
8. If Economic is very low, Environmental is low, and Social is very low, then final score is very low.
9. If Economic is very low, Environmental is low, and Social is low, then final score is very low.
10. If Economic is very low, Environmental is low, and Social is mid-low, then final score is low.
11. If Economic is very low, Environmental is low, and Social is mid, then final score is low.
12. If Economic is very low, Environmental is low, and Social is mid-high, then final score is very low.
13. If Economic is very low, Environmental is low, and Social is high, then final score is low.
14. If Economic is very low, Environmental is low, and Social is very high, then final score is mid-low.
15. If Economic is very low, Environmental is mid-low, and Social is very low, then final score is very low.
16. If Economic is very low, Environmental is mid-low, and Social is low, then final score is low.
17. If Economic is very low, Environmental is mid-low, and Social is mid-low, then final score is low.
18. If Economic is very low, Environmental is mid-low, and Social is mid, then final score is low.
19. If Economic is very low, Environmental is mid-low, and Social is mid-high, then final score is low.
20. If Economic is very low, Environmental is mid-low, and Social is high, then final score is mid-low.
21. If Economic is very low, Environmental is mid-low, and Social is very high, then final score is mid-low.
22. If Economic is very low, Environmental is mid, and Social is very low, then final score is low.

23. If Economic is very low, Environmental is mid, and Social is low, then final score is low.
24. If Economic is very low, Environmental is mid, and Social is mid-low, then final score is low.
25. If Economic is very low, Environmental is mid, and Social is mid, then final score is low.
26. If Economic is very low, Environmental is mid, and Social is mid-high, then final score is mid-low.
27. If Economic is very low, Environmental is mid, and Social is high, then final score is mid-low.
28. If Economic is very low, Environmental is mid, and Social is very high, then final score is mid-low.
29. If Economic is very low, Environmental is mid-high, and Social is very low, then final score is low.
30. If Economic is very low, Environmental is mid-high, and Social is low, then final score is low.
31. If Economic is very low, Environmental is mid-high, and Social is mid-low, then final score is mid-low.
32. If Economic is very low, Environmental is mid-high, and Social is mid, then final score is mid-low.
33. If Economic is very low, Environmental is mid-high, and Social is mid-high, then final score is mid-low.
34. If Economic is very low, Environmental is mid-high, and Social is high, then final score is mid-low.
35. If Economic is very low, Environmental is mid-high, and Social is very high, then final score is mid.
36. If Economic is very low, Environmental is high, and Social is very low, then final score is mid-low.
37. If Economic is very low, Environmental is high, and Social is low, then final score is mid-low.
38. If Economic is very low, Environmental is high, and Social is mid-low, then final score is mid-low.
39. If Economic is very low, Environmental is high, and Social is mid, then final score is mid-low.
40. If Economic is very low, Environmental is high, and Social is mid-high, then final score is mid-low.
41. If Economic is very low, Environmental is high, and Social is high, then final score is mid.
42. If Economic is very low, Environmental is high, and Social is very high, then final score is mid.
43. If Economic is very low, Environmental is very high, and Social is very low, then final score is mid-low.
44. If Economic is very low, Environmental is very high, and Social is low, then final score is mid-low.
45. If Economic is very low, Environmental is very high, and Social is mid-low, then final score is mid-low.
46. If Economic is very low, Environmental is very high, and Social is mid, then final score is mid-low.

