

## AHP-TOPSIS Social Sustainability Approach for Supplier Selection in the Construction Supply Chain Using AHP-TOPSIS Methodologies in Selecting Sustainable Suppliers in an Electronic Supply Chain

Hamid Goodarzi<sup>1</sup>, Samad Khaledian<sup>2</sup>, Mahdi Mirzaei<sup>3</sup>, Ramin Jahanshahi<sup>4</sup>, Hamidreza Motamedi<sup>5</sup>, Omid Fanaei Niya<sup>6</sup>

1. Bachelor's, Master's and PhD in Civil Engineering Master's student in Industrial Engineering, Engineering Management
2. Bachelor of industrial safety and industrial engineering in engineering management
3. Bachelor of Industrial Engineering, Isfahan University of Technology Master of Industrial Engineering, Engineering Management, Isfahan University of Technology
4. Bachelor of Civil Engineering, Bahonar University of Kerman and Master of Industrial Engineering, Engineering Management, Isfahan University of Technology.
5. Bachelor of Industrial Engineering and Master of Industrial Engineering majoring in Engineering Management
6. Bachelor of Industrial Management and industrial engineering in Engineering Management

### ARTICLE INFO

#### Keywords:

Social Sustainability, Supplier Selection, Construction Supply Chain, Multi-Criteria Decision Making, TOPSIS, AHP, Electronics Industry

### ABSTRACT

These two papers examine the challenges of selecting sustainable suppliers in the supply chain, particularly in the construction and electronics industries. Both studies emphasize the importance of a multi-criteria decision-making (MCDM) approach due to the complexity of these decisions. Both papers use a combination of Analytic Hierarchy Process (AHP) to weight criteria and TOPSIS to rank suppliers.

The first paper focuses specifically on social sustainability in the construction industry and seeks to identify and weight key social criteria by interviewing experts and using AHP and TOPSIS. It aims to provide an MCDM model for construction organizations to improve the social sustainability of projects. The second paper examines the different dimensions of sustainability in the electronics industry and evaluates four dimensions: economic, social, environmental and ethical and 16 sub-criteria. The aim of this study is to provide a comprehensive and practical model for selecting sustainable suppliers in this industry.

In both papers, the AHP method is used to determine the relative weight of the criteria and TOPSIS is used to evaluate suppliers based on these criteria. The results show that although economic factors are of great importance in selecting sustainable suppliers, other sustainability criteria such as human rights, occupational health and safety, pollution control, financial transparency, and social criteria should also be considered. These two studies propose MCDM computational models as an effective tool to help companies select sustainable suppliers in their supply chains.

## **Introduction**

### **1.Problem definition:**

The main issue discussed in both papers is the lack of attention to the different dimensions of sustainability in the supplier selection process in supply chains, especially in the construction and electronics industries. While much research has focused on the environmental and economic aspects, the social and ethical dimensions of sustainability have often been neglected. This neglect poses serious challenges, especially in industries with significant social and environmental impacts, such as construction and electronics.

In the construction industry, the focus is particularly on the social aspects of sustainability, given that these criteria are often neglected in the supplier selection process. In the electronics industry, the complexity and challenges of selecting sustainable suppliers, taking into account the different economic, social, environmental and ethical dimensions, have been raised as a major problem.

Both papers, by presenting a multi-criteria decision-making (MCDM) approach based on AHP and TOPSIS methods, seek to provide a comprehensive solution for evaluating and selecting suppliers that are committed to sustainability principles. The goal is to enable organizations to select suppliers that are not only financially and environmentally sound, but also adhere to social and ethical values at the same time, thereby helping to promote overall sustainability in supply chains.

### **2. Problem classification:**

According to the content presented in the abstracts of the two papers, the following classifications can be considered for the issues raised in them:

#### **2-1First paper:**

Main topic: AHP-TOPSIS social sustainability approach for supplier selection in the construction supply chain

#### **2-1-1Main area:**

- Supply chain sustainability: The paper focuses on the field of supply chain management and specifically on supply chain sustainability. This means examining how to select and manage suppliers in a way that simultaneously achieves economic, social and environmental goals.

