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A new hybrid method for prioritizing Investment Options in the Holding Companies

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Abstract

One of the most fundamental economic issues for holding companies is capital allocation. Typically, investors in selecting investment alternatives follow conflicting preferences and goals simultaneously. Therefore, developing a model based on available information can help decision makers to identify the most important competitive factors and focus their attention on the improvement of performance. However, several techniques have been introduced to determine the most important components. Analytical hierarchy process (AHP), a branch of multi criteria decision making (MCDM) methods, is a powerful tool for ranking a set of elements. Nevertheless, the AHP is disable to take into account the uncertainty involved in the process of decision making. On the other hand, intuitionistic fuzzy sets (IFS) are capable of handling the vagueness and ambiguity by using the scale of the pairwise comparisons represented by the IFS. The IFS-AHP (a combination of the IFS and AHP method) can lead to more precise description of the problem under consideration since the IFS is robust in describing complexity and uncertainty. Therefore, the IFS-AHP technique has much more advantages in comparison with the conventional AHP or fuzzy AHP. To demonstrate the potential application of the proposed approach, a real case study on ranking the critical factors influencing the Investment Options in the Holding Companies is illustrated. The results show that criterion C6 (Risk) with value of 0.1451 is the most important factor in Holding Companies.

Keywords: IFS, AHP, Holding Companies, MCDM.

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Introduction

One of the most fundamental economic issues for holding companies is resource allocation and capital is one of the important resources (Jiang et al., 2015). Although the capital is a necessary condition but not a sufficient condition for economic profitability and investment can return the cost of production stage and guarantee economic growth and development (Thijssen, 2015). Therefore, the problem of the best alternative (option) for investment is created and then the concept of prioritizing investment options is used by investors (Li et al., 2015). Typically, investors in selecting investment alternatives follow conflicting preferences and goals such as performance, risk, liquidity, liquidity ratios, financial constraints, market share, industry risk factor, and others; simultaneously. Accordingly, selection the better alternative for investment, is one of the most important issues in financial literature that follows maximizing the efficiency (return) and minimizing the investment risk with respect to other preferences (Clausen & Flor, 2015). Various methods such as random control models, multi-objectives programming models, discrimination analysis, neural networks and optimization models are presented to solve the problems of optimal portfolio selection and prioritization of investment options by various researchers. In recent years, some models like the rankings by assessing available alternatives have been introduced as benchmarking and portfolios and investment alternatives evaluation models that can be used for solving the problem. The problems with choosing the right investment alternative and the existence of multiple and contradictory standards, indicate positions of decision that have not been described in traditional literature clearly and requires the use of non-classical methods of investment such as multi criteria planning model (Anvari Rostami and Tabata, 1998, Yanhong Ma et al., 2016). So, this article attempts to consider criteria for prioritizing investment alternatives, investigate the impact of these criteria in addition to conventional measures of investment risk and return, in the process of selecting the appropriate alternative. If the effect of these criteria is significance, they could be used for selection the preferred alternative. In fact, the aim of this study is to investigate the issue that whether by taking into account various criteria can achieve better investment alternatives or not? Or whether it can be concluded that the holding companies to capitalize on their investment alternatives, should also consider another effective criterion in addition to common criteria? Although several techniques have been developed to formulate prioritizing the Investment Options in the Holding Companies with maximum profitability, multi criteria decision making methods (MCDM) are the well-known techniques for prioritizing components under a complex and sophisticated environment. Analytical hierarchy process (AHP) is an MCDM method that employed a mathematical approach to solve a decision making problem by converting a complicated problem into simple and understandable structures. This technique is capable of processing the subjective and personal preferences of an individual or a group in decision-making (Saaty, 2001). The AHP method employs a pairwise comparison process to obtain the relative importance of two selected criteria. The levels of the comparisons can change from one to nine, in which 1 indicates that two criteria are equally important, while 9 represents that one criterion is absolutely more important than the other (Sadiq & Tesfamariam, 2009). However, uncertainty is an inevitable component of any decision-making process (Sadiq & Tesfamariam, 2009). The definition of uncertainty in management and science is different and diverse (Parsons, 2001). However, the source of the uncertainty is two areas: (i) uncertainty in subjective judgments (i.e. experts may not be 100% sure when making subjective judgments) and (ii) uncertainty due to lack of data or incomplete information (i.e. sometimes information of some attributes may not be fully available or even not available at all).

