

## Chapter 3

# Enablers of Sustainable Manufacturing Overview, Framework and Further Research Directions

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### ABSTRACT

*The aim of this paper is to develop a conceptual sustainable manufacturing (SM) framework, which is the pressing need of highly competitive and natural resource scarce world. Systematic literature review has been adopted to identify enablers of SM. The enablers identified through systematic literature review includes product design, material selection & procurement, customer requirements, regulatory norms, social values & ethics, environmental priorities, energy costs, natural resource scarcity, supply chain & logistics systems, fuel price regulations, public awareness, technology and total quality management. Author has attempted to develop a contextual relationship among enablers of SM using interpretive structural modeling. The author has further classified enablers into four categories using MICMAC analysis. The author has also outlined the limitations of present study and identified further research directions.*

### 1. INTRODUCTION

Sustainable manufacturing is the need of the current era as global warming, manmade pollution and natural resource scarcity are becoming like a sword of Damocles to the world. Insights from the literature on the topic show that, sustainability in manufacturing must be taken into consideration from the product design stage through production to the logistics stage. Sustainability has got three aspects in manufacturing. These aspects includes: 1) the manufacturing sustainability in the production process; 2) sustainability during the use of the product, 3) sustainability for the recycling and logistics point of view. We can say that product design, material selection, manufacturing process design and resource utilization as the factors of first aspect; environmental emission from the product, ease of maintenance

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etc. as the factors of second aspect and ease of disassembly, recyclability, reusability of materials as the factors of third aspect. According to Garbie (2014); Carter and Easton (2011); Dyllick and Hockerts (2002), Environment, society and economy are the three widely accepted components of sustainability. Manufacturing can be defined as the process of converting raw materials into value added useful tangible finished products for a specific use through one or more operations. Hence, sustainable manufacturing can be defined as the innovative technology and organizational practices which ensures zero negative impact to the environment, community, employees with the minimum use of raw materials and energy and which produces high quality recyclable finished products. Different viewpoints and definitions on sustainability and sustainable development from different literature are listed in Table 1. Through systematic literature review, the authors have identified twelve key driving factors of sustainable manufacturing. Since these factors are much broad in their sense, sub-dimensions of these variables are also elaborated from literature.

*Table 1. Definitions of Sustainability*

Author(s), (Year)	Definition
IPCC, Copenhagen, Denmark (2014).	Sustainable Development is defined as the one which is based on three pillars such as economic, social and environmental and preserves the interests of future generations and ecosystem services and balance on which the existence of human kind is dependent on.
Institute for Sustainability (2011)	Sustainability can be defined as increasing the productivity by minimizing the resources used without compromising on service quality, profitability and competitiveness to help to preserve the environment.
Jayal et al. (2010)	Sustainability is the term which can be achieved only through an integrated approach incorporating closed loop supply chain, manufacturing process and systems, multiple product life-cycles etc. at product process and system levels with the objective of reduce, reuse, recover, redesign, remanufacture and recycle.
Ciceri et al. (2010)	Sustainability is a quality which helps to preserve, save and keep.
Hutton et al. (2007)	Sustainable development can be defined as the one which helps to fulfill the needs of the present without compromising the capability of the future to fulfill their own needs.
Barber (2007)	Sustainable production and consumption is defined as the system which helps to meet the human needs and improve the quality of life through social and economic improvement for all, including future generations, while maintaining the ecosystems on which human life is depended up on.
Asheim et al. (2007)	Sustainability is defined by using the framework of ethical social choice theory and explains that sustainable behavior is the ethically justifiable treatment of all future generations with equity and efficient consistent consumption of natural resources.
Seliger (2007)	Sustainability is defined as the direction in which the living standards of human being is improved at the same time the availability of natural resources and ecosystems are also preserved and improved for future generations.
Jenkins and Yakovleva (2006)	Sustainable development is defined as the progress in economic development, environmental protection and social consistency.
Szekely and Knirsch (2005)	Sustainability is the process by which organizations amalgamate their social, economic and environmental objectives with the organization strategic goals and balances all these three dimensions in an optimum way.
Stavins et al. (2003)	Sustainable growth is defined in an economic framework as the one which is both dynamically efficient and non-decreasing over time.
Deloitte and Touche (1992)	Sustainability can be defined as the process of adopting new business strategies and ideas which will fulfill today' needs of the organization and all other stakeholders, which will protect, sustain and enhance all natural and human resources for the requirement of the future.
UN - The World Commission on Environment and Development (1987)	Sustainable development can be defined as the usage of resources, investment guidelines, technological advancement and organizational changes are made to meet the need of the present as well as of future generations consistently.

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