47. If Economic is very low, Environmental is very high, and Social is mid-high, then final score is mid.
48. If Economic is very low, Environmental is very high, and Social is high, then final score is mid.
49. If Economic is very low, Environmental is very high, and Social is very high, then final score is mid.
50. If Economic is low, Environmental is very low, and Social is very low, then final score is very low.
51. If Economic is low, Environmental is very low, and Social is low, then final score is very low.
52. If Economic is low, Environmental is very low, and Social is mid-low, then final score is low.
53. If Economic is low, Environmental is very low, and Social is mid, then final score is low.
54. If Economic is low, Environmental is very low, and Social is mid-high, then final score is low.
55. If Economic is low, Environmental is very low, and Social is high, then final score is low.
56. If Economic is low, Environmental is very low, and Social is very high, then final score is mid-low.
57. If Economic is low, Environmental is low, and Social is very low, then final score is very low.
58. If Economic is low, Environmental is low, and Social is low, then final score is low.
59. If Economic is low, Environmental is low, and Social is mid-low, then final score is low.
60. If Economic is low, Environmental is low, and Social is mid, then final score is low.
61. If Economic is low, Environmental is low, and Social is mid-high, then final score is low.
62. If Economic is low, Environmental is low, and Social is high, then final score is mid-low.
63. If Economic is low, Environmental is low, and Social is very high, then final score is mid-low.
64. If Economic is low, Environmental is mid-low, and Social is very low, then final score is low.
65. If Economic is low, Environmental is mid-low, and Social is low, then final score is low.
66. If Economic is low, Environmental is mid-low, and Social is mid-low, then final score is low.
67. If Economic is low, Environmental is mid-low, and Social is mid, then final score is low.
68. If Economic is low, Environmental is mid-low, and Social is mid-high, then final score is mid-low.
69. If Economic is low, Environmental is mid-low, and Social is high, then final score is mid-low.
70. If Economic is low, Environmental is mid-low, and Social is very high, then final score is mid-low.
71. If Economic is low, Environmental is mid, and Social is very low, then final score is low.
72. If Economic is low, Environmental is mid, and Social is low, then final score is low.
73. If Economic is low, Environmental is mid, and Social is mid-low, then final score is mid-low.
74. If Economic is low, Environmental is mid, and Social is mid, then final score is mid-low.
75. If Economic is low, Environmental is mid, and Social is mid-high, then final score is mid-

low.
76. If Economic is low, Environmental is mid, and Social is high, then final score is mid-low.
77. If Economic is low, Environmental is mid, and Social is very high, then final score is mid.
78. If Economic is low, Environmental is mid-high, and Social is very low, then final score is mid-low.
79. If Economic is low, Environmental is mid-high, and Social is low, then final score is mid-low.
80. If Economic is low, Environmental is mid-high, and Social is mid-low, then final score is mid-low.
81. If Economic is low, Environmental is mid-high, and Social is mid, then final score is mid-low.
82. If Economic is low, Environmental is mid-high, and Social is mid-high, then final score is mid-low.
83. If Economic is low, Environmental is mid-high, and Social is high, then final score is mid.
84. If Economic is low, Environmental is mid-high, and Social is very high, then final score is mid.
85. If Economic is low, Environmental is high, and Social is very low, then final score is mid-low.
86. If Economic is low, Environmental is high, and Social is low, then final score is mid-low.
87. If Economic is low, Environmental is high, and Social is mid-low, then final score is mid-low.
88. If Economic is low, Environmental is high, and Social is mid, then final score is mid.
89. If Economic is low, Environmental is high, and Social is mid-high, then final score is mid.
90. If Economic is low, Environmental is high, and Social is high, then final score is mid.
91. If Economic is low, Environmental is high, and Social is very high, then final score is mid.
92. If Economic is low, Environmental is very high, and Social is very low, then final score is mid-low.
93. If Economic is low, Environmental is very high, and Social is low, then final score is mid-low.
94. If Economic is low, Environmental is very high, and Social is mid-low, then final score is mid.
95. If Economic is low, Environmental is very high, and Social is mid, then final score is mid.
96. If Economic is low, Environmental is very high, and Social is mid-high, then final score is mid.
97. If Economic is low, Environmental is very high, and Social is high, then final score is mid-high.
98. If Economic is low, Environmental is very high, and Social is very high, then final score is mid-high.
99. If Economic is mid-low, Environmental is very low, and Social is very low, then final score is low.
100. If Economic is mid-low, Environmental is very low, and Social is low, then final score is low.
101. If Economic is mid-low, Environmental is very low, and Social is mid-low, then final score is low.
102. If Economic is mid-low, Environmental is very low, and Social is mid, then final score is

low.