- Construction Industry: The specific focus of the paper is on the construction industry. This industry is of particular importance in the area of sustainability due to its wide-ranging impacts on the environment and society.

#### **2.1.2Key Aspects of Sustainability:**

- Social Sustainability: The main issue of the paper is the lack of attention to the social aspects of sustainability in the supplier selection process. This means examining the social impacts of supply chain decisions on local communities, workers and other stakeholders.

#### **2.1.3Problem Type:**

- Multi-Criteria Decision Making (MCDM): The paper seeks to present a multi-criteria decision making model that helps organizations make decisions based on several different criteria (social, economic, and environmental). This indicates the complexity of the problem and the need for a structured approach to solve it.

- Supplier Evaluation and Selection: The main focus of the paper is on supplier evaluation and selection. In other words, the paper attempts to identify criteria that help organizations select the best suppliers in terms of social sustainability.

#### **.2.1.4Research Gap:**

- Lack of Research in the Field of Social Sustainability: The paper specifically points out the lack of research in the field of social sustainability compared to economic and environmental sustainability. This indicates a gap in knowledge that the paper attempts to fill.

#### **2.1.5Methodology:**

- Combination of quantitative and qualitative methods: The paper used a combination of quantitative

(such as AHP and TOPSIS) and qualitative (such as interviews with experts) methods for data collection and analysis.

o AHP: To determine the weight of social criteria.

o TOPSIS: To rank suppliers based on different criteria.

2.1.6 Overall objective:

•Providing a decision-making model: The ultimate objective of the paper is to provide a practical and applicable decision-making model that construction organizations can use to improve social sustainability in their projects.

•Promoting social sustainability: Finally, the paper attempts to contribute to promoting social sustainability in the construction industry by providing a decision-making tool.

In short, the main issue of the paper is categorized in the field of supply chain sustainability, especially in the construction industry, focusing on social sustainability and providing a multi-criteria decision-making model for selecting suppliers based on social indicators.

2-2 Second Paper:

Main Topic: Using AHP-TOPSIS Methodologies Helps in Selecting Sustainable Suppliers in a Sustainable Electronics Supply Chain.

2-2-1 Main Research Area:

•This paper is in the field of supply chain management and, in particular, the selection of sustainable suppliers in the electronics industry.

2-2-2 Key Issue:

•The main issue of the paper is the complexity of the process of selecting suppliers that, in addition to economic aspects, also meet social, environmental and ethical sustainability criteria.

2-2-3 Main challenges:

•Multi-criteria decision making: Selecting a sustainable supplier requires the simultaneous evaluation of several criteria that overlap.

•Uncertainty and ambiguity: In this process, we face incomplete information and various uncertainties.

•Prioritizing different criteria: Determining the relative importance of economic, social, environmental and ethical criteria, as well as their multiple sub-criteria, is a challenge in itself.

2-2-4 Proposed methodology:

•The paper presents a hybrid approach that uses two multi-criteria decision making methods, namely AHP and TOPSIS.

•AHP: is used to weight the main criteria and sub-criteria.

•TOPSIS: is used to rank suppliers based on their proximity to the positive ideal solution.

2-2-5 Dimensions of sustainability under consideration:

•Sustainability is examined in the following four main dimensions:

o Economic

o Social

o Environmental

o Ethical

•Each of these dimensions is further divided into different sub-criteria.

2-2-6 Ultimate Objective:

•The aim of the paper is to provide a comprehensive and practical model to help electronics companies select sustainable suppliers.

•This model helps managers make more informed decisions and move their supply chain towards

greater sustainability.

#### 2-2-7Key Results:

- Economic factors remain of great importance in supplier selection.
- However, social and ethical dimensions should not be ignored and require more attention.