Intuitionistic fuzzy set (IFS) is a proper tool for solving a decision problem in the existence of the uncertainty. The intuitionistic fuzzy set is a successful generalization of the fuzzy set (Li, 2014). This technique is capable of formulating a sophisticated phenomenon when the other conventional techniques are disable to model the problem under consideration. Therefore, a combination of the IFS and AHP tools is adopted to rank the critical factors of the Investment in the Holding Companies. The overarching aim of the paper is twofold: (i) to identify and strengthen the components that can improve the sale opportunities in order to gain a better result and (ii) to help investors and property developers to understand the Investment Options in the Holding Companies. The remainder of the paper is organized as follows. A briefly discussion on intuitionistic fuzzy AHP is presented in Section 2, including the intuitionistic fuzzy set (IFS), AHP, and a combination approach. The proposed model is illustrated in Section 3. Finally, in the last section, the conclusions are described.

Literature Review

According to today's complex and competitive world, organizations and companies need to create focused and integrated system by which all proposed investment projects can be evaluated, prioritized and chosen (Yanhong Ma et al., 2016). In fact, the administration of holding companies has created special challenges for their managers. One of the biggest challenges is that conscious investment is complex due to the deal with different levels of risk, differences in the use of resources and interaction between investment proposed alternatives (Bidgoli and Saranj, 2008). In other words, the problem is that it is not possible to select and manage an alternative that is optimal in terms of all criteria. Thus, financial decision makers should consider different criteria in order to obtain optimal investment alternative and prioritize alternatives (Bai, 2016). According to the above-mentioned problems and challenges in the field, implementation of this research will be applied and absolutely necessary. Since the answers of proposed model will be determined based on careful attention to the preferences structure of decision-makers and their criteria and targets, the utility of investment holding companies will be maximized if model runs. Also, the existing gap and difference will provide the solutions and moderator actions in available portfolio and change it into optimal portfolio. This study seeks to prioritize investment alternatives of holding companies and therefore can offer results and offers for asset management at the macro level of these holding companies. Importance of attention to the decision base, prioritizing criteria and indicators and determine their importance in holding companies' investment management is because in these institutions and organizations, achieving optimum performance results depends on the management of investment alternatives in a clever manner. Evaluating investment alternatives and ranking of them is important because holding companies can have the best performance by investing at due time. It is natural that potential investors are looking for investment alternatives that have outperformed the other market alternatives. Also, study and research on assess the alternatives available to invest can be a step toward encouraging more investment; because one of the barriers is the investment risk. Various studies with different approaches have addressed the issue of prioritizing investment alternatives that some are as follows:

Mokhtari et al (1395) studied on prioritizing investment alternatives in the service sector using Fuzzy TOPSIS's decision making method. The researchers used TOPSIS method based on the combination of fuzzy concepts used fuzzy theory for combining the views of experts and decision-makers and performance evaluation of qualitative criteria that were expressed in form of triangular fuzzy numbers. The results of their study showed that the financial and insurance services sector, has achieved the first priority investments among the service sectors.

Asgharizadeh and Haj Zavvar (2011) analyzed the post- optimally of ranking the factors influencing investment decisions in companies listed on Tehran Stock Exchange. The researchers identified the factors influencing investment decisions at first, and then using the Topsis technique concluded that indicators of earnings per share, dividend per share, increased production and covered financial costs are sensitive indicators.

vadiei and Shokouhi zadeh M. (2012) study the financial measures affecting investment decisions in Tehran's Stock Exchange. In this study, the Student t test, Krucsal Wallis, chi-square, Fisher, Wilcoxon and Friedman tests were used which suggest that Financial measures affect investment decisions and factors such as speed and power of stock liquidity, the stock price trend and conditions of the stock market are the top rated factors that influence the decision.

Chen (2008), using multi-objective planning, established a new model for portfolio selection that can compromise between risk and return according to the preference of investors. Researcher used data on 10 stocks to experimental test of his model. The results of the study indicate the potential of new model for solving the problems of the traditional model of portfolio selection. In that study, credibility and validity of the created model was confirmed.

