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Linguistic multi-criteria decision making for energy and environmental corporate policy

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ABSTRACT

Nowadays, it is imperative need for the State to support Small Medium Enterprises (SMEs) operation in this difficult business environment through the development and adoption of appropriate policies, fostering green entrepreneurship and green energy growth. This paper aims to present a coherent and transparent methodological multi-criteria framework, using linguistic variables, for assessing companies' energy and environmental corporate policies. The use of linguistic variables is a realistic approach, taking into consideration that the information needed is often unquantifiable, imprecise and uncertain. The proposed framework is based on the developed 2-tuple TOPSIS method, with its application to a number of SMEs. Moreover, a comparison with the 2-tuple LOWA operator and a sensitivity analysis are provided. According to the results, SMEs that integrate systematic environmental practices, beyond the required legislation, achieve high overall performance. These SMEs come mainly from countries with essential implementation of Corporate Social Responsibility (CSR) concepts.

1. Introduction

Green economy is defined as the economy that improves human well-being and social equity, while significantly reducing environmental risks and ecological scarcities [5]. The need to develop alternative models that will address the current economic situation through the exploitation of sustainable patterns is of crucial importance.

As a successor of the Lisbon Strategy, the European Commission has launched the Europe 2020 Strategy (Commission of the European Communities, [7]) to overcome the crisis and prepare European Union (EU) economy for the next decade, giving priority to the following challenges:

- Shift towards a low-carbon economy that is efficient in the way it uses all resources.
- Foster "green" growth, through mobilization and development of partnerships for the promotion of environmental friendly practices.

Enterprises are at the heart of the Europe 2020 Strategy, taking into consideration their vital role towards national prosperity and Sustainable Development (SD). Enterprises have to integrate social and environmental concerns in their business operations and in their interaction with stakeholders on a voluntary basis, within the framework of the Corporate Social Responsibility (CSR) concept. Moreover, there is growing recognition of the important role Small Medium Enterprises (SMEs)

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play in these new fields of green development, as the technology is still evolving and partnerships are described as "dynamic" (Commission of the European Communities [6]). The companies, more than other stakeholders, have to address the problem in a long term plan, and become a driving force for the adoption of relative initiatives towards "green" development and the promotion of energy efficiency and environmentally friendly practices (Good et al. [19]; Toke and Oshima [37]). The need for the promotion of energy and environmental policies within the CSR framework is indicated in various studies, such as Panayiotou et al. [28], Apostolakou and Jackson [1] and Gjølberg studies [18].

According to Doukas et al. [10], new tools and methods are required, connecting indicators with policies, for the formulation of State's strategies for green corporate development policies, fostering in this respect green entrepreneurship and green energy growth. In this context, coherent and transparent decision support methods could assist decision makers in formulating energy and environmental policy priorities towards SD. The Multi-criteria Decision Making (MCDM) methods can be a supportive tool in the policy making, providing the flexibility and capacity to assess the alterative options' implications to the economical, environment and social framework, as pointed out by Doukas et al. [12,13].

However, the information needed for assessing companies' energy and environmental corporate policies is often unquantifiable, imprecise and uncertain [31]. Doukas et al. [8] pointed out that a realistic approach is to use linguistic variables for expressing alternatives' ratings to criteria and the weights' importance within the process of a MCDM method. The linguistic variables take values from a set of linguistic terms and their semantics are represented by the corresponding fuzzy sets. This paper aims to present a methodological multi-criteria framework, using linguistic variables for assessing companies' energy and environmental policies, based on the already developed 2-tuple TOPSIS method, and its application to a number of SMEs.

The paper is structured along six sections. Section 2 is dedicated to decision support aspects for energy and environmental corporate policy and the presentation of the adopted approach. Section 3 gives some fundamental aspects of the linguistic variables, regarding their representation models and computational techniques, and refers to the proposed linguistic multi-criteria method. Section 4 presents the pilot appraisal of this method in order to evaluate SMEs of Greek and global industry. The fifth section contains the discussion concerning the application's results, providing also their comparison with another common method and sensitivity analysis. Lastly, the sixth section summarizes the main points drawn up in the analysis.

2. Decision support for energy and environmental corporate policy

2.1. Energy and environmental corporate policy

Several methodologies are capable for the collection and organization of data for companies' corporate responsibility. Standards tools and guidelines have been developed to actively communicate information about the companies' operational and long-term investment decisions, such as the Global Reporting Initiative (GRI). Global Reporting Initiative (GRI) has pioneered and developed a comprehensive Sustainability Reporting Framework that is widely used around the world. The implementation efforts of the GRI can provide some fruitful information about the main environmental friendly practices and their impacts on enterprises and society.

However, existing methodologies and tools to report companies' environmental responsibility do not connect indicators with policies, aims and their interactions and do not provide appropriate guidelines and strategic interventions to improve operational and environmental performance of companies, as also described by Doukas [11]. This is particular true for the Hellenic environment, as Greece is definitely one of the lowest ranking countries in terms of CSR performance. Subsequently, CSR does not appear to be a systemic activity for Greek companies. According to the Eurobarometer [16] the percentage of companies using environmental management systems is small (20% in Greece). Based on recent studies, an integrated policy framework for analyzing CSR is required (Gjølberg [17]) and the need for specific decision support methodologies to measure the results of CSR (Panayiotou et al. [28]), especially as concerns the energy and environmental related issues (Skouloudis et al. [34,35]; Panayiotou et al. [29]) has been identified. Indeed, there is still the need for customized tools to identify crucial energy and environmental parameters for companies and help prioritize the areas to focus on (Veleva [38]).

As shown in Table 1, SMEs are one of the main driving forces in European economy, but they often face different and sometimes greater challenges than larger companies. SMEs are also responsible for 64% of the European industrial footprint,

Table 1
Number of enterprises, employment and gross value added in EU-27. *Source*: Eurostat/National Offices of Member States/Cambridge Econometrics/Ecorys [45].

	Number of enterprises		Employment		Gross value added	
	Number	%	Number	%	EUR Millions	%
Micro	19,143,521	92.2	38,395,819	29.6	1307361	21.2
Small	1,357,533	6.5	26,771,287	20.6	1143935.70	18.5
Medium	226,577	1.1	22,310,205	17.2	1136243.50	18.4
SMEs	20,727,627	99.8	87,477,311	67.4	3587540	58.1
Large	43,654	0.2	42,318,854	32.6	2591731.50	41.9