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Procedia CIRP 78 (2018) 347–352

www.elsevier.com/locate/procedia

6th CIRP Global Web Conference
"Envisaging the future manufacturing, design, technologies and systems in innovation era"

Conceptual Framework for Evaluating the Environmental Awareness and Eco-efficiency of SMEs

Jenifer Vásquez [ab*], Giulia Bruno [a], Luca Settineri [a], Santiago Aguirre [b]

[a] *Politecnico di Torino, Department of Management and Production Engineering, Corso Duca degli Abruzzi 24, Torino 10129, Italy*

[b] *Pontificia Universidad Javeriana, Department of Industrial Engineering Carrera 7 No.40-62, Bogotá 110231, Colombia*

* Corresponding author. Tel.: +39-388-858-3674; fax: +39-011-090-6098. *E-mail address:* jenifer.vasquez@polito.it

Abstract

Environmental problems are increasingly impacting society and nature. For this reason, companies are expected to become aware of the importance of seeking strategies and measures to mitigate and prevent environmental impacts. The growing concern about the availability of natural resources for future generations and their survival has been the premise for decision making in the industrial sector to improve the quality of life and preserve the environment. In this domain, important concepts such as sustainable development and eco-efficiency have been developed. They represent the trend to achieve a balanced use of resources and a reduction of environmental pollution by preventing waste and establishing economic returns. The aim of this paper is to present a conceptual framework for evaluating the eco-efficiency of small and medium-sized enterprise (SMEs) through four main factors: analysis, identification and evaluation, integration, and an action plan. As a result of the analysis, sustainability strategies are proposed to decrease the negative impact and increase the cost-effectiveness and the competitiveness of the SMEs.

Selection and peer-review under responsibility of the scientific committee of the 6th CIRP Global Web Conference "Envisaging the future manufacturing, design, technologies and systems in innovation era".

Keywords: Sustainable development; eco-efficiency; environmental monitoring

1. Introduction

Sustainable development is the practice of using economic, environmental, and social guidelines to create a new development process or improve an older process in the companies[1–3]. This practice has a heavy emphasis on making sure that whatever process can minimize its emission[4, 5].

In the literature of research, several strategies were applied to the sustainable development. This paper is focused on a conceptual eco-efficiency framework to evaluate and integrate other aspects that literature had not studied. The eco-efficiency is a common strategy applied in small and medium-sized enterprises (SMEs), based on the concept of creating more good and services while using fewer resources and producing fewer wastes and pollution[2, 6–9].

The SMEs general most positive aspects associated with the industry are also responsible for most of the negative environmental effects[10–13]. For this reason, the guide for

Selection and peer-review under responsibility of the scientific committee of the 6th CIRP Global Web Conference "Envisaging the future manufacturing, design, technologies and systems in innovation era".
10.1016/j.procir.2018.09.062

SMEs to reach a sustainability development is to adopt a conceptual eco-efficiency framework that analyses their process, evaluates the inputs and outputs, integrate factors, and made an action plan.

The research methodology used in this paper can be divided into four main stages: the exploratory phase, the identification phase, design phase, and the result phase.

First, the exploratory phase includes a literature review. Second, the specification phase identifies the factors that influence to design of the conceptual framework. Third, the design phase is the main phase, in which the factors are analyzed to determine the process to evaluate the environmental awareness of SME. Finally, the last section provides conclusive remarks and states future works. All the phases are exposed hereafter.

2. State of the art

2.1. Sustainability Development

In 1987, the Brundtland Commission published a report, Our Common Future, which provides the definition of sustainable development, i.e., a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1, 14]. According to sustainability studies, to understand the concept of sustainable development, it is essential to evaluate the following question: What do we mean by sustainability? Some authors have been expressing that this question is not a simple rhetorical question [3].

The companies and organization that would answer that question need to formulate quantitative goals, qualitative goals, social techniques, economic techniques, and environmental techniques [8, 13]. Furthermore, authors who contributed to the state of the art have defined sustainable development depending on their research problem, thus a lot of different definition is possible. In addition, several studies defined sustainability as a set of strategies to change bad habits inside the companies by improving the environmental and social condition of employees (e.g., the security, well-being, and health) [15].

