



IJMIRD 2015; 2(3): 459-464  
www.allsubjectjournal.com  
Impact factor: 3.672  
Received: 01-03-2015  
Accepted: 17-03-2015  
E-ISSN: 2349-4182  
P-ISSN: 2349-5979

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## Environmental sustainability and manufacturing sector

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### Abstract

The Industrial Revolution transformed society and its interaction with the environment, increasing the use of natural resources and the pace of development of new products and processes. This has left permanent changes in the structure of society and also on the earth through depletion of resources, alteration of natural habitats and pollution from unwanted byproducts of the production process and discarded products at the end of their useful life. Technology is the cause of and solution to many of our environmental problems. Technology enabled the industrial revolution which improved average quality of life in the developed world, but led to serious environmental problems. But technological development occurs when innovative people are faced with major challenges. The challenge today is to have sustainable development. There's no alternative to sustainable development. Even so, many companies are convinced that the more environment-friendly they become, the more the effort will erode their competitiveness. They believe it will add to costs and will not deliver immediate financial benefits. Indeed, the quest for sustainability is already starting to transform the competitive landscape, which will force companies to change the way they think about products, technologies, processes, and business models. Companies are making all the efforts to make manufacturing more environmentally sustainable. Sustainable manufacturing is the processing of resources into products with minimal negative environmental impact. Products are manufactured through processes that prevent ghg's, conserve energy and natural resources, and that are non-hazardous to employees and consumers. By treating sustainability as a goal today, early movers will develop competencies that rivals will be hard-pressed to match.

**Keywords:** Industrial Revolution, depletion of resources, pollution, Technology, environment, sustainable development

### 1. Introduction

Though India banks heavily on its service sector for growth, the manufacturing sector too plays a significant role in Indian economy contributing nearly 21.5% to the GDP. Encouraged by the increasing presence of multinationals, scaling up of operations by domestic companies and an ever expanding domestic market, the Indian manufacturing sector has been showing a good growth rate. India is fast emerging as a global manufacturing hub. It has all the requisite skills in product, process and capital engineering, thanks to its long manufacturing history and higher education system. India's cheap, skilled manpower is attracting a number of companies, spanning diverse industries, making India a global manufacturing power house. The rapid growth of the Indian economy is likely to make India the fifth largest consumer market in the world by 2025 from twelfth in 2005 according to a study by MCKINSEY Global Institute. Manufacturing is also an integral component of the value chain in many other Industry sectors, such as, services, transport, infrastructure and agribusiness. As a result, there is a high level of integration between manufacturing and the rest of the economy. This connectivity with the broader economy is evidenced by what is referred to as the 'multiplier effect'. There is evidence that many natural resources are reaching their peak in terms of availability at either reasonable cost or quality. This applies to a wide range of mineral resources and non renewable fossil fuels. There is scarcity of fresh water resources relative to demand. Energy demand is forecast to rise throughout the world for the coming decades. These issues combined will drive the pursuit of resource efficiency within the manufacturing sector.

### Meaning of Sustainable Manufacturing

Manufacturing around the world is undergoing considerable change and India is no exception. The challenge being faced by Indian manufacturing sector is to have sustainable growth putting less pressure on the resources and environment. As a starting point, it is important to understand the meaning of sustainable manufacturing perhaps because it is a process or journey, rather than a state or endpoint. A commonly referenced definition is from the Bruntland Report (1987) which defines sustainable development as "...development that meets the needs of the present without compromising

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the ability of future generations to meet their own needs.” The US Department of Commerce defines sustainable manufacturing as “the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound.”

### **Effects of Industrialisation and Need for Sustainable Manufacturing**

The rise in growth in the resource intensive Manufacturing sector is enabled and facilitated by an ever-increasing rate of material use leading to manifold impacts to the environment. The cost of environmental damage has been estimated at approximately \$32 billion as per figures identified by the National Productivity Council of India. The Central Pollution Control Board has identified 17 highly polluting industries, the majority of which are manufacturing industries. There’s no alternative to sustainable development. Even so, many companies are convinced that the more environment-friendly they become, the more the effort will erode their competitiveness. They believe it will add to costs and will not deliver immediate financial benefits. The Industrial Revolution transformed society and its interaction with the environment, increasing the use of natural resources and the pace of development of new products and processes. This has left permanent changes in the structure of society and also on the earth through depletion of resources, alteration of natural habitats and pollution from unwanted byproducts of the production process and discarded products at the end of their useful life. Technology is the cause of and solution to many of our environmental problems. Technology enabled the industrial revolution which improved average quality of life in the developed world, but led to serious environmental problems. But technological development occurs when innovative people are faced with major challenges. The challenge today is to have sustainable development. The contribution of the manufacturing sector to environmental degradation primarily occurs during the following stages:

- **Procurement and Use of Natural Resources**

The first stage essential to any manufacturing process is procuring raw materials. Procurement processes tend to require the use of hazardous substances to extract natural resources. Mitigation and control measures for these polluting substances tend to be ineffective and inefficient, leading to ecological imbalances in the surrounding natural environment through air emissions, effluent run-off and improper disposal of solid wastes. Environmental damage is also spread through excessive procurement of natural resources which inevitably leads to an amount of spoiling of the environment. Rapid extraction can cause irrevocable changes to the local area where mitigation impacts to reduce the effects are not implemented.

- **Industrial Processes and Activities**

Industrial processes and activities consume materials and resources for manufacturing products generating emissions, effluents and solid wastes. Finite amounts of natural resources and raw materials used in the manufacturing industry can create resource security issues where the country faces the

possibility of exhausting these resources if they are used unsustainably.

- **Product Use and Disposal**

The environmental impact during a product’s use is determined by the manufacturer, who is directly responsible for polluting effects brought about due to the use of the manufacturer’s product. In the absence of proper disposal system the hazardous chemicals and bio-non-degradable contents present in the product drastically affect the environment.

### **Environmental Impact of Manufacturing Sector**

Increased industrialization and urbanization have led to significant growth in waste generation and environmental pollution. Industrial waste with chemical composition can be potentially dangerous to health, and its disposal without treatment is leading to land and water pollution. The release of industrial effluents in rivers and other water bodies is destroying local habitats. The environmental impacts created through the operations of manufacturing units are listed below:

- **Air Pollution**

Industrial air borne emissions emitted from various industries are a cause of major concern. The primary air pollutants attributed to industry are sulphur dioxide (SO<sub>2</sub>), suspended particulate matter (