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Indicators and Framework for Measuring Industrial Sustainability in Italian Footwear Small and Medium Enterprises

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Abstract: As small and medium enterprises (SMEs) have limited resources, they need a manageable number of indicators that are simple and easy to use for measuring sustainability performance. However, the lack of suitable indicators tailored to industry needs, particularly for SMEs, has been a major challenge in measuring and managing industrial sustainability. Our study aims to empirically analyze and select the useful and applicable indicators to measure sustainability performance in Italian footwear SMEs. To achieve this objective, we proposed a methodological approach to identify, analyze and select sustainability indicators. First, we carried out a systematic review to identify potential sustainability indicators from the literature. Then, we developed a questionnaire based on the identified indicators and pre-tested it with selected industrial experts, scholars, and researchers to further refine the indicators before collecting data. We applied the fuzzy Delphi method to analyze and select the final indicators. Based on a sample of 48 Italian footwear SMEs, the results of our study show that product quality, material consumption, and customer satisfaction were the top priorities among the selected indicators for measuring the economic, environmental, and social dimensions of industrial sustainability, respectively. The selected indicators stressed the measuring of industrial sustainability performance associated with financial benefits, costs, market competitiveness, resources, customers, employees, and the community. Our study proposed a framework that helps to apply the selected indicators for measuring sustainability performance in SMEs. Finally, our study contributes to the existing theory and knowledge of industrial sustainability performance measurement by providing indicators supported by empirical evidence and a framework to put the indicators into practice in the context of SMEs.

Keywords: indicator; framework; industrial sustainability; Italian footwear SMEs; fuzzy Delphi method

Citation: Mengistu, A.T.; Panizzolo, R. Indicators and Framework for Measuring Industrial Sustainability in Italian Footwear Small and Medium Enterprises. *Sustainability* **2021**, *13*, 5472. https://doi.org/10.3390/su13105472

Academic Editors: Carlos Rodriguez-Monroy and Marc A. Rosen

Received: 1 February 2021
Accepted: 7 May 2021
Published: 13 May 2021

1. Introduction

Adopting sustainability practices in manufacturing industries requires a holistic approach at different application scopes, which varies from the production line to the plant, firm, and supply chain level [1]. Industrial sustainability refers to the adoption of sustainability practices at the firm level [2]. It has become an essential topic of discussion [3] and has gained substantial attention among industrial decision-makers, policy-makers, and scholars [2,4]. Manufacturing industries are the main driving force of economic growth and social development of a country [5,6]. However, they are believed to be one of the main causes leading to unintended environmental and social consequences [6]. Subsequently, they are duly required to improve sustainability and be transparent about their sustainability practices [7]. Various stakeholders have put pressure on them to adopt sustainability practices [1,8,9] in order to address the growing concerns of environmental and social impacts [10–12].The stakeholders of industrial sustainability include governments, investors, political groups, trade associations, suppliers, employees, customers, and communities [13].

Moreover, sustainability is adopted to gain a competitive advantage [11,14,15]. To effectively adopt sustainability in manufacturing industries, it is essential to measure their performance [3,7]. In this context, industrial sustainability refers to the adoption of sustainability practices at the industrial plant (firm) level [2]. It considers actions that are taken at the material, product, process, plant, and production system levels [16].

The term industrial sustainability was coined by the Institute for Manufacturing at the University of Cambridge, which defines it as "conceptualization, design and manufacture of goods and services that meet the needs of the present generation while not diminishing economic, social and environmental opportunity in the long-term" [13]. Moreover, Zeng et al. [6] defined it as "development that meets the needs of economic growth, social development, environmental protection and results in industrial advantage for the short- and long-term future of the region". In this study, industrial sustainability is defined as a set of activities that includes all of the following: considering economic, environmental, and social aspects simultaneously while producing products and services; ensuring economic growth, conserving resources, and minimizing negative environmental and social impacts; and meeting stakeholder requirements in the short- to long-term. There is a common understanding that sustainability should emphasize economic, environmental, and social aspects [6,13]. Elkington [17] proposed the triple bottom line (TBL) approach, consisting of three interrelated dimensions of sustainability (economic, environmental, and social). The TBL provides a comprehensive approach for measuring sustainability performance considering these three dimensions [18]. To adequately address industrial sustainability, it is necessary to adopt a holistic approach based on the TBL [3]. Manufacturing industries have a significant impact on the three dimensions of sustainability [19,20]. Thus, they should simultaneously consider economic, environmental, and social dimensions while producing their products and services [21–24].

Small and medium enterprises (SMEs) contribute significantly to the economic growth of a country through innovation, production volume, and employment generation [25–28]. Although SMEs have significant economic, environmental, and social implications, they still struggle to address environmental and social dimensions to measure and manage their sustainability performance [29,30], and are primarily focused on the economic dimension [7,31]. This is due to limited resources [7,30,32–34], lack of awareness of the associated impacts and benefits of sustainability [30,33], and a lack of skills and expertise [7,30,33]. Moreover, the lack of suitable indicators tailored to SMEs' needs is still a major challenge in measuring industrial sustainability [9,18]. This creates a potential research opportunity, in particular, empirical research on the analysis and selection of appropriate indicators that are simple and easy to use in the context of SMEs (i.e., indicator-based framework tailored to their characteristics).

Regarding the footwear industry, our literature analysis showed a lack of research on sustainability performance measurement based on the TBL approach. There is limited research that primarily addresses the environmental dimension [35,36]. This motivated us to consider Italian footwear SMEs as our research context to conduct an empirical study. The footwear sector is one of the main industrial sectors driving the economic growth and social development of Italy. According to Assocalzaturifici [37], the sector had about 74,890 employees and a yearly turnover of about 14.3 billion euros by 2019, and consumes a variety of input materials such as leather, synthetic, rubber, and textile materials for production. These figures indicate that the economic, environmental, and social (TBL) implications of the sector have a significant potential for promoting sustainability. The lack of clear sustainability goals, lack of suitable indicators and framework, and limited resources are major challenges in measuring the sustainability performance of footwear firms, particularly SMEs. Thus, our study was intended to address two research questions. Research question one (RQ1): what are the indicators suitable for measuring sustainability in Italian footwear SMEs? Additionally, research question two (RQ2): how can the selected indicators be applied to measure sustainability performance in SMEs? We applied the fuzzy Delphi method (FDM) to answer RQ1. In using FDM, all of the experts' opinions were incorporated into one investigation to comprehensively consider the uncertainty and ambiguity of their responses and achieve a group consensus. Thus, the results obtained become objective and rational. We proposed a framework to answer RQ2. We believe that properly addressing the research questions will help SMEs to effectively measure and manage their sustainability performance.

The rest of the work is divided into four sections. Section 2 briefly describes the research methodology applied in this study. Section 3 presents the results of the analysis. The results and the proposed framework are briefly discussed in Section 4. Finally, the conclusions of our study are presented in Section 5.