103. If Economic is mid-low, Environmental is very low, and Social is mid-high, then final score is mid-low.
104. If Economic is mid-low, Environmental is very low, and Social is high, then final score is mid-low.
105. If Economic is mid-low, Environmental is very low, and Social is very high, then final score is mid-low.
106. If Economic is mid-low, Environmental is low, and Social is very low, then final score is low.
107. If Economic is mid-low, Environmental is low, and Social is low, then final score is low.
108. If Economic is mid-low, Environmental is low, and Social is mid-low, then final score is mid-low.
109. If Economic is mid-low, Environmental is low, and Social is mid, then final score is mid-low.
110. If Economic is mid-low, Environmental is low, and Social is mid-high, then final score is mid-low.
111. If Economic is mid-low, Environmental is low, and Social is high, then final score is mid-low.
112. If Economic is mid-low, Environmental is low, and Social is very high, then final score is mid.
113. If Economic is mid-low, Environmental is mid-low, and Social is very low, then final score is low.
114. If Economic is mid-low, Environmental is mid-low, and Social is low, then final score is mid-low.
115. If Economic is mid-low, Environmental is mid-low, and Social is mid-low, then final score is mid-low.
116. If Economic is mid-low, Environmental is mid-low, and Social is mid, then final score is mid-low.
117. If Economic is mid-low, Environmental is mid-low, and Social is mid-high, then final score is mid-low.
118. If Economic is mid-low, Environmental is mid-low, and Social is high, then final score is mid.
119. If Economic is mid-low, Environmental is mid-low, and Social is very high, then final score is mid.
120. If Economic is mid-low, Environmental is mid, and Social is very low, then final score is mid-low.
121. If Economic is mid-low, Environmental is mid, and Social is low, then final score is mid-low.
122. If Economic is mid-low, Environmental is mid, and Social is mid-low, then final score is mid-low.
123. If Economic is mid-low, Environmental is mid, and Social is mid, then final score is mid-low.
124. If Economic is mid-low, Environmental is mid, and Social is mid-high, then final score is mid.
125. If Economic is mid-low, Environmental is mid, and Social is high, then final score is mid.

