A DECISION-MAKING APPROACH FOR SELECTING SUSTAINABLE SUPPLIER BASED ON SPHERICAL FUZZY AHP-TOPSIS

ABSTRACT

In this study, problem of sustainable supplier selection (SSS) is discussed. Since SSS considered a decision process that includes high uncertainty, multiple interests and perspectives, this study proposes a framework to evaluate SSS by using an integrated Analytical Hierarchy Process (AHP) and TOPSIS techniques with spherical fuzzy sets (SFS). Here, weights of the evaluation criteria are calculated with the application of SF-AHP and sustainable suppliers of selected company are ranked using SF-TOPSIS method. The originality of the study stems from the fact that this integrated technique, which is new in the literature, is applied for the first time in a real case study for the SSS problem.

Keywords: Multi Criteria Decision Making, Spherical fuzzy sets, SF-AHP, SF-TOPSIS, Sustainable Supplier Selection,

1. Introduction

In recent years, companies have been working on sustainability as a concept that focuses on, and have tried to apply this concept with its social, environmental and economic dimensions to generate a range of benefits. Supply Chain Management (SCM), which contributes to the competitive advantage to enterprises, also significantly determines the social, environmental and economic effects. In this way, it can also lead to sustainable growth. SCM, which supports the productivity, growth and development of enterprises with its many effects, has become an important success factor.

In recent years, traditional-based studies on supplier selection within the scope of SCM have started to be replaced by approaches based on sustainability perspective. Suppliers, being the component of the supply chain, play a critical role in ensuring its long-term viability. Today, when the advantages of suppliers such as being the direct determinant of product performance and providing companies with high levels of added value are considered, suppliers and supply chains become critical for the success of companies. Companies should select sustainable suppliers that can provide them with competitive advantage and comply with company strategies by developing approaches based on a sustainability perspective.

The paper is organized as follows. Section 2 reviews the literature, Section 3 outlines the Hypotheses/Objectives, Section 4 explains the Research design/methodology, Section 5 presents the Data Model Analysis, Section 6 presents Limitations, Section 7 outlines Conclusion, and finally Section 8 outlines Key references.

2. Literature Review

In practice, many different criteria are presented for sustainable supplier selection problem. For example; Hendiani et al (2020) developed a comprehensive model for STS that includes economic, social and environmental criteria. Rajesh (2020) developed a model that includes 30 criteria in his study. Mohammed et al., (2019) created a model for the STS problem consisting of 10 criteria, including criteria such as cost, quality, and environmental management. In this study, three main criteria and 15 sub-criteria have been determined in Figure 1.
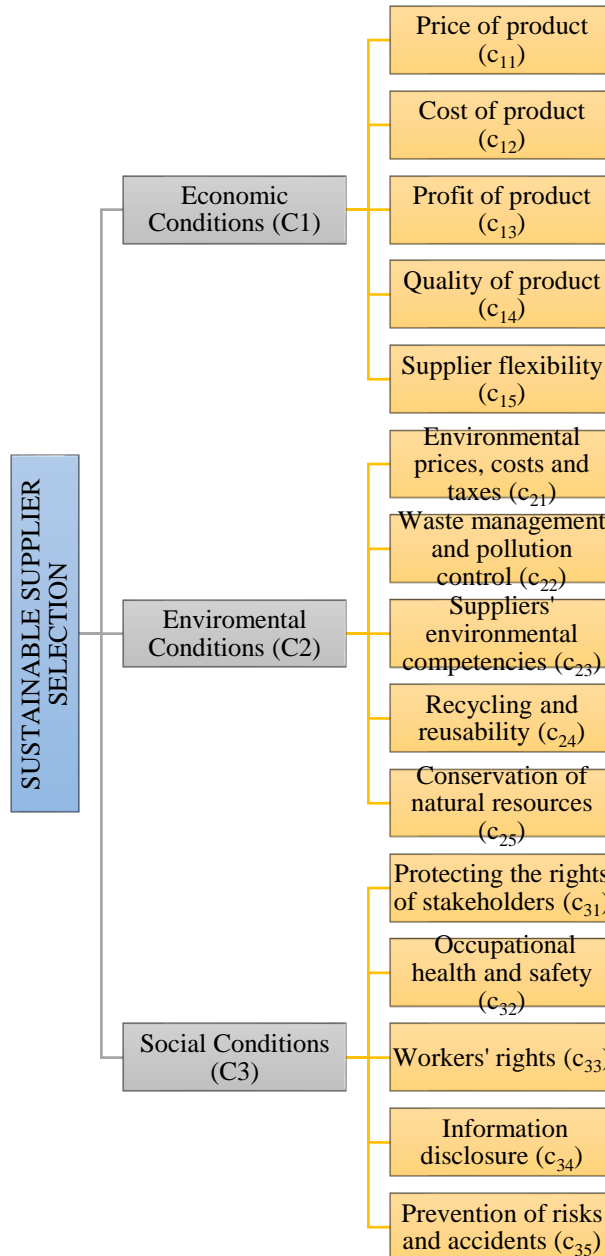
Fig. 1. The evaluation criteria for sustainable supplier selection

