FUZZY OPTIMIZATION AND MODELLING MODELLING 3(4) (2023) 9-16

E-ISNN: 2676-7007

Contents lists available at FOMJ

Fuzzy Optimization and Modelling

Journal homepage: http://fomj.qaemiau.ac.ir/

Paper Type: Research Paper

Choosing the Best Company for Investment according to the Financial Factors in the Neutrosophic Environment (Case Study: Automotive Industry)

Mohsen Imeni [a,*], Bardia Pouresmaeil Motlagh [a], Faezeh Pirouz [b], Azadeh Shemshad [c]

[a] *Department of Accounting, Ayandegan Institute of Higher Education, Tonekabon, Iran.*
[b] *Department of Accounting, Tohid Girls College, Amol, Iran.*
[c] *Department of Accounting and Control, Erasmus University, Rotterdam, Netherlands.*

ARTICLE INFO

Article history:
Received 29 October 2022
Revised 24 December 2022
Accepted 30 December 2022
Available online 30 December 2022

Keywords:
SVNS
Neutrosophic Sets
Similarity Measure
Financial Ratio

ABSTRACT

The analysis of financial ratios is one of the methods of examining the state of companies, which expresses the relationships between the items in the financial statements. The study of financial ratios helps us to get a comprehensive and correct understanding of the performance and financial status of companies and to benefit from them when investing and checking the efficiency of companies. Since many current phenomena in finance and the economy are ambiguous, they are treated as if they are clear, so this article, using Neutrosophic, examines the selection of a company for investment using financial ratios in the Neutrosophic environment. Where verbal judgments (qualitatively) are used for decision-making, the proposed approach will perform better than previous approaches. To rank the options in this research, eight financial ratios widely used in investment analysis are considered indicators of the problem. Then, ranking the alternatives is done by defining the ideal option (with the best performance in all indicators) and applying the known criterion of similarity. A numerical example is operated to understand the proposed approach better, and the results are presented.

1. Introduction

The higher returns of the stock market in the past long periods compared to other markets have made this market one of the suitable investment options [25]. Analysis of financial statements can be used to evaluate the performance and predict the future of companies [11]. There are different approaches to achieving this goal [16, 36]. Some believe that horizontal and vertical analyzes of financial statements depict a definite trend in a company's financial situation and provide appropriate information about the activities of the company in question [13]. Another approach is to use financial statements for short-term and long-term evaluations of a company's situation, which is critical to focus on parts of the financial statements according to each type of evaluation [18, 38].

* Correspondig author
E-mail address: *mohsen.imeni86@yahoo.com* (Mohsen Imeni)

DOI: 10.30495/fomj.2023.1971807.1081

For this reason, a different category can be assigned to the analysis of financial statements [20, 28]. Using financial ratio analysis techniques, a better understanding of the financial situation of companies can be obtained. Usually, the calculation of financial ratios is straightforward, but the analysis of these ratios is essential [8, 22]. Analyzing financial statements using some ratios is actually an effort to evaluate the strengths and weaknesses of a company by examining the figures stated in the reports. Some ratios may be used more according to the view and interests of CEOs of companies [14].

But it should be noted that when a particular ratio is calculated, this ratio is related to other ratios of the company in question. In addition, it was compared to the same ratio last year and with similar ratios in competing companies [29]. These comparisons show the trend of the company's situation during different periods as well as the strength of the company's competition with other companies in its industry. Therefore, investors need to choose the right investment company, and financial ratios can help investors in this matter [10]. Considering various criteria, the public center has to select the best alternative concerning uncertainty [24]. In the MCDM context, the ratings of the options provided by decision-makers can be expressed with the Fuzzy Set theory [15, 33].

