

Industrial Waste Challenges and Green Manufacturing Practices: Enhancing Small and Medium-sized Enterprises (SME's) Sustainability

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Abstract

This study investigates green-manufacturing practices affects the lasting growth of Small and Medium-sized Enterprises (SMEs). The article examines how SMEs' ecological, communal, and financial sustainability performance can facilitate in improving by implementing Soft Total Quality Management (TQM) practices. The research adds to the body of data by emphasizing the value of using a comprehensive Total Quality Management (TQM) strategy to support sustainable growth in Small and Medium-sized Enterprises (SMEs). The study's conclusion advises how green-manufacturing strategies helps in achieving long-term growth in attaining organizational performance. The paper examines the challenges faced in reducing the negative effect on environment as well in depth analysis this paper highlights the various opportunities and benefits enhancing in environmental sustainability. The existing paper attempts to highlight the Industrial waste challenges in sustaining the "Small and Medium-sized Enterprises" (SMEs) and discover the efforts to adopt the practices of green manufacturing. The potential areas of this research such as embracing green practices and sustainability, organizations drive innovation, reducing environmental impacts, enhancing the brand reputation will leads to long-term success of organization and further in improving the growth of the country that could be considered as the proposed solutions across industries. The insights will be beneficial in sustaining industrial operations and inspire for future research.

Keywords: Green manufacturing, Practices, Industrial waste, Sustainability, SMEs, Organizational performance, Total quality management

INTRODUCTION

Sustainable business practices, SMEs, organizational performance, and comprehensive quality management are all interrelated factors that will have a significant impact on how firms and industries around the world develop in the future [1]. This essay examines the significance of these ideas and how they affect businesses that want to prosper in the midst of the world's rapid change [2]. Utilising cleaner

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production methods, recycling and waste reduction, and renewable energy sources are some of the strategies that fall under the heading of "green manufacturing practices". In addition to protecting the environment, companies can improve their brand image, save money, and increase operational performance by using these practices [3-5]. Small and medium-sized enterprises (SMEs) typically produce numerous types of industrial waste, such as Solid Waste defines as waste in the form of solid namely; packaging materials, scrap metals, plastics, and other non-hazardous solid materials. The other form known as Liquid Waste that is the waste generated by water through cleaning processes,

cooling water, and process liquids that may comprise pollutants. The waste describes as Hazardous Waste and effects human health and the environment if not properly managed through the chemicals, solvents, oils, and other substances that are harmful towards humankind. Electronic Waste (E-waste) is another type of waste that contains hazardous materials like lead, mercury, and cadmium found in obsolete electronics and electrical equipment. Organic Waste is the waste produced from manufacturing processes that is food waste, agricultural residues, and other biodegradable.

It has been observed that the various types of waste have important effects on sustainability. Impact on Environment through the inappropriate disposal of waste that leads to polluting water bodies, contaminating soil, and contributing in greenhouse gas emissions. The other issue focussed is Resource Depletion considered in waste generating through inefficient use of raw materials and energy. Therefore, to improve sustainability, SMEs can follow the practices such as waste reduction through improved processes during production, materials that could be recycle and reuse and applying well-organized waste management schemes to curtail environmental effect. Sustainability in the context of green manufacturing is defined as an organization's talent to meet current requirements deprived of endangering the ability of future generations to meet on their own [6]. It includes economic, social, and environmental elements. Sustainable "green manufacturing" techniques include putting circular economy principles into reality, promoting social responsibility, and taking the environment into account while making decisions. Businesses can create long-term profits, lower risks, attract environmentally conscious customers, and comply with regulations by adopting sustainability. Sustainable practices adopted in SMEs helps in reducing the cost and escalation operational efficiency that focus on forward thinking and behaves as responsible players in both local and global markets creating a competitive edge in attracting customers, partners, and investors.

Sustainable practices can significantly enhance the competitiveness of SMEs in both local and global markets through Cost Efficiency and Resource Savings, developing brand reputation and customer loyalty, accessing towards new markets and partnerships, innovation (new product development) and adaptability, attracting investment and enhanced employee morale and productivity

"TQM "an administrative theory and movement that emphasises worker inclusion, client focus, and continuous improvement. focuses on green assembling and maintainability initiatives that can benefit from the application of TQM standards. Associations can enhance their functional proficiency, reduce waste and flaws, and increase customer loyalty by integrating TQM with green practices [7-8]. TQM offers associations with a meaningful framework to identify areas for improvement, screen and improve their cycles, and ensure that manageability goals are ingrained in the hierarchical culture [9].