126. If Economic is mid-low, Environmental is mid, and Social is very high, then final score is mid.
127. If Economic is mid-low, Environmental is mid-high, and Social is very low, then final score is mid-low.
128. If Economic is mid-low, Environmental is mid-high, and Social is low, then final score is mid-low.
129. If Economic is mid-low, Environmental is mid-high, and Social is mid-low, then final score is mid-low.
130. If Economic is mid-low, Environmental is mid-high, and Social is mid, then final score is mid.
131. If Economic is mid-low, Environmental is mid-high, and Social is mid-high, then final score is mid.
132. If Economic is mid-low, Environmental is mid-high, and Social is high, then final score is mid.
133. If Economic is mid-low, Environmental is mid-high, and Social is very high, then final score is mid-high.
134. If Economic is mid-low, Environmental is high, and Social is very low, then final score is mid-low.
135. If Economic is mid-low, Environmental is high, and Social is low, then final score is mid.
136. If Economic is mid-low, Environmental is high, and Social is mid-low, then final score is mid.
137. If Economic is mid-low, Environmental is high, and Social is mid, then final score is mid.
138. If Economic is mid-low, Environmental is high, and Social is mid-high, then final score is mid.
139. If Economic is mid-low, Environmental is high, and Social is high, then final score is mid-high.
140. If Economic is mid-low, Environmental is high, and Social is very high, then final score is mid-high.
141. If Economic is mid-low, Environmental is very high, and Social is very low, then final score is mid.
142. If Economic is mid-low, Environmental is very high, and Social is low, then final score is mid.
143. If Economic is mid-low, Environmental is very high, and Social is mid-low, then final score is mid.
144. If Economic is mid-low, Environmental is very high, and Social is mid, then final score is mid.
145. If Economic is mid-low, Environmental is very high, and Social is mid-high, then final score is mid-high.
146. If Economic is mid-low, Environmental is very high, and Social is high, then final score is mid-high.
147. If Economic is mid-low, Environmental is very high, and Social is very high, then final score is mid-high.
148. If Economic is mid, Environmental is very low, and Social is very low, then final score is low.
149. If Economic is mid, Environmental is very low, and Social is low, then final score is low.

150. If Economic is mid, Environmental is very low, and Social is mid-low, then final score is mid-low.
151. If Economic is mid, Environmental is very low, and Social is mid, then final score is mid-low.
152. If Economic is mid, Environmental is very low, and Social is mid-high, then final score is mid-low.
153. If Economic is mid, Environmental is very low, and Social is high, then final score is mid-low.
154. If Economic is mid, Environmental is very low, and Social is very high, then final score is mid.
155. If Economic is mid, Environmental is low, and Social is very low, then final score is low.
156. If Economic is mid, Environmental is low, and Social is low, then final score is mid-low.
157. If Economic is mid, Environmental is low, and Social is mid-low, then final score is mid-low.
158. If Economic is mid, Environmental is low, and Social is mid, then final score is mid-low.
159. If Economic is mid, Environmental is low, and Social is mid-high, then final score is mid.
160. If Economic is mid, Environmental is low, and Social is high, then final score is mid.
161. If Economic is mid, Environmental is low, and Social is very high, then final score is mid.
162. If Economic is mid, Environmental is mid-low, and Social is very low, then final score is mid-low.
163. If Economic is mid, Environmental is mid-low, and Social is low, then final score is mid-low.
164. If Economic is mid, Environmental is mid-low, and Social is mid-low, then final score is mid-low.
165. If Economic is mid, Environmental is mid-low, and Social is mid, then final score is mid.
166. If Economic is mid, Environmental is mid-low, and Social is mid-high, then final score is mid.
167. If Economic is mid, Environmental is mid-low, and Social is high, then final score is mid.
168. If Economic is mid, Environmental is mid-low, and Social is very high, then final score is mid.
169. If Economic is mid, Environmental is mid, and Social is very low, then final score is mid-low.
170. If Economic is mid, Environmental is mid, and Social is low, then final score is mid-low.
171. If Economic is mid, Environmental is mid, and Social is mid-low, then final score is mid.
172. If Economic is mid, Environmental is mid, and Social is mid, then final score is mid.
173. If Economic is mid, Environmental is mid, and Social is mid-high, then final score is mid.
174. If Economic is mid, Environmental is mid, and Social is high, then final score is mid.
175. If Economic is mid, Environmental is mid, and Social is very high, then final score is mid-high.
176. If Economic is mid, Environmental is mid-high, and Social is very low, then final score is mid-low.
177. If Economic is mid, Environmental is mid-high, and Social is low, then final score is mid.
178. If Economic is mid, Environmental is mid-high, and Social is mid-low, then final score is mid.
179. If Economic is mid, Environmental is mid-high, and Social is mid, then final score is mid.