Chang and Lee (2012) in an article examined selecting appropriate portfolio of projects. They focused on solving the problem of organizations limits in application of capital resources. Therefore, to solve the problem used a model based on data envelopment analysis and fuzzy set theory.

Intuitionistic fuzzy set

Fuzzy set theory, first introduced by Zadeh (1965), is developed to cope with the uncertainty involved in the process of decision making. However, a fuzzy set simultaneously define the two states of the support and opposition by using a single index (membership function). In other words, the membership degree of supporting some proposition x is $\mu(x)$, then the membership degree of opposing the proposition x is just equal to the complement to 1, i.e., $1-\mu(x)$ (Li, 2014). Therefore, the neutral state cannot be described by a fuzzy set. To overcome the problem, the philosophy of an intuitionistic fuzzy set is firstly introduced by Atanassov (1986). In the concept of an intuitionistic fuzzy set, a set is simultaneously represented by three states of the support, opposition, and neutrality. This set employs membership and non-membership degrees to define a vagueness. Hence, the intuitionistic set can be more adapted for facing with real-world problems where the uncertainty is influenced by hesitancy degree. The intuitionistic fuzzy set A in E is mathematically described as follows:

$$A=\{\langle x,\mu_A(x),\upsilon_A(x)\rangle \mid x\in E\} \tag{1}$$

Where there are two mapping on the set A:

$$\mu_A : E \to [0,1] \tag{2}$$

and

$$\upsilon_A : E \to [0,1] \tag{3}$$

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

$$0 \le \mu_A(x)+\upsilon_A(x) \le 1 \tag{4}$$

An intuitionistic fuzzy set can be defined as:

$$A=\{\langle x,\mu_A(x),1-\mu_A(x)\rangle \mid x\in E\} \tag{5}$$

The following relations and operations can be defined for two intuitionistic fuzzy sets A and B:

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

$$A \supset B \text{ if and only if } B \subset A \tag{7}$$

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

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

$$A \cap B = \left\{ \langle x, \min(\mu_A(x), \mu_B(x)), \max(\upsilon_A(x), \upsilon_B(x)) \rangle \middle| x \in E \right\} \tag{10}$$

$$A \cup B = \left\{ \langle x, \max(\mu_A(x), \mu_B(x)), \min(\upsilon_A(x), \upsilon_B(x)) \rangle \middle| x \in E \right\} \tag{11}$$

$$A + B = \left\{ \langle x, \mu_A(x) + \mu_B(x) - \mu_A(x).\mu_B(x), \upsilon_A(x).\upsilon_B(x) \rangle \middle| x \in E \right\} \tag{12}$$

$$A.B = \left\{ \langle x, \mu_A(x).\mu_B(x), \upsilon_A(x) + \upsilon_B(x) - \upsilon_A(x).\upsilon_B(x) \rangle \middle| x \in E \right\} \tag{13}$$

Intuitionistic fuzzy AHP

Decision makers usually prefer linguistic values to show how much a criterion is more important than another one. A linguistic phrase is a variable whose value is determined as a fuzzy membership function for facing with unknown situations to appropriately describe a phenomenon in a traditional way. The relative importance of each criterion may be defined by the pair comparison procedure employed in the framework of an AHP analysis. This assessment can be transferred into corresponding intuitionistic fuzzy numbers.

The procedure of the IF-AHP technique contains of four steps:

Step 1. The decision group are asked to make the pair-wise comparisons by using the standard scale.

Step 2. The importance weights of criteria are determined. In this step, the importance of the decision makers is assigned. Assume that $D_l = \left[\mu_l, \upsilon_l, \pi_l\right]$ is an intuitionistic fuzzy number for rating of *k*th decision maker; then, the weight of *l*th decision maker can be obtained by using the following equation:

$$\lambda_l = \frac{\mu_l + \pi_l \left(\frac{\mu_l}{\mu_l + \upsilon_l} \right)}{\sum_{l=1}^{k} \left[\mu_l + \pi_l \left(\frac{\mu_l}{\mu_l + \upsilon_l} \right) \right]} \tag{14}$$

where

$$\lambda_l \in [0,1] \tag{15}$$

and

$$\sum_{l=1}^{k} \lambda_l = 1 \tag{16}$$

Step 3. Group decision matrix based on intuitionistic fuzzy numbers is determined. The aggregated intuitionistic fuzzy decision matrix is obtained by employing the intuitionistic fuzzy weighted averaging operator (Xu, 2007). Based on the process of group decision making, all the individual matrices are transferred into a group matrix.

