Integral sustainability model for the improvement of environmental and productive processes in small and medium enterprises

Abstract

Environmental problems and the depletion of natural resources are a worldwide concern which has not yet been fully solved. These environmental problems have had a negative impact on the population and economic development of all countries, the industrial sector being one of the biggest sources of pollution.

The present doctoral dissertation focuses on small and medium sized enterprises (SMEs), which actually constitute the productive gear in emerging countries. The negative impact of a small business is so weak that it tends to be neglected, but considering that this sector accounts for 90% of an average country´s economy, its effect on the exacerbation of environmental pollution through commercial, industrial and service activities significantly contributes to overall environmental, social and economic difficulties.

Therefore, SMEs play an important role in the adoption of sustainable and respectful practices when it comes to reducing negative impacts on ecosystems. Thus, the adoption of sustainability is related to the effective application of environmental practices and tools that must be incorporated into an organization's internal strategies and objectives. This actually means considering environmental sustainability as a priority in all aspects of business activity.

However, by gathering the relevant literature related to the subject of study, it could be observed that there are multiple sustainability models designed for the industrial sector, but few research studies comprehensively evaluating and exploring the social, environmental, economic and technological aspects of SMEs. For this reason, and in order to reach a deep understanding of the adoption of sustainability by SMEs in Colombia, the present research is framed in the analysis of the current state of small businesses in face of the challenge posed by the achievement of corporate sustainability.

In this sense, this work proposes the development of an Integral Sustainability Model for SMEs (ISM-S), framed in an environmental management system aimed at improving economic indicators, minimizing negative environmental impacts and making their employees adopt more sustainable and responsible behaviors.

The ISM-S developed in this doctoral dissertation focuses on the analysis of a series of factors related to (*i*) a decision-making management system, (*ii*) sustainable tools and strategies, (*iii*) social responsibility and knowledge management, and (*iv*) technological convergence. It also includes a sustainability maturity classification model that operates through data analysis and supervised classification algorithms, and a predictive simulation model that allows examining a sequence of changing events that can be subjected to probabilistic analysis as the company goes through different scenarios to achieve sustainability. In summary, this research resorts to a conceptual framework, descriptive statistical methods, data analysis, and stochastic prediction models.

Additionally, the ISM-S model was quantitatively evaluated through its components (statistical analysis, classification of sustainable maturity states and predictive simulation) in different

productive SME sectors in Colombia. In relation to the statistical analysis of the case study, the results show that SMEs have internal and external barriers that affect the adoption of practices of interest at the national level, since they lack environmental, social, economic and technological strategies.

Using the techniques Design Science Research and Design of Computational Intelligence Experiments, the classification of sustainable maturity was applied to a group of companies in Colombia. Making use of data analytics and supervised classification algorithms, the model found that the studied group of Colombian (micro,small and medium sized enterprises-MSMEs) was composed as follows: 6% of the companies were at an insufficient sustainability maturity level; 31% were at the basic one; and 45% and 18% at the developing and consolidated levels, respectively. According to the current model's simulation of the fulfillment of a set of characteristics, assumptions and constraints on the part of Colombian MSMEs from different productive sectors, they will have reached a maximum level of sustainability maturity after a two and a half-year period (on average).

The conclusions of this research reveal it is one of the first empirical studies to integrally analyze various sustainability factors in connection with the behavior of SMEs in Colombia. Therefore, the current framework can be applied to both regional development plans and the evaluation and monitoring of economic indicators in companies. This, in turn, allows them to minimize negative environmental impacts and have their employees adopt more responsible behaviors.

Thus, this doctoral dissertation constitutes a platform for future research projects wishing to improve the analysis of other factors than those studied here. This may aid researchers in comparing SMEs across different regions of Latin America, thus allowing them to determine similarities or differences in the achievement of sustainable development and framing other methodologies in future research studies.