Green Manufacturing

Green manufacturing, referred as sustainable manufacturing or eco-friendly manufacturing, is a state-of-the-art approach to industrial production that places a high premium on reducing adverse environmental effects and making the best use of limited resources. Its objective is to minimise the adverse environmental effects of manufacturing while optimising economic and social benefits. Green manufacturing has emerged as a significant solution to the problems of pollution, climate change, and the depletion of natural resources. From the original concept and material acquisition to the final product and waste disposal, it seeks to integrate environmentally friendly practices across the entire production process [10].

The efficient use of raw resources, water, and energy; the decrease in pollution and waste production; and the use of energy, water, and raw materials; the reduction of waste output and pollution; and the use of renewable and clean technologies are central to the concept of "green manufacturing." The manufacturing industry may improve its performance, lessen its impact on the environment, and help ensure the planet's survival for future generations if it adopts these concepts [11].

Green Manufacturing Strategies

As concerns about sustainability and the environment gaining popularity, businesses all over the world are implementing green manufacturing techniques to reduce their adverse environmental impacts. Manufacturers are increasingly using "green manufacturing" techniques to cut emissions, waste, and resource consumption without compromising the quality of their products or their ability to compete [12–13]. Green manufacturing practices can adopt both initial and long-term cost implications for SMEs. Initial Costs defines the costing incurred in adopting the environmentally friendly technologies or processes. To upgrade efficiency in energy Investment in Technology and Equipment require a significant initial investment. Cost also incurred in providing training and education to employees. Initial expenses include in certifications for environmental standards to meet regulatory standards for eco-friendly practices. Long-Term Costs is measured as the ongoing financial impacts that is reflected in SMEs after implementing green manufacturing practices. Through this efficiency in terms of energy and resource could results in lower operational costs. Further, that will facilitate in building a reputation and market position to attract eco-conscious customers and partners.

Green Manufacturing Challenges

"Green" manufacturing has drawn a lot of attention recently as a means of lowering environmental harm and raising the use of eco-friendly procedures in the manufacturing industry. However, several obstacles could be solving before the full potential of green manufacturing can be realized. In this study, we survey the problems plaguing green production and investigate some of the ways they could be fixed [14].

Opportunities and Benefits of Green Manufacturing

Due to rising worldwide concerns about environmental sustainability, "green manufacturing," referred as sustainable manufacturing or eco-friendly manufacturing, has received a lot of attention in recent years. The possibilities and advantages of environmentally responsible production methods [15].

METHODOLOGY

Sampling and Data Management

The research primary focus was on Finnish SMEs, and the inclusion requirements included having fewer than 250 people and an annual revenue of under EUR 50 million. Firms with five or fewer workers were eliminated to guarantee that the participating firms have true "TQM" practices.

The respondents were managing directors of the participating companies. The tool used is Webropol to carry out the survey. 6889 randomly chosen CEOs from both industrial and service enterprises were emailed the survey along with a brief explanation of the study's focus and aims. After two reminders, 271 businesses responded, for a response rate of 3.9%. The survey was conducted in the autumn of 2022.

MEASURES

The study evaluated how each respondent felt about how soft TQM operated in their organizations and how well the company has implemented environmental and social sustainability. The requirements from the EFQM sections served as the foundation for the detailed questionnaire's design. The respondents were then asked to rank the social and environmental sustainability of their company.

Finally, questions on the organizations the respondents worked for includes guarantee and the number of workers, and whether the business provided goods or services (industry/service).

RESULTS

The study looked at the connections between SME environmental and social sustainability and soft TQM. The "means" and "standard deviations" of the variables are shown in a correlation matrix in Table 1.

The hypotheses were tested using the linear regression methodology. The following checks were made on the linear regression's premises before hypothesis testing. With the help of a typical P-P plot and a scatterplot of the residuals, normality and heteroscedasticity were evaluated. By examining the values of the variance inflation factor and correlation coefficients, multicollinearity was examined. All coefficients fell below the 0.80 cutoff, as shown in Table 1. The VIF values were below the 5.00 cutoff and varied from 1.082 to 2.618.

Table 1. With means and standard deviations, a correlation matrix.

