
MAPPING INDUSTRIAL SUSTAINABILITY ASSESSMENT METHOD: A STUDY OF TEXTILE

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ABSTRACT

Indonesia's textile and textile product (TPT) industry is a strategic manufacturing sector facing various challenges in maintaining competitiveness and sustainability. These issues encompass energy and raw material efficiency, waste management, demands for improved workforce welfare, technological modernization, and supply chain resilience. The complexity of these challenges indicates that sustainability assessment in the textile industry requires a multidimensional approach that considers the interrelationships among indicators. This research aims to develop a measurement model and a strategy for enhancing the sustainability of Indonesia's TPT industry using a Multi-Criteria Decision Making (MCDM) approach. The study employs the Delphi method to identify and validate sustainability indicators, the Analytical Hierarchy Process (AHP) to determine indicator weights, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) to analyze cause-and-effect relationships among indicators, and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to measure and prioritize sustainability performance. The developed indicators cover five dimensions: economic, environmental, social, technological, and supply chain. The integration of these methodologies is expected to yield an assessment model capable of determining the industry's sustainability level, identifying critical indicators and key causal factors, and establishing priorities for improvement strategies within the textile industry.

KEYWORDS

MCDM, Sustainability, Indicator, Industry, Textile



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INTRODUCTION

The challenges facing the Indonesian textile industry are not only related to productivity and economic aspects, but also encompass environmental, social, technological, and supply chain aspects. The government has identified a number of structural challenges, including high dependence on imported raw materials, relatively high energy and logistics costs, a gap in human resource competency, and weak supply chain integration from upstream to downstream. Furthermore, the textile and textile industry also faces external pressures in the form of excess production capacity from competing countries and dumping practices. On the other hand, global market developments are increasingly driving the demand for high-value-added products and sustainable materials, making the industry's ability to meet sustainability demands a crucial component of future competitiveness (Limanseto, 2025).

Transformation towards a sustainable industry is becoming increasingly important because the textile production process has various environmental consequences, particularly related to the use of raw materials, energy, water, chemicals, waste, and emissions (Khan, Nizami, Yasar, & Musharavati, 2025). At the same time, industrial sustainability cannot be assessed solely on environmental performance, as economic and social aspects also determine a company's long-term viability. The Indonesian government has even developed a green industry instrument that covers the selection of raw materials and auxiliary materials, energy, water, production processes, products, packaging, waste, greenhouse gas emissions, and management and labor aspects. This demonstrates that measuring the sustainability of the textile industry requires a multidimensional approach (Agusti, Buwono, Dwyanton, & Wahyono, 2025) (Agusti, Destyarini, Buwono, Novira, & Dwyanton, 2026).

Several previous studies have developed approaches to measure the sustainability of the textile industry. The TOPSIS method to assess the sustainability performance of the textile industry using data from Inditex, emphasizing the importance of integrating economic, social, and environmental dimensions into sustainability measurement (Netto, et al., 2021). Subsequently, applied a combination of AHP and TOPSIS to evaluate the sustainability programs of six textile companies in Brazil. Their research demonstrated that MCDM approaches can generate a sustainability index while simultaneously ranking alternatives based on triple bottom line criteria.

MCDM approaches have also been applied to specific issues within the textile supply chain (Rahman, Bari, Ali, & Taghipour, 2022). For instance, research on sustainable supplier selection in the textile dyeing industry utilized SWARA to determine criterion weights and WASPAS to rank suppliers. The study results indicated that chemical quality, price, delivery punctuality, worker health and safety, and environmental management systems were critical criteria for sustainable supplier selection. Another study employed a combination of AHP and ELECTRE-TRI to integrate economic, social, environmental, and ethical criteria into supplier evaluation within the textile industry. The findings demonstrated the need to consider sustainability aspects simultaneously during supply chain decision-making.

Recent research developments indicate efforts to establish more comprehensive sustainability indicators (Fadara, Wong, & Zarei, 2024), for example, developed a sustainability indicator framework for the textile industry in developing countries by integrating the Delphi method and the fuzzy Best-Worst Method. The study yielded 64 indicators, comprising 16 economic, 24 environmental, and 24 social indicators. Notably, raw material usage, operational costs, and fuel consumption were identified as high-importance indicators. These findings suggest that measuring sustainability in the textile

industry requires taking into account the specific characteristics of the industry in developing countries, rather than focusing solely on environmental aspects. Given these conditions, a model is required that is capable not only of measuring the sustainability level of the textile industry but also of identifying critical indicators and determining priority strategies to enhance sustainability performance.

RESEARCH METHOD

This research consists of four main stages that form a systematic flow in developing product sustainability indicators. These four stages include: (1) collecting articles, (2) sorting articles, (3) selecting indicators, and (4) developing indicators. Figure 1 was a flowchart of the overall research process from the initial to the final stage.