Based on the above definitions, it can be determined that sustainability has been focusing on the capacity to support a system, which depends directly on the well-being of the natural world and the responsible use of natural resources. In this way, when analyzing the interpretations of sustainability, it is proposed that sustainable development has been promoting the use of alternative energy sources, avoiding the carrying capacity of the planet as the population, the level of consumption and the use of products increase. Also, it is necessary to highlight that sustainable development has been integrated with macroeconomic context. Therefore, the environmental and international legislation has reinforced the idea of the sustainable development that contributes to the economic growth of any nation.

On the other hand, different environmental strategies were developed to facilitate the implementation of sustainable development. One of them is the eco-efficiency strategy, i.e., a management strategy to integrate environmental, social, and economic aspects inside productivity's activities, which is described in the next subsection.

2.2. Eco-efficiency

The term eco-efficiency is known as a response from businessman to improve products, startup cleaner production processes and provide environmentally friendly services.

This initiative was born in 1992 promoted globally by the World Business Council for Sustainable Development (WBCSD). According to the WBCSD definition, eco-efficiency is achieved through the delivery of "...competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life-cycle to a level at least in line with the Earth's estimated carrying capacity" [18, 19]. On the other hand, some authors express the eco-efficiency with a mathematical formula for its measurement [20]:

$$\text{ECO-EFFICIENCY} = \text{economic value (added)} / \text{environmental impact (added)}$$

The higher the economic value added, the lower the environmental impact, the higher the eco-efficiency index will be. Some authors associate the eco-efficiency with the productivity by defining it as a strategy to "create more value with less impact or do more with less" [10, 14].

Relevant research was carried out in SMEs in many countries, such as Venezuela, Thailand, Romania, Germany Brazil, Portugal and the United States. For example, Fernández-viñé et al. [6, 7] proposed to implement a public tool for eco-efficiency administration, which provides a characterization for comparing the SMEs of Venezuela with the SMEs European, with the aim of facilitating the design of the different environmental plans based on the public policies established for Venezuela.

On the other hand, In Thailand Rattanapan et al.[4] identified a series of eco-efficiency indicators for a rubber gloves company, which would help discover new economic and practical techniques to improve productivity, as well as include new processes to develop recycling activities and control emissions reduction.

Uhlman [21] implemented a methodology for measuring eco-efficiency in Germany, which includes a comprehensive approach to evaluation. Also, this study analyzed the life cycle of a product and the effects on customers along the supply chain. In addition, the authors illustrate a proposal of strategic value to offer more sustainable products in the market.

In Romania, a research was carried out that describes and analyzes a possible sustainability tool to encourage SMEs to be more efficient from the environment through the Ecoprofit program [22]. Other authors have applicated a questionnaire in 32 SMEs of the Brazilian to determine the implementation of the environmental management practices. In the study, it found that only 50% SMEs uses to an environmental management practice. Also, in Brazil, the possibility to adopt the eco-efficiency practices between small businesses and micro-

enterprises through of statistical methodology was explored [5].

In Portugal, with 19 SMEs producing marble, a model was developed that integrated the concept of sustainable value, eco-efficiency analysis and cleaner production [13]. The result was an indicator that included the three aspects of sustainability: the economic, social, and environmental, allowing the monitoring of the evolution of these aspects in the companies studied. The fundamental objective was to increase the sustainable value of this sector by improving the economic and the ecological efficiency of the companies.

Finally, the implementation of the eco-efficiency strategy in SMEs requires the adoption of environmental practices [9, 23, 24]. This will lead to changes in raw material, product redesign, changes in specifications, replacement of technology by energy-efficient equipment, changes in processes, reduction of waste, reprocessing and implementation of statistical quality controls, among others [8, 25, 26].

