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EXTRACTING AND PRIORITIZING THE ATTRACTIVENESS PARAMETERS OF SHOPPING CENTERS UNDER INTUITIONISTIC FUZZY NUMBERS

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Abstract. Shopping center plays an important role in distribution system and marketing. These canters provide an appropriate atmosphere for customers; so that, the customers achieve the best service within a short time. However, there is an intense competition among shopping centers to attract more customers for increasing the profit. Therefore, a powerful model assists authorities in identifying the critical competitive aspects and directing their efforts toward performance improvement. However, a number of strategies have been developed to identify the most relevant components. The Delphi technique under intuitionistic fuzzy environment, called intuitionistic fuzzy Delphi method (IFDM) study, is a group-based technique that can simply formulate the uncertainty imposed by decision making circle. On the other hand, multi criteria decision making (MCDM) method such as analytical network process (ANP) is a mathematical tool for taking into account mutual relationships in order to rank a number of criteria. Nonetheless, the ANP is unable to account for the uncertainty involved in the decision-making process. Similarly, the intuitionistic fuzzy set (IFS) can express ambiguity and vagueness by utilizing the given scale. Because the IFS is robust in dealing with complexity and ambiguity, the IFS-GANP (an integrated model of the IFS and ANP methods under group decision) can result in a more specific description of the situation. As a result, the IFS-GANP approach outperforms both conventional ANP and fuzzy ANP. To demonstrate the model's feasibility, a case study rating the essential aspects impacting the attractiveness of retail centers is shown. The result demonstrates factor C31 (Location) with value of 0.202 plays the greatest role in attracting customers.

Keywords: IFS, ANP, shopping centers, IFDM, MCDM.

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1. Introduction

Iran has emerged as one of the largest economies in the world because of its remarkable economic growth. Based on the statistics issued by Statistical Centre of Iran in 2014, the total retail sales of consumer goods for each family dramatically increased from 19,960 thousand IRR to 97,200 thousand IRR in a ten-year period from 2005 to 2014[1].

Many vendors have tremendously benefited from this incredible economic growth, especially dwellers of the metropolitan areas such as Tehran, Esfahan, and Tabriz. For instance, the retail sales of consumer goods in Tehran, the capital of Iran and considered as the major economic hub, increased more than 4.5 times in ten years, from 2005 to 2014[2]. According to the rapid economy growth, a number of investors and sellers have rushed to the metropolitan areas in order to earn a better yield by focusing on profitable business opportunities, comprising the establishment and development of shopping malls. Based on municipality reports, there is more than 300 mall projects under construction only in Tehran.

In spite the fact that the last global financial crisis in 2008/2009 and the restricting sanctions in 2006–2016 have weakened often business activities and opportunities, the retail market still remains powerful and capable[3]. Although the shopping center atmosphere is quite different from traditional bazar system, this business atmosphere has been broadly accepted by Iranians.

[1] www.cbi.ir

[2] www.worldbank.org

[3] www.mordorintelligence.com

Shopping malls play a key role in the modern marketing distribution system (Finn & Louviere, 1996), because many potential customers still hesitate to shop online (Klepek & Bauerová, 2020). A typical customer desires to receive an extraordinary diversity of goods and the best service within a short time. Generally, not only a shopping mall contains shops; but also, comprises other types of public services such as banking and exchange services. Nowadays, a modern shopping mall provides a broad spread of entertainment for customers such as cinemas and food courts. Moreover, shopping malls are positively affecting the housing market (Zhang et al., 2019). However, with the emergence of modern lifestyles, retail shopping shifted from patronizing at shops nearest to one's place of residence to regional shopping centers and from shopping at small independent shops to large shopping centers (Cheng et al., 2007).

There is a growing need for analysis to understand how the factors can contribute to the success or failure of a shopping mall. However, there is a continuing interest in relationship between the parameters that shopping mall decision makers can manage the patronage attracted to the malls (Finn & Louviere, 1996). Management of a shopping mall requires to understand how mall patronage fluctuates as a function of the factors influencing the image of the mall. Therefore, in order to obtain a substantial profit margin for retail investors, it is necessary to identify the parameters manipulating the behavior of shoppers.

According to the key importance of the attractiveness parameters of shopping centers, a wide variety of studies are conducted. Yu et al. (2007) employed the genetic algorithm technique to optimize the layout of shopping centers in order to satisfy shoppers and vendors in terms of understanding the minimum car-based shopping trips. Cheng et al. (2007) used a GIS approach to select the location of shopping mall. Eckert et al. (2013) accomplished an empirical analysis on shopping centers to investigate the locational form of stores. Lin et al. (2021) explored location determinants of shops.

Oppewal et al. (1997) investigated how consumer choice behavior changes when shopping center size and store varies. Timmermans (1982) investigated the relationship between the physical attributes of the consumer decision making, overt behavior, and retailing system by using information integration theory under an empirical analysis. Wakefield and Baker (1998) demonstrated how shopping involvement, mall environment, and tenant variety impact on shoppers' excitement.

Finn and Louviere (1996) investigated how physical characteristics of shopping centers influence the consumer choice. Mittal and Jhamb (2016) accomplished a quantitative analysis to identify the key features of a shopping mall. Onut et al. (2010) used a model based on a combined MCDM methodology to solve the problem of site selection for a shopping center. Cheng et al. (2005) selected the best site for a shopping mall by using the ANP method. Frasquet et al. (2001) used the methodology of consumer choice modelling to select shopping center. El-Adly (2007) used the shoppers' perspective to determine the attraction parameters of shopping malls.

Although numerous strategies have been created to formulate customer behavior in order to design a shopping mall with the greatest attractiveness, MCDMs are among the widely used tools for ranking factors in a multifaceted problem. The analytical network process (ANP), an MCDM approach, uses a scientific procedure to model a sophisticated problem through transferring a complex problem into simple and understandable structures (Shariatmadari-Serkani et al., 2022; Song et al., 2022; Nasri et al., 2023; Nalbant, 2024; Zhang et al., 2024). This technique can process the personal and subjective preferences (Saaty, 2001). The ANP approach uses the comparison matrix to determine the related weights of criteria.

The comparison matrix ranges from one to nine, with one indicating that two criteria are equally relevant and nine indicating that one criterion is significantly more important than the other (Sadiq & Tesfamariam, 2009). This technique is capable of taking into consideration mutual relationships involved by elements. The main reasons for employing an ANP-based decision can be described as (Fouladgar et al., 2012): (1) the ANP method takes into account all qualitative and quantitative factors, (2) the technique uses a relatively intuitive and simple procedure accepted by authorities, (3) the method can formulate a mutual connection between the decision levels without restricting to a strict hierarchical structure, and (4) the technique is more compatible with real case applications.

However, the ambiguity is to be expected in any decision-making process (Sadiq & Tesfamariam, 2009). Management and science have distinct approaches to ambiguity (Parsons, 2001). However, the vagueness sources are arisen from two parts (Fouladgar et al., 2011): (1) the vagueness imposed by subjective judgments (i.e. decision team is not 100% sure when making certain decision) and (2) the vagueness resulted from lack or less of information (i.e. information about decision elements is not completely available).

The intuitive fuzzy set (IFS) is an appropriate method for addressing a complex issue in the presence of the ambiguity. The IFS is an effective general form of fuzzy logic (Li, 2014). When other traditional approaches fail to simulate a sophisticated problem, this strategy can find out an appropriate solution. As a result, an integrated model of the IFS and ANP techniques is used to prioritize the key elements influencing shopping center attractiveness. The overarching aim of this study is double: (1) the identification of the factor increasing sales possibilities in order to achieve better results, and (2) the assistance of merchants and property developers in understanding the needs of their customers.

The rest of the paper is arranged as follows. Section 2 provides a brief overview of intuitionistic fuzzy ANP, which includes the IFS, ANP, an integrated technique, competitive advantage, and intuitionistic fuzzy Delphi method. The suggested approach is described in Section 3. Section 4 includes a description of retail centers. Finally, the findings are clearly described in the last section.