Fuzzy sets theory has been widely and successfully applied in many different areas to handle such uncertainty [35]. Nevertheless, it presents limitations to dealing with imprecise and vague information when various sources of vagueness appear simultaneously [23]. Atanassov mentioned that there should be a degree of non-membership (ν) in addition to membership function (μ) in fuzzy sets. Such sets are called intuitionistic fuzzy sets (IFSs) [2]. Intuitionistic fuzzy sets can only handle incomplete information, not indeterminate information, and inconsistent information, which exists commonly in belief systems [37]. Smarandache [30, 41] germinated the notion of having a neutrosophic set (NS) holding three different fundamental elements (i) truth, (ii) indeterminate, and (iii) falsity. Each attribute of the neutrosophic sets is relevant to our real-life models [6]. The most exciting point is that all these three functions are entirely independent, and one function is not affected by another [30]. These NSs can handle indeterminate and inconsistent information quite well, whereas IFSs and FSs can only handle incomplete or partial information [27].

Since NSs are difficult to apply in real engineering problems and scientific applications, a subclass of NS has been proposed by Wang et al. [37]. These sets are called single-valued neutrosophic sets. SVNSs are well suited for handling ambiguous, incomplete, imprecise information [21]. Since its appearance and the ability to tackle the indeterminacy at the initial stage of data, SVNS is one of the hot topics to tackle the DMPs [12]. SVNS is one of the most favorable environments to access the alternatives [7]. Ratings of criteria of decision problems can be expressed using linguistic variables that can be transformed into SVNNs [1].

Moreover, many information measures for the SVNS model have been proposed over the years, such as similarity, distance, entropy, inclusion, and correlation coefficients [5]. Many scholars and researchers have continuously proposed new similarity measures for fuzzy-based models, including the SVNS model, and applied these measures to solve various practical problems related to MCDM [24]. In some real applications and related fields, the researcher uses similarity measure, an important mathematical tool [7].

In many cases, the closeness of judgments (data) related to different options in a problem makes decision-making challenging. Classical approaches in the field of decision-making are unable to solve the problem in such a situation. Since the introduction of the fuzzy theory, researchers have been able to deal with the above data in a more appropriate way. Among fuzzy sets and their extensions, it has been shown that Neutrosophic sets make this distinction between data better than fuzzy and intuitionistic fuzzy sets [31]. As choosing the suitable company for investment is an MCDM one, including various factors and uncertainty, this article has addressed the idea of choosing that by considering the practical factors as the problem criteria in a neutrosophic environment. In this regard, the rest of the article is arranged as follows: In Section 2, some preliminaries, including the NS, SVNS, and SM, are described. Section 3 presents the proposed approach and in Section 4, a numerical example is defined, and the results are presented. Finally, conclusions are drawn in Section 5.

2. Preliminaries

In light of big data as a branch of information theory, it is essential to have a tool to manage the vulnerability and irregularity of information [1]. SVNS is one of the hot topics for tackling real-life decision-making problems [12]. To compute SVNS in the application, this section provides the related definitions.

Definition 1. Let X be a universe of discourse. A neutrosophic set A is an object having the farm $A=\left\{\left(x: T_{A(x)}, I_{A(x)}, F_{A(x)}\right), x \in X\right\}$ characterized by truth-membership function $T_{A(x)}$, indeterminacy-membership function $I_{A(x)}$, and falsity-membership function $F_{A(x)}$. These functions are real standard or nonstandard subsets of $]0^-,1^+[$, with the condition $0^- \leq T_{A(x)}+I_{A(x)}+F_{A(x)} \leq 3^+$.

Definition 2 [37]. Let X be a universe of discourse. The single-valued neutrosophic set A is an object having the farm $A=\{(x: T_{A(x)}, I_{A(x)}, F_{A(x)}), x \in X\}$, where the functions are real standard subsets $[0,1]$, with the condition $0 \leq T_{A(x)}+I_{A(x)}+F_{A(x)} \leq 3$.

For convenience, we can use $x=(T_A, I_A, F_A)$ to represent an element x in SVNS, and x is a single-valued neutrosophic number.