180. If Economic is mid, Environmental is mid-high, and Social is mid-high, then final score is mid-high.
181. If Economic is mid, Environmental is mid-high, and Social is high, then final score is mid-high.
182. If Economic is mid, Environmental is mid-high, and Social is very high, then final score is mid-high.
183. If Economic is mid, Environmental is high, and Social is very low, then final score is mid.
184. If Economic is mid, Environmental is high, and Social is low, then final score is mid.
185. If Economic is mid, Environmental is high, and Social is mid-low, then final score is mid.
186. If Economic is mid, Environmental is high, and Social is mid, then final score is mid.
187. If Economic is mid, Environmental is high, and Social is mid-high, then final score is mid-high.
188. If Economic is mid, Environmental is high, and Social is high, then final score is mid-high.
189. If Economic is mid, Environmental is high, and Social is very high, then final score is mid-high.
190. If Economic is mid, Environmental is very high, and Social is very low, then final score is mid.
191. If Economic is mid, Environmental is very high, and Social is low, then final score is mid.
192. If Economic is mid, Environmental is very high, and Social is mid-low, then final score is mid-high.
193. If Economic is mid, Environmental is very high, and Social is mid, then final score is mid-high.
194. If Economic is mid, Environmental is very high, and Social is mid-high, then final score is mid-high.
195. If Economic is mid, Environmental is very high, and Social is high, then final score is mid-high.
196. If Economic is mid, Environmental is very high, and Social is very high, then final score is mid-high.
197. If Economic is mid-high, Environmental is very low, and Social is very low, then final score is low.
198. If Economic is mid-high, Environmental is very low, and Social is low, then final score is mid-low.
199. If Economic is mid-high, Environmental is very low, and Social is mid-low, then final score is mid-low.
200. If Economic is mid-high, Environmental is very low, and Social is mid, then final score is mid-low.
201. If Economic is mid-high, Environmental is very low, and Social is mid-high, then final score is mid-low.
202. If Economic is mid-high, Environmental is very low, and Social is high, then final score is mid.
203. If Economic is mid-high, Environmental is very low, and Social is very high, then final score is mid.
204. If Economic is mid-high, Environmental is low, and Social is very low, then final score is mid-low.
205. If Economic is mid-high, Environmental is low, and Social is low, then final score is mid-

low.
206. If Economic is mid-high, Environmental is low, and Social is mid-low, then final score is mid-low.
207. If Economic is mid-high, Environmental is low, and Social is mid, then final score is mid-low.
208. If Economic is mid-high, Environmental is low, and Social is mid-high, then final score is mid
209. If Economic is mid-high, Environmental is low, and Social is high, then final score is mid.
210. If Economic is mid-high, Environmental is low, and Social is very high, then final score is mid.
211. If Economic is mid-high, Environmental is mid-low, and Social is very low, then final score is mid-low.
212. If Economic is mid-high, Environmental is mid-low, and Social is low, then final score is mid-low.
213. If Economic is mid-high, Environmental is mid-low, and Social is mid-low, then final score is mid.
214. If Economic is mid-high, Environmental is mid-low, and Social is mid, then final score is mid.
215. If Economic is mid-high, Environmental is mid-low, and Social is mid-high, then final score is mid.
216. If Economic is mid-high, Environmental is mid-low, and Social is high, then final score is mid.
217. If Economic is mid-high, Environmental is mid-low, and Social is very high, then final score is mid-high.
218. If Economic is mid-high, Environmental is mid, and Social is very low, then final score is mid.
219. If Economic is mid-high, Environmental is mid, and Social is low, then final score is mid.
220. If Economic is mid-high, Environmental is mid, and Social is mid-low, then final score is mid.
221. If Economic is mid-high, Environmental is mid, and Social is mid, then final score is mid.
222. If Economic is mid-high, Environmental is mid, and Social is mid-high, then final score is mid.
223. If Economic is mid-high, Environmental is mid, and Social is high, then final score is mid-high.
224. If Economic is mid-high, Environmental is mid, and Social is very high, then final score is mid-high.
225. If Economic is mid-high, Environmental is mid-high, and Social is very low, then final score is mid.
226. If Economic is mid-high, Environmental is mid-high, and Social is low, then final score is mid.
227. If Economic is mid-high, Environmental is mid-high, and Social is mid-low, then final score is mid.
228. If Economic is mid-high, Environmental is mid-high, and Social is mid, then final score is mid-high.
229. If Economic is mid-high, Environmental is mid-high, and Social is mid-high, then final

score is mid-high.