2. Research methodology

2.1. IFS description

Zadeh (1965) initially proposed fuzzy logic for dealing with the vagueness imposed by the decision process (Fouladgar et al., 2012; Yazdani-Chamzini, 2014a, 2014b; Kar, 2015; Alcantud, 2016; Sun et al., 2017). A fuzzy set, on the other hand, uses a single index (membership function) to define both the states of support and opposition. Whereas, if the degree of support membership is $\mu(x)$, then the degree of opposition membership is just the complement of 1, i.e., $1-\mu(x)$ (Li, 2014). As a result, a fuzzy set cannot accurately characterize the neutral state. To address this issue, Atanassov (1986) introduced the idea of an IFS.

An IFS function indicates three values neutrality, opposition, and support. The function uses non-membership and membership degrees to describe the ambiguity (Natarajan et al., 2024). As a result, the IFS is more suited for dealing with practical issues in which the vagueness is impacted by hesitant degree. The IFS A in E is scientifically defined in the following:

$$A=\left\{\langle x,\mu_A(x),\upsilon_A(x)\rangle \middle| x\in E\right\}. \quad (1)$$

Where there are two mapping on the set A:

$$\mu_A : E\rightarrow\left[0,1\right]. \quad (2)$$

And

$$\upsilon_A : E\rightarrow\left[0,1\right]. \quad (3)$$

The non-membership and membership degree of the element $x\in E$, respectively, is defined for every $x\in E$ as:

$$0\le\mu_A(x)+\upsilon_A(x)\le 1. \quad (4)$$

An IFS is described as:

$$A=\left\{\langle x,\mu_A(x),1-\mu_A(x)\rangle \middle| x\in E\right\}. \quad (5)$$

The following operations and relations can be described for two IFSs A and B:

$$A\subset B \text{ if and only if } (\forall x\in E)(\mu_A(x)\le\mu_B(x)\,\&\,\upsilon_A(x)\ge\upsilon_B(x)). \quad (6)$$

$$A\supset B \text{ if and only if } B\subset A. \quad (7)$$

$$A=B \text{ if and only if } (\forall x\in E)(\mu_A(x)=\mu_B(x)\,\&\,\upsilon_A(x)=\upsilon_B(x)). \quad (8)$$

$$\bar{A}=\left\{\langle x,\upsilon_A(x),\mu_A(x)\rangle \middle| x\in E\right\}; \quad (9)$$

$$A+B=\left\{\langle x,\mu_A(x)+\mu_B(x)-\mu_A(x).\mu_B(x),\upsilon_A(x).\upsilon_B(x)\rangle \middle| x\in E\right\}; \quad (10)$$

$$A.B=\left\{\langle x,\mu_A(x).\mu_B(x),\upsilon_A(x)+\upsilon_B(x)-\upsilon_A(x).\upsilon_B(x)\rangle \middle| x\in E\right\}; \quad (11)$$

$$A\cap B=\left\{\langle x,\min(\mu_A(x),\mu_B(x)),\max(\upsilon_A(x),\upsilon_B(x))\rangle \middle| x\in E\right\}; \quad (12)$$

$$A\cup B=\left\{\langle x,\max(\mu_A(x),\mu_B(x)),\min(\upsilon_A(x),\upsilon_B(x))\rangle \middle| x\in E\right\}. \quad (13)$$

The distances between IFSs A and B in $X=\left\{x_1,x_2,\ldots,x_n\right\}$ is described as:

The Hamming distance:

$$d(A,B)=\sum_{i=1}^{n}\left(\left|\mu_A(x_i)-\mu_B(x_i)\right|+\left|\upsilon_A(x_i)-\upsilon_B(x_i)\right|+\left|\pi_A(x_i)-\pi_B(x_i)\right|\right). \quad (14)$$

The Euclidean distance:

$$e(A,B)=\sqrt{\sum_{i=1}^{n}(\mu_A(x_i)-\mu_B(x_i))^2+(\upsilon_A(x_i)-\upsilon_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2}, \quad (15)$$

where

$$0\le d(A,B)\le 2n \quad (16)$$

and

$$0\le e(A,B)\le\sqrt{2n}. \quad (17)$$

2.2. Intuitionistic fuzzy ANP

Evaluators typically choose verbal variables to demonstrate how much one element is more essential than another (Fouladgar et al., 2011). A verbal value is a variable whose value is determined by a function when dealing with the unidentified conditions in order to accurately represent an event in a conventional model (Yazdani-Chamzini & Yakhchali, 2012; Shariati et al., 2017; Havle & Büyüközkan, 2023). The pair comparison approach used in an ANP analysis can determine the relative value of each criterion (Büyüközkan et al., 2024). This judgment is converted into appropriate IFSs.

The IF-GANP approach consists of eight steps:

Step 1. The evaluators are instructed to do the two-by-two judgements using the given scale.

Step 2. The primary weights extracted by decision team are aggregated into the group weights.

Step 3. Pairwise comparisons are made on the assumption that dependency between criteria is neglected.

Step 4. The impact of each factor on every other factor is investigated to extract inner-dependency relationships between criteria.

Step 5. Calculating the relative importance of the elements.

Step 6. Determining the inner-dependence decision matrices.

Step 7. Computing the final weights of the sub-factors.

Step 8. Prioritizing the factors according to their ranks.

2.3. Competitive advantage

Competitive advantage is defined as a plan of a particular company to establish and defend their desired strategic position against competitors. It can be evaluated by investigating the resources or calculating the outcome of competitive efforts (Maury, 2018). This approach uses a systematic procedure to integrate three main factors, including cost, differentiation, and leadership components. The first component reflects how a firm produces goods or services with the features accepted by customers at the lowest cost. This factor allows to produce superior margins

Figure 1. Competitive advantage components

or more sales in comparison with market competitors. The second component shows how a firm produces goods or services in a different manner to adapt with customers' requirements. In the differentiation strategy, by considering several dimensions valued by consumers, the firm aims to be unique in its industry (Hanson et al., 2017). The last component shows how a firm pursues differentiation and low cost simultaneously. Competitive advantage makes a product more desirable to customers by taking into account both unique and higher quality features (see Figure 1). Therefore, it generates higher value for a firm and its shareholders because of certain strengths or conditions. A sustained competitive advantage makes it difficult for competitors to neutralize the advantage.

2.4. Intuitionistic fuzzy Delphi method

Group decision-making is an effective technique for resolving complicated challenges and difficulties. Expert viewpoints can help groups make better decisions on certain issues. The Delphi technique is one of the qualitative methodologies used to achieve universal agreement in group decision-making procedures. Delphi studies involve specialists on the topic under debate (Rejeb et al., 2022; Zhu et al., 2023; Danacı & Yıldırım, 2023). This strategy is intended to combine and synthesis expert opinions in a certain subject in order to obtain a final judgment (Cafiso et al., 2013).

This method is combined with an intuitionistic fuzzy technique known as the intuitionistic fuzzy Delphi method (IFDM), which employs the benefits of intuitionistic fuzzy theory in expressing the inherent ambiguity involved in the decision-making process. In this study, the assessment criteria were determined using a three-round IFDM with nine experts.

In the first round of the IFDM research, in addition to commenting on the structure of the created algorithm, participants were requested to add different more dimensions and modes as needed. At this stage, different dimensions and states of the dimensions were confirmed, with minor alterations recommended by specialists. In the second phase, each expert was asked to organize the various states of each dimension in order of relevance. At the conclusion of the second round, the findings were reviewed again, and distinct states of dimensions were organized based on expert aggregated judgments.

The experts received the second round's results in the third round. They were encouraged to modify their minds regarding the sequence of the dimensions' states. According to the experts' aggregated assessments, the third round did not result in a substantial change in the overall outcomes of the second round, hence the study was discontinued.

In this section, the steps of the application of the IFDM can be explained as follows.

Step 1. The expert $i \in (1,n)$ is requested to give a response based on the scale given in Table 1.

$$(\mu_l^i, \upsilon_l^i, \pi_l^i), \qquad l = 1, \tag{18}$$

where i expresses the index attached to the expert and l expresses the phase of the IFDM process.