#### -1Mathematical Modeling:

##### 3-1First Paper

The mathematical modeling presented in the paper uses two main techniques, including Analytic Hierarchy Process (AHP) and the Top-Priority Similarity to Ideal Solution (TOPSIS) technique, to develop a Multi-Criteria Decision Making (MCDM) model. This model helps select suppliers in the construction supply chain with respect to social sustainability criteria. First, using AHP, the relative weights of 23 social criteria are determined. These criteria are collected through expert interviews and literature review. AHP uses pairwise comparisons to create a hierarchy of importance of criteria and sub-criteria, which helps to avoid inconsistencies in the results.

After determining the weights of the criteria with AHP, the TOPSIS model is used to rank suppliers based on social attributes. The TOPSIS process involves creating a decision matrix based on the suppliers' scores on the 17 identified attributes, normalizing this matrix, and then determining the positive and negative ideal solutions. By calculating the distances of each supplier from the ideal solutions, a closeness coefficient is calculated, which indicates the suppliers' social performance. This process allows for an accurate assessment of suppliers against the defined social criteria.

Finally, a sensitivity analysis is performed to examine the impact of changing the attribute weights on the ranking. This analysis is performed in five different scenarios, in which one of the characteristics is removed in each scenario and its impact on the overall ranking is examined. The results show that some suppliers are more consistent in their social performance. This model is introduced as a practical tool for construction organizations that can be effective in improving the social aspects of sustainability and in selecting appropriate suppliers for construction projects.

##### 3-2 Second article:

##### Determining the weight of criteria using AHP

In this article, the Analytic Hierarchy Process (AHP) method is used to determine the relative weight of different sustainability criteria. AHP is a multi-criteria decision-making method that helps in structuring and analyzing complex problems. In this method, the main criteria (economic, social, environmental and ethical) and their related sub-criteria are evaluated through pairwise comparisons. These comparisons are made using a nine-point hourly scale, in which a pairwise comparison matrix is formed and then the relative weight of each criterion is obtained by calculating the eigenvector. These weights indicate the relative importance of each criterion in the decision-making process and are then used to rank suppliers.

##### **Ranking suppliers using TOPSIS**

After determining the weight of criteria with AHP, the Technique for Sorting by Similarity to the Ideal Solution (TOPSIS) is used to rank suppliers. In this method, first a decision matrix is formed in which the performance of each supplier in each sub-criteria is evaluated. Then, the decision matrix is normalized and a weighted matrix is created using the weights calculated from AHP. Next, the positive ideal solution (best performance in each criterion) and the negative ideal solution (worst performance in each criterion) are determined. Finally, the distance of each

supplier from the positive and negative ideal solutions is calculated and the proximity index of each supplier to the positive ideal solution is obtained using a special formula. The supplier with the highest proximity index is selected as the best option.

### **Combination of AHP and TOPSIS models**

The combination of AHP and TOPSIS methods in this paper provides an integrated model that includes both weighting of criteria and ranking of suppliers. AHP is used in the first stage to determine the weights of different sustainability criteria (economic, social, environmental and ethical). These weights are then fed as input into the TOPSIS method and used to rank suppliers based on their performance on various criteria. This model helps electronics companies make better decisions when selecting sustainable suppliers. Using this model, companies can simultaneously consider economic, social, environmental, and ethical factors and select suppliers that contribute to their sustainability goals. This model also serves as a decision-making tool to promote sustainability in the supply chain.

#### **1. Problem-solving method:**

##### **4-1 First article:**

The problem-solving method in the attached article is carried out with a structured approach and a combination of two multi-criteria decision-making techniques, namely the Analytic Hierarchy Process (AHP) and the TOPSIS technique, for the selection of suppliers in the construction supply chain. This approach is designed with the aim of evaluating and selecting suppliers who are committed to social sustainability in addition to economic and environmental aspects. In short, this method consists of several basic steps: First, using interviews with experts and a literature review, important social sustainability criteria related to the selection of suppliers are identified and categorized. Then, using the AHP method, the relative weight of each of these criteria is determined based on their importance in the decision-making process. Finally, the TOPSIS method is used to rank suppliers based on their performance in the determined criteria.