According to the literature reviewed, it appears that the existing models present some gaps in the implementation of the eco-efficiency strategy. For example, lack of the policies for environmental management and strategies for acquisition of data economic and the environment in SMEs, limited management experience in environmental management and operations issues [10], lack of design of methodological guidelines for the implementation of eco-efficiency aimed especially at SMEs [9], strengthening of programs of learning and communication to implement the eco-efficiency among the actors of the value chain [21, 27, 28], and difficulty in promoting environmental compensation through the inclusion of eco-efficiency policies and incentives [7, 21],

For this reason, it is evident that the SMEs need to develop models that integrate other factors that have not been taken into consideration. In the next section, some specifications that help to design a conceptual model are identified.

3. Specification for the design of the conceptual framework

There are two essential specifications before to design of the conceptual framework for evaluating the environmental awareness and eco-efficiency of SMEs: the framework aims, and the measures that influence inside the framework.

These specifications were selected for two reasons. First, the aims help to identify the scope of works that have been done so far in our research area and the foundation to build the new framework. Finally, the measures influence the environmental planning and environmental accounting, so the companies need to articulated measurement and evaluation tools to analyze the performances obtained in the environmental and economic field.

The framework could be used for SMEs managers or leadership of the operations, academic research and government analysis whom will interest to use this framework to analyze the result of the sector, improve the process, and to design and implement effective environmental laws and policies.

The main focus of this research is the SMEs, one small company does not generate large economic and environmental impacts but analyzing the economic and environmental together, they have a big impact [12]. Also, the SMEs have been characterized for limited resources. For this reason, this proposal emerges as a viable option that SMEs can implement without the need for major monetary expenditures. Therefore, the comprehensive sustainability model could be used by the company of similar size.

One of the intentions in this framework evaluates the current situation of the manufacturing SMEs. In that case, the boundaries are focus examining and analyzing the main process or the principal product in the company. In this way, the first step is to know the inputs and outputs in the main process of identifying the elements of the framework.

There are several contributions of the framework. First, it could get a statistic report from set manufacturing companies about the analysis of the operation, identification and evaluation the environmental impacts, integration of the management system, environmental knowledge, eco-efficiency measurement, and an action plan for improving the environment. Second, the conceptual framework could be including a methodology the sustainability to involve the elements, steps, tools and different techniques to the application the eco-efficiency inside the company. Also, the advantages of the proposed frameworks could be the design or redesign the strategic indicators and operative indicator to take a decision.

As mentioned in section 1, eco-efficiency is related to the measures [8, 29–31], so it is necessary to focus on measurements of:

- Environmental costs measures:
  - Pollution emissions (CO2) o Resource-used (energy, material, water)
  - The cost associated with an environmental
- Economic measures:
  - Value-added of benefit
  - Unit of product or service (per Km, per m2)
  - The cost associated with an environmental burden

These specifications had been considered as resources to design a conceptual framework.

4. Design a conceptual framework for evaluating the environmental awareness

Following the above specifications, the conceptual framework was designed to assess the environmental awareness of SMEs. The conceptual framework eco-efficiency has four strategic phases: analysis, identification and evaluation, integration, and action plan, as shown in Fig. 2.

Fig. 1. Conceptual Eco-efficiency Framework

This conceptual framework is an interactive four management steps, that could be used in business for evaluation and continual improvement of the process and products that impact on the environment. Also, this framework has been designed as such diagram cycle to illustrate this continues process should be repeated again and again for continues improvement.

4.1. Analysis phase

The analysis phase involves selecting the sector to be evaluated, which for this case study has selected SMEs as the main source of the economy of any country. The elements in this phase are shown in Fig 3. First, it is necessary to explore the characteristics of the sector, how to do it and analyze the macroeconomic and environmental aspect. Second, companies are selected to evaluate eco-efficiency, and then sequences and interaction of all activities within companies are determined. Finally, a report of the processes (PR) of the sector to be evaluated is obtained.