Step 2. The responses from n experts can be shown as follows:

$$(\mu_l^i, \upsilon_l^i, \pi_l^i), \quad i = 1, \ldots, n. \tag{19}$$

The mean of this function is as:

$$(\bar{\mu}_l, \bar{\upsilon}_l, \bar{\pi}_l). \tag{20}$$

Furthermore, for each expert, the divergence is obtained as:

$$D_i = \left\{\bar{\mu}_l - \mu_l^i, \bar{\upsilon}_l - \upsilon_l^i, \bar{\pi}_l - \pi_l^i\right\}, \tag{21}$$

where D_i values can be negative, zero, or positive. The value is submitted to each individual expert.

Next, each expert presents a new response:

$$(\mu_l^i, \upsilon_l^i, \pi_l^i), \qquad l = 2. \tag{22}$$

Moreover, the process will be repeated.

When the means of intuitionistic fuzzy values become sufficiently stable or two successive means become reasonably close and decision team is satisfactory, the process is stopped. After that, the outputs are aggregated by using the following equations:

$$\mu_A = \frac{1}{n}\sum_{i=1}^{n} \mu_l^i, \ \ \upsilon_A = \frac{1}{n}\sum_{i=1}^{n} \upsilon_l^i, \ \ \pi_A = \frac{1}{n}\sum_{i=1}^{n} \pi_l^i. \tag{23}$$

Finally, for making the comparison analysis among different criteria, the values should be converted into crisp ones. For achieving the aim, the defuzzification method proposed by Atanassov and Sotirov (2012) is utilized as follows:

$$\mu_A^*(x) = \mu_A(x) + \frac{\mu_A(x)}{\mu_A(x) + \upsilon_A(x)} \times \pi_A(x). \tag{24}$$

Table 1. Linguistic variables and corresponding intuitionistic fuzzy values

Linguistic variables	Intuitionistic fuzzy values
Very unimportant	(0.0, 1.0, 0.0)
Unimportant	(0.25, 0.70, 0.05)
Medium	(0.50, 0.40, 0.1)
Important	(0.75, 0.20, 0.05)
Very important	(1.0, 0.0, 0.0)

3. The proposed approach

To identify the most critical components, the IFDM study is firstly conducted. This process recognizes the most important factors influencing the shopping center attractiveness. Figure 2 shows a step-by-step technique by using the IF-GANP approach for determining the relative rank of elements based on competitive advantages under group decision. The graphic shows that the process of addressing a decision-making challenge consists of six phases. The expert team defines language variables initially, as shown in Table 2. The table displays the ANP rating, related IF numbers, and reciprocal IF numbers. The IF judgment matrix conducts two-by-two comparisons in the second stage, after the construction of the hierarchical structure based on competitive advantage components.

For example, a decision maker establishes a strong important while comparing the first criterion (C1) and the second criterion (C2) with relation to the overall aim (see Table 2). This implies that C1 is five times more significant than C2. To determine the relative significance of the components, the IF-GANP methodology under group decision (IF-GANP) uses an IFS stated as three values (0.70, 0.20, 0.10), similar to the ANP method that uses a crisp value of 5.

Next, the IFS comparison matrix of each evaluator is combined into a group one trough the aggregated procedure. The aggregation matrix is turned into the overall one using the arithmetic mean procedure (Wei & Tang, 2011). The consistency ratio (CR) is used to assess the consistency of an aggregated decision matrix after it has been constructed. This study used a modified version of CR created by Abdullah and Najib (2016) to assess consistency with IF data. This formula estimates the consistency of pair-wise comparisons (Karacan et al., 2020). A CR value < 0.10 indicates that the comparison matrix is consistent. The following phases demonstrate how CR is determined (Xu & Liao, 2014).

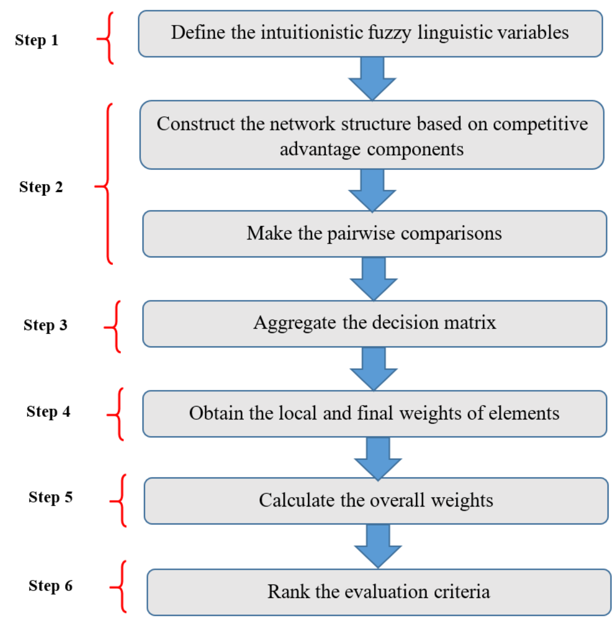

Figure 2. The proposed approach

Stage 1: for $k > i+1$

$$\bar{\mu}_{ik} = \frac{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\mu_{it}\mu_{tk}}}{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\mu_{it}\mu_{tk}} + \sqrt[k-i-1]{\prod_{t=i+1}^{k-1}(1-\mu_{it})(1-\mu_{tk})}}; \quad (25)$$

$$\bar{\upsilon}_{ik} = \frac{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\upsilon_{it}\upsilon_{tk}}}{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\upsilon_{it}\upsilon_{tk}} + \sqrt[k-i-1]{\prod_{t=i+1}^{k-1}(1-\upsilon_{it})(1-\upsilon_{tk})}}; \quad (26)$$

$$\bar{\pi}_{ik} = \frac{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\pi_{it}\pi_{tk}}}{\sqrt[k-i-1]{\prod_{t=i+1}^{k-1}\pi_{it}\pi_{tk}} + \sqrt[k-i-1]{\prod_{t=i+1}^{k-1}(1-\pi_{it})(1-\pi_{tk})}}, \quad (27)$$

where $R = (r_{ik})_{n\times n} = (\mu_{ik}, \upsilon_{ik})$ is an intuitionistic preference relation and $\bar{R} = (\bar{r}_{ik})_{n\times n} = (\bar{\mu}_{ik}, \bar{\upsilon}_{ik})$ is a perfect multiplicative consistent intuitionistic preference relation.

Stage 2: for $k = i+1$

$$r_{ik} = \bar{r}_{ik}. \quad (28)$$

Stage 3: for $k < i$

$$\bar{r}_{ik} = (\upsilon_{ki}, \mu_{ki}). \quad (29)$$

Stage 4: calculate the distance between the given intuitionistic preference relation R and its corresponding perfect multiplicative consistent intuitionistic preference relation $\bar{R}$ by the following equation:

$$d(\bar{R}, R) = \frac{1}{2(n-1)(n-2)}\sum_{i=1}^{n}\sum_{k=1}^{n}\left(\left|\bar{\mu}_{ik}-\mu_{ik}\right| + \left|\bar{\upsilon}_{ik}-\upsilon_{ik}\right| + \left|\bar{\pi}_{ik}-\pi_{ik}\right|\right). \quad (30)$$

Decision matrix is consistent when $d(\bar{R}, R)$ is less than 0.1.

In the subsequent stage, the importance weights of factors are calculated by employing the entropy technique described as follows (Abdullah & Najib, 2016):

$$w_i = \frac{1-\bar{\bar{w}}_i}{n-\sum_{j=1}^{n}\bar{\bar{w}}_i}, \quad (31)$$

where

$$\sum_{j=1}^{n} w_i = 1 \quad (32)$$

and

$$\bar{\bar{w}}_i = -\frac{1}{n\ln 2}\left[\mu_i \ln\mu_i + \upsilon_i \ln\upsilon_i - (1-\pi_i)\ln(1-\pi_i) - \pi_i \ln 2\right]. \quad (33)$$

If $\mu_i = 0$, $\upsilon_i = 0$, $\pi_i = 0$, then $\mu_i \ln\mu_i = 0$, $\upsilon_i \ln\upsilon_i = 0$, $(1-\pi_i)\ln(1-\pi_i) = 0$.