Definition 3 [26]. Let $A=\left\{x:\ T_{A(x)}, I_{A(x)}, F_{A(x)}\right\}$ and $B=\left\{x:\ T_{B(x)}, I_{B(x)}, F_{B(x)}\right\}$ be two single-valued neutrosophic sets and S (A, B) be a similarity measure for SVNSs. S (A, B) satisfies the following properties:

$i)$ $\quad 0 \leq S(A,B) \leq 1,$

$ii)$ $\quad S(A,B)=S(B,A),$

$iii)$ $\quad S(A,B)=1 \text{ if } A=B,$

$iv)$ $\quad S(A,B) \leq S(A,C), \text{if } A \leq B \leq C.$

Definition 4 [5]. Let $A=\left\{x:\ T_{A(x)}, I_{A(x)}, F_{A(x)}\right\}$ and $B=\left\{x:\ T_{B(x)}, I_{B(x)}, F_{B(x)}\right\}$ be two SVNSs. We can calculate S (A, B) applying Eq. (1) as follow:

$$S(A,B)=\frac{\sum x \in X(T_A^2(x) \cap T_B^2(x))+(1-I_A^2(x)) \cap (1-I_B^2(x))+(1-F_A^2(x)) \cap (1-F_B^2(x))}{\sum x \in X(T_A^2(x) \cup T_B^2(x))+(1-I_A^2(x)) \cup (1-I_B^2(x))+(1-F_A^2(x)) \cup (1-F_B^2(x))}. \tag{1}$$

3. Methodology

Decision makers' judgments regarding an investment option are made in many cases based on financial ratios and quantitatively. However, in practice, some decision-makers make intuitive decisions when choosing the right company to invest in. In such a situation, the proximity of judgments regarding the available options (based on interests or other financial indicators) challenges the problem of choosing the best option. Since this group of decision-makers is usually not interested in solving a complex problem, it is necessary to solve the problem for them by presenting a straightforward approach.

This practical, straightforward method includes six steps as follows:

Step 1. Making a list of alternatives

In the first step, decision-makers should prepare a list of all the companies considered for investment. It is better to choose the initial alternatives without any judgment.

Step 2. Listing financial ratios and choosing some of the most important ones

At this stage, decision-makers can use all financial ratios. Nevertheless, to maintain the problem's simplicity, more commonly used ratios can be used in the research background [17].

Step 3. Defining the Ideal Alternative (Id)

An ideal alternative is an assumptive option that performs best in all indicators of the problem, although no such option exists in the real world [21].

Step 4. Forming the decision-making matrix D

As mentioned earlier, some decision-makers choose the right option for investment in a judgmental way. In this case, they must judge each option based on the indicators selected in the previous step. For this purpose, the linguistic scale shown in Table 1 can be used.

Table 1. Conversion of linguistic terms to the SVNSs

Linguistic terms	SVNSs
Excessive high (EH)	(1.00, 0.00, 0.00)
Very very high (VVH)	(0.90, 0.10, 0.10)
Very high (VH)	(0.80, 0.15, 0.20)
High (H)	(0.70, 0.25, 0.30)
Medium high (MH)	(0.60, 0.35, 0.40)
Fair (F)	(0.50, 0.50, 0.50)
Medium low (ML)	(0.40, 0.65, 0.60)
Low (L)	(0.30, 0.75, 0.70)
Very low (VL)	(0.20, 0.85, 0.80)
Very very low (VVL)	(0.10, 0.90, 0.90)
Excessive low (EL)	(0.00, 1.00, 1.00)

Step 5. Calculating the similarity measure

At this stage, the similarity of each investment alternative to the ideal one can be easily measured by applying Eq. (1).

Step 6. Ranking the alternatives according to previous step results

In the final step, the options are ranked based on the degree of similarity with the ideal option, which is a number between zero and one. The option most similar to the ideal (highest value) is the best option.

4. Numerical example

Here, by a numerical example, we will show how one can apply our approach to select the best company for investment-based financial ratio. In the first step, consider five different alternatives (Co_1, Co_2, Co_3, Co_4, Co_5), and the sixth one is Ideal Alternative (I_A). To choose the criteria (financial ratio), we used factors shown in Table 2:

Table 2. Investment Factors

Financial ratio	Abbreviation
Current Ratio	CR
Assets Turnover	AT
Inventory Turnover	IT
Debt Ratio	DR
Debt of Equity Ratio	DER
Account Receivable Turnover	ART
Return of Assets	RoA
Return of Equity	RoE

