

**AN INTEGRATED METHODOLOGY FOR SELECTING AND  
EVALUATING SUSTAINABLE SUPPLIERS  
IN SUPPLY CHAINS**

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**DOI: 10.5958/2249-7307.2021.00075.X**

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**ABSTRACT**

*Business companies have highlighted the significance of greening and sustainability in their supply chain via supplier selection as a result of increasing consumer awareness and ecological demands from markets and different stakeholders. As a result, from the viewpoint of an organizational supply chain, a systematic and sustainability-focused assessment methodology for supplier selection is required. This paper offers a framework for evaluating sustainable supplier selection by combining an Analytical Hierarchy Process (AHP) with Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR), a multi-criteria optimization and compromise solution method. Initially, literature and expert views established 22 sustainable supplier selection criteria and three aspects of criteria (economic, environmental, and social). To illustrate the applicability of the suggested framework, a real-world example of an automotive business in India is presented. The top five sustainable supplier selection factors, according to the results, are 'Environmental costs,' 'Quality of product,' 'Price of product,' 'Occupational health and safety systems,' and 'Environmental competences.' Furthermore, among the five sustainable supplier options, supplier number three received the highest ranking. The research provided in this article may assist managers and business professionals in not only identifying key supplier selection criteria, but also in evaluating the most efficient supplier for supply chain sustainability and market competitiveness. To evaluate the proposed framework's resilience, a sensitivity analysis is performed.*

**KEYWORDS:** *Sustainable Supplier Selection; Supply Chains; Sustainability; AHP; VIKOR; Indian Automobile Industry.*

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**1. INTRODUCTION**

Organizations cannot ignore environmental and sustainability issues in business due to rising global awareness, rigorous government directives, and increased community understanding (Gaziulusoy et al., 2015; Govindan et al., 2016). Green and sustainability-focused supplier selection is a critical choice in industrial supply chains in order to improve company performance and competitive advantage (Govindan et al., 2013; Grimm et al., 2014) [1]. The sustainability-focused supply chain (Mangla et al., 2014) is an extension of the green supply

chain in that it addresses social, economic, and environmental factors in a supply chain context. Green and/or sustainable practices (from here on, “green” and “sustainable” shall be used interchangeably) are becoming an increasingly important component of contemporary industrial companies' supply chain planning processes in order to enhance supply [2] chain performance (Rostamzadeh et al., 2015). In recent years, incorporating ecological, economic, and social elements to guarantee sustainable growth has become a top strategic challenge for businesses (Benn et al., 2014). Suppliers may have a significant role to play in adopting sustainable supply chain activities and attaining social, environmental, and economic benefits (Shen et al., 2013; Govindan et al., 2013). As a result, sustainable supplier selection (SSS) is a critical strategic choice in the management of a sustainability-focused supply chain (Amindoust et al., 2012), and it must be thoroughly investigated in order to execute sustainable supply chain efforts (Grimm et al., 2016).

In this regard, the goals of this research project are as follows:

- To differentiate the relative significance weights of the SSS assessment criteria for supply chains;
- To choose the most efficient sustainable supplier from a group of alternatives in the supply chain;
- To provide managerial and practical consequences of the research.

For the assessment and selection of sustainable suppliers in the supply chain, an Analytical Hierarchy Process (AHP)- Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR) based integrated method is utilized to accomplish the above-mentioned goals. This paper is an early attempt that offers an AHP-VIKOR method for identifying and prioritizing the SSS assessment criteria, as well as selecting the most efficient supplier from a collection of options for supply chain sustainability. AHP is a decision-making method that aids in the prioritization of supplier assessment criteria for long-term sustainability. The VIKOR approach (Akman, 2015; Sivakumar et al., 2015; Rostamzadeh et al., 2015) is used to choose the most efficient sustainable supplier in a supply chain from a collection of options [3].

This paper discusses a case study of the Indian automotive sector in order to demonstrate how the suggested framework may be used. It should be emphasized that the Indian automotive sector is one of the world's major participants, and it has been forced to shift toward sustainable economic growth by competition, regulation, and community pressures (Luthra et al., 2016a). Furthermore, the example business understands the advantages of using effective SSS assessment criteria and wants to create a structural framework for selecting and evaluating the most efficient sustainable suppliers from a range of supply chain options. The following is how this article's reminder is organized. Section 2 includes a review of the current literature that is relevant to our research. Section 3 explains how to solve the problem. The suggested research framework is explained in Section 4. Section 5 discusses the application of the proposed framework. Section 6 is devoted to a review of study results and their managerial and practical consequences. The sensitivity analysis is shown in Section 7. Section 8 concludes with some observations, limits, and suggestions for further research.

