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Name of Research Scholar: Mr. Abdul Gani

Name of Supervisor: Dr. Mohammad Asjad

Name of Co- Supervisor: Dr. Faisal Talib

Department/Centre: Department of Mechanical Engineering, Jamia Millia Islamia

Title of the Thesis: Development of a Methodology for Environmental Sustainability Assessment.

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Findings

Micro, Small, and Medium Enterprises (MSMEs) face numerous environmental challenges encompassing resource and energy conservation; waste generation and disposal; water and air pollution, and so on. Due to strict government legislation and increasing awareness of environmentally sustainable manufacturing, MSMEs are encouraged to adopt sustainable manufacturing practices. In this context, sustainability assessment plays an important role in sensitizing the manufacturing organization's success in reducing the environmental impact of manufacturing. Therefore, the purpose of the present research was to develop a methodology for environmental sustainability assessment in Indian MSMEs involved in manufacturing. The work was carried out in three phases.

In the first phase, the indicators of environmental sustainability (EN) that are relevant to the manufacturing sector were identified through an exhaustive review of the literature. Then through the application of "Pareto Analysis", a list of 28 vital indicators concerning manufacturing were short listed. Further, these indicators were prioritized and ranked with the help of the Best-Worst method, which is a new multi-criteria decision-making technique. This technique is implemented to rank and arrange the ENs in accordance with their criticality by assigning them a weight. Based on the assigned weight, a set of 15 critical indicators were selected for the next phase of the study.

In the next phase of the research, the interdependence among the selected indicators was explored by taking the views of industry professionals. An integrated DEMATEL-MMDE-ISM approach was employed to analyze the inputs of industry professionals. The results of the study highlighted that Design for disassembly, reuse, recycle, & safe material, which facilitates the product's being disassembled, reused, or recycled, and is free from hazardous materials, plays a significant role in enhancing the environmental sustainability of the concerned industry. Design for disassembly, reuse, recycle, & safe material significantly affects 12 other indicators out of 15 under consideration. Thus, incorporating green practices into the design and development of products leads to significant improvement in environmental sustainability. Furthermore, the application of ISM ensured that the interdependence among indicators is expressed in the form of a digraph.

From the first two phases, the weights and interdependent relations between the indicators were known. Hence, in the third phase, a manufacturing sustainability index (MSI) is proposed, using the same set of 15 environmental sustainability indicators. The present phase of work utilized a structural approach to graph theory and matrix for the development of the MSI. To perform sustainability assessment, indicators are required to be identified and evaluated. Each indicator is constituted by several sub-indicators. Moreover, all these indicators are interrelated and influence other indicators. Modeling of these indicators and their interdependent relationships is accomplished through graph theory. The sustainability digraph of indicators obtained in phase two was further modified to represent the degree of interdependent relationship between the indicators. From this digraph, an equivalent matrix is developed to establish a manufacturing sustainability assessment function that steers to the estimation of the MSI. Higher values of MSI indicate the higher level of environmental sustainability of an organization which reflects a lower negative impact on the environment.

The proposed methodology can be implemented for evaluating and comparing the sustainability level of different manufacturing firms. That, in turn, will lead towards environmentally conscious manufacturing. This work will be helpful in the successful implementation and/or evaluation of sustainability assessments, particularly in manufacturing industries in India. The study is expected to aid decision-makers (industry practitioners and academic researchers) to identify strategic areas in order to achieve higher environmental sustainability in manufacturing organizations.