If $\mu_i = 1$, $\upsilon_i = 0$, $\pi_i = 0$, then $\mu_i \ln\mu_i = 0$, $\upsilon_i \ln\upsilon_i = 0$, $(1-\pi_i)\ln(1-\pi_i) = 0$, respectively.

Next, the overall weights are resulted from multiplying the local weights with inner-dependency weights. Then, the factors are prioritized based on the overall comparative importance.

Table 2. Linguistic variables

Preference on pair wise comparison	Intuitionistic fuzzy numbers	Reciprocal intuitionistic fuzzy numbers	ANP rating
Equally Important (EI)	(0.50, 0.50, 0.0)	(0.50, 0.50, 0.0)	1
Intermediate Value (IEM)	(0.55, 0.40, 0.05)	(0.40, 0.55, 0.05)	2
Moderately More Important (MI)	(0.60, 0.30, 0.10)	(0.30, 0.60, 0.10)	3
Intermediate Value (IMS)	(0.65, 0.25, 0.10)	(0.25, 0.65, 0.10)	4
Strongly More Important (SI)	(0.70, 0.20, 0.10)	(0.20, 0.70, 0.10)	5
Intermediate Value (ISV)	(0.75, 0.15, 0.10)	(0.15, 0.75, 0.10)	6
Very Strong More Important (VS)	(0.80, 0.10, 0.10)	(0.10, 0.80, 0.10)	7
Intermediate Value (IVE)	(0.90, 0.05, 0.05)	(0.05, 0.90, 0.05)	8
Extremely More Important (EM)	(1.0, 0.0, 0.0)	(0.0, 1.0, 0.0)	9

4. A case study

This case study demonstrates the use of the IFS-GANP approach to prioritize the essential variables of shopping center attractiveness based on competitive advantage components. Since several shopping centers have been completed by large scale companies over the recent decades, the retail management in Tehran, the capital of Iran, is coped with a more serious challenge. The sellers usually decline the price to attract more customers, but they shortly find themselves in a no-win situation. Therefore, it is necessary to develop some models based on competitive advantage to find the most important factors influencing the successfulness of a shopping center. This can lead to focus the key activities on the main factors.

4.1. Extraction of the main components by the IFDM procedure

Round 1: All assessors are given instructions on how to complete the questionnaire and are informed that the questions are open-ended. Once returned, the surveys are qualitatively examined, themes are found, and the findings are utilized to develop statements for Round 2. A total of 21 statements are comprised.

Round 2: Participants are asked to score their degree of agreement with each statement using a five-point Likert scale ranging from strongly agree to strongly disagree. Responses from Round 2 are assessed using descriptive statistics and sent back to participants during Round 3.

Round 3: The last round comprised all of the comments and outcomes from Round 2. Round 3 requests participants to re-rate their degree of agreement with the statements based on the group's distribution of opinions. They are also urged to provide feedback on their replies. The responses from Round 3 are examined using descriptive statistics. After examining the data, it is discovered that no new variables are introduced by experts, and the IFDM operation was discontinued. The findings are analyzed using the previously described IFDM procedure. The degree of consensus is defined as ≥70% agreement with an interquartile range (IQR) of ≤1. An IQR of ≤1 is commonly used as a consensus indicator for a five-unit scale (Denecke et al., 2023).

It is recommended to use the IFDM process to provide feedback on reasons or arguments as well as measurements of central tendency or dispersion. The theory behind the IFDM technique is largely statistical, combining numerical estimates of participants' perspectives leading to more trustworthy estimates than estimates from an individual evaluator. Furthermore, the IFDM approach enables users to communicate knowledge in an iterative and cost-effective manner.

As previously stated, in the first step, the decision makers extract a list of characteristics impacting the attractiveness of shopping centers and make the necessary modifications. Then, in the second phase, the IFDM research is carried out with the assistance of an expert panel, and seven variables are recognized as the most important factors determining the attractiveness of shopping malls. Table 3 shows a list of these variables, as well as their defuzzified scores.

Table 3. The results of IFDM study

Row	Variable	Defuzzified score of IFDM study
1	Location	0.95
2	Merchandising	0.89
3	Atmosphere	0.82
4	Convenience	0.77
5	Facilities	0.72
6	Size	0.69
7	Assortment	0.62

4.2. A conceptual model

As previously stated, the IFS-GANP technique is an appropriate and strong instrument for solving decision-making issues including qualitative and quantitative criteria in a complex and unpredictable situation. Nine evaluators, comprising technical, sales, and senior managers with high experience are asked in this study to assess the essential elements retrieved from competitive advantage components. The computational technique is given in the stages below.

The first stage of the study extracts the most relevant elements based on competitive advantage components for evaluating retail center attractiveness. A literature study is conducted to identify the most significant criteria. Finally, by using a three-round process of the IFDM study, seven criteria are used to guide the review process (see Table 4).

A conceptual model for an MCDM issue should be created before data collection. The conceptual model is the most important component in the IFS-GANP model creation process. This model summarizes all subsequent efforts to solve the issue under consideration.

The first stage defines a decision problem. The primary objective is to evaluate the assessment criteria. Finally, as the aforementioned above, only extremely influencing factors were used (Louviere & Meyer, 1981). The classified graph based on competitive advantage components is constructed as depicted in Figure 3. This figure depicts the mutual relationships between the main criteria and sub-criteria. For better understanding, Table 5 shows the main and sub-criteria and their corresponding components.

Table 4. The previous studies and indicators applied for evaluation of shopping mall

	Merchandising	Atmosphere	Convenience	Facilities	Assortment	Location	Size
Dubihlela and Dubihlela (2014)	✓	✓	✓			✓	
Nevin and Houston (1980)				✓	✓	✓	
Mas-Ruiz (1999)		✓		✓			
Wong et al. (2001)				✓	✓	✓	✓
Sit et al. (2003)	✓	✓				✓	
Yilmaz (2004)	✓					✓	
Singh and Sahay (2012)		✓	✓	✓			✓
González-Hernández and Orozco-Gómez (2012)		✓	✓	✓			
Gudonaviciene and Alijosiene (2013)	✓	✓	✓			✓	✓
Ibrahim (2002)	✓	✓	✓	✓		✓	✓
Finn and Louviere (1996)						✓	✓
El-Adly (2007)			✓				
Jhamb and Kiran (2012)	✓	✓			✓		
Anuradha and Manohar (2011)	✓	✓		✓		✓	✓
Verhoef et al. (2009)		✓			✓	✓	
Baker et al. (2002)	✓	✓					
Mittal and Jhamb (2016)	✓	✓		✓	✓	✓	
Nordic Council of Shopping Centers (2013)	✓			✓	✓		
Rajagopal (2008)	✓	✓	✓	✓			
Michon et al. (2005)	✓	✓					
Teller (2008)		✓		✓		✓	
Wakefield and Baker (1998)		✓				✓	
Ahmad (2012)	✓	✓	✓			✓	
Severin et al. (2001)	✓					✓	
Stoltman et al. (1991)		✓	✓	✓	✓		
Timmermans (1982)				✓		✓	
Frasquet et al. (2001)	✓	✓		✓	✓	✓	
Zolfani et al. (2013)						✓	
Cheng et al. (2005)						✓	
Patel and Sharma (2009)		✓	✓				
Reikli (2012)	✓					✓	
Onut et al. (2010)		✓					
Anikeeff (1996)	✓					✓	
Wong (2015)	✓				✓	✓	
Oppewal et al. (1997)	✓						