2. Methodology

We proposed the following methodological approach (Figure 1) to address the research question by providing indicators suitable for Italian footwear SMEs to measure their sustainability performance. The main steps in our approach include conducting a systematic review to identify the potential sustainability indicators (step 1), designing the questionnaire (step 2), collecting data (step 3), and analyzing the data with the fuzzy Delphi method (step 4).

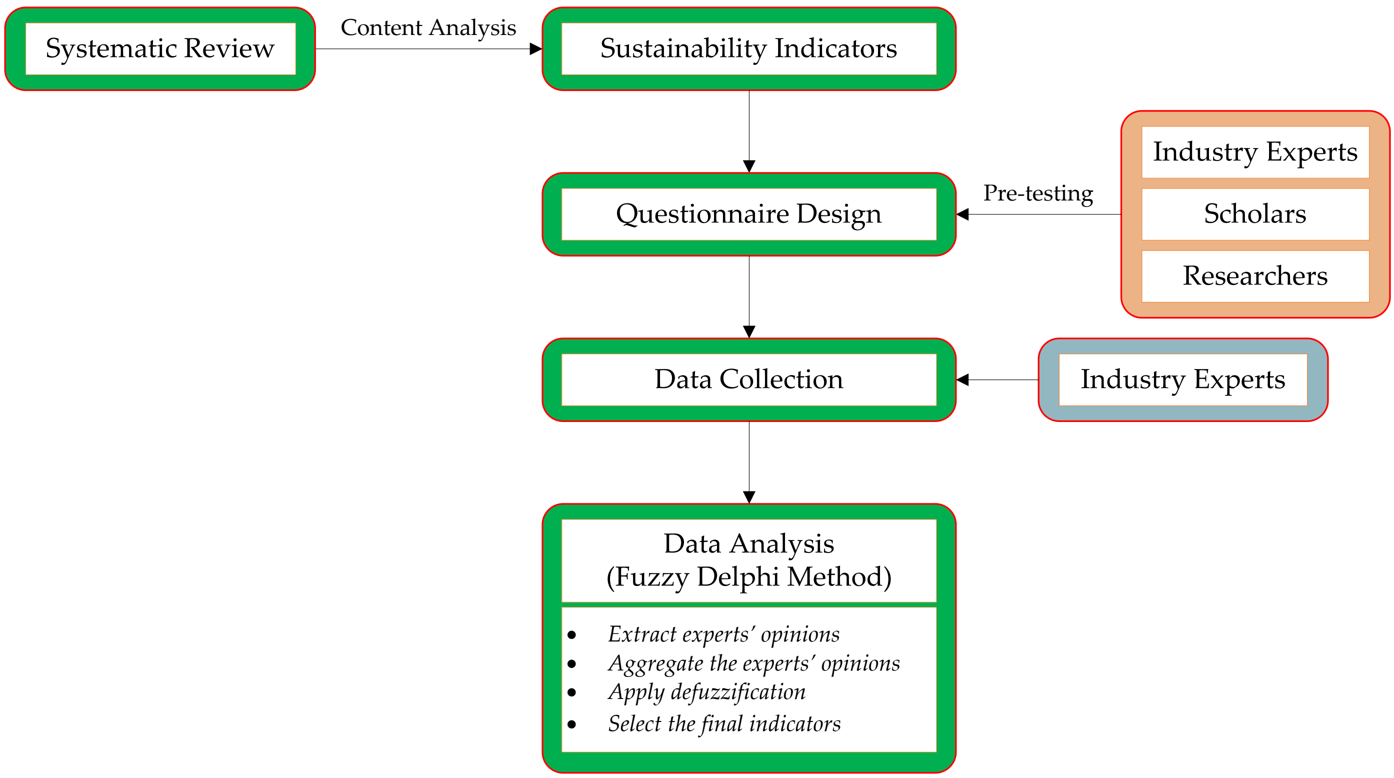

Figure 1. Methodological approach used to conduct the study.

2.1. Identification of Potential Sustainability Indicators

We conducted a systematic review to explore indicators within articles published in peer-reviewed journals that are relevant to measuring sustainability performance of manufacturing industries. For this purpose, we selected Scopus and Web of Science (WoS) as search databases, since they provide extensive coverage of peer-reviewed journal articles [38]. We used two sets of keywords correlated with the research topic for the search: ("industrial sustainability" or "sustainable manufactur*" or "sustainable firm*" or "sustainable enterpri*" or "sustainable industr*" or "sustainable factory" or "sustainable production*" or "sustainable organi*" or "sustainable compan*") in the first set, and ("indicator*" or "metric*" or "performance measure*") in the second set.

As shown in Figure 2, a total of 1456 papers published up to 2020 were initially found using the keyword searches in Scopus and WoS. Considering 919 articles that were thoroughly peer-reviewed, a total of 537 reviews, conference papers, book chapters, and other documents were excluded; additionally, 329 articles were found to be duplicates. It was not possible to access 10 full-text papers through the online search, and 1 paper was not written in the English language. In the abstract reading, 463 papers that did not focus on measuring, evaluating, or assessing the sustainability of manufacturing industries, and/or were not based a comprehensive approach (i.e., TBL) were excluded. Then, 57 papers that did not consider indicator-based assessment, and/or did not propose indicators relevant to the purpose of this study were also excluded. Finally, 59 papers were selected to explore the indicators.

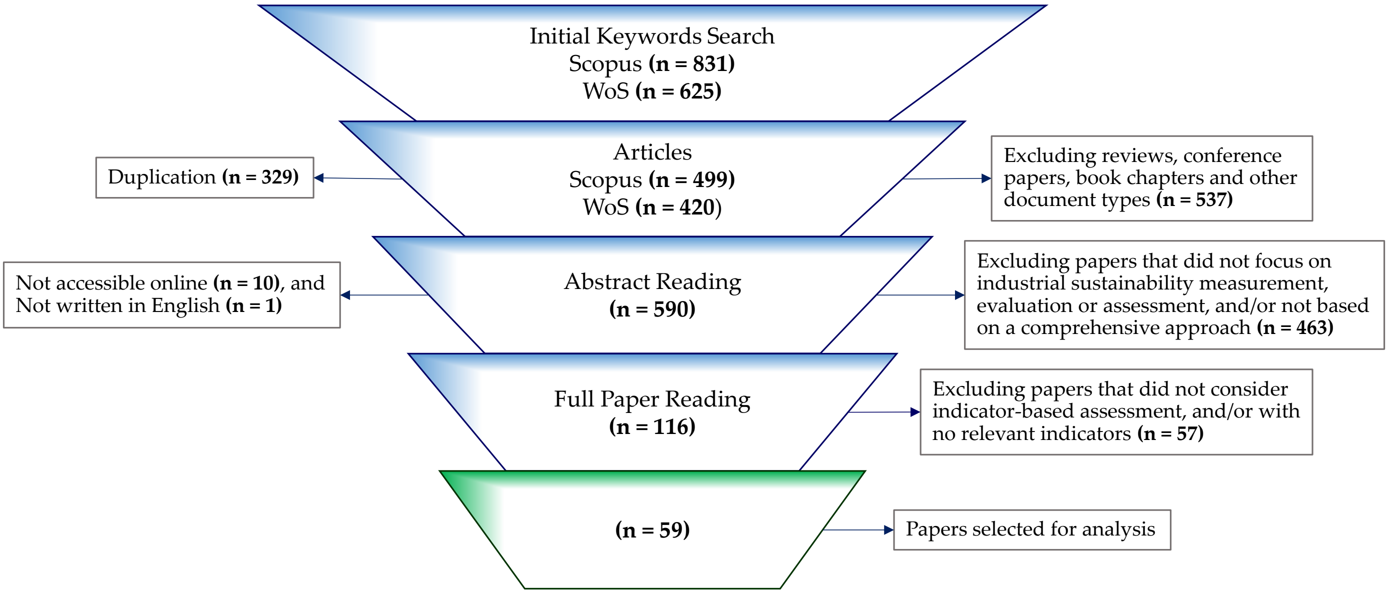

Figure 2. Approach of the systematic review.