A review of many pertinent articles is included in this research. The following are the responsible criteria that were selected for this review:

1. Environmental, ecological, and social sustainability adoption in the supply chain, as well as sustainable supplier selection and assessment in the supply chain, should be

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included in selected articles. "Supply Chain Management," "Environmental and Economic and Social and Sustainability," "Environmental and Economic and Social and Sustainability and Supply Chain Management," "Sustainable Supplier Selection and Evaluation," "Supplier Selection and Evaluation and Sustainability," and "Supplier Selection and Evaluation and Sustainability" were among the keywords used in the article collection.

## **2.1 Selection Of Suppliers And Long-Term Viability**

In supplier selection studies, there has been a lot of debate on how to improve supplier capabilities in terms of increasing their environmental performance, either by obtaining required certifications or by including sustainable elements (Govindan et al., 2013). Supplier selection is critical in assisting a company in achieving optimum environmental and economic advantages (Hsu and Hu, 2009; Shaw et al., 2012; Kannan et al., 2014).

From an industrial perspective, managing supplier selection criteria and implementation methods is critical to a company's legitimacy and public image (Bai and Sarkis, 2010; Lin, 2013; Hsu et al., 2013). Sueuring (2013), Grimm et al. (2014), and Kumar et al. (2016) all agree that managing supply chains with a sustainable approach is a major issue for businesses. Several research on the different elements of green and sustainability-focused supplier choices in supply chain management have been performed. Walton et al. (1998), for example, looked at five furniture firms' supply chains to see how green they were. According to the results, the majority of the businesses included ecological aspects in their supplier selection process, which is an important stage in the construction of any supply chain network. In their supplier selection procedure, Hsu and Hu (2009) recommended hazardous material management to reduce environmental deterioration. Lee et al. (2009) developed a methodology that assesses the variables that are used to choose a green supplier based on their performance. Shaw et al. (2012) proposed a methodology for analyzing carbon emissions-related supplier selection choices. Hsu et al. (2013) developed a methodology for analyzing a supplier's performance in terms of carbon management problems; they identified thirteen key supplier carbon management criteria that were divided into three categories. The most influential factors in supplier selection were 'carbon information' and 'training related to carbon management.' Green suppliers were assessed by Shen et al. (2013) based on their environmental performance. In their research, they discovered nine criteria for evaluating green suppliers. To assess green supplier development initiatives, Akman (2015) developed a two-step supplier evaluation framework (performance criteria and green criteria) [5].

## **2. DISCUSSION**

Supplier selection is an important activity that has an impact on the various phases of supply chain sustainability (Kumar et al., 2014a). Traditional economic goals, as well as ecological and social elements, should be included in a sustainability-focused supply chain (Ageron et al., 2012). Furthermore, assessing and choosing suitable suppliers in the sustainability-focused supply chain is critical since suppliers play a critical role in an organization's performance (Hsu et al., 2013). In general, while assessing the overall performance of their suppliers, business organizations examine traditional factors such as quality, flexibility, and pricing. When sustainability factors are added to traditional characteristics, the supplier assessment process becomes more complicated (Brandenburg et al., 2014; Azadi et al., 2014). (2015).

Many studies have focused on problems related to economic-environmental supplier selection choices in rich nations (Amindoust et al., 2012; Hsu et al., 2013), however there is still a scarcity of research on supplier selection for sustainability in poor countries (Govindan et al.,

2013; Grimm et al., 2014). In a developing nation like India, there is a major shortage of information and awareness in the field of SSS (economic-ecological-social aspects) (Luthra et al., 2016a). Furthermore, from the perspective of poor countries, sustainability standards are likely to differ since consumers may not be prepared to pay more for sustainable goods (Gandhi et al., 2016). Furthermore, there are many SSS-related gaps that may be investigated (Anisul Huq et al., 2014; Grimm et al., 2016). For example, current research fails to recognize that in a hierarchical organization, the appropriate SSCM criteria should match [6]with supplier selection criteria (Su et al., 2015). Furthermore, research indicates that there is a broad variety of work on green supplier selection (Akman, 2015; Kannan et al., 2015). Despite this, Mahdiloo et al. (2015) found that studies have overlooked the social aspects of supplier selection decision-making. According to Seuring and Müller (2008), there is a clear gap in supply chain management and buying literature on the integration of all three aspects of sustainable development in supply chains. As a result, the idea of sustainability-focused supplier selection and assessment is becoming more essential for businesses [5]. As a result, it is apparent that there is a significant vacuum in research in the field of SSS and supply chain assessment. It should also be emphasized that most SSS methods are fuzzy-based single model approaches and are not integrative in nature (Shaw et al., 2012; Shen et al., 2013).

Govindan et al. (2015a) also looked at the literature on MCDM methods for evaluating green suppliers. According to their findings, AHP is the most often used MCDM method for assessing green supplier choices, however it may be necessary to combine AHP with other techniques to handle the issue more effectively and flexibly. As a result, a framework for identifying SSS criteria and evaluating the most efficient supplier choices in a supply chain environment is required. In this regard, an effort is made to establish appropriate criteria for supplier selection campaigns that incorporate sustainability-oriented (ecological, economic, and social) elements. Furthermore, the SSS-related discovered criteria are evaluated using an integrated AHP–VIKOR framework. To the best of our knowledge, this study is the first to use the combined AHP–VIKOR method to evaluate SSS in supply chains [7].