Let $R^{(l)} = (r_{ij}^{(l)})_{m \times n}$ be an intuitionistic fuzzy decision matrix of each decision maker and $\lambda = \left\{ \lambda_1, \lambda_2, ..., \lambda_k \right\}$ be the vector weight of decision makers; then,

$$R = \left(r_{ij} \right)_{m \times n} \tag{17}$$

Where:

$$r_{ij} = IFWA_{\lambda}(r_{ij}^{(1)}, r_{ij}^{(2)}, \ldots, r_{ij}^{(l)}) = \lambda_1 r_{ij}^{(1)} \oplus \lambda_2 r_{ij}^{(2)} \oplus \ldots \oplus \lambda_k r_{ij}^{(k)} = \tag{18}$$

$$= \left[1 - \prod_{l=1}^{k} (1-\mu_{ij}^{(l)})^{\lambda_l}, \prod_{l=1}^{k} (\upsilon_{ij}^{(l)})^{\lambda_l}, \prod_{l=1}^{k} (1-\mu_{ij}^{(l)})^{\lambda_l} - \prod_{l=1}^{k} (\upsilon_{ij}^{(l)})^{\lambda_l} \right]$$

If same weights for decision makers is considered; then the intuitionistic fuzzy weighted averaging operator reduces to an intuitionistic fuzzy averaging operator (Xu & Cai, 2012).

$$IFA(\alpha_1, \alpha_2, \ldots, \alpha_n) = \frac{1}{n}(\alpha_1 \oplus \alpha_2 \oplus \ldots \oplus \alpha_n) \tag{19}$$

Step 4. The importance weight of each criterion is calculated. The final step of the IF-AHP process is to calculate the final weight of criteria for the purpose of ranking. For any intuitionistic fuzzy number $\alpha = (\mu_\alpha, \upsilon_\alpha, \pi_\alpha)$, the score $s(\alpha)$ can be calculated by the score function proposed by Chen and Tan (1994) as follows:

$$s(\alpha) = \mu_\alpha - \upsilon_\alpha \tag{20}$$

The proposed approach

A step-by-step procedure based on the IF-AHP process for calculating the importance weights of the evaluation criteria is depicted in Fig. 1. From the figure, it can be obvious that the procedure of solving a decision making problem contains of six steps. In the first step, linguistic variables are defined by the expert team as presented in Table 1. From the table, the AHP rating and corresponding intuitionistic fuzzy numbers and reciprocal intuitionistic fuzzy numbers are provided.

In the second step, after constructing the hierarchical structure, the pairwise comparisons by using intuitionistic fuzzy judgment matrix is made. For example, for making a pairwise (two-by-two) comparison between the first criterion (C1) and the second criterion (C2) with respect to the overall goal, a decision maker determines a strong important (Table 1). This means that C1 is five times more important than C2. Like the AHP method, using a crisp value of 5, the IF-AHP technique employs an intuitionistic fuzzy number expressed by three values (0.70, 0.20, 0.10) to calculate the relative weights of the criteria.

In the third step, the intuitionistic fuzzy comparison matrix of each decision maker is fused into a group comparison matrix by using the aggregation process given in Eq. 17. In the next step, the aggregated matrix is converted into the overall aggregated matrix by the arithmetic averaging process. In the fifth step, the weights of criteria are obtained by using the entropy approach presented in the following equations:

$$w_i = \frac{1-\bar{\bar{w}}_i}{n-\sum_{j=1}^{n}\bar{\bar{w}}_i} \qquad (21)$$

Where:

$$\sum_{j=1}^{n} w_i = 1 \qquad (22)$$

and

$$\bar{\bar{w}}_i = -\frac{1}{n\ln 2}\left[\mu_i \ln\mu_i + \upsilon_i \ln\upsilon_i - (1-\pi_i)\ln(1-\pi_i) - \pi_i \ln 2\right] \qquad (23)$$