According to Tables 1 & 2, the decision matrix D is available in Table 3:

Table 3. The decision matrix

D	CR	AT	IT	DR	DER	ART	RoA	RoE
Co_1	(0.8, 0.1, 0.2)	(0.5, 0.5, 0.5)	(0.7, 0.3, 0.3)	(0.9, 0.1, 0.1)	(0.6, 0.75, 0.4)	(0.4, 0.65, 0.6)	(0.7, 0.75, 0.3)	(0.4, 0.65, 0.6)
Co_2	(0.85, 0.3, 0.15)	(0.8, 0.3, 0.2)	(0.6, 0.35, 0.4)	(0.5, 0.5, 0.5)	(0.5, 0.5, 0.5)	(0.6, 0.50, 0.4)	(0.6, 0.35, 0.4)	(0.8, 0.15, 0.2)
Co_3	(0.65, 0.45, 0.35)	(0.5, 0.4, 0.5)	(0.7, 0.45, 0.3)	(0.4, 0.55, 0.6)	(0.8, 0.15, 0.2)	(0.8, 0.15, 0.2)	(0.7, 0.25, 0.3)	(0.6, 0.25, 0.4)
Co_4	(0.75, 0.3, 0.25)	(0.5, 0.35, 0.5)	(0.7, 0.25, 0.3)	(0.8, 0.15, 0.2)	(0.8, 0.5, 0.2)	(0.7, 0.25, 0.3)	(0.6, 0.35, 0.4)	(0.3, 0.4, 0.7)
Co_5	(0.5, 0.35, 0.5)	(0.55, 0.5, 0.45)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(0.2, 0.85, 0.8)	(0.5, 0.5, 0.5)	(1.0, 0.0, 0.0)	(0.4, 0.5, 0.6)
I_A	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)	(1.0, 0.0, 0.0)

"Co" is the symbol of the five largest companies in the automotive industry in Iran, such as Iran Khodro, Saipa, etc.). Now, applying Eq. (1), we can compute the similarity measures as shown in Table 4:

Table 4. Similarity Measure

S (Co_i, I_A)	**Score**	**Rank**
S (Co_1, I_A)	0.653	5
S (Co_2, I_A)	0.721	2
S (Co_3, I_A)	0.719	3
S (Co_4, I_A)	0.725	1
S (Co_5, I_A)	0.682	4

As seen in Table 4, company number 4, with a similarity of 0.735, is the closest alternative to the ideal and the best company for investment according to the problem indicators. After that, companies 2 and 3 have the second and third ranks with similarities of 0.721 and 0.719, respectively. In the same way, companies number 5 and 1 are ranked fourth and fifth with similarities of 0.682 and 0.653, respectively.

Suppose the data of the problem were not neutrosophic, and we considered the element of truth (T) as a definitive judgment. In that case, the problem data would be as shown in Table 5:

Table 5. The crisp decision matrix

D	CR	AT	IT	DR	DER	ART	RoA	RoE
Co_1	(0.8)	(0.5)	(0.7)	(0.9)	(0.6)	(0.4)	(0.7)	(0.4)
Co_2	(0.85)	(0.8)	(0.6)	(0.5)	(0.5)	(0.6)	(0.6)	(0.8)
Co_3	(0.65)	(0.5)	(0.7)	(0.4)	(0.8)	(0.8)	(0.7)	(0.6)
Co_4	(0.75)	(0.5)	(0.7)	(0.8)	(0.8)	(0.7)	(0.6)	(0.3)
Co_5	(0.5)	(0.55)	(1.0)	(1.0)	(0.2)	(0.5)	(1.0)	(0.4)
I_A	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)

According to Table 5, the similarity measures for companies 1 to 5 are 0.38, 0.34, 0.36, 0.36, and 0.36, respectively. Therefore, it can be seen that the decision-making problem in this situation faces a severe challenge.

5. Conclusion

Ratio analysis is a standard tool for analyzing financial statements. A ratio is a mathematical relationship between one number and another number. The ratio is used as an indicator to evaluate the financial performance of the business company. The accounting ratio shows the mathematical relationship between two numbers that have a significant relationship with each other. Therefore, it can be said that financial ratios can be a suitable measure for investors (Largani et al., 2013). Since the financial ratios are obtained based on crisp numbers, and the conditions of uncertainty are not seen, this study tried to see this problem.