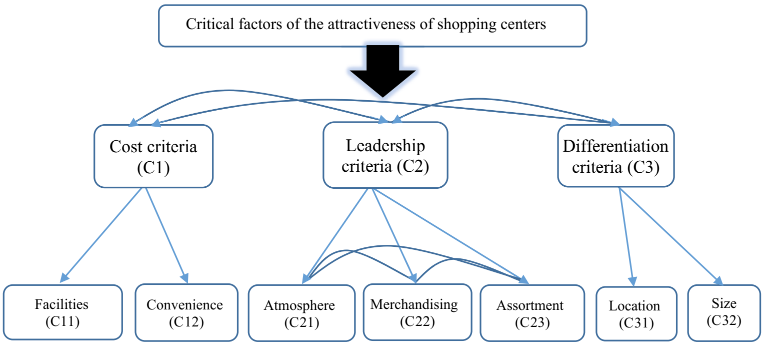

Figure 3. The network structure

Table 5. Main and sub-criteria and their groups

The overall goal	Main-criteria	Sub-criteria
The most important attractiveness factors of shopping center	Cost criteria	Convenience
		Facilities
	Leadership criteria	Assortment
		Merchandising
		Atmosphere
	Differentiation criteria	Location
		Size

4.3. The IFS-GANP technique

The pairwise comparison matrix is then obtained through the use of an IFS-GANP-based questionnaire. Next, two-by-two comparisons are performed by the IFS judgment matrix shown in Table 2. Table 6 shows an example questionnaire filled out by one of the experts. The language variables are transformed into matching numerical values, as shown in Table 7.

Table 6. A primary questionnaire filled by one of the decision makers

	C1	C2	C3
C1	EI	IEM	MI
C2	IEM*	EI	EI
C3	MI*	EI	EI

Note: *Red color reflects reverse values.

Table 7. A questionnaire converted into numerical values

	C1	C2	C3
C1	(0.5, 0.5, 0.0)	(0.55, 0.4, 0.05)	(0.6, 0.3, 0.1)
C2	(0.4, 0.55, 0.05)	(0.5, 0.5, 0.0)	(0.5, 0.5, 0.0)
C3	(0.3, 0.6, 0.1)	(0.5, 0.5, 0.0)	(0.5, 0.5, 0.0)

In the third stage, the individual comparison matrices are integrated to create the group comparison matrix. In this study, all decision makers are equally important, hence the integrated values are calculated using the mean average. The aggregated matrices are depicted in Tables 8, 9, 10, and 11. In order to check the CR, the above-mentioned process by using Eqs (8)–(13) is conducted. The results of the CR analysis are shown in Table 12 and 13. The last row of Tables 8–11 shows the CR. As well as this, the local weights obtained by the proposed process is listed in the last column of Tables 8–11.

Table 8. The local weights of the main criteria

	C1	C2	C3	The local weights
C1	(0.5, 0.5, 0.0)	(0.31, 0.61, 0.08)	(0.58, 0.33, 0.09)	0.331
C2	(0.61, 0.31, 0.08)	(0.5, 0.5, 0.0)	(0.67, 0.23, 0.1)	0.335
C3	(0.33, 0.58, 0.09)	(0.23, 0.67, 0.1)	(0.5, 0.5, 0.0)	0.334
CR =	0.086			

Table 9. The local weights of the cost sub-criteria

	C11	C12	The local weights
C11	(0.5, 0.5, 0.0)	(0.58, 0.32, 0.05)	0.537
C12	(0.32, 0.58, 0.05)	(0.5, 0.5, 0.0)	0.463

Table 10. The local weights of the differentiation sub-criteria

	C31	C32	The local weights
C31	(0.5, 0.5, 0.0)	(0.72, 0.18, 0.05)	0.581
C32	(0.18, 0.72, 0.05)	(0.5, 0.5, 0.0)	0.419

Table 11. The local weights of the leadership sub-criteria

	C21	C22	C23	The local weights
C21	(0.5, 0.5, 0.0)	(0.32, 0.63, 0.05)	(0.19, 0.71, 0.1)	0.334
C22	(0.63, 0.32, 0.05)	(0.5, 0.5, 0.0)	(0.27, 0.64, 0.09)	0.33
C23	(0.71, 0.19, 0.1)	(0.64, 0.27, 0.09)	(0.5, 0.5, 0.0)	0.335
CR =	0.089			

Table 12. The perfect multiplicative consistent intuitionistic preference relation for main criteria

$\bar{R}$		C1			C2			C3	
C1	0.50	0.50	0.00	0.31	0.61	0.08	0.48	0.32	0.01
C2	0.74	0.18	0.08	0.50	0.50	0.00	0.67	0.23	0.10
C3	0.32	0.48	0.01	0.23	0.67	0.10	0.50	0.50	0.00
					$d(\bar{R},R)$ = 0.086				

Table 13. The perfect multiplicative consistent intuitionistic preference relation for leadership sub-criteria

$\bar{R}$		C21			C22			C23	
C21	0.50	0.50	0.00	0.32	0.63	0.05	0.15	0.75	0.01
C22	0.63	0.32	0.05	0.50	0.50	0.00	0.27	0.64	0.09
C23	0.75	0.15	0.01	0.64	0.27	0.09	0.50	0.50	0.00
					$d(\bar{R},R)$ = 0.089				

For calculating the interdependent weights, the inner-dependency relationships of each element with respect to the other elements is extracted. By evaluating the impact of each criterion on every other criterion, the interdependency among the elements is extracted. The interdependency among the elements is shown in Tables 14–19 by using the intuitionistic fuzzy judgment matrices. The matrices are constructed by asking "What is the relative importance of "one criterion" when compared with "one another criterion" on controlling "another criterion"?" After constructing decision matrix, the final matrix is obtained by aggregating all matrices. Next, the local weights are computed by the proposed process as presented in the last column of Tables 14–19.

Table 14. The interdependency relationships with respect to "C1"

C1	C2	C3	The local weights
C2	(0.5, 0.5, 0.0)	(0.33, 0.57, 0.1)	0.466
C3	(0.57, 0.33, 0.1)	(0.5, 0.5, 0.0)	0.534

Table 15. The interdependency relationships with respect to "C2"

C2	C1	C3	The local weights
C1	(0.5, 0.5, 0.0)	(0.26, 0.64, 0.1)	0.445
C3	(0.64, 0.26, 0.1)	(0.5, 0.5, 0.0)	0.555

Table 16. The interdependency relationships with respect to "C3"

C3	C1	C2	The local weights
C1	(0.5, 0.5, 0.0)	(0.73, 0.18, 0.09)	0.582
C2	(0.18, 0.73, 0.09)	(0.5, 0.5, 0.0)	0.418

Table 17. The interdependency relationships with respect to "C21"

C21	C22	C23	The local weights
C22	(0.5, 0.5, 0.0)	(0.12, 0.69, 0.09)	0.403
C23	(0.69, 0.12, 0.09)	(0.5, 0.5, 0.0)	0.597

Table 18. The interdependency relationships with respect to "C22"

C22	C21	C23	The local weights
C21	(0.5, 0.5, 0.0)	(0.19, 0.71, 0.1)	0.422
C23	(0.71, 0.19, 0.1)	(0.5, 0.5, 0.0)	0.578

Table 19. The interdependency relationships with respect to "C23"

C23	C21	C22	The local weights
C21	(0.5, 0.5, 0.0)	(0.34, 0.61, 0.05)	0.464
C22	(0.61, 0.34, 0.05)	(0.5, 0.5, 0.0)	0.536

Then, the final weights of the factors are resulted from the relative importance extracted in the previous steps. For this reason, the interdependent weights of the factors are obtained by multiplying the local weights of the elements in the form of interdependency with those of independency as follows:

$$\begin{bmatrix} C1 \\ C2 \\ C3 \end{bmatrix} = \begin{bmatrix} 1.00 & 0.445 & 0.582 \\ 0.466 & 1.00 & 0.418 \\ 0.534 & 0.555 & 1.00 \end{bmatrix} \times \begin{bmatrix} 0.331 \\ 0.335 \\ 0.334 \end{bmatrix} = \begin{bmatrix} 0.337 \\ 0.315 \\ 0.348 \end{bmatrix}.$$

It can be seen that the local weights change from 0.331, 0.335, and 0.334 to 0.337, 0.315, and 0.348, respectively.