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

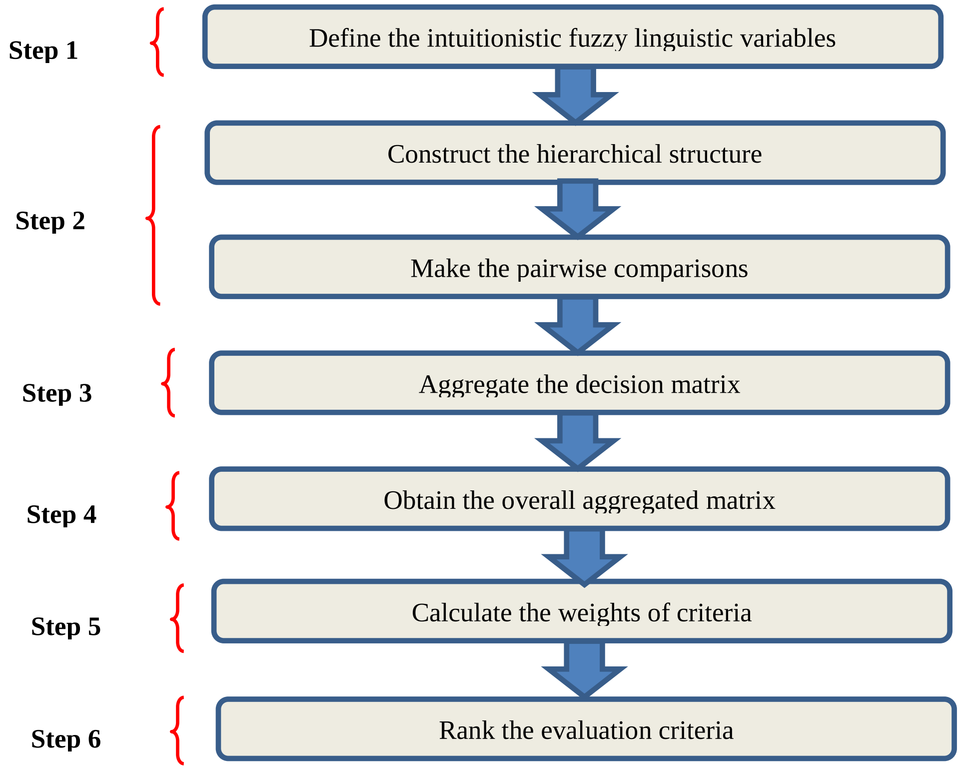

Fig. 1. The proposed approach

In the last step, the criteria are ranked based on their final relative weights.

Table 1. Linguistic variables and corresponding intuitionistic fuzzy function

Preference on pair wise comparison	AHP rating	Intuitionistic fuzzy numbers	Reciprocal intuitionistic fuzzy numbers
Equally important	1	(0.50, 0.50, 0.0)	(0.50, 0.50, 0.0)
Intermediate value	2	(0.55, 0.40, 0.05)	(0.40, 0.55, 0.05)
Moderately more important	3	(0.60, 0.30, 0.10)	(0.30, 0.60, 0.10)
Intermediate value	4	(0.65, 0.25, 0.10)	(0.25, 0.65, 0.10)
Strongly more important	5	(0.70, 0.20, 0.10)	(0.20, 0.70, 0.10)
Intermediate value	6	(0.75, 0.15, 0.10)	(0.15, 0.75, 0.10)
Very strong more important	7	(0.80, 0.10, 0.10)	(0.10, 0.8, 0.10)
Intermediate value	8	(0.90, 0.05, 0.05)	(0.05, 0.90, 0.05)
Extremely more important	9	(1.0, 0.0, 0.0)	(0.0, 1.0, 0.0)

A case study

This case study is illustrated to explain the application of the IFS-AHP method in prioritizing the critical factors of the Investment Options in the Holding Companies. As previously aforementioned, the IFS-AHP approach is a proper and powerful tool in solving the decision making problems with quantitative and qualitative criteria under a sophisticated and uncertainty environment. In this study, nine decision makers, including senior managers, financial managers, and technical managers with a professional background in the field of Investing, are asked to evaluate the critical factors. The computational procedure is summarized in the following steps.

In the first part of the study, the most important factors for evaluating the Investment Options in the Holding Companies are examined. A literature review process is fulfilled to extract the most important criteria. Finally, seven criteria are adopted for the process of evaluation.