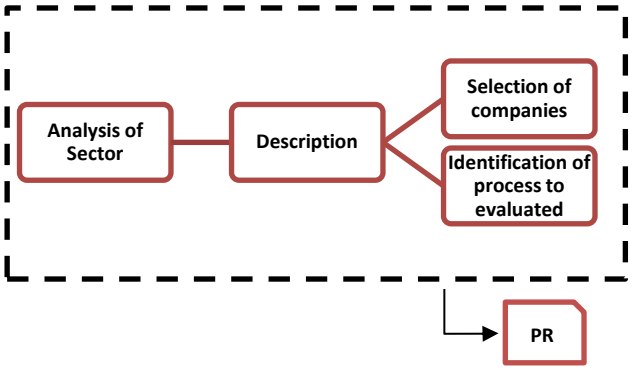

Fig. 2. Analysis phase

4.2. Identification and evaluation phase

After obtaining the process report in the previous phase, it is used to know to evaluate the environmental impact of the process selected. The identification and evaluation phase include the inputs and outputs in the process. In this phase, the input material, energy, and water are analyzed, and at the same time, the waste and emissions outputs. There are two essential types of inputs from nature for evaluating the eco-efficiency: the supply of resources (energy and water) and nature's function as a sink for the discharge of residuals and pollutants [4, 5, 8, 24]. Indicators of environmental pressure (impact) such as emissions, land use and resource extractions can be used to monitor changes in environmental effects [32]. Finally, the impact report (IR) of this phase is obtained. The elements are shown in Fig. 4.

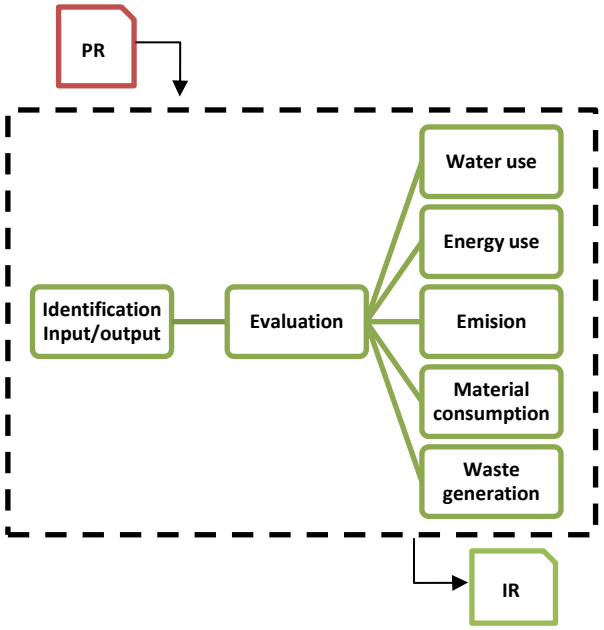

Fig. 3. Identification phase

4.3. Integration phase

After obtaining the impact report in the previous phase, it is used to know which work area will integrate through elements exposed by this phase. The elements in this phase are shown in Fig. 5.

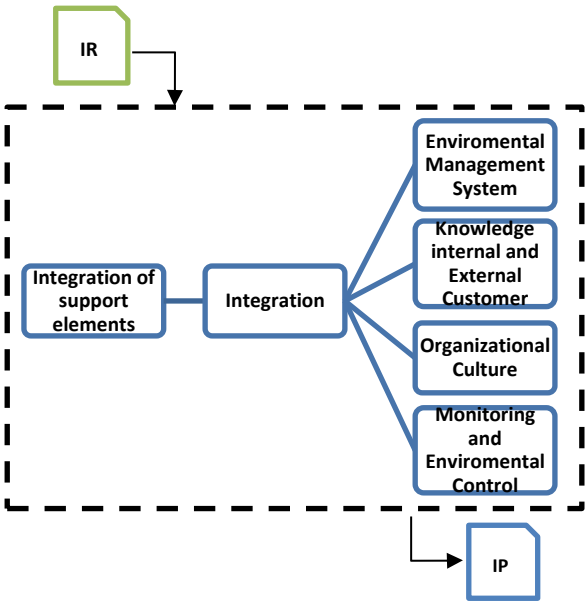

Fig. 4. Integration phase

First, the environmental management system within an organization has been evaluated. This element is characterized by design environmental rules, mitigate and keep an excellent environment behavior. The aim of this element in the eco-efficiency framework is to establish a set of environmental guidelines in a company, defining the environmental management strategies, documented support and policies integrated with the quality systems [33, 34].