Approach to the Problem this paper suggests using an integrated AHP-VIKOR approach as a solution technique for evaluating SSS choices in the context of a supply chain. The weights of SSS dimensions and their corresponding criteria are produced using the AHP method, and the weights acquired using the AHP technique are then utilized by VIKOR to identify the most efficient sustainable providers. In a decision-making scenario, AHP assists decision-makers in analyzing the relative significance of examined factors (Saaty, 1980; Saaty, 2000). AHP is considered to be more helpful than ANP because of its simplicity of application and fewer number of pair-wise comparisons. Although AHP may make decisions on its own, the MCDM approach typically produces better outcomes by combining AHP with additional decision support technologies [8] (Kang and Park, 2014; Mangla et al., 2016). Furthermore, owing to human participation, creating alternatives is a common activity. The VIKOR method, which is a compromise solution method, has been identified as an effective decision tool for evaluating alternatives; it is particularly useful in situations where experts are unable or unwilling to communicate their ratings for decision-making processes at the outset (Athawale et al., 2012; Rostamzadeh et al., 2015). TOPSIS may be used to evaluate options; nevertheless, practitioners have expressed skepticism about its applicability (Harputlugil et al., 2011). Furthermore, the VIKOR technique is very useful when criteria are incompatible, and it can calculate weight stability intervals (Opricovic, 2011). Additive MCDM techniques, such as outranking methods like PROMETHEE, may also be used to analyze weight stability (Mareschal et al., 1984; Olson, 2001). The ranking index in VIKOR is calculated by taking into account both the opponent's greatest group utility and lowest individual regret (Jerry et

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al., 2011), variables that are not feasible in PROMETHEE.

The AHP method can analyze choice issues in a linear fashion, while the VIKOR approach can effectively assess expert preferences at an early stage of decision making.

The potential of VIKOR's dual-disciplinary approaches to AHP makes this integration crucial. This integration with multi-faceted decision analysis tools makes it easier and more efficient to cope with complicated decision-making processes. In decision-making circumstances, this integrated approach may offer a reasonable, logical, and successful answer. Several researchers and professionals in various disciplines use the integrated AHP-VIKOR approach, including robot selection (Parameshwaran et al., 2015), firm performance evaluation (Rezaie et al., 2014), conservation priority assessment (Pourebrahim et al., 2014), and product development partner selection (Büyüközkan and Görener, 2015). The following are the comprehensive processes for the AHP and VIKOR techniques [9].

### **3. CONCLUSION**

The adoption of sustainable practices has become an essential issue for corporate organizations with respect to their supply chains as a consequence of increasing awareness of environmental preservation and the consequent strict regulations. These factors may assist them in determining their long-term development and viability. It's crucial to choose the right supplier. Using an integrated AHP-VIKOR methodology, this study offers a scientific model that gives complete insights on supplier selection for sustainability. The AHP method was used to evaluate the relative significance weights of the SSS criterion, and the VIKOR technique was used to identify the most efficient sustainable supplier. The weights of the SSS assessment criteria acquired via AHP were used as input in VIKOR to identify the best alternative sustainable supplier among the options.

A case study of the Indian automotive sector demonstrates the legitimacy of the suggested integrated framework from a management standpoint. A comprehensive literature study and expert contributions resulted in the identification of 22 SSS assessment criteria and three major aspects of sustainability, including economic, environmental, and social. According to the AHP approach, the "Environmental dimension" has the highest priority weight. Furthermore, global weights were assigned to all criteria to determine their overall ranking. The highest rating was given to 'environmental expenses,' and VIKOR findings showed that sustainable suppliers were ranked  $S3 > S5 > S1 > S4 > S2$  in decreasing order. To evaluate the proposed framework's robustness, a sensitivity analysis was performed.

There are certain limits to this work as well. There have been discovered and rated 22 key supplier selection criteria for supply chain sustainability. There are no further criteria or dimensions that have been established. To assess SSS criteria and choose the most efficient sustainable supplier among options, an AHP and VIKOR-based framework is employed. The required calculations were carried out with the inputs of the specialists in mind. As a result, it is recommended that these calculations be done carefully. Because the results are based on a single case study, they cannot be applied to other situations. Because the fuzziness of the data was not taken into account in this study, a fuzzy-based judgment method may be used in future research. Various methods and MCDM tools (such as ISM, TISM, and DEMATEL) may also be used to examine the interrelationships and strength of connections between or among SSS in the supply chain. TOPSIS and PROMETHEE may be used in future research to choose suppliers for sustainability, with the findings compared to the current study. Finally, an Interpretive Ranking Process (IRP) may be used to rank the SSS assessment criteria related to supply chain performance indicators [10].

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