Before data collection, a conceptual model should be developed for an MCDM issue. The conceptual model plays the most significant role in model development of the IFS-AHP. This model outlines all subsequent works for solving the decision problem (as shown in Fig. 1).

Firstly, the definition of a decision problem is presented in the first step. The main goal of the problem is to rank the evaluation criteria. Then, as previously mentioned, only highly predictive criteria are employed (Louviere and Meyer, 1981). The hierarchy structure is constructed as depicted in Fig.2.

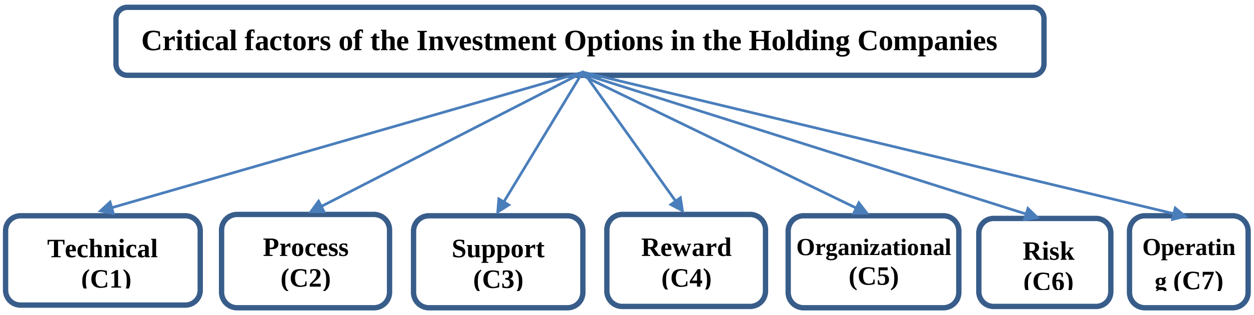

Fig. 2. The hierarchy structure

Then, a questionnaire based on the IFS-AHP is designed to obtain the pairwise comparison matrix. Next, the pairwise comparisons are made by using the intuitionistic fuzzy judgment matrix given in Table 1. A sample of the questionnaire filled by one of the experts is presented in Table 2.

Table 2. A sample of the questionnaire filled by one of the experts

	C1	C2	C3	C4	C5	C6	C7
C1	(0.5,0.5,0)	(0.55,0.4,0.05)	(0.6,0.3,0.1)	(0.5,0.5,0)	(0.55,0.4,0.05)	(0.25,0.65,0.1)	(0.25,0.65,0.1)
C2	(0.4,0.55,0.05)	(0.5,0.5,0)	(0.5,0.5,0)	(0.3,0.6,0.1)	(0.55,0.4,0.05)	(0.15,0.75,0.1)	(0.2,0.7,0.1)
C3	(0.3,0.6,0.1)	(0.5,0.5,0)	(0.5,0.5,0)	(0.2,0.7,0.1)	(0.4,0.55,0.05)	(0.1,0.8,0.1)	(0.25,0.65,0.1)
C4	(0.5,0.5,0)	(0.6,0.3,0.1)	(0.7,0.2,0.1)	(0.5,0.5,0)	(0.6,0.3,0.1)	(0.25,0.65,0.1)	(0.3,0.6,0.1)
C5	(0.4,0.55,0.05)	(0.4,0.55,0.05)	(0.55,0.4,0.05)	(0.3,0.6,0.1)	(0.5,0.5,0)	(0.2,0.7,0.1)	(0.3,0.6,0.1)
C6	(0.65,0.25,0.1)	(0.75,0.15,0.1)	(0.8,0.1,0.1)	(0.65,0.25,0.1)	(0.7,0.2,0.1)	(0.5,0.5,0)	(0.55,0.4,0.05)
C7	(0.65,0.25,0.1)	(0.7,0.2,0.1)	(0.65,0.25,0.1)	(0.6,0.3,0.1)	(0.6,0.3,0.1)	(0.4,0.55,0.05)	(0.5,0.5,0)

In the third step, the group comparison matrix is obtained by fusing the individual comparison matrices. In this paper, the decision makers have same importance; so that, Eq. (19) is applied to calculate the aggregated matrix. The aggregated matrix is presented in Table 3.