3. Hypotheses/Objectives

The main purpose of the study is to select the most suitable sustainable supplier alternative for decision making process.

4. Research Design/Methodology

This section presents the results of a real case study to evaluate the sustainable supplier alternatives for a manufacturing firm located in Bartın, Turkey. The firm is one of the leading companies in Turkey with its technology, quality and competitiveness in the plastics industry, has adopted the policy of meeting customer expectations and orders quickly and completely. For this reason, business partnership with sustainable suppliers in all its activities is based on a mutual win-win relationship. Considering production activities, it is of great importance for the firm to supply the necessary raw materials for the products on time and at low cost. Therefore, it is aimed to choose the most suitable sustainable supplier in the purchase of plastic raw materials required in the production of pipes.

In this study, the spherical fuzzy AHP and TOPSIS is used owing to its effectiveness. The steps of this method are followed using the methodology proposed by Kutlu Gündoğdu and Kahraman, (2020).

5. Data/Model Analysis

This study proposes a framework to evaluate SSS by using an integrated Analytical Hierarchy Process (AHP) and TOPSIS techniques with spherical fuzzy sets (SFS). Here, evaluation criteria and their hierarchy are determined based on a detailed literature review and expert opinions. In the second section, the weights of the evaluation criteria are calculated with the application of SF-AHP. In the final section, sustainable suppliers of selected company are ranked, using SF- TOPSIS method.

6. Limitations

In this study, to assess how far the criteria weights have an impact on the ranking of the suppliers, a sensitivity analysis should be carried out for future studies. Also, it is necessary to benefit from the opinions of more experts or it is aimed to make a comparative analysis with the SF- TOPSIS method, with the other MCDM methods.

7. Conclusions

The main purpose of the study is to select the most suitable sustainable supplier alternative for decision making process. The case study was carried out among four possible supplier alternatives in YEPSA. For further research, SF-AHP-TOPSIS will be compared with other extensions of MCDM methods such as fuzzy, intuitionistic and pythagorean fuzzy extensions of integrated techniques. The future research also will focus on applying the decision framework to diverse disciplines as the extended version of this paper.

8. Key References

Hassini, E., Surti, C., Searcy, C. (2012), "A literature review and a case study of sustainable supply chains with a focus on metrics", International Journal of Production Economics, 140(1), pp. 69–82.

Hendiani, S., Mahmoudi, A., Liao, H. (2020), "A multi-stage multi-criteria hierarchical decision-making approach for sustainable supplier selection", Applied Soft Computing Journal, 94, 106456, pp. 1-19.

Kutlu Gündoğdu, F., & Kahraman, C. (2019). Spherical fuzzy sets and spherical fuzzy TOPSIS method. *Journal of Intelligent and Fuzzy Systems*, *36*(1), 337–352.

Kutlu Gündoğdu, F., & Kahraman, C. (2020). A novel spherical fuzzy analytic hierarchy process and its renewable energy application. *Soft Computing*, *24*(6), 4607–4621.

Mathew, M., Chakrabortty, R. K., Ryan, M. J. (2020), "A novel approach integrating AHP and TOPSIS under spherical fuzzy sets for advanced manufacturing system selection", Engineering Applications of Artificial Intelligence, 96, 103988, pp.1-13.