We carried out a content analysis of the selected papers to identify consistent and frequently used indicators. After recording and organizing all the indicators published in the papers, word-by-word and phrase-by-phrase analyses were conducted to determine their consistency and frequency of use. Indicators that were found to be essentially similar were counted together. On the other hand, indicators that were different were considered to be unique [38,39].

2.2. Questionnaire Design

Based on the identified indicators from the literature analysis, we developed a questionnaire. Then, we conducted pre-testing (pilot testing) of the questionnaire with selected industry experts, scholars, and researchers [40,41]. The pre-testing was aimed at checking clarity (language clarity, context clarity, and content clarity), time (to complete the questionnaire within a few minutes if possible), redundancy (possibility of redundant questions), and relevance (connection to the objective of the study and the appropriateness of the initial indicators). We used the feedback from the pre-test to modify, add, or delete indicators so as to improve the questionnaire and increase its convergence [41].

2.3. Data Collection

The survey sample size depends on data analysis method. In the case of FDM, a small survey sample can be enough to get an objective and reasonable result [42]. Research trends also show that it is an accepted practice to use a small sample size for FDM applications. There are no guidelines or standards for an appropriate sample size for the Delphi method, but the general rule-of-thumb is to have a sample size of 15 to 30 for a homogeneous population (i.e., experts from the same profession), and 5 to 10 for a heterogeneous population (i.e., experts from different profession) [43]. In our study, to acquire the required sample size, the questionnaire was randomly distributed via email to a large sample (more than 1000 firms, regardless of size) among of a population of about 4300 footwear firms in Italy. A total of 53 responses were obtained, and 5 responses were excluded for various reasons, such as that they had missing data or were from large firms. Subsequently, we conducted the data analysis based on valid responses from 48 Italian footwear SMEs. To get empirical evidence from the users of the final selected indicators, and to increase the reliability of the results, the data collection focused on industry experts. Table 1 summarizes the position and work experience of the experts.

Table 1. Profile of experts by frequency.

Variable	Position	Frequency	Percentage (%)
Position	Chief Executive Officer/General Manager	21	44%
	Production Manager	7	15%
	Operation Manager	9	19%
	Expert/Professional Employee of Sustainability	6	13%
	Others	5	10%
Work Experience	Over 20 years	23	49%
	15 to 20 years	4	9%
	10 to 15 years	10	21%
	5 to 10 years	6	13%
	Less than 5 years	4	9%

As shown in Table 2, the largest proportion (44%) of industrial experts were chief executive officers or general managers. Most of the experts (58%) had over 15 years of work experience.

Table 2. Linguistic variables with their corresponding scales and triangular fuzzy numbers.

Fuzzy Scales	Linguistic Variables	Triangular Fuzzy Numbers (a, b, c)
1	Not important (NI)	(1, 1, 3)
3	Slightly important (SI)	(1, 3, 5)
5	Moderately important (MI)	(3, 5, 7)
7	Important (I)	(5, 7, 9)
9	Very important (VI)	(7, 9, 9)

We conducted a reliability analysis to check the consistency or repeatability of the questionnaire items (i.e., the indicators). The internal consistency method was applied for testing reliability [40]. Cronbach's alpha, which is the most common test for internal consistency, was used to assess the reliability of the data. Cronbach's alpha (α) was calculated in IBM SPSS software (version 26). The values of α were 0.710, 0.936, and 0.854 for the economic, environmental, and social dimensions, respectively, which are higher than the minimum acceptable value (0.7).

2.4. Data Analysis: Fuzzy Delphi Method (FDM)

After collecting and organizing the experts' opinions, we applied FDM to analyze and select the most useful and applicable indicators for measuring industrial sustainability in Italian footwear SMEs. FDM integrates the traditional Delphi method and fuzzy theory to address the drawbacks of the former [44]. The use of fuzzy theory combined with the traditional Delphi method can solve the vagueness and ambiguity of expert judgments to improve the efficiency and quality [41,45]. In FDM, the linguistic variables (qualitative) are converted into fuzzy membership functions (quantitative) for analysis [44]. Triangular, trapezoidal, and Gaussian fuzzy numbers are the membership functions that have been used in previous research [46]. In this study, the triangular fuzzy number was applied as a fuzzy membership function [46,47]. FDM, as applied in this study, avoided the drawbacks of the traditional Delphi method, such as the low convergence of experts' opinions [48] and the high cost and considerable time needed for collecting opinions [41,44,48] due to the several rounds of a survey undertaken using the traditional Delphi method [47]. In this study's use of FDM, all of the experts' opinions were incorporated into one investigation [48,49] to comprehensively consider their uncertainty and ambiguity [47] and to achieve a consensus [49]. Thus, this method is considered to be robust [41] and can create a better data analysis effect [48], and the results obtained are objective and rational [47]. We used the following steps for the FDM analysis:

1. Extract experts' opinions: collect and organize the assessment scores given by each expert for each sustainability indicator in the questionnaire.
2. Aggregate the experts' opinions: first, convert the linguistic variables used to assess the indicators (i.e., the experts' opinions) into triangular fuzzy numbers [47], as shown in Table 2. The linguistic variables are used to represent the experts' opinions on the importance (i.e., usefulness and applicability) of the indicator.

Then, calculate the aggregate triangular fuzzy number (i.e., aggregate assessment score of the experts) for each indicator. To aggregate the experts' opinions, the approach by Tsai et al. [44] was adapted as follows:

$$\mathrm{Vij} = (\mathrm{lij},\ \mathrm{mij},\ \mathrm{uij}) \tag{1}$$

where Vij represents the aggregate triangular fuzzy number (i.e., aggregate fuzzy opinion) of indicator (i), and n is the total number of experts (j).

$$\mathrm{lij} = \left(\prod_{j=1}^{n} \mathrm{aij}\right)^{1/n} \tag{2}$$

This indicates the geometric mean of the fuzzy numbers at the left end (i.e., lower/minimum scores given by the experts (j) for each indicator (i).

$$\mathrm{mij} = \left(\prod_{j=1}^{n} \mathrm{bij}\right)^{1/n} \tag{3}$$

This indicates the geometric mean of the fuzzy numbers in the middle (i.e., median/optimum scores given by the experts).

$$\mathrm{uij} = \left(\prod_{j=1}^{n} \mathrm{cij}\right)^{1/n} \tag{4}$$

This indicates the geometric mean value of the fuzzy numbers at the right end (i.e., upper/maximum scores given by the experts).