Table 3. The aggregated matrix

	C1	C2	C3	C4	C5	C6	C7
C1	**(0.5,0.5,0)**	**(0.45,0.49,0.05)**	**(0.58,0.33,0.09)**	**(0.5,0.48,0.02)**	**(0.54,0.41,0.05)**	**(0.24,0.65,0.1)**	**(0.26,0.64,0.1)**
C2	**(0.5,0.44,0.05)**	**(0.5,0.5,0)**	**(0.47,0.49,0.03)**	**(0.31,0.6,0.09)**	**(0.52,0.43,0.05)**	**(0.16,0.74,0.1)**	**(0.29,0.62,0.09)**
C3	**(0.34,0.57,0.09)**	**(0.51,0.46,0.04)**	**(0.5,0.5,0)**	**(0.24,0.65,0.1)**	**(0.4,0.54,0.05)**	**(0.2,0.7,0.1)**	**(0.22,0.68,0.1)**
C4	**(0.49,0.5,02)**	**(0.6,0.3,0.1)**	**(0.66,0.24,0.1)**	**(0.5,0.5,0)**	**(0.59,0.32,0.09)**	**(0.27,0.64,0.09)**	**(0.3,0.61,0.09)**
C5	**(0.42,0.53,0.05)**	**(0.44,0.51,0.05)**	**(0.56,0.38,0.06)**	**(0.32,0.59,0.09)**	**(0.5,0.5,0)**	**(0.25,0.65,0.1)**	**(0.32,0.59,0.09)**
C6	**(0.66,0.24,0.1)**	**(0.74,0.15,0.1)**	**(0.78,0.12,0.1)**	**(0.64,0.26,0.1)**	**(0.65,0.25,0.1)**	**(0.5,0.5,0)**	**(0.51,0.44,0.05)**
C7	**(0.64,0.26,0.1)**	**(0.63,0.28,0.09)**	**(0.68,0.21,0.1)**	**(0.61,0.29,0.1)**	**(0.6,0.31,0.09)**	**(0.47,0.49,0.04)**	**(0.5,0.5,0)**

Then, the overall aggregated matrix is obtained by the arithmetic averaging process. The overall aggregated matrix is presented in Table 4.

Table 4. The overall aggregated matrix

C1	**(0.45,0.49,0.06)**
C2	**(0.41,0.54,0.06)**
C3	**(0.36,0.58,0.06)**
C4	**(0.50,0.42,0.08)**
C5	**(0.41,0.53,0.06)**
C6	**(0.65,0.25,0.09)**
C7	**(0.59,0.32,0.08)**

In the next step, the weights of criteria are calculated by using the entropy approach. The results of the entropy approach are listed in Table 5. Finally, the evaluation criteria are ranked based on their weights as shown in the last column of Table 5. For better understanding, Fig. 3 schematically shows the relative weight of the evaluation criteria. The results demonstrate that criterion C6 (Risk) with value of 0.1451 is the most important factor in the Investment Options in the Holding Companies.

Table 5. The final weight of criteria

	Weight	Rank
C1	**0.1420**	**7**
C2	**0.1423**	**4**
C3	**0.1429**	**3**
C4	**0.1421**	**6**
C5	**0.1422**	**5**