In the first step, social sustainability criteria that are important in the selection of suppliers are identified. These criteria are usually grouped into different categories such as social strategy, health and safety, stakeholder participation and technical training of employees. Once identified, the relative weight of each criterion is determined using the AHP method by conducting structured interviews with experts. In this step, pairwise comparisons are used to determine the relative importance of the criteria to each other, and a hierarchical structure of the criteria is created, which helps to avoid inconsistencies in the results. These weights indicate the degree of influence of each criterion in the final decision-making.

In the second step, using the weights obtained from the AHP, the TOPSIS technique is applied to evaluate and rank suppliers. In this step, data on the performance of suppliers in different criteria are collected and normalized using the TOPSIS method. Then, the distance of each supplier from the positive and negative ideal solutions is calculated, and according to this distance, the closeness coefficient is determined for each supplier. Based on this coefficient, suppliers are ranked from best to worst based on social sustainability. Finally, a sensitivity analysis is performed to assess the impact of changes in the weights of the criteria on the supplier rankings. This analysis shows how changes in the relative importance of the criteria affect the final supplier selection and allows decision makers to adjust their decisions based on different conditions. In this way, the proposed method provides a comprehensive and reliable approach for selecting suppliers based on social sustainability criteria in the construction industry. 4-2 Second paper:

A multi-stage approach to sustainable supplier selection The paper addresses the issue of

sustainable supplier selection with a multi-stage approach. In the first stage, sustainability criteria relevant to the electronics industry are identified through a literature review and expert opinion. In the next stage, the Delphi method is used to finalize these criteria and their sub-criteria using expert opinion. This process ensures that the supplier selection criteria are comprehensive and appropriate to the context. These initial stages help prepare the decision-making framework and identify the key criteria for evaluating suppliers.

Using the combination of AHP and TOPSIS methods After preparing the decision-making framework, two multi-criteria decision-making methods (MCDM), namely the Analytic Hierarchy Process (AHP) and the Priority Sorting Technique with Similarity to Ideal Solution (TOPSIS), are used in combination to solve the problem. First, the AHP method is used to determine the relative weight of each of the identified main criteria and sub-criteria. At this stage, pairwise comparisons between criteria are made to determine their relative importance in the decision-making process. Then, TOPSIS method is used to rank suppliers based on their performance on different criteria. In this method, the distance of each supplier from the positive and negative ideal solution is calculated and the ranking is done based on the proximity to the positive ideal solution.

Application in Electronics Industry and Evaluation of Results The proposed model is implemented in the paper in an electronics company located in Western India. Six potential suppliers are evaluated using the established sustainability criteria. The results of this study show that in the studied industry, economic factors still have the greatest impact on supplier selection, but social factors have also become of great importance. Also, the model showed that the combination of AHP and TOPSIS can be an effective tool for evaluating suppliers by simultaneously considering qualitative and quantitative criteria. Finally, the ranking of suppliers from best to worst is presented using the proposed model and helps managers to make better decisions about supplier selection.

#### Literature Review

##### **5-1 First Article:**

The literature review of the attached article shows that this research has been able to identify gaps in the literature related to the construction supply chain. This article specifically addresses the lack of attention to the social dimensions of sustainability compared to the economic and environmental dimensions. By carefully reviewing previous articles, the authors have shown that most of the existing research in this field has focused on financial aspects and reducing environmental impacts, while social criteria, which play a vital role in supply chain sustainability, have been ignored. This article takes an important step towards filling this gap by identifying and categorizing 23 social sustainability criteria, such as stakeholder participation, worker health and safety, and employee rights. These criteria are introduced as a tool for evaluating suppliers that directly affect the sustainability of construction projects.

The paper then critiques the methodologies used in previous research and shows that many existing multi-criteria decision-making models are unable to comprehensively evaluate suppliers based on social criteria due to their excessive focus on environmental criteria. Introducing the AHP-TOPSIS hybrid model as a solution to this problem, the authors show that by integrating social criteria into the decision-making process, it is possible to select suppliers that have a greater commitment to social sustainability. However, the paper acknowledges that one of the challenges in this area is the lack of a precise and agreed-upon definition of social sustainability. Emphasizing the need to create a standard framework for measuring social dimensions, the authors emphasize the importance of further research in this field and introduce the paper as an important step towards creating the required frameworks. By providing a comprehensive and well-documented view of the challenges and imperatives of social sustainability in supplier selection, this article not only

contributes to the existing literature but also paves the way for future research in this area.