In this step, the geometric mean was taken to determine the aggregate triangular fuzzy numbers to obtain statistically unbiased results and avoid the impact of extreme values [41,46,49].

3. Apply defuzzification: apply the center of gravity method (CGM) to defuzzify the aggregate triangular fuzzy number of the indicator:

$$\mathrm{Si} = \frac{\mathrm{lij} + \mathrm{mij} + \mathrm{uij}}{3} \tag{5}$$

where Si is the final defuzzified score that indicates the aggregate importance of each indicator (i).

4. Select the final indicators: compare the defuzzified value (Si) with a threshold value (*d*):
   - If Si $\geq$ d, the indicator is selected.
   - If Si < d, the indicator is not selected.

The threshold value depends on the fuzzy linguistic scale and user preference [41,47]. If the users want more indicators, they can take a small value of the threshold, and vice versa [47]. In this study, we took a threshold value of (d = 5.6) for a 9-fuzzy linguistic scale to select the indicators [41,47].

3. Results

This section summarizes the results of our analysis based on the systematic review and FDM. Section 3.1 presents the potential sustainability indicators that were identified after conducting the literature analysis and pre-testing. The aggregate fuzzy scores of each indicator and the final selected sustainability indicators based on the defuzzified score are described in Section 3.2.

3.1. Potential Sustainability Indicators

After conducting a content analysis, we identified the most consistent and frequently used indicators for measuring industrial sustainability in the literature [38,39]. As shown in Table 3, 1013 indicators (277 for economic, 402 for environmental, and 334 for social dimensions) were initially explored; 44 indicators (14 for economic, 18 for environmental, and 12 for social dimensions) were used at least five times (i.e., by at least five papers).

Table 3. Identified indicators by frequency of use.

Frequency of Use	Identified Indicators	Frequency of Use	Identified Indicators
1	860	15	
2	58	16	
3	35	17	1
4	16	18	1
5	13	19	
6	10	20	
7	6	21	
8	1	22	
9	1	23	
10	1	24	
11	4	25	
12	1	26	1
13	1	27	1
14	2	Total	1013

Table 3 also shows that the majority of indicators (about 85%) were used only once in the literature, and this is due to (1) a lack of consistency and consensus on how sustainability performance should be measured in manufacturing industries [38,39] and (2) industry context differences affecting the use of indicators for measuring industrial sustainability [3,7]. This result implies that measuring industrial sustainability will continue to invite an ongoing research debate and open potential research opportunities.

Table 4 presents the most consistent and frequently used indicators in the literature. Profit, water consumption, and employment/job opportunity were the most consistent and frequently employed indicators for measuring the economic, environmental, and social dimensions of industrial sustainability, respectively. Indicators in the economic dimension placed more emphasis on measuring the progress in obtaining high financial benefits, including profit [3,18,50] and revenue [3,18,51], from business activities; allocating reasonable expenditure to R&D activities [3,10,18]; reducing costs such as material [18,52,53], labor [18,53,54], energy [1,52,54], operating/operational [3,39,55], maintenance [1,3,39], production [3,9,54], packaging [1,18,20], and inventory [3,53,54] costs; improving product quality [3,52,56]; and properly managing lead time [1,3,7] and delivery time [32,53,57].

Table 4. Frequently used TBL sustainability indicators.

Indicators for Economic Dimension	Frequency of Use	Indicators for Environmental Dimension	Frequency of Use	Indicators for Social Dimension	Frequency of Use
Profit	14	Water consumption	27	Employment/Job opportunity	11
Research and development expenditure	14	Energy consumption	26	Employee turnover	11
Product quality	13	Greenhouse gas emissions	18	Work-related injuries	10
Revenue	12	Material consumption	17	Customer satisfaction	7
Material cost	11	Renewable energy use	9	Employee satisfaction	6
Labor cost	11	Recycled water use	7	Working hours	6
Energy cost	8	Recycled material use	7	Corruption	6
Operating/Operational cost	7	Wastewater discharge	7	Occupational health and safety	5
Maintenance cost	6	Hazardous waste	7	Training and development	5
Production cost	6	Land use	6	Fair salary	5
Packaging cost	6	Solid waste	6	Customer complaints	5
Lead time	6	Recyclable waste	6	Lost working days	5
Inventory cost	5	Packaging material consumption	5		
On-time delivery	5	Electricity consumption	5		
		Air emissions	5		
		Global warming potential	5		
		Energy efficiency	5		
		Energy intensity	5		

In the environmental dimension, more weight was given to indicators that measured progress in the efficient use of input resources such as water [3,18,50], energy [51,52,54], and material [3,18,52] consumption; the use of recycled resources such as recycled water [1,3,8] and recycled material [3,8,58]; the use of renewable energy [1,3,10]; the reduction of emissions consisting of GHG emissions [8,10,54] and air emissions [53,55,59]; and the proper management of waste, including wastewater discharge [8,11,55] and hazardous [34,55,58], solid [10,39,60], and recyclable [3,7,60] wastes.

Regarding the social dimension of industrial sustainability, the focus was on indicators that were used to measure progress in creating employment/job opportunities [3,39,52]; improving the well-being of employees by minimizing employee turnover [18,50,60], minimizing work-related injuries [3,39,50], ensuring employee satisfaction [9,39,51] and occupational health and safety [18,53,57], providing training, development [18,61,62], and a fair salary [12,18,63]; improving the well-being of customers in terms of customer satisfaction [3,51,59] and minimizing customer complaints [19,21,58]; properly managing employee working time in terms of working hours [18,22,57] and lost working days [23,39,50]; and reducing corruption [39,57,61].

In our literature analysis, to explore the indicators, we found that automotive [20,64–67], food [18,63,68], and electronics [58,69,70] were some of the industrial sectors where previous studies had carried out case studies. There is a lack of research on the analysis and selection of indicators for the footwear industry. This motivated us to consider the footwear industry as our research context.

For this purpose, we initially used the indicators in Table 4 to develop the questionnaire. Due to their high consistency and frequency of use, these indicators can be considered to be more understandable and relevant to manufacturing industries [39]. Then, to further refine the indicators (i.e., modify, add, and delete), we pre-tested the questionnaire with selected industry experts from Italian footwear SMEs, scholars, and researchers. Finally, 40 potential sustainability indicators (12 for economic, 14 for environmental, and 14 for social dimensions) were identified. Table 5 presents the indicators that were used to develop the final questionnaire distributed for data collection.

Table 5. Indicators identified after the literature analysis and pre-testing.

