

A review of Socio-economic indicators of sustainable Manufacturing

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Abstract. Manufacturing organizations are implementing sustainability practices to become more sustainable. Understanding the manufacturing sustainability involves indicators which provide a quantitative or qualitative way of measure to the organizations success in implementing the sustainability practices in the organization. Hence present paper analyses the studies conducted in the field of sustainable manufacturing and identifies the socio-economic indicators of sustainability frequently used by the researchers. From the review of the literature the 51 indicators were identified and then categorized into meaningful groups to provide for the meaning context to these indicators. These indicators will be quite helpful in the assessment of manufacturing organizations with respect to socio-economic sustainability.

Keywords: Sustainable Manufacturing, Socio-Economic Indicators, Economic sustainability, Social Sustainability

1 Introduction

Sustainable manufacturing concepts are gaining widespread recognition across all walk of industrial activities. Sustainable manufacturing refers to producing products that produce minimum negative environmental impact [1]. Sustainable Manufacturing should include Triple bottom line approach of the sustainability which includes the environmental, economic and social aspects of the sustainability [2]. Thus, apart from reducing negative environmental impact sustainable manufacturing should result in economic prosperity and social equity. While environmental aspects of sustainable manufacturing have been widely re-searched but the socio-economic aspects of the sustainability are under reported in Indian manufacturing context [3]. Further for the adoption of sustainability any organization needs to consider the indicators to measure the level of sustainability achieved by the organization. These indicators provide the important tools for the sustainability assessment of a manufacturing organization and provide valuable insight about the sustainability of thing por process [4].

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This paper attempts to consolidate the socio-economic indicators of sustainability in manufacturing.

2 Method and Materials

In order to find out the socio-economic indicators that are relevant to Indian manufacturing an exhaustive review of literature was conducted. The databases of major research publishers like Elsevier, Springer, Taylor & Francis, Inderscience were searched. The key words like ‘Sustainable Manufacturing’ ‘Sustainability Indicators’ ‘Indicators of sustainable manufacturing’ etc. were used to find the research article from these databases. In this way around 200 papers relevant to sustainable manufacturing were reviewed and indicators identified from these research papers. Further these indicators were classified in to the relevant categories of socio-economic indicators. This was done to provide a proper context to each indicator in terms of uses. The categorization of social and economic indicators is provided in Table 1 and Table 2. The economic indicators were further divided in to 4 categories, like Cost/profit, Customer and Supplier, EHS compliance and related costs, Resource/Product related categories ss can be observed from Table 1. Similarly, the Social Indicators are further divided into three categories like, Community, Employment, Product and customer related indicators.

Table 1 Categorization of economic indicators

S. No.	Categories of Economic Indicators
1	Cost/profit related indicators
2	Resource/Product related indicators
3	Customer and Supplier related indicators
4	EHS compliance and related costs

Table 2: Categorization of Social Indicators

S. No.	Categories of Social Indicators
1	Community indicators
2	Employment related indicator
3	Product and customer related indicators

The category wise detailed description of these indicators is provided in to the next section.

3 Economic indicators of sustainable manufacturing

In order to provide a proper context to the indicators economic indicators were further divided in to sub-categories as explained in previous section in Table 1. The detailed description of each indicators are provide category wises.

3.1 Cost/profit related indicators

The literature pertaining to the economic indicators in general and Cost/profit related indicators in particular are found in 58 research papers out of 135 studies. However, some of them may consider more than one Cost/profit related indicators related indicators. The table 3 shows the Cost/profit related indicators. Profit indicators are used for measuring the profit earned by the organization. Profit is an absolute number while profitability is an indicator

utilized in determine the scope of the profits from a company. Profitability is a measure of financial health of an organization in context to sustainability [5]. Costs related indicators can be the cost of manufacturing the product, total cost incurred while manufacturing the product, operational cost and initial investment needed to start the production etc. [6]. Separate cost related indicators [7–11] were used in different studies as shown in table 3.

Table 3: Cost/profit related indicators

Cost/profit related indicators	Profitability
	Life cycle cost/Product life cycle
	Total cost/ Production cost/initial Cost
	Labour cost
	Cost Reduction
	Share profitability
	National/international subsidies

3.2 Resource/Product related indicators:

Resource/product related indicators consisted of quality of product or resources, production rate/productivity, resource efficiency and technological improvements adopted to make product economically sustainable. The literature pertaining to the economic indicators in general and Resource/Product related indicators in particular are found in 67 research papers out of 135 studies. However, some of them have considered more than one Resource/Product related indicators simultaneously [12–15]. The table 4 shows the Resource/Product related indicators [16, 17]. Here quality refers to the quality of the product after adopting sustainable technologies/practices. Different quality measurement methods were used by different authors [13, 18]. Many experiment-based studies have used Production rate as an indicator of success or failure of adopting sustainable methods of manufacturing [19]. While productivity as a sustainability indicator has been mostly used in theoretical or survey-based analysis. For the present study the production rate and productivity have been taken as one single indicator. Despeisse et al. (2013) [20] described various tactics of improving the resource efficiency to achieving economic benefits. Technological improvement indicators refer to cost associated with developing sustainable methods and benefits obtained from these.