230. If Economic is mid-high, Environmental is mid-high, and Social is high, then final score is mid-high.
231. If Economic is mid-high, Environmental is mid-high, and Social is very high, then final score is mid-high.
232. If Economic is mid-high, Environmental is high, and Social is very low, then final score is mid.
233. If Economic is mid-high, Environmental is high, and Social is low, then final score is mid-high.
234. If Economic is mid-high, Environmental is high, and Social is mid-low, then final score is mid-high.
235. If Economic is mid-high, Environmental is high, and Social is mid, then final score is mid-high.
236. If Economic is mid-high, Environmental is high, and Social is mid-high, then final score is mid-high.
237. If Economic is mid-high, Environmental is high, and Social is high, then final score is mid-high.
238. If Economic is mid-high, Environmental is high, and Social is very high, then final score is high.
239. If Economic is mid-high, Environmental is very high, and Social is very low, then final score is mid-high.
240. If Economic is mid-high, Environmental is very high, and Social is low, then final score is mid-high.
241. If Economic is mid-high, Environmental is very high, and Social is mid-low, then final score is mid-high.
242. If Economic is mid-high, Environmental is very high, and Social is mid, then final score is mid-high.
243. If Economic is mid-high, Environmental is very high, and Social is mid-high, then final score is high.
244. If Economic is mid-high, Environmental is very high, and Social is high, then final score is high.
245. If Economic is mid-high, Environmental is very high, and Social is very high, then final score is high.
246. If Economic is high, Environmental is very low, and Social is very low, then final score is mid-low.
247. If Economic is high, Environmental is very low, and Social is low, then final score is mid-low.
248. If Economic is high, Environmental is very low, and Social is mid-low, then final score is mid-low.
249. If Economic is high, Environmental is very low, and Social is mid, then final score is mid-low.
250. If Economic is high, Environmental is very low, and Social is mid-high, then final score is mid.
251. If Economic is high, Environmental is very low, and Social is high, then final score is mid.
252. If Economic is high, Environmental is very low, and Social is very high, then final score

is mid.
253. If Economic is high, Environmental is low, and Social is very low, then final score is mid-low.
254. If Economic is high, Environmental is low, and Social is low, then final score is mid.
255. If Economic is high, Environmental is low, and Social is mid-low, then final score is mid.
256. If Economic is high, Environmental is low, and Social is mid, then final score is mid.
257. If Economic is high, Environmental is low, and Social is mid-high, then final score is mid.
258. If Economic is high, Environmental is low, and Social is high, then final score is mid.
259. If Economic is high, Environmental is low, and Social is very high, then final score is mid-high.
260. If Economic is high, Environmental is mid-low, and Social is very low, then final score is mid-low.
261. If Economic is high, Environmental is mid-low, and Social is low, then final score is mid.
262. If Economic is high, Environmental is mid-low, and Social is mid-low, then final score is mid.
263. If Economic is high, Environmental is mid-low, and Social is mid, then final score is mid.
264. If Economic is high, Environmental is mid-low, and Social is mid-high, then final score is mid-high.
265. If Economic is high, Environmental is mid-low, and Social is high, then final score is mid-high.
266. If Economic is high, Environmental is mid-low, and Social is very high, then final score is mid-high.
267. If Economic is high, Environmental is mid, and Social is very low, then final score is mid.
268. If Economic is high, Environmental is mid, and Social is low, then final score is mid.
269. If Economic is high, Environmental is mid, and Social is mid-low, then final score is mid.
270. If Economic is high, Environmental is mid, and Social is mid, then final score is mid-high.
271. If Economic is high, Environmental is mid, and Social is mid-high, then final score is mid-high.
272. If Economic is high, Environmental is mid, and Social is high, then final score is mid-high.
273. If Economic is high, Environmental is mid, and Social is very high, then final score is mid-high.
274. If Economic is high, Environmental is mid-high, and Social is very low, then final score is mid.
275. If Economic is high, Environmental is mid-high, and Social is low, then final score is mid-high.
276. If Economic is high, Environmental is mid-high, and Social is mid-low, then final score is mid-high.
277. If Economic is high, Environmental is mid-high, and Social is mid, then final score is mid-high.
278. If Economic is high, Environmental is mid-high, and Social is mid-high, then final score is mid-high.
279. If Economic is high, Environmental is mid-high, and Social is high, then final score is high.
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