In real decision-making, to choose the best alternative from all the feasible sets of other options [34], multi-criteria decision-making problems and solution methods are the essential branches of modern decision sciences to deal with incomplete, indeterminate, and inconsistent information [32]. The indeterministic part of uncertain data, introduced in NS theory, plays a vital role in making a proper decision that is impossible by intuitionistic fuzzy set theory [19]. By NS, we can better represent reality by considering all aspects of the decision-making process [9].

In this study, we proposed a simple, practical approach to address the problem of selecting the best investment. This approach considers the most important financial ratios affecting the investment selection and copes with uncertainty using SVNSs. However, the current research has limitations that can be taken into consideration by other researchers. In this research, verbal judgments were considered; While in many cases, decision-makers pay attention to quantitative indicators [3]. The problem discussed in this research (closeness of options to each other) can also exist in quantitative problems. Therefore, presenting the approach of dealing with quantitative data can also be a solution for decision-makers. Another limitation of this research is related to the same attention to financial ratios, while according to the opinion of financial experts, these indicators do not have the same importance [4]. In addition, the relationship between financial ratios is a significant point that this study has not addressed. Considering the interdependency criteria by applying ANP or DEMATEL-based ANP can be an exciting topic for future research. Another limitation of the proposed approach is that it faces a problem when dealing with a large amount of data (a large number of alternatives) [40]. The use of two or three-phase methods can be suitable for this situation. Using more critical indicators in the first phase, we can exclude some weaker options from the analysis, and other options can be examined in the next phase. In a three-phase approach, using a technique such as data envelopment analysis, options that are not effective can be excluded from the study. Moreover, as hesitancy is the most common problem in decision-making, and single-valued neutrosophic hesitant fuzzy sets are more general and practical than existing decision-making methods [39], we will use them in our subsequent study.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Abdullah, L., Ong, Z., & Mohd Mahali, S. (2021). Single-valued neutrosophic DEMATEL for segregating types of criteria: a case of subcontractors' selection. *Journal of mathematics*, *2021*, 1-12.
2. Aydemir, S. B., & Kaya, T. (2021). TOPSIS method for multi-attribute group decision making based on neutrality aggregation operator under single valued neutrosophic environment: A case study of airline companies. *Neutrosophic Operational Research: Methods and Applications*, 471-492.
3. Azar, A., & Sorourkhah, A. (2015). Designing a model for three-dimensional robustness analysis: A case study of Iran Khodro machine tools industries company. *Indian Journal of Science and Technology*, *8*(28), 1.
4. Chadow, D., Robinson, N. B., Cancelli, G., Soletti Jr, G., Audisio, K., Rahouma, M., Perezgrovas, R., & Gaudino, M. (2022). Predictors of failure to reach target sample size in surgical randomized trials. *British Journal of Surgery*, *109*(2), 176–177.
5. Chai, J. S., Selvachandran, G., Smarandache, F., Gerogiannis, V. C., Son, L. H., Bui, Q.-T., & Vo, B. (2021). New similarity measures for single-valued neutrosophic sets with applications in pattern recognition and medical diagnosis problems. *Complex & Intelligent Systems*, *7*(2), 703–723.
6. Das. S. K., & Edalatpanah. S. A. (2020). A new ranking function of triangular neutrosophic number and its application in integer programming. *International Journal of Neutrosophic Science*, *4*(2).
7. Deli, I. (2020). A New Multi-Attribute Decision-Making Method Based on Similarity Measures of SVTN-Numbers. In *Neutrosophic Sets in Decision Analysis and Operations Research* (pp. 59-81). IGI Global.
8. Durrah, O., Abdul Rahman, A. A., Jamil, S. A., & Ghafeer, N. A. (2016). Exploring the Relationship between Liquidity Ratios and Indicators of Financial Performance: An Analytical Study on Food Industrial Companies Listed in Amman Bursa. *International Journal of Economics and Financial Issues*, *6*(2), 435–441.
9. Edalatpanah, S. A. (2020). Neutrosophic structured element. *Expert Systems*, *37*(5), e12542.
10. Falavigna, G., & Ippoliti, R. (2022). Financial constraints, investments, and environmental strategies: An empirical analysis of judicial barriers. *Business Strategy and the Environment*, *31*(5), 2002–2018.