This demonstrates there is a significant change in the weights after taking into account the interdependency relationships. In addition, with considering the interdependency between the sub-criteria, the local weights are obtained as follows:

$$\begin{bmatrix} C21 \\ C22 \\ C23 \end{bmatrix} = \begin{bmatrix} 1.00 & 0.422 & 0.464 \\ 0.403 & 1.00 & 0.536 \\ 0.597 & 0.578 & 1.00 \end{bmatrix} \times \begin{bmatrix} 0.334 \\ 0.33 \\ 0.335 \end{bmatrix} = \begin{bmatrix} 0.315 \\ 0.322 \\ 0.363 \end{bmatrix}.$$

It can be seen that the local weights change from 0.334, 0.33, and 0.335 to 0.315, 0.322, and 0.363, respectively. This demonstrates a substantial change in the weights after taking into account the interdependency relationships.

Then, the overall weights are obtained by multiplying the final weights resulted by the main criteria with those of the sub criteria. The overall weights are presented in Table 20.

Table 20. The overall weights

	Weight	Rank
C11	0.181	2
C12	0.156	3
C21	0.099	7
C22	0.101	6
C23	0.114	5
C31	0.202	1
C32	0.146	4

Finally, the assessment criteria are prioritized according to their importance, indicated in Table 20. Figure 4 depicts the relative relevance of the components to better find out the results. The output shows criterion C31 (Location) has the greatest impact on the attractiveness of the shopping centers. As seen in Figure 4, the criterion C21 (Atmosphere) is situated in the end of list of priorities.

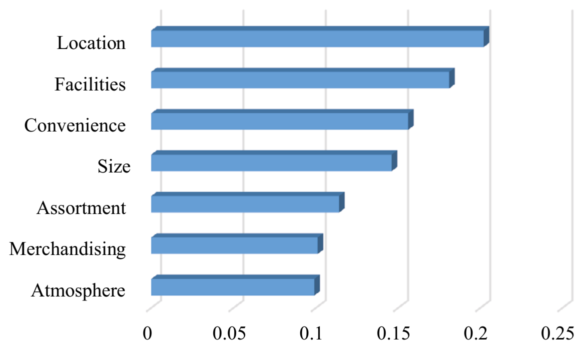

Figure 4. The overall weight of the evaluation criteria

5. Conclusions

In a highly competitive retail market, shopping centers play the significant role in distribution system. The competition is an inseparable part among between shopping centers. Therefore, extracting the most critical components influencing the attractiveness of a shopping center is a necessary action. To overcome this issue, the IFDM study is employed for recognizing the most critical components influencing the shopping center successfulness. By using the IFDM study, seven criteria are identified and grouped into three main criteria. On the other hand, many strategies have been introduced to prioritize the operative components. The ANP approach is widely used MCDM tool in prioritizing a collection of components. This technique is essentially subjective, with uncertainties in the evaluation phase that may influence the selection process. In contrast, intuitionistic fuzzy systems can handle the ambiguity and uncertainty imposed by the decision circle. The integration of IFS with the ANP approach under group decision can assist an authority in making more accurate and realistic judgments by utilizing linguistic variables rather than explicit ones. The IFS-GANP approach creates the decision matrix through pairwise comparisons.

The suggested technique is designed to rank the parameters that influence the attractiveness of retail complexes in order to demonstrate its potential use. The results of the suggested technique demonstrate that criterion C31 (Location) is the most important element in the appeal of shopping malls. The outcome illustrates that the proposed strategy can reduce the ambiguity in the decision process.

The main limitation of the research is few variables taken for study. However, further studies are required to demonstrate how the findings change with levels of belief. Also, further research is required to evaluate model stability using more educational and academic studies.

References

Abdullah, L., & Najib, L. (2016). Sustainable energy planning decision using the intuitionistic fuzzy analytic hierarchy process: Choosing energy technology in Malaysia. *International Journal of Sustainable Energy*, *35*(4), 360–377. https://doi.org/10.1080/14786451.2014.907292

Ahmad, A. M. K. (2012). Attractiveness factors influencing shoppers' satisfaction, loyalty, and word of mouth: An empirical investigation of Saudi Arabia shopping malls. *International Journal of Business Administration*, *3*(6), 101–112. https://doi.org/10.5430/ijba.v3n6p101

Alcantud, J. C. R. (2016). A novel algorithm for fuzzy soft set based decision making from multiobserver input parameter data set. *Information Fusion*, *29*, 142–148. https://doi.org/10.1016/j.inffus.2015.08.007

Anikeeff, M. A. (1996). Shopping center tenant selection and mix: A review. In J. D. Benjamin (Ed.), *Megatrends in retail real estate* (pp. 215–238). Kluwer Academic Publishers. https://doi.org/10.1007/978-94-009-1802-3_11

Anuradha, D., & Manohar, H. L. (2011). Customer shopping experience in malls with entertainment centres in Chennai. *African Journal of Business Management*, *5*(31), 12319–12324. https://doi.org/10.5897/AJBM11.902

Atanassov, K. T. (1986). Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, *20*(1), 87–96. https://doi.org/10.1016/S0165-0114(86)80034-3

Atanassova, V., & Sotirov, S. (2012). A new formula for de-i-fuzzification of intuitionistic fuzzy sets. *Notes on Intuitionistic Fuzzy Sets*, *18*, 49–51.

Baker, J., Parasuraman, A., Grewal, D., & Voss, G. B. (2002). The influence of multiple store environment cues on perceived merchandise value and patronage intentions. *Journal of Marketing*, *66*(2), 120–141. https://doi.org/10.1509/jmkg.66.2.120.18470

Büyüközkan, G., Karabulut, Y., & Göçer, F. (2024). Spherical fuzzy sets based integrated DEMATEL, ANP, VIKOR approach and its application for renewable energy selection in Turkey. *Applied Soft Computing*, *158*, Article 111465. https://doi.org/10.1016/j.asoc.2024.111465

Cafiso, S., Graziano, A. D., & Pappalardo, G. (2013). Using the Delphi method to evaluate opinions of public transport managers on bus safety. *Safety Science*, *57*, 254–263. https://doi.org/10.1016/j.ssci.2013.03.001

Cheng, E. W. L., Li, H., & Yu, L. (2005). The analytic network process (ANP) approach to location selection: A shopping mall illustration. *Construction Innovation*, *5*(2), 83–97. https://doi.org/10.1108/14714170510815195

Cheng, E. W. L., Li, H., & Yu, L. (2007). A GIS approach to shopping mall location selection. *Building and Environment*, *42*, 884–892. https://doi.org/10.1016/j.buildenv.2005.10.010

Danacı, M., & Yıldırım, U. (2023). Comprehensive analysis of lifeboat accidents using the Fuzzy Delphi method. *Ocean Engineering*, *278*, Article 114371. https://doi.org/10.1016/j.oceaneng.2023.114371

Denecke, K., Romero, O. R., Petersen, C., Benham-Hutchins, M., Cabrer, M., Davies, S., Grainger, R., Hussein, R., Lopez-Campos, G., Martin-Sanchez, F., McKillop, M., Merolli, M., Miron-Shatz, T., Trigo, J. D., Wright, G., Wynn, R., Hullin, C., Cossio, L., & Gabarron, E. (2023). Defining and scoping participatory health informatics: An eDelphi study. *Methods of Information in Medicine*, *62*(03–04), 90–99. https://doi.org/10.1055/a-2035-3008

Dubihlela, D., & Dubihlela, J. (2014). Attributes of shopping mall image, customer satisfaction and mall patronage for selected shopping malls in Southern Gauteng, South Africa. *Journal of Economics and Behavioral Studies*, *6*(8), 682–689. https://doi.org/10.22610/jebs.v6i8.528

Eckert, A., He, Z., & West, D. S. (2013). An empirical examination of clustering and dispersion within Canadian shopping centers. *Journal of Retailing and Consumer Services*, *20*, 625–633. https://doi.org/10.1016/j.jretconser.2013.06.006