Table 4: Resource/Product related indicators times

Resource/Product related indicators	Process Management/Resource efficiency
	Production Rate/Productivity
	Quality
	Technological improvements

3.3 Customer and Supplier related indicators:

Indicators of this category are presented in Table 5. These indicators are associated with the cost which is incurred in maintaining the relationship of various stake holder of the company [1, 21]. Zero customer complaints [22–24] or returns as an indicator will reflect the

organization willingness to address the grievances of the customers. Similarly taking stakeholders review and investment in local suppliers are other indicators in this aspect.

Table 5: Customer and Supplier related indicators

Customer and Supplier related indicators	Zero customer complaints or returns
	Investments in local suppliers
	Percent suppliers participating in Life Cycle Assessment of materials or products
	Stakeholder review and participation in decision-making

3.4 Environment Health and Safety (EHS) compliance and related costs:

Due to stricter government legislations manufacturing organizations are forced to invest in the environmentally sustainable techniques and practices. So, the investment incurred in this regard comes under the EHS compliance cost[25, 26]. The indicators under this category are explained in the Table 6.

Table 6: EHS compliance and related costs

EHS compliance	Reduce environment health and safety compliance costs
	Investments in Environmental Protection
	Costs associated with EHS compliance
	Percent of suppliers without EHS violations

4 Social sustainability indicators of manufacturing

Social sustainability primarily covers the implication of manufacturing to the society and country. Thus, as mentioned in table 2 the social sustainability related indicators were primarily come under three categories i.e Community, Employment and, product and customer indicators.

4.1 Community Indicators

Under this category of indicators, the responsibility of the manufacturing organization towards the local community and country are reflected. As shown in table 7 such indicators reflect the organization willingness to engage with the local communities in its domain of operations. A total of 7 Community indicators of sustainable manufacturing were identified from the literature. Indicators chosen for this category were selected based on the benefits nearby communities' getting from the manufacturing facility[27–31].

Table 7: Community Indicators

Community related indicators	Percent or nos of suppliers from the local area
	Percent of locally consumed products
	Increase employment opportunities for local community
	Community spending and charitable contributions as percent of revenues
	Increased community–company partnerships
	Regulatory and public services
	Percent of investment in human rights clauses

4.2 Product and customer related indicators

Table 9 shows the indicators which are related to the customers of the organization. All organizations give utmost emphasis to the well-being of the customers and its satisfaction[32–34]

Table 9: Product and customer related indicators

Product and customer related indicators	Percentage of business units analysed for corruption related risks
	Number of actions taken in response to incidents of corruption
	Monetary value of Non-compliance with laws and regulations(e.g significant fines and total number of non-monetary sanctions).
	product safety
	Research and development
	Security

4.3 Employment related indicator

Employment indicators covers the organizations responsibilities towards its employee. Table 8 shows the indicators that are frequently used to evaluate the organizations success in fulfilling its responsibilities towards the employee[35–39].

Table 8: Employment related indicator

Employment Related indicators	Achieve zero lost workdays as result of work-related injuries and illness.
	Increase the rate of employee suggested improvement in quality, social and environment health and safety performance
	Reduce employee turnover rate
	Increase employee training on green knowledge (Avg no of hours)
	Increase employee well-being and job satisfaction
	Total workforce by employment type, employment contract, and region.
	Total number and rate of employee turnover by age group, gender, and region
	Percentage of total workforce represented in formal joint management-worker health, and safety committees
	injury rates, occupational diseases, lost days, and absenteeism, and number of work-related fatalities
	Number of education, training, counseling, prevention, and risk-control programs
	Programmes for skills management and lifelong learning
	Regular performance and career development reviews (Percentage of employees receiving).
	Ratio of basic salary of men to women.
	Percentage of employees trained in anti-corruption policies and procedures.
	Employment compensation
	Health and safety practices/ Worker Safety
	Health and education/worker health
Average hours of employee training per year/ Training and education	
Gender Ratio	

5 Conclusions

Based on extensive and exhaustive review of studies pertaining to socio-economic indicators of utilized in context to sustainable manufacturing were identified and presented in this study.

After examining 200 relevant research paper it was found that researchers have used different set of indicators for assessing sustainability. Even the context of using these indicators were different in different studies. Similarly, methods and units adopted for the measurement of these indicators have varied from one research to other. But the aim of these studies was to improve sustainability of the organization, product or process. the present works compiles only those socio-economic indicators which can be helpful in addressing the socio-economic issues arising out of manufacturing activity. This will help industry practitioner to identify the social and economic issues and guide them to resolve them so that the socio-economic sustainability can be achieved in manufacturing.

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