11. Fuertes-Callén, Y., Cuellar-Fernández, B., & Serrano-Cinca, C. (2022). Predicting startup survival using first years financial statements. *Journal of Small Business Management*, *60*(6), 1314–1350.
12. Garg, H., & Nancy. (2020). Algorithms for single-valued neutrosophic decision making based on topsis and clustering methods with new distance measure. *AIMS Mathematics*, *5*(3), 2671–2693.
13. Gibson, C. H. (2012). *Financial Reporting and Analysis* (13th ed.). Cengage Learning.
14. Gregory, A. (2021). *Complete Analysis of Netflix, Inc*. The University of Mississippi.
15. Imeni, M. (2020). Fuzzy Logic in Accounting and Auditing. *Journal of Fuzzy Extension and Applications*, *1*(1), 66–72.
16. Imeni, M., Rahnamay Roodposhti. F., & Banimahd, B. (2019). Relationship Real Activities Manipulation with Accrual-Based Earnings Management Using Recursive Equation System Approach. *Journal of Management Accounting and Auditing Knowledge*, 8(29), 1-14.
17. Jing, D., Imeni, M., Edalatpanah, S. A., Alburaikan, A., & Khalifa, H. A. (2023). Optimal Selection of Stock Portfolios Using Multi-Criteria Decision-Making Methods. In *Mathematics* (Vol. 11, Issue 2).
18. Largani, M. S., Zamani, M., Imeni, M., & Kaviani, M. (2013). Determine the Effects of Fundamental Variables and Mass Behaviors in Changes of Stock Price (Evidence from Iran Stock Exchange). *Asian Journal of Finance & Accounting*, *5*(1).
19. Mahapatra, N. K., & Bera, T. (2020). Generalised Single-Valued Neutrosophic Number and Its Application to Neutrosophic Linear Programming. In M. Abdel-Basset & F. Smarandache (Eds.), *Neutrosophic Sets in Decision Analysis and Operations Research* (pp. 180–214).
20. Paramasivan, C., & Subramanian, T. (2010). *Financial Management*. NEW AGE INTERNATIONAL.
21. Qiu, P., Sorourkhah, A., Kausar, N., Cagin, T., & Edalatpanah, S. A. (2023). Simplifying the Complexity in the Problem of Choosing the Best Private-Sector Partner. In *Systems* (Vol. 11, Issue 2).
22. Quesada, H. J. (2019). Analysis of Financial Statements Using Ratios. *Virginia Tech*, *CNRE-43P*, 1–16.
23. Rodríguez. R., Martinez. L., Torra. V., Xu. Z., & Herrera. F. (2014). Hesitant Fuzzy Sets: State of the Art and Future Directions. *International Journal of Intelligent Systems*, *29*, 495–524.
24. Saberhoseini, S. F., Edalatpanah, S. A., & Sorourkhah, A. (2022). Choosing the Best Private-Sector Partner According to the Risk Factors in Neutrosophic Environment. *Big Data and Computing Visions*, *2*(2), 61–68.
25. Saha, S., Gao, J., & Gerlach, R. (2022). A survey of the application of graph-based approaches in stock market analysis and prediction. *International Journal of Data Science and Analytics*, *14*(1), 1–15. -9
26. Şahin, M., & Kargın, A. (2020). New Similarity Measure Between Single-Valued Neutrosophic Sets and Decision-Making Applications in Professional Proficiencies. In M. Abdel-Basset & F. Smarandache (Eds.), *Neutrosophic Sets in Decision Analysis and Operations Research* (pp. 129–149). PA, USA: IGI Global.
27. Şahin, R., & Liu, P. (2017). Correlation coefficients of single valued neutrosophic hesitant fuzzy sets and their applications in decision making. *Neural Computing and Applications*, *28*.