El-Adly, M. I. (2007). Shopping malls attractiveness: A segmentation approach. *International Journal of Retail & Distribution Management*, *35*(11), 936–950. https://doi.org/10.1108/09590550710828245

Finn, A., & Louviere, J. J. (1996). Shopping center image, consideration, and choice: Anchor store contribution. *Journal of Business Research*, *35*(3), 241–251. https://doi.org/10.1016/0148-2963(95)00129-8

Fouladgar, M. M., Yazdani-Chamzini, A., & Zavadskas, E. K. (2011). An integrated model for prioritizing strategies of the Iranian mining sector. *Technological and Economic Development of Economy*, *17*(3), 459–483. https://doi.org/10.3846/20294913.2011.603173

Fouladgar, M. M., Yazdani-Chamzini, A., Zavadskas, E. K., & Moini, S. H. H. (2012). A new hybrid model for evaluating the working strategies: Case study of construction company. *Technological and Economic Development of Economy*, *18*(1), 164–188. https://doi.org/10.3846/20294913.2012.667270

Frasquet, M., Gil, I., & Molla, A. (2001). Shopping-centre selection modelling: A segmentation approach. *The International Review of Retail, Distribution and Consumer Research*, *11*(1), 23–38. https://doi.org/10.1080/09593960122279

González-Hernández, E. M., & Orozco-Gómez, M. A. (2012). A segmentation study of Mexican consumers based on shopping centre attractiveness. *International Journal of Retail & Distribution Management*, *40*(10), 759–777. https://doi.org/10.1108/09590551211263173

Gudonaviciene, R., & Alijosiene, S. (2013). Influence of shopping centre image attributes on customer choices. *Economics and Management*, *18*(3), 545–552. https://doi.org/10.5755/j01.em.18.3.5132

Hanson, D., Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management: Competitiveness & globalisation* (6th Asia-Pacific ed.). Cengage Learning.

Havle, C. A., & Büyüközkan, G. (2023). Sustainable future technology evaluation with digital transformation perspective in air cargo industry using IF ANP method. In C. Kahraman, I. U. Sari, B. Oztaysi, S. Cebi, S. Cevik Onar, & A. Ç. Tolga (Eds.), *Lecture notes in networks and systems: Vol. 759. Intelligent and fuzzy systems* (pp. 389–397). Springer. https://doi.org/10.1007/978-3-031-39777-6_47

Ibrahim, M. F. (2002). Disaggregating the travel components in shopping centre choice. *Journal of Property Investment & Finance*, *20*(3), 277–294. https://doi.org/10.1108/14635780210433508

Jhamb, D., & Kiran, R. (2012). Emerging trends of organized retailing in India: A shared vision of consumers and retailers perspective. *Middle-East Journal of Scientific Research*, *11*(4), 481–490.

Kar, A. K. (2015). A hybrid group decision support system for supplier selection using analytic hierarchy process, fuzzy set theory and neural network. *Journal of Computational Science*, *6*, 23–33. https://doi.org/10.1016/j.jocs.2014.11.002

Karacan, I., Senvar, O., Arslan, O., Ekmekçi, Y., & Bulkan, S. (2020). A novel approach integrating intuitionistic fuzzy analytical hierarchy process and goal programming for chickpea cultivar selection under stress conditions. *Processes*, *8*(10), Article 1288. https://doi.org/10.3390/pr8101288

Klepek, M., & Bauerová, R. (2020). Why do retail customers hesitate for shopping grocery online? *Technological and Economic Development of Economy*, *26*(6), 1444–1462. https://doi.org/10.3846/tede.2020.13970

Li, D. F. (2014). Decision and game theory in management with intuitionistic fuzzy sets. In *Studies in fuzziness and soft computing* (Vol. 308). Springer-Verlag Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40712-3

Lin, S. H., Hsu, C. C., Zhong, T. Y., He, X. W., Li, J. H., Tzeng, G. H., & Hsieh, J. C. (2021). Exploring location determinants of Asia's unique beverage shops based on a hybrid MADM model. *International Journal of Strategic Property Management*, *25*(4), 291–315. https://doi.org/10.3846/ijspm.2021.14796

Louviere, J. J., & Meyer, R. J. (1981). A composite attitude-behavior model of traveler decision making. *Transportation Research Part B: Methodological*, *15*, 411–420. https://doi.org/10.1016/0191-2615(81)90025-4

Mas-Ruiz, F. J. (1999). Image of suburban shopping malls and two-stage versus uni-equational modelling of the retail trade attraction: An empirical application. *European Journal of Marketing*, *33*(5/6), 512–530. https://doi.org/10.1108/03090569910262071

Maury, B. (2018). Sustainable competitive advantage and profitability persistence: Sources versus outcomes for assessing advantage. *Journal of Business Research*, *84*, 100–113. https://doi.org/10.1016/j.jbusres.2017.10.051

Michon, R., Chebat, J. C., & Turley, L. W. (2005). Mall atmospherics: The interaction effects of the mall environment on shopping behavior. *Journal of Business Research*, *58*(5), 576–583. https://doi.org/10.1016/j.jbusres.2003.07.004

Mittal, A., & Jhamb, D. (2016). Determinants of shopping mall attractiveness: The Indian context. *Procedia Economics and Finance*, *37*, 386–390. https://doi.org/10.1016/S2212-5671(16)30141-1

Nalbant, K. G. (2024). A methodology for personnel selection in business development: An interval type 2-based fuzzy DEMATEL-ANP approach. *Heliyon*, *10*(1), Article e23698. https://doi.org/10.1016/j.heliyon.2023.e23698

Nasri, S. A., Ehsani, B., Hosseininezhad, S. J., & Safaie, N. (2023). A sustainable supplier selection method using integrated Fuzzy DEMATEL–ANP–DEA approach (case study: Petroleum industry). *Environment*, *Development and Sustainability*, *25*, 12791–12827. https://doi.org/10.1007/s10668-022-02590-2

Natarajan, E., Augustin, F., Saraswathy, R., Narayanamoorthy, S., Salahshour, S., Ahmadian, A., & Kang, D. (2024). A bipolar intuitionistic fuzzy decision-making model for selection of effective diagnosis method of tuberculosis. *Acta Tropica*, *252*, Article 107132. https://doi.org/10.1016/j.actatropica.2024.107132

Nevin, J. R., & Houston, M. J. (1980). Image as a component of attraction to intra-urban shopping areas. *Journal of Retailing*, *56*, 77–93.

Nordic Council of Shopping Centers. (2013, October). *Online retail – Threat or opportunity for shopping centers* (Annual Research – Report no. 1). https://ncscnordic.org/wp-content/uploads/2014/07/NCSC-report-2013_Online-Retail_lowENG.pdf

Onut, S., Efendigil, T., & Kara, S. S. (2010). A combined fuzzy MCDM approach for selecting shopping center site: An example from Istanbul, Turkey. *Expert Systems with Applications*, *37*, 1973–1980. https://doi.org/10.1016/j.eswa.2009.06.080

Oppewal, H., Timmermans, H. J. P., & Louviere, J. J. (1997). Modelling the effects of shopping centre size and store variety on consumer choice behavior. *Environment and Planning A*, *29*, 1073–1090. https://doi.org/10.1068/a291073

Parsons, S. (2001). *Qualitative methods for reasoning under uncertainty*. MIT. https://doi.org/10.7551/mitpress/5716.001.0001

Patel, V., & Sharma, M. (2009). Consumers' motivations to shop in shopping malls: A study of Indian shoppers. In S. Samu, R. Vaidyanathan, & D. Dipankar Chakravarti (Eds.), *AP - Asia-Pacific advances in consumer research* (Vol. 8, pp. 285–290). Association for Consumer Research.

Rajagopal, D. (2008). Growing shopping malls and behaviour of urban shoppers. *Journal of Retail* & *Leisure Property*, *8*(2), 99–118. https://doi.org/10.1057/rlp.2009.3

Reikli, M. (2012). *The key of success in shopping centers*, *composing elements of shopping centers and their strategic fit* (Ph.D. dissertation). Corvinus University of Budapest.