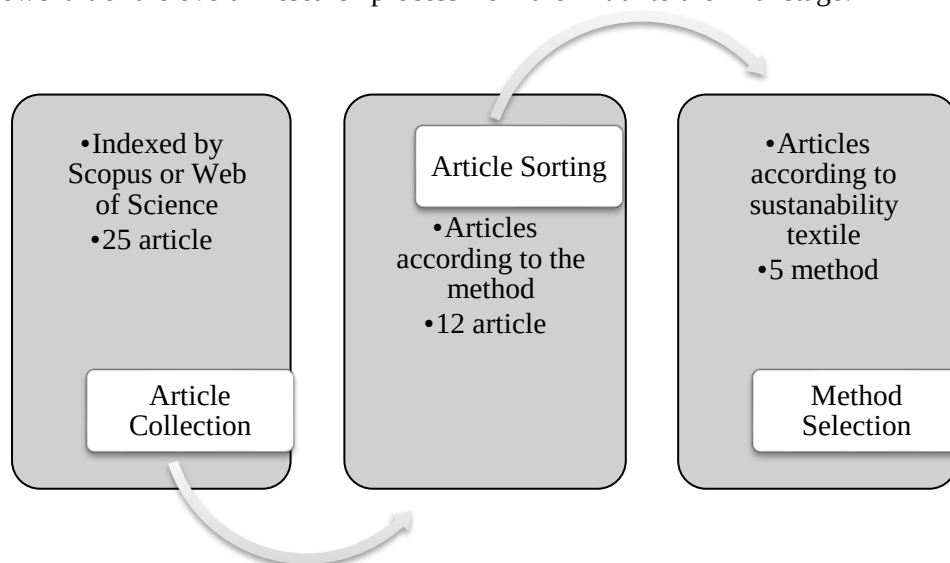


Figure 1. Research Flowchart

Stage 1: Article Collection

The first stage aims to gather relevant literature as a basis for indicator development. This collection was conducted by searching articles from various academic sources, using three main criteria:

- Articles must come from reputable international journals,
- Proceedings of credible international conferences,
- National journals accredited by authorized institutions.

This search was conducted using keywords relevant to the topic of sustainability textile. The result of this stage was the collection of 25 scientific articles deemed to meet these three criteria and be relevant to the research topic.

Stage 2: Article Selection

In the second stage, a further selection process was conducted on the 11 articles collected. The selection was based on two additional criteria:

- Topic relevance, meaning the article must directly address sustainability in the context of sustainability textile,
- Research method suitability, meaning the method used in the article must be appropriate or applicable within the research methodology framework.

Through this selection process, the number of articles deemed worthy of further analysis was narrowed down to 12. These articles were then used as the basis for the next stage.

Stage 3: Method Selection

The third stage focused on identifying the sustainability method used in the selected articles. Each emerging method was analyzed in terms of:

- a. Its relevance to sustainability assessment,
- b. Its relationship to sustainability principles (environmental, social, and economic),
- c. Its frequency of occurrence in the literature.

The goal was to identify key indicators that have been tested or suggested by previous researchers in the context of sustainable textile. This stage resulted in a diverse initial list of method, covering various aspects of sustainability.

Through this process, a comprehensive sustainability method framework is developed that can be used in the development of future sustainable textile.

RESULT AND DISCUSSION

Several previous studies have developed approaches to measuring the sustainability of the textile industry. Acar, Kılıc, and Guner used the TOPSIS method to measure the textile industry's sustainability performance based on Inditex company data and emphasized the importance of integrating economic, social, and environmental dimensions in sustainability measurement. Furthermore, Lombardi Netto and Salomon applied a combination of AHP and TOPSIS to evaluate the sustainability programs of six textile companies in Brazil. This study demonstrated that the MCDM approach can generate a sustainability index while also ranking alternatives based on triple bottom line criteria.

The MCDM approach has also been used for more specific issues in the textile supply chain. For example, a study on sustainable supplier selection in the textile dyeing industry used SWARA to determine criteria weights and WASPAS to rank suppliers. The results showed that chemical quality, price, on-time delivery, worker health and safety, and environmental management systems are important criteria in sustainable supplier selection. Another study used a combination of AHP and ELECTRE-TRI to integrate economic, social, environmental, and ethical criteria in evaluating textile industry suppliers. The results demonstrate that sustainability aspects need to be considered simultaneously in supply chain decision-making.

Recent research developments indicate efforts to develop more comprehensive sustainability indicators. Fadara tahun 2024, for example, developed a sustainability indicator framework for the textile industry in developing countries through an integration of the Delphi method and the fuzzy Best-Worst Method. The study yielded 64 indicators, consisting of 16 economic, 24 environmental, and 24 social indicators. Interestingly, raw material use, operational costs, and fuel consumption were among the indicators with high levels of importance. These findings demonstrate that measuring the sustainability of the textile industry needs to consider the characteristics of the industry in developing countries and cannot simply focus on environmental aspects.

More recent research also reinforces the relevance of MCDM in measuring sustainability within the textile industry. Acar tahun 2025 employed TOPSIS and WASPAS to evaluate the annual sustainability performance of global textile groups based on a range of sustainability indicators. Meanwhile, a 2026 study developed a sustainability evaluation model for the textile industry by integrating KPIs based on sustainability standards and the three key pillars: social, environmental, and economic.