**5-2 Article II:**

**Strengths in the coverage of existing literature** The article has well covered the existing literature on sustainable supply chain management (SSCM) and sustainable supplier selection (SSS). The authors rightly emphasize the increasing importance of sustainability in supply chains, especially in sensitive industries such as electronics. The literature review shows that the authors are well acquainted with the historical developments in supplier selection criteria, from focusing solely on economic criteria to considering environmental, social, and ethical aspects (the triple bottom line approach). The article also well points out the lack of attention to the ethical dimension in previous research and highlights its importance in selecting sustainable suppliers. This comprehensive approach helps the authors to identify the gap in the literature and justify the necessity of their research. Also, the literature review provides a good theoretical and practical background for the use of multi-criteria decision-making (MCDM) methods such as AHP and TOPSIS.

**Possible weaknesses and limitations in the literature review** Despite the good coverage of the existing literature, the paper could have addressed some of the more specific aspects of research conducted on sustainable supplier selection in the electronics industry. For example, a closer examination of case studies that have used a combination of AHP and TOPSIS methods in similar contexts could have led to a deeper understanding of the strengths and weaknesses of this approach in practice. The paper could also have pointed out more about the limitations of using multi-criteria decision-making approaches, such as the dependence of the results on the choice of evaluation criteria and expert opinion. Failure to examine these limitations more closely may leave the reader with an incomplete view of the applicability of the proposed model. Overall, the literature review of the paper is strong, but more attention to similar case studies and an examination of the limitations of the methods used could have added to its comprehensiveness.

Aspect	Article 1: AHP-TOPSIS Social Sustainability Approach in the Construction Supply Chain	Paper 2: AHP-TOPSIS Methodologies in the Electronics Supply Chain	Gaps and Questions
Main focus	Supplier Selection with a Focus on Social Sustainability in Construction	Sustainable Supplier Selection in the Electronics Industry	Do the models address both dimensions of sustainability (social and environmental) equally?
Industry type	Construction	Electronics	What are the differences in supplier selection criteria between these industries?
Methodology	AHP-TOPSIS	AHP-TOPSIS	How are the weighted criteria in the AHP determined in both papers and are they reasonable?
Sustainability dimensions	Social Sustainability	Sustainability (possibly including social and environmental aspects)	Or do both papers examine different dimensions of sustainability equally? If not, which aspects are emphasized more?
Supplier selection criteria	(must be specified in the article)	(must be specified in the paper)	What specific criteria were used in each industry for supplier selection? Are there any fundamental differences?
Data used	(must be specified in the article)	(must be specified in the paper)	What sources did the data come from? Is the quality of the data similar in both papers?

**Conclusion:**

These two papers highlight the growing importance of sustainability in supply chains, particularly in supplier selection in the electronics and construction industries. Both studies show that in the past, economic criteria often dominated supplier selection, but increasing pressures on sustainability have necessitated the integration of social, environmental, and ethical criteria. To address this challenge, these papers propose multi-criteria decision-making (MCDM) models based on the AHP and TOPSIS methods. The model presented in the electronics industry selects the supplier that performs best in these areas by considering economic, social, environmental, and ethical dimensions in the form of 16 criteria. In the construction industry, the proposed model helps decision-makers make more informed choices by focusing on social sustainability and ranking suppliers based on social criteria. The results of both studies show that considering sustainability criteria not only leads to better performance in this area, but also helps to promote accountability and transparency in business relationships. These papers suggest that supply managers should consider comprehensive approaches that incorporate different dimensions of sustainability alongside economic considerations and, by implementing sustainable supply chain practices, contribute to broader goals such as corporate social responsibility and sustainable development. Finally, future research should examine the proposed models in different industries and incorporate uncertainties to improve and expand these models.