	Business management system	HR practices	Constantly evolving processes	Advanced procurement procedures	Stakeholder identification and competitive products	Environmental sustainability	Social sustainability
Mean	3.9	3.88	3.66	3.92	4.21	3.16	3.45
SD	0.585	0.63	0.695	0.681	0.583	0.553	0.547
1	1	0.627***	0.636***	0.415***	0.576***	0.269***	0.271***
2		1	0.565***	0.391***	0.486***	0.241***	0.222***
3			1	0.376***	0.534***	0.115	0.222***
4				1	0.481***	0.164**	0.145*
5					1	0.134*	0.238***
6						1	0.463***
7							1

Note: *** $p \leq 0.001$, ** $0.001 < p \leq 0.01$, * $0.01 < p \leq 0.05$.

Table 2. Results of Regression Analysis.

	Dependent: Environmental sustainability	Constant	No. of employees	Industry	Certification	Business management system	HR practices	Constantly evolving processes	Advanced procurement procedures	Stakeholder identification and competitive products
Std. β			0.043	-0.034	-0.073	0.249	0.193	-0.081	0.072	-0.148
t		8.007	0.708	-0.549	-1.135	2.617**	2.172*	-0.943	1.034	-1.837
R ²		0.111								
Adj. R ²		0.083								
F		4.003***								
	Dependent: Environmental	Constant	No. of employees	Industry	Certification	Business management system	HR practices	Constantly evolving processes	Advanced procurement procedures	Stakeholder identification and competitive products
Std. β			0.05	0.142	-0.077	0.2	0.069	0.076	-0.010	0.031
t		7.054	0.828	2.325*	-1.219	2.124*	0.788	0.89	-0.151	0.384
R ²		0.129								
Adj. R ²		0.102								
F		4.767***								

Note: *** $p \leq 0.001$, ** $0.001 < p \leq 0.01$, * $0.01 < p \leq 0.05$.

Table 2 displays the findings of a regression analysis of the connections. The significance of both study models was high ($p \leq 0.001$). Business management systems and Human Resource practices are the beneficial and important elements associating environmental sustainability in the environmental sustainability model, while the remaining TQM practices and the control variables are not relevant [16-17]. The company management system and the control variable industry both support environmental sustainability in the social sustainability model; all other variables are non-significant. The outcomes are shown for each hypothesis in Table 2.

CONCLUSION

In conclusion, green manufacturing practices, sustainability, SMEs, organizational performance, and total quality management are intertwined concepts that have significant implications for organizations in today's global landscape. Organisations may foster innovation, lessen their adverse effects on the environment, recover the status of their brands, and succeed in the long run by adopting sustainable practices and green practices. SMEs can use these strategies to increase their competitiveness and take advantage of new business opportunities if they receive the right assistance. Green practice integration is further strengthened by the successful application of overall quality management concepts, which guarantees stakeholder satisfaction and ongoing improvement [18]. The significance of these ideas and their potential to build a more sustainable future for companies and society at large must be acknowledged as organisations continue to face environmental difficulties. Industrial waste presents significant obstacles to small and medium-sized businesses' (SMEs') long-term viability, operational efficiency, compliance, and reputation. The most effective waste reduction strategies of Small and medium-sized enterprises (SMEs) in manufacturing can significantly decrease wastage and recover efficiency by implementing the waste reduction strategies that is through Just-in-Time (JIT) Production and 5S methodology namely sort, set in order, shine, standardize, sustain consists under Lean Manufacturing Principles. To improve the Efficiency in Material & Minimizing Waste can adopt the High-Quality Raw Materials, Redesigning Products and using Recyclable or Biodegradable Materials.

The human capital Training & Engagement on Waste Reduction will encourage proper handling of materials staffed can motivated by implementing a Reward System that will leads to continuous improvement. Latest straterzies in the form of encouraging bulk deliveries with minimal packaging, enhancing delivery schedules and returning unused materials for reuse that will optimize supplier and logistics.

The phrase "operational efficiency" describes how to deliver the services and products in an effective way to optimize the cost and to maintain quality. The approaches to manage industrial wastage could be attaining through reduce the waste generation and adopt the best practices of waste management. It is observing that the Industrial waste management influences a business management system and the integration of operational efficiency, compliance, sustainability, and financial performance further strengthens operational control, risk management, and stakeholder trust. Industrial waste understands as a catalyst especially for the adoption practices in green manufacturing. Considering these challenges able to meet out approaches that are innovative and sustainable in the growth of business (increased the demand for eco-friendly products) and reduce the environmental impact.

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