Sustainability Dimensions	Indicators	Short Descriptions
Economic	Profit	Excess revenue over the cost of producing the product [71]
	Revenue	Value of output (product) sold, i.e., the number of products sold times the unit price [71]
	Research and development expenditure	Expenses allocated to carry out research and development (R&D) activities [71]
	Material cost	Cost of input materials used to produce the product [71]
	Labor cost	Salaries and wages of active employees, pensions, various social charges, and related costs [71]
	Energy cost	Cost allocated for the quantity of energy consumed [71]
	Maintenance cost	Costs (such as expenses for lubricants, spare parts, tools and equipment, and maintenance crew) incurred to carry out maintenance activities [71]
	Packaging cost	Cost allocated for packaging material
	Inventory cost	Expenses associated with holding and storing raw materials and products
	Product quality	Features incorporated that can meet customer needs
	Lead time	Time between order placement and shipment
	On-time delivery	Delivery of finished products on time
Environmental	Water consumption	Use of water for processing, washing, drinking, and related activities [71]
	Recycled water use	Reuse of wastewater after treatment [8]
	Energy consumption	Use of energy (electricity, fuel) for manufacturing process, lighting, heating, and other purposes [71]
	Renewable energy use	Use of energy comes from renewable sources such as solar, wind, hydro, biomass, and others [72]
	Energy efficiency	Ratio of energy used in manufacturing process, heating, lighting, and other purposes to input energy [51]
	Material consumption	Input materials consumed to produce the output (product) [19]
	Recycled material use	Use of recycled input materials by replacing virgin materials [72]
	Packaging material consumption	Use of materials such as containers or wrapping for handling, protecting, and marketing the product
	Land use	Use of land for industrial activities [71]
	Greenhouse gas emissions	Release of greenhouse gases (GHGs) such as carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), chlorofluorocarbons (CFCs), and others contributing to the greenhouse effect/global warming [71]
	Wastewater discharge	Industrial sewage (used water) released to surface water, groundwater, seawater, or a third party [72]
	Hazardous waste	Waste with toxic, infectious, radioactive, or flammable properties that poses a potential hazard to human health, other living organisms, and the environment [71]
	Solid waste disposal	Disposal of solid waste (waste with low liquid content) that is not recycled [71]
	Recyclable waste	Waste that can be used in the production and consumption processes [71]

Table 5. *Cont.*

Sustainability Dimensions	Indicators	Short Descriptions
Social	Employment/Job opportunity	Opportunities created for employment [71]
	Fair salary	Regular fair payments to employees for their service [71]
	Employee turnover	Employees leaving the organization voluntarily or due to dismissal, retirement, or death [72]
	Employee satisfaction	Contentment of employees with their job
	Occupational health and safety	Promotion of employee health and safety by preventing work-related injuries and illnesses [72]
	Training and development	Organizational activities to enhance employees' knowledge and skills for the better performance of specific tasks
	Working conditions	Promoting a safe working environment by preventing work-related injuries and illnesses due to exposure to hazardous substances, dust, high temperature, loud noise, and other risk factors
	Work-related injuries	Injuries arising from exposure to hazards and accidents at work [72]
	Working hours	Hours that employees spend doing paid work [71]
	Lost Working days	Lost days due to work-related injuries and illnesses [73,74]
	Customer health and safety	Systematic efforts to address incidents concerning the health and safety impacts of products and services on customers [75]
	Customer satisfaction	How well customers' needs are met by the products and services offered
	Customer complaints	Customers' feedback on the products and services that did not meet their needs
	Corruption	Abuse of power in leadership for personal, financial, or other benefits [71,72]

3.2. Selected Indicators

After collecting the experts' opinions on the potential indicators, we applied FDM to incorporate fuzzy logic with the opinions to select the final representative indicators. By using FDM, it was possible to analyze a group consensus by addressing uncertainty and ambiguity when evaluating each indicator [41]. Table 6 summarizes the results of the analysis based on FDM.

The results show that 24 indicators were selected to measure industrial sustainability in Italian footwear SMEs (Figure 3). This does not mean that the unselected indicators were irrelevant, but, compared to the selected indicators, they had a lower priority. Among the selected indicators, customer satisfaction (7.88) was the top prioritized indicator, followed by product quality (7.69), on-time delivery (7.56), working conditions (7.37), customer complaints (7.34), lead time (7.29), work-related injuries (7.27), employee satisfaction (7.22), and occupational health and safety (7.10). The other selected indicators were fair salary (6.99), customer health and safety (6.94), training and development (6.84), profit (6.72), employment/job opportunity (6.60), material consumption (6.44), revenue (6.43), working hours (6.32), labor cost (6.06), research and development (R&D) expenditure (6.04), recycled material use (5.96), lost working days (5.81), employee turnover (5.77), energy efficiency (5.72), and material cost (5.71).

Table 6. Aggregate assessment scores of the indicators.

Sustainability Dimensions	Indicators (i)	Aggregate Fuzzy Opinion			Defuzzified Score (Si)	Selected
		Min (lij)	Optimum (mij)	Max (uij)		
Economic	Profit	4.82	6.97	8.38	6.72	Yes
	Revenue	4.43	6.56	8.29	6.43	Yes
	Research and development expenditure	4.11	6.18	7.84	6.04	Yes
	Material cost	3.67	5.76	7.69	5.71	Yes
	Labor cost	4.05	6.21	7.94	6.06	Yes
	Energy cost	3.26	5.54	7.48	5.42	
	Maintenance cost	2.92	4.71	6.86	4.83	
	Packaging cost	2.45	4.53	6.67	4.55	
	Inventory cost	2.68	4.51	6.72	4.64	
	Product quality	6.07	8.16	8.84	7.69	Yes
	Lead time	5.55	7.61	8.72	7.29	Yes
	On-time delivery	5.89	7.94	8.86	7.56	Yes
Environmental	Water consumption	2.28	3.49	5.72	3.83	
	Recycled water use	2.36	3.40	5.70	3.82	
	Energy consumption	3.48	5.36	7.35	5.40	
	Renewable energy use	3.23	5.28	7.17	5.23	
	Energy efficiency	3.80	5.81	7.55	5.72	Yes
	Energy intensity	2.97	4.91	6.96	4.95	
	Material consumption	4.51	6.66	8.16	6.44	Yes
	Recycled material use	3.98	6.10	7.81	5.96	Yes
	Packaging material consumption	3.53	5.26	7.28	5.36	
	Land use	2.17	3.72	5.90	3.93	
	Greenhouse gas emissions	2.49	4.32	6.32	4.37	
	Wastewater discharge	2.28	3.83	5.97	4.03	
	Solid waste disposal	3.13	5.16	7.13	5.14	
	Recyclable waste	3.05	5.12	7.00	5.05	
Social	Employment/Job opportunity	4.61	6.78	8.41	6.60	Yes
	Fair salary	5.15	7.22	8.59	6.99	Yes
	Employee turnover	3.78	5.86	7.66	5.77	Yes
	Employee satisfaction	5.43	7.49	8.72	7.22	Yes
	Occupational health and safety	5.31	7.42	8.57	7.10	Yes
	Training and development	4.94	7.00	8.59	6.84	Yes
	Working conditions	5.67	7.73	8.72	7.37	Yes
	Work-related injuries	5.51	7.57	8.72	7.27	Yes
	Working hours	4.33	6.50	8.15	6.32	Yes
	Lost working days	3.74	5.97	7.73	5.81	Yes
	Customer health and safety	5.22	7.17	8.44	6.94	Yes
	Customer satisfaction	6.34	8.38	8.91	7.88	Yes
	Customer complaints	5.60	7.70	8.71	7.34	Yes
	Corruption	3.20	4.53	6.65	4.79	