Table 1 presents a list of previous studies used as references. Based on the initial research concept, several research sources were obtained from the opinions of experts and previous researchers.

Table 1. List of Previous Research

No	Method	Advantages	Disadvantages	Author
1	Multi Criteria Decision Making (MCDM)	SWARA - WASPAS	SWARA is a simple method for determining weights based on expert opinion; WASPAS combines the WSM and WPM approaches; the method is easy to implement, suitable for handling numerous alternatives, and allows for sensitivity analysis.	(Rahman, Bari, Ali, & Taghipour, 2022)
		AHP - TOPSIS	Systematic structure; AHP is easy to understand; TOPSIS yields a proximity value relative to the ideal condition; capable of generating indices and rankings; proven application in the textile industry.	(Netto, et al., 2021)
		WASPAS - TOPSIS	Using two methods so as to compare the consistency of results; relatively simple; suitable for multidimensional evaluation; TOPSIS and WASPAS produce rankings that are easy to understand	(Acar, 2025) (Ozdagoglu, Acar, Guner, & Bakadur, 2024)
		ELECTRE -TRI	Suitable for classification rather than mere ranking; non-compensatory in nature, meaning poor performance on one criterion cannot easily be "masked" by another; capable of accommodating thresholds.	(Guarnieri & Trojan, 2019)
		DEMATEL	Excellent for identifying cause-and-effect relationships; capable of distinguishing between cause and effect factors; suitable for complex, interconnected	Not designed to directly measure sustainability values; does not yield a complete performance ranking of alternatives; requires expert judgment; results can be

No	Method	Advantages	Disadvantages	Author
		problems; produces a causal diagram.	sensitive to expert perceptions.	
2	Fuzzy Best-Worst Method (BWM)	Requires fewer comparisons than AHP; efficient for handling numerous indicators; fuzzy logic accommodates uncertainty in expert judgments; yields more structured indicator weights.	Focuses solely on weighting; does not explain causal relationships; does not rank alternatives; fuzzy implementation is more complex and requires clear mathematical explanation.	(Fadara, Wong, & Zarei, 2024)
3	Fuzzy Modified Balanced Scorecard Technique	Integrates strategic perspectives—incorporating economic, environmental, social, and organizational dimensions—and employs a fuzzy approach to handle uncertainty.	The BSC structure is fundamentally oriented toward performance management rather than specific sustainability assessment; the construction of perspectives and indicators is quite subjective; and it lacks flexibility regarding causal relationships.	(Liu, et al., 2023)
4	Life Cycle Assessment (LCA)	Highly robust for measuring environmental impacts across the entire lifecycle; data-driven; capable of identifying environmental hotspots; highly suitable for energy, water, emissions, and materials.	Primary focus on the environment; requires extensive data; relatively expensive and complex; less suitable for simultaneously integrating social, technological, and supply chain aspects.	(Edirisinghe, De-Alwis, Wijayasundara, & Hemali, 2024) (Gonzalez, Lou, & Chi, 2022) (Moazzem, Crossin, Daver, & Wang, 2021)
5	Textile Sustainability Index (TSI)	Specific to the textile industry; produces an easily understandable index; allows for comparison against targets/benchmarks; capable of identifying indicators with poor performance.	Highly dependent on the defined indicators and targets; can be static; does not explain cause-and-effect relationships; not necessarily generalizable to the Indonesian context.	(Khan, Nizami, Yasar, & Musharavati, 2025)

CONCLUSION

Based on a synthesis of various sustainability assessment methods for the textile industry, it can be concluded that no single method is capable of simultaneously identifying indicators, determining weights, analyzing inter-indicator relationships, measuring sustainability levels, and formulating improvement strategies. Methods such as AHP–TOPSIS, SWARA–WASPAS, and WASPAS–TOPSIS excel in weighting and ranking alternatives but fail to elucidate the cause-and-effect relationships between indicators. DEMATEL excels at identifying causal relationships but does not directly yield a sustainability level value. Fuzzy BWM is effective for determining indicator weights with

fewer comparisons and accommodates the uncertainty inherent in expert judgments, yet it cannot be used to measure performance or prioritize alternatives. Meanwhile, LCA is highly robust in evaluating environmental impacts across the entire life cycle, but its scope does not directly encompass economic, social, technological, and supply chain aspects. The Textile Sustainability Index offers the advantage of producing an easily understandable sustainability metric, but it does not explain the underlying factors or mechanisms for enhancing sustainability performance.

The research implies the development of sustainability indicators tailored to the context of the Indonesian textile industry. Unlike studies relying on generic "triple bottom line" indicators, this research incorporates economic, environmental, social, technological, and supply chain dimensions. This approach is crucial because the Indonesian textile industry faces specific challenges, such as aging machinery, high energy consumption, reliance on raw materials, pressure from imports, and demands for more environmentally friendly production.

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