28. Samadi Lorgani, M., & Imeni, M. (2013). The relationship between working capital management and cash holding companies listed in Tehran stock exchange. *Journal of management accounting and auditing knowledge*, 2(5), 39-52.
29. Seifzadeh, M., Rajaeei, R., & Allahbakhsh, A. (2022). The relationship between management entrenchment and financial statement fraud. *Journal of Facilities Management*, *20*(1), 102–119.
30. Smarandache, F., Broumi, S., Singh, P. K., Liu, C. -f., Venkateswara Rao, V., Yang, H.-L., & Elhassouny, A. (2019). 1 - Introduction to neutrosophy and neutrosophic environment. In Y. Guo & A. S. Ashour (Eds.), *eutrosophic Set in Medical Image Analysis* (pp. 3–29). Academic Press.
31. Sorourkhah, A. (2022). Coping Uncertainty in the Supplier Selection Problem Using a Scenario-Based Approach and Distance Measure on Type-2 Intuitionistic Fuzzy Sets. *Fuzzy Optimization and Modeling Journal*, *3*(1), 64–71.
32. Sorourkhah, A., Azar, A., Babaie-Kafaki, S., Shafiei-Nikabadi, M., & Author, C. (2018). Using Weighted-Robustness Analysis in Strategy Selection (Case Study: Saipa Automotive Research and Innovation Center). *Industrial Management Journal*, *9*(4), 665–690.
33. Sorourkhah, A., Babaie-Kafaki, S., Azar, A., & Shafiei Nikabadi, M. (2019). A Fuzzy-Weighted Approach to the Problem of Selecting the Right Strategy Using the Robustness Analysis (Case Study: Iran Automotive Industry). *Fuzzy Information and Engineering*, *11*(1), 39–53.
34. Sorourkhah, A., Babaie-Kafaki, S., Azar, A., & Shafiei-Nikabadi, M. (2018). Matrix Approach to Robustness Analysis for Strategy Selection. *International Journal of Industrial Mathematics*, *10*(3), 261–269.
35. Sorourkhah, A., & Edalatpanah, S. A. (2021). Considering the Criteria interdependency in the Matrix Approach to Robustness Analysis with Applying Fuzzy ANP. *Fuzzy Optimization and Modeling Journal*, *3*(2), 22–33.
36. Taghvaei, F., & Safa, R. (2021). Efficient energy consumption in smart buildings using personalized NILM-based recommender system. *Big Data and Computing Visions*, *1*(3), 161–169.
37. Wang, H., Smarandache, F., Zhang, Y., & Sunderraman, R. (2010). Single Valued Neutrosophic Sets. *Rev Air Force Acad*, *1*(16), 10–14.
38. Welc, J. (2022). *Financial Statement Analysis BT - Evaluating Corporate Financial Performance: Tools and Applications* (J. Welc, Ed.; pp. 131–212). Springer International Publishing.
39. Ye, J. (2015). Multiple-attribute decision-making method under a single-valued neutrosophic hesitant fuzzy environment. *Journal of Intelligent Systems*, *24*(1), 23–36.

40. Zayat, W., Kilic, H. S., Yalcin, A. S., Zaim, S., & Delen, D. (2023). Application of MADM methods in Industry 4.0: A literature review. *Computers & Industrial Engineering*, *177*, 109075.
41. Zhang, K., Xie, Y., Noorkhah, S. A., Imeni, M., & Das, S. K. (2023). Neutrosophic management evaluation of insurance companies by a hybrid TODIM-BSC method: a case study in private insurance companies. *Management decision*, *61*(2), 363-381.

Imeni M., Pouresmaeil Motlagh B., Pirouz F., & Shemshad A. (2022). Choosing the best company for investment according to the financial factors in the Neutrosophic environment (case study: Automotive industry). *Fuzzy Optimization and Modelling Journal*, 3(4), 9-16.

https://doi.org/10.30495/fomj.2023.1971807.1081

Received: 26 October 2022 Revised: 24 December 2022 Accepted: 30 December 2022