The results of our study are based on indicators used to measure sustainability performance in manufacturing industries in the literature. We intended to empirically select and prioritize useful and applicable indicators for measuring sustainability in Italian footwear SMEs from the huge set indicators explored in the literature. The originality of our study lies in involving industry experts' opinions in selecting and prioritizing the final indicators, and addressing how the selected indicators can be applied to measure sustainability performance in SMEs.

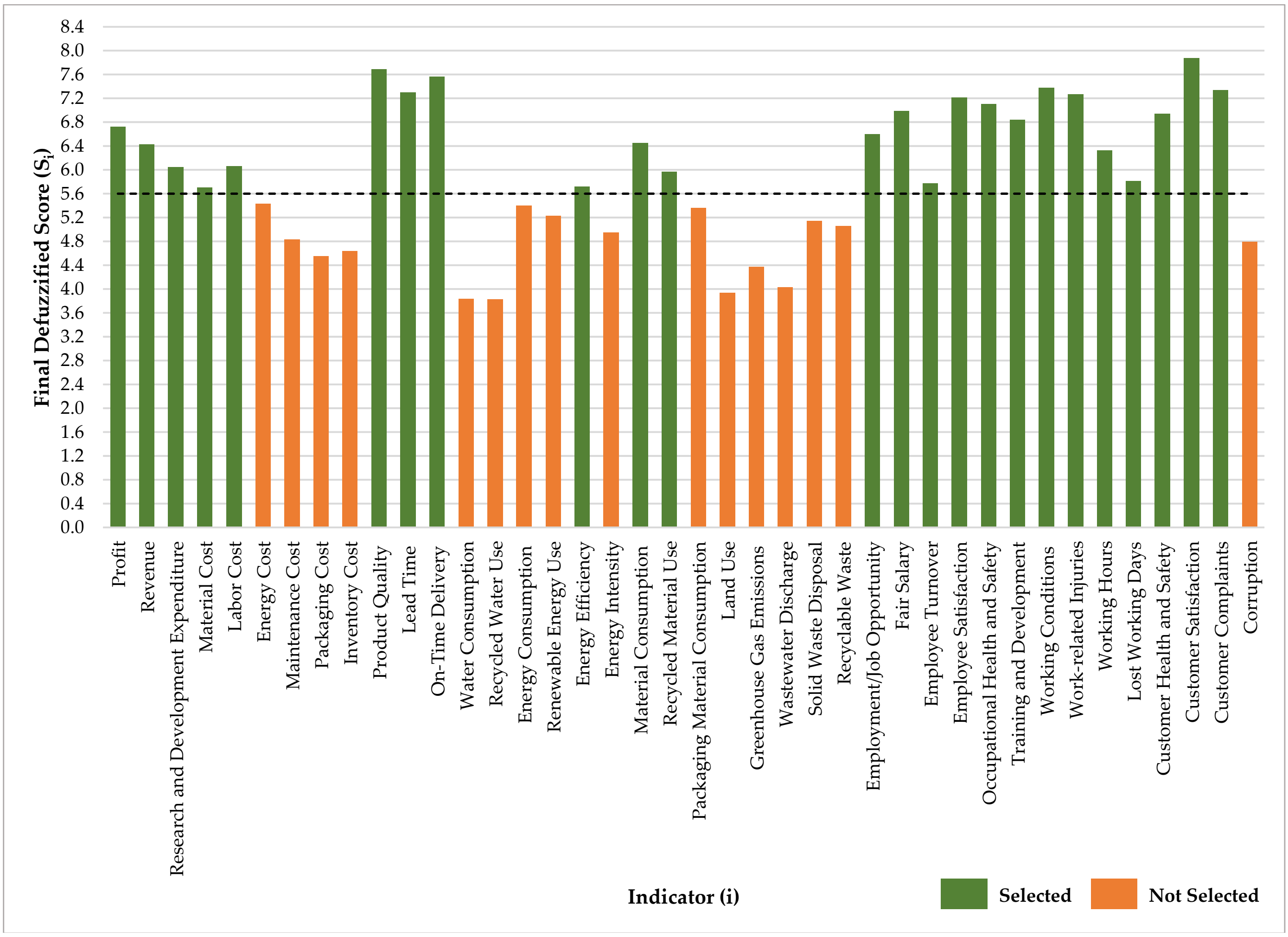

Figure 3. Final selected indicators.

4. Discussion

The results of our study show that product quality, material consumption, and customer satisfaction were the top priorities among the selected indicators for measuring the economic, environmental, and social dimensions of industrial sustainability, respectively. As customers seek to play a significant role in the change towards a sustainable lifestyle, SMEs should respond by producing sustainable products (eco-friendly products). The use of renewable, biodegradable materials and non-hazardous materials promotes product quality in terms of a sustainable product.

Indicators related to financial benefits (profit and revenue), costs (labor and material cost), and market competitiveness (R&D expenditure, on-time delivery, lead time, and product quality) were prioritized for measuring the economic dimension of the sustainability of SMEs. On-time delivery, lead time, and product quality are essential to ensure market competitiveness and financial benefits in the short run. Besides, SMEs need to allocate reasonable expenditure to conduct R&D activities for promoting innovation for producing sustainable products and enhancing market competitiveness in the long run.

Water consumption [3,18,50,60] and greenhouse gas (GHG) emissions [3,8,10,54] were frequently used indicators in previous studies to measure the environmental dimension. However, our empirical study revealed that these indicators are less prioritized. This may be because the production process of footwear SMEs is not water-intensive, as in other industrial sectors such as food and beverages, and produces fewer emissions. On the other hand, material consumption, recycled material use, and energy efficiency were prioritized over other environmental indicators. A wide variety of materials are utilized by the footwear industry to produce a range of products [76]. Leather, synthetics, plastic, rubber, and textiles are the most common materials consumed by the footwear production process [77]. The footwear industry have exerted a significant effort to improve material efficiency and eliminate the use of hazardous materials during production [76]. Italian footwear SMEs that paid more attention to material consumption could measure their progress in terms of improved material efficiency, reduced use of hazardous materials, and the use of eco-friendly and biodegradable materials. They can minimize waste generation by improving material efficiency. The safety of their products for customers can be improved by reducing the use of hazardous materials in the production phase. Moreover, reducing the use of hazardous materials, increasing the use of eco-friendly and biodegradable materials, and promoting the use of recycled materials are significant in minimizing growing concerns about the environmental and social impacts of end-of-life (EOL) products in the post-use phase. SMEs should also measure their progress in saving energy and reducing cost with energy efficiency as a prioritized indicator.