C6	0.1451	1
C7	0.1434	2

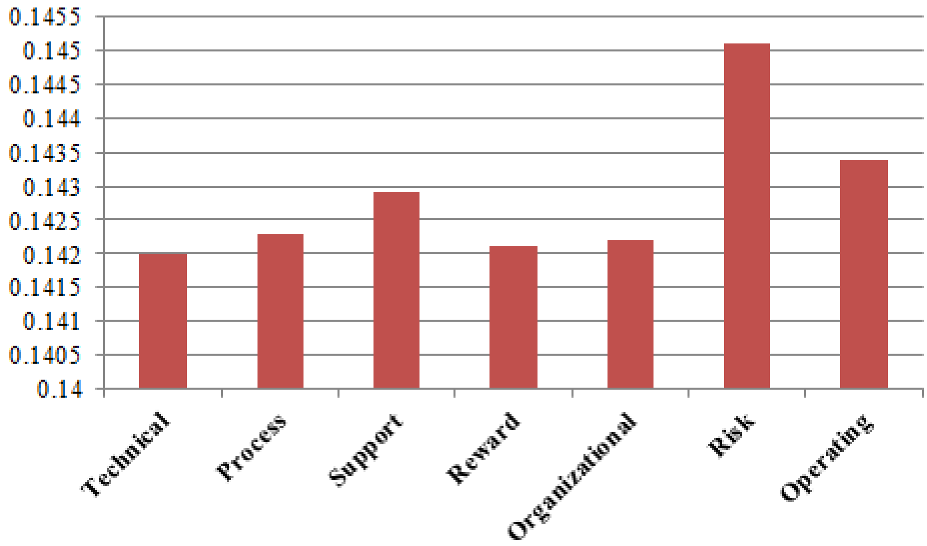

Fig. 3. The relative weight of criteria

Conclusion

Typically, investors in selecting investment alternatives follow conflicting preferences and goals simultaneously. Therefore, it is necessary to find the most importance parameters that affect the Investment Options in the Holding Companies. However, several techniques have been developed for prioritizing the effective criteria. The AHP technique is one of the most popular MCDM tools for ranking a set of elements. This method is inherently a subjective process, including uncertainty in the evaluation process that can affect the process of decision-making. On the other hand, the intuitionistic fuzzy systems are capable of handling the vagueness and uncertainty involved in the process of decision making. The combination of the intuitionistic fuzzy sets (IFS) and the AHP technique can help an authority to make more realistic and accurate decisions by using linguistic values instead of crisp ones. The IFS-AHP technique employs pairwise comparisons to establish the decision matrix. The proposed approach is developed for ranking the criteria influencing the Investment Options in the Holding Companies to show the potential application of the proposed approach. The output of the proposed approach shows that criterion C6 (Risk) is the most important factor in the Investment Options in the Holding Companies. The results demonstrate that the proposed approach can fix the uncertainty involved in the process of decision making. In comparison with the IFS-AHP, the scale employed in the fuzzy AHP and conventional AHP techniques cannot reflect the perceptions of the decision maker accurately. However, further research is needed to show how the results can vary with degrees of belief.

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یک روش ترکیبی جدید برای اولویت بندی گزینه های سرمایه گذاری در شرکت های هلدینگ

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یکی از اساسی ترین مسائل اقتصادی برای شرکت های هلدینگ، تخصیص سرمایه است. به طور معمول، سرمایه گذاران در انتخاب گزینه های سرمایه گذاری، به طور همزمان با ترجیحات و اهداف متضادی روبرو هستند. بنابراین، توسعه یک مدل مبتنی بر اطلاعات موجود می تواند به تصمیم گیرندگان برای شناسایی مهم ترین عوامل رقابتی و تمرکز بر بهبود عملکرد کمک کند. با این وجود، چندین تکنیک برای تعیین مهمترین بخش ها معرفی شده است. فرایند تحلیل سلسله مراتبی (AHP)، شاخه ای از روش های تصمیم گیری چند معیاره (MCDM)، ابزار قدرتمندی برای رتبه بندی مجموعه ای از عناصر است. AHP در بررسی عدم قطعیت فرایند تصمیم گیری ناتوان است. از سوی دیگر، مجموعه های فازی شهودی (IFS) با استفاده از مقیاس مقایسه های زوجی که توسط IFS نشان داده می شود، قادر به اداره ابهام می باشد. IFS-AHP (ترکیبی از روش IFS و AHP) می تواند به توصیف دقیق تر مشکل بپردازد، زیرا IFS در توصیف پیچیدگی و عدم قطعیت کاربردی تر است. بنابراین، استفاده از تکنیک IFS-AHP در مقایسه با AHP یا AHP فازی دارای مزایای بسیار بیشتری است. برای نشان دادن کاربرد بالقوه رویکرد پیشنهادی، یک مطالعه موردی واقعی در مورد رتبه بندی عوامل مؤثر بر گزینه های سرمایه گذاری در شرکت های هلدینگ شرح داده شده است. نتایج نشان می دهد که معیار C6 (ریسک) با مقدار ۰,۱٤٥۱ مهم ترین عامل در سرمایه گذاری شرکت های هلدینگ است.

واژگان کلیدی: مجموعه های فازی شهودی، فرایند تحلیل سلسله مراتبی، شرکت های هلدینگ، تصمیم گیری چند معیاره

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