Second, the knowledge of internal and external clients about the environment has been evaluated; this element proposes the ability to acquire, to use, to confront and to transform the knowledge of the environmental issues in a company. Also, this element proposes to encourage the use of different environmental strategies to improve competitiveness and sustainability inside of companies [35, 36].

Thirds, the corporate culture of sustainability has been evaluated. This element proposes to incentive and motivation to adopt the principles linked with eco-efficiency strategies and sustainability by the employees of the company. [11, 37, 38].

Then, the monitor and the environmental control have been evaluated. This factor involves the ability to identify which are the right actions to measure the environmental impacts in the SMEs [2, 8]. To be able to identify the indicators and essentials that help analyze the environment, establish the support tools that help the follow up in the environmental analysis and identification of the regulations that may directly affect the SMEs. Finally, an integrated system (IS) of the four elements is obtained.

4.4. Action plan phase

After obtaining the integration procedures (IP) of the four proposed elements. The action plan phase includes the variability and work plan for awareness environmental and implementation of the practices eco-efficiency. First, The SMEs must make the work team. The work team analyze result from the integration phase and propose different ideas to improve the achievement in this phase. Second, the work team selects ideas considering the improvement of their process. Finally, the action plan (AP) and the budget of the action plan are defined as being their implementation dependent on top management decision. So, the application of conceptual framework eco-efficiency will only be effective after the evaluation and implementation in SMEs. The elements are shown in Fig. 6.

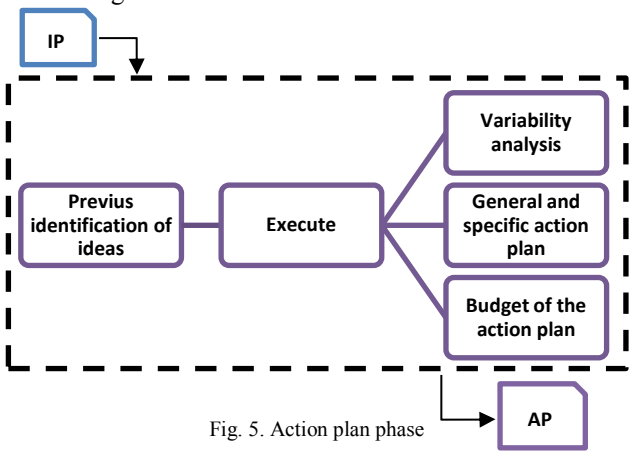

Fig. 5. Action plan phase

5. Conclusion

Sustainability development requires time and cost for a SMEs, making thus the need for new guide methods inevitable. The environmental and economic strategies are oriented toward the development of new practices productive.

The proposed conceptual eco-efficiency framework for evaluating the environmental awareness of SMEs involves four factors exploring many advantages for application and evaluation the sustainability. First of all, for a SMEs, it is easier to understand how to applicate environmental practices using elements ways of interaction. The factors of the framework can easily adapt to different SMEs environments, depending on the research preferences. The integration factors are one more advantage of the proposed framework.

The factors can be easily implemented inside the different process in the companies, such as for examples such as for example incentives to motivate employees of a company, identify responsibilities in the company, improve the levels of communication and training based on the principles linked to eco-efficiency strategies and sustainability.

In addition, this eco-efficiency framework can be used for evaluating the economic and environmental indicators. Last but not least, the proposed framework can be used in different sectors, making this conceptual eco-efficiency framework a universal approach to environmental management and administrative management.

The future research, it is intended to provide applicated the framework for identify whether the proposed factors affect the development of eco-efficiency in the SMEs. Additionally, it is also proposed for future research to establish the appropriate mechanisms for the adoption of the eco-efficiency framework in SMEs in an agile and efficient manner for their development.

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