Rejeb, A., Rejeb, K., Keogh, J. G., & Zailani, S. (2022). Barriers to blockchain adoption in the circular economy: A Fuzzy Delphi and Best-Worst Approach. *Sustainability*, *14*(6), Article 3611. https://doi.org/10.3390/su14063611

Saaty, T. L. (2001). How to make a decision? In T. L. Saaty & L. G. Vargas (Eds.). *Models*, *methods*, *concepts and applications of the analytic hierarchy process* (Chap. 1, pp. 1–25). Kluwer. https://doi.org/10.1007/978-1-4615-1665-1_1

Sadiq, R., & Tesfamariam, S. (2009). Environmental decision-making under uncertainty using intuitionistic fuzzy analytic hierarchy process (IF-AHP). *Stochastic Environmental Research and Risk Assessment*, *23*, 75–91. https://doi.org/10.1007/s00477-007-0197-z

Severin, V., Louviere, J. J., & Finn, A. (2001). The stability of retail shopping choices over time and across countries. *Journal of Retailing*, *77*(2), 185–202. https://doi.org/10.1016/S0022-4359(01)00043-4

Shariati, Sh., Abedi, M., Saedi, A., Yazdani-Chamzini, A., Tamošaitienė, J., Šaparauskas, J., & Stupak, S. (2017). Critical factors of the application of nanotechnology in construction industry by using ANP technique under fuzzy intuitionistic environment. *Journal of Civil Engineering and Management*, *23*(7), 914–925. https://doi.org/10.3846/13923730.2017.1343202

Shariatmadari Serkani, E., Hosseinzadeh Lotfi, F., Najafi, E., & Ahadzadeh Namin, M. (2022). Efficiency measurement for hierarchical network systems using network DEA and intuitionistic fuzzy ANP. *Scientia Iranica*, *29*(4), 2252–2269.

Singh, H., & Sahay, V. (2012). Determinants of shopping experience. Exploring the mall shoppers of capital region (NCR) of India. *International Journal of Retail* & *Distribution Management*, *40*(3), 235–248. https://doi.org/10.1108/09590551211207184

Sit, J., Merrilees, B., & Birch, D. (2003). Entertainment seeking shopping centre patrons: The missing segments. *International Journal of Retail* & *Distribution Management*, *31*(2), 80–94. https://doi.org/10.1108/09590550310461985

Song, J., Jiang, L., Liu, Z., Leng, X., & He, Z. (2022). Selection of third-party reverse logistics service provider based on intuitionistic fuzzy multi-criteria decision making. *Systems*, *10*(5), Article 188. https://doi.org/10.3390/systems10050188

Stoltman, J. J., Gentry, J. W., & Anglin, K. A. (1991). Shopping choices: The case of mall choice. In R. H. Holman & M. R. Solomon (Eds.), *NA – Advances in consumer research* (Vol. 18, pp. 434–440). Association for Consumer Research.

Sun, B., Ma, W., & Qian, Y. (2017). Multigranulation fuzzy rough set over two universes and its application to decision making. *Knowledge-Based Systems*, *123*, 61–74. https://doi.org/10.1016/j.knosys.2017.01.036

Teller, C. (2008). Shopping streets versus shopping malls – Determinants of agglomeration format attractiveness from the consumers' point of view. *International Review of Retail*, *Distribution and Consumer Research*, *18*(4), 381–403. https://doi.org/10.1080/09593960802299452

Timmermans, H. (1982). Consumer choice of shopping centre: An information integration approach. *Regional Studies*, *16*(3), 171–182. https://doi.org/10.1080/09595238200185201

Verhoef, P. C., Lemon, K. N., Parasuraman, A., Roggeveen, A., Tsiros, M., & Schlesinger, L. A. (2009). Customer experience creation: Determinants, dynamics and management strategies. *Journal of Retailing*, *85*(1), 31–41. https://doi.org/10.1016/j.jretai.2008.11.001

Wakefield, K., & Baker, J. (1998). Excitement at the mall: Determinants and effects on shopping response. *Journal of Retailing*, *74*(4), 515–539. https://doi.org/10.1016/S0022-4359(99)80106-7

Wei, C., & Tang, X. (2011). An intuitionistic fuzzy group decision-making approach based on entropy and similarity measures. *International Journal of Information Technology* & *Decision Making*, *10*(6), 1111–1130. https://doi.org/10.1142/S0219622011004737

Wong, G. K. M., Lu, Y., & Yuan, L. L. (2001). SCATTR: An instrument for measuring shopping centre attractiveness. *International Journal of Retail* & *Distribution Management*, *29*(2), 76–86. https://doi.org/10.1108/09590550110381535

Wong, S. (2015). *Factors affecting the success of shopping centres in Hong Kong*. The University of Hong Kong. hub.hku.hk/bitstream/10722/221307/1/FullText.pdf?accept=1

Xu, Z., & Liao, H. (2014). Intuitionistic fuzzy analytic hierarchy process. *IEEE Transactions on Fuzzy Systems*, *22*(4), 749–761. https://doi.org/10.1109/TFUZZ.2013.2272585

Yazdani-Chamzini, A. (2014a). An integrated fuzzy multi criteria group decision making model for handling equipment selection. *Journal of Civil Engineering and Management*, *20*(5), 660–673. https://doi.org/10.3846/13923730.2013.802714

Yazdani-Chamzini, A. (2014b). Proposing a new methodology based on fuzzy logic for tunnelling risk assessment. *Journal of Civil Engineering and Management*, *20*(1), 82–94. https://doi.org/10.3846/13923730.2013.843583

Yazdani-Chamzini, A., & Yakhchali, S. H. (2012). Tunnel Boring Machine (TBM) selection using fuzzy multicriteria decision making methods. *Tunnelling and Underground Space Technology*, *30*, 194–204. https://doi.org/10.1016/j.tust.2012.02.021

Yilmaz, V. (2004). Consumer behavior in shopping center choice. *Social Behavior and Personality*, *32*(8), 783–790. https://doi.org/10.2224/sbp.2004.32.8.783

Yu, B., Yang, Z., & Cheng, C. (2007). Optimizing the distribution of shopping centers with parallel genetic algorithm. *Engineering Applications of Artificial Intelligence*, *20*(2), 215–223. https://doi.org/10.1016/j.engappai.2006.06.015

Zadeh, L. A. (1965). Fuzzy set. *Information and Control*, *8*(3), 338–353. https://doi.org/10.1016/S0019-9958(65)90241-X

Zhang, L., Zhou, J. T., Hui, E. C. M., & Wen, H. Z. (2019). The effects of a shopping mall on housing prices: A case study in Hangzhou. *International Journal of Strategic Property Management*, *23*(1), 65–80. https://doi.org/10.3846/ijspm.2019.6360

Zhang, Y., Wang, S., Liu, J., Liu, D., Li, T., & Wu, W. (2024). A corrosion assessment methodology based on triangular intuitionistic fuzzy comprehensive evaluation (TIFCE) with analytic network process (TIFANP): An application to external corrosion of the storage tank floor. *Expert Systems with Applications*, *238*, Article 121896. https://doi.org/10.1016/j.eswa.2023.121896

Zhu, M., Zhou, W., Hu, M., Du, J., & Yuan, T. (2023). Evaluating the renewal degree for expressway regeneration projects based on a model integrating the fuzzy Delphi method, the fuzzy AHP method, and the TOPSIS method. *Sustainability*, *15*(4), Article 3769. https://doi.org/10.3390/su15043769

Zolfani, S. H., Aghdaie, M. H., Derakhti, A., Zavadskas, E. K., & Varzandeh, M. H. M. (2013). Decision making on business issues with foresight perspective; An application of new hybrid MCDM model in shopping mall locating. *Expert Systems with Applications*, *40*(17), 7111–7121. https://doi.org/10.1016/j.eswa.2013.06.040