Regarding the social dimension of industrial sustainability, indicators that promote sustainability performance measurement associated with employees, customers, and the community were selected. The footwear industry is among the industrial sectors that are the most low-technology and labor-intensive [78]. As it is a labor-intensive industry, improving employee well-being is required of Italian footwear SMEs. To measure progress towards this goal, working conditions, occupational health and safety, work-related injuries, fair salary, training and development, and employee satisfaction are highly prioritized indicators. They also need to measure progress in improving employee well-being. For this purpose, customer satisfaction, customer complaints, and customer health and safety were identified as relevant indicators. High priority was given to employment/job opportunities for measuring progress towards community development. Moreover, working hours and lost working days were key indicators associated with employees' work time management.

SMEs have limited resources to measure and manage their sustainability performance. Consequently, they require a manageable number of indicators that are simple and easy to use. Our study analyzed and selected the suitable indicators that have significant impacts and benefits for the sustainability performance of Italian footwear SMEs by addressing the three sustainability dimensions (i.e., economic, environmental, and social). Moreover, as long as SMEs are not facing a scarcity of resources or other challenges, we suggest them to use the other potential sustainability indicators. The selected indicators were built upon the currently available knowledge of industrial sustainability performance measurement, allowing SMEs to take advantage of a big body of validated knowledge without spending time and resources on it.

To address research question two (i.e., to put the selected indicators into practice), we proposed the following four-stage framework, shown in Figure 4, by adapting the methodology suggested by Veleva and Ellenbecker [74] for implementing the indicators of sustainable production.

1. Sustainabilty_Plan: this stage includes setting sustainability goals to improve industrial sustainability performance, selecting indicators to measure progress towards achieving the goals and setting sustainability targets. A manufacturing firm can specify targets in consultation with stakeholders [74]. The target could be critical loads, acceptable limits, or standards set by governmental or non-governmental organizations [51].
2. Sustainability_Apply: this involves defining metrics for the indicators, collecting and organizing data, measuring the sustainability performance for a reporting period (e.g., fiscal year, calendar year, six months, quarter, month [74]), and documenting the results.
3. Sustainability_Check: this focuses on comparing the performance results obtained with the targets, interpreting the comparison results to check whether the performance

of the firm is sustainable or not, and communicating the results to the stakeholders to have a common understanding and for taking actions.

4. Sustainability_Action: this consists of taking actions regarding sustainability performance that needs improvement, and reviewing the plan for continuous improvement.

The proposed framework provides a comprehensive view of indicators' application, ranging from setting sustainability goals to selecting indicators; setting sustainability targets, measuring, evaluating, and interpreting sustainability performance; taking actions on the performance results; and reviewing for continuous improvement. Moreover, it promotes stakeholder engagement, especially in setting sustainability goals and targets, interpreting sustainability performance and taking improvement actions, and reviewing the plan, which eventually builds a high level of trust between SMEs and their stakeholders. It can act as a reporting mechanism and as a continuous improvement tool for industrial sustainability performance.

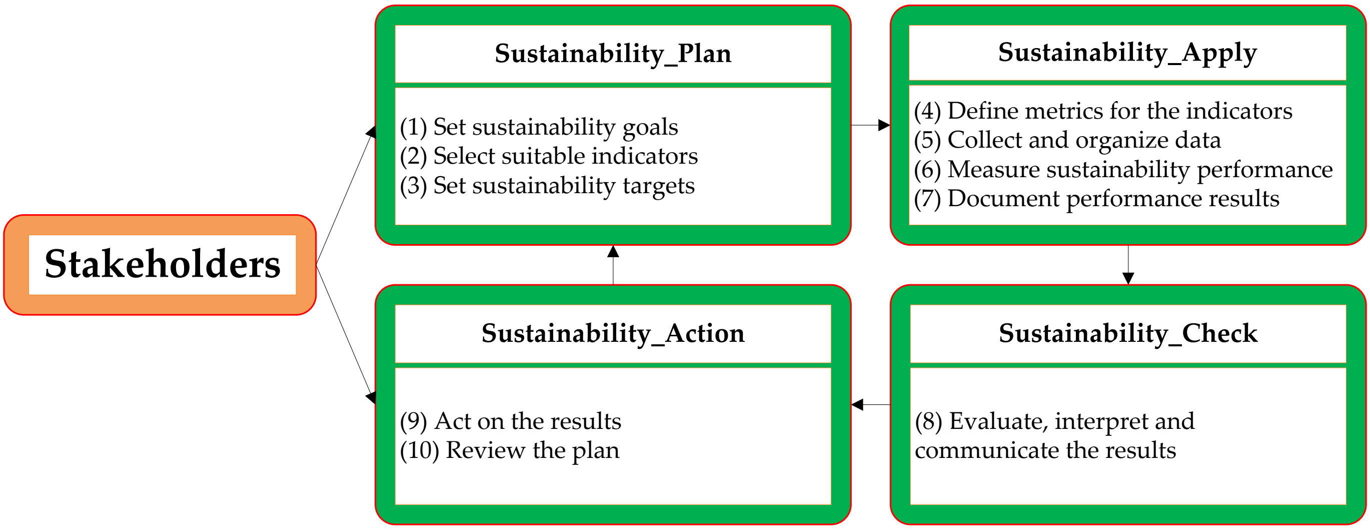

Figure 4. Proposed framework for applying the indicators.

To make the indicators measurable and manageable, defining a quantifiable metric was essential [69]. In our study, as shown in Table 7, we defined both absolute and relative metrics for the selected indicators.

Our study has significant academic and practical implications. From an academic viewpoint, our study will be a good theoretical base for future research in measuring the sustainability performance of manufacturing industries, mainly the footwear industry. Our study simultaneously conducted an extensive analysis of the indicators published in peer-reviewed articles, carried out an empirical analysis to select and prioritize the indicators, and proposed a framework to put the selected indicators into practice in SMEs. These subsequently contribute to the existing theory and knowledge of industrial sustainability performance measurement. From a practical viewpoint, by providing suitable indicators and a framework for their application, our study can serve as a tool for manufacturing industries, particularly for Italian footwear SMEs, to effectively measure and manage their sustainability performance. Moreover, the proposed framework is flexible and can be applied in different industry contexts.

Even though our study provides a comprehensive methodological approach for selecting and prioritizing indicators, and proposed a framework to put the selected indicators into practice, its scope was limited to the firm level. To get a more comprehensive view of sustainability by including the environmental and social impacts of end-of-life (EOL) products, it would be better to look for additional indicators to measure sustainability performance at the supply chain level. Hence, it would be interesting for future research to expand the methodological approach applied in this study to the entire supply chain consisting of supply, production, distribution, use, and post-use. It would also be interesting for future research to conduct a comparative analysis considering the footwear firms of various countries (e.g., European countries) to identify the similarities and differences in the indicators from the perspective of geographical or national diversity.

Table 7. Metrics defined for the indicators.

Indicators	Metrics		Adapted From
	Absolute	Relative	
Profit	Net profit gained during the reporting period (USD, Euro)	Net profit to total revenue ratio (%)	[61]
Revenue	Total revenue generated during the reporting period (USD, Euro)	Revenue generated per unit of product sold (USD, Euro/uop)	[19]
Research & development expenditure	R&D spending during the reporting period (USD, Euro)	R&D spending to total revenue ratio (%)	[19,79]
Material cost	Total material cost during the reporting period (USD, Euro)	Percentage of material cost relative to total revenue (%)	[19]
Labor cost	Total labor cost during the reporting period (USD, Euro)	Percentage of labor cost relative to total revenue (%)	[19]
Product quality	Number of products that met customer requirements during the reporting period (#)	Percentage of products that met customer requirements (%)	Proposed metrics
Lead time	Total number of products produced within the required lead time (#)	Percentage of products produced within the required lead time (%)	Proposed metrics
On-time delivery	Total number of products delivered on time during the reporting period (#)	Percentage of products delivered on time (%)	Proposed metrics
Material consumption	Total weight or volume of materials consumed during the reporting period (kg, m^3, L, m^2, pc)	Material consumption per unit of product produced (kg, m^3, l, m^2, pc/uop); material efficiency (%); percentage of biodegradable materials used (%); percentage of renewable materials used (%); percentage of hazardous materials used (%)	[1,74]
Recycled material use	Total weight or volume of recycled materials used during the reporting period (kg, m^3, L, m^2, pc)	Percentage of recycled materials used (%)	[1]
Energy efficiency	----	Ratio of final energy used for production to the total input energy (%)	[51]
Employment/Job opportunity	Total number of new employees hired during the reporting period (#)	Recruitment efficiency (%)	[75]
Fair salary	----	Average salary per employee (USD, Euro/emp)	[19]
Employee turnover	Total number of employee turnover during the reporting period (#)	Percentage of employee turnover (%)	[1,75]
Employee satisfaction	Total number of employees who reported job satisfaction during the reporting period (#)	Percentage of employees who reported job satisfaction (%)	[1,74]

Table 7. *Cont.*

Indicators	Metrics		Adapted From
	Absolute	Relative	
Occupational health and safety (OHS)	Total number of employees covered by the OHS program (#); total number of fatalities as a result of work-related injuries (#); total number of fatalities as a result of work-related illnesses (#); total number of cases of work-related illnesses during the reporting period (#)	Percentage of employees covered by OHS program (%); percentage of fatalities as a result of work-related injuries (%); percentage of fatalities as a result of work-related illnesses (%); percentage of cases of work-related illnesses (%)	[75]
Training and development	Total number of total employees who received a regular performance and career development review (#); total training hours during the reporting period (h)	Percentage of employees who received a regular performance and career development review (%); average training hours per employee (h/emp)	[75]
Working conditions	Total number of employees working in decent conditions (#)	Percentage of employees working in decent conditions (%)	Proposed metrics
Work-related injuries	Total number of work-related injuries during the reporting period (#)	Work-related injuries per employee (#/emp)	[75]
Working hours	Total working hours during the reporting period (h)	Average working hours per employee (h/emp)	[8]
Lost Working days	Total lost working days due to injuries and illnesses during the reporting period (day)	Percentage of lost working days due to injuries and illnesses (%)	[73,74]
Number of employees	Total number of active employees during the reporting period (#)	Number of active employees per unit of product produced (#/uop)	[3,74]
Customer health and safety	Total number of incidents concerning the health and safety impacts of the products and services provided during the reporting period (#)	Number of health and safety incidents per unit of product sold (#/uop)	[75]
Customer satisfaction	Total number of customers who reported satisfaction with the products and services offered during the reporting period (#)	Percentage of customers who reported satisfaction with the products and services offered (%)	[19]
Customer complaints	Total number of customer complaints during the reporting period (#)	Customer complaints per unit of product sold (#/uop)	[19,74]

Note: #: number, kg: kilogram, m^3: cubic meter, m^2: square meter, L: liter, pc: piece, h: hour, uop: unit of product (pair of shoes), emp: employee.

5. Conclusions

Our study provides a methodological approach to identify, analyze, and select indicators suitable to measure sustainability in the context of SMEs. It applied FDM, which combines a qualitative method (gathering experts' opinions using a questionnaire) and a quantitative method (fuzzy analysis considering the ambiguity and subjectivity associated with those opinions) to analyze and select useful and applicable indicators for measuring sustainability performance in Italian footwear SMEs. It also proposed a four-stage framework that helped to effectively apply the selected indicators to measure industrial sustainability performance.

The results of our literature analysis revealed that the majority of indicators (85% of 1013 indicators explored in the literature) were used only once, showing the lack of consistency in the use of indicators to measure sustainability performance in different industry contexts. Our study empirically selected and prioritized indicators for measuring the sustainability performance of Italian footwear SMEs from the wide range of indicators available in the literature. Based on a sample of 48 Italian footwear SMEs, the results of our empirical analysis show that the selected indicators (24 indicators) emphasized measuring industrial sustainability performance associated with financial benefits, cost, market competitiveness, resources, employees, customers, and community. We therefore stress that SMEs focus on and allocate their limited resources to apply the selected indicators for measuring progress towards achieving industrial sustainability goals in terms of increasing financial benefits, reducing costs, and improving market competitiveness, thereby improving resource utilization effectiveness (efficiency improvement, recycling, and substitution) and promoting the well-being of employees, customers, and the community.

The proposed framework is goal-driven, target-based, and continuously improving. Following the framework, SMEs start from the setting of sustainability goals and targets; pass through the selection of indicators needed to measure sustainability performance, perform performance measurement, and evaluate and interpret the performance results by comparing them with the sustainability targets; and finally, act on the performance results and review to bring continuous sustainability performance improvements. Since the framework is based on a predefined list of indicators, it does not overload SMEs with information whose utility is uncertain or placed far in the future.

Author Contributions: Conceptualization, A.T.M. and R.P.; methodology, A.T.M. and R.P.; software, A.T.M.; validation, A.T.M. and R.P.; formal analysis, A.T.M.; investigation, A.T.M. and R.P.; resources, A.T.M. and R.P.; data curation, A.T.M.; writing—original draft preparation, A.T.M.; writing—review and editing, A.T.M. and R.P.; visualization, A.T.M. and R.P.; supervision, R.P.; project administration, A.T.M. and R.P; funding acquisition, R.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors gratefully acknowledge the advice and contributions from Cipriano Forza, a member of the faculty of the PhD program in Management Engineering at the University of Padova. The authors would also like to thank the Cassa di Risparmio di Padova e Rovigo (CARIPARO), Padova, Italy for its financial support.

Conflicts of Interest: The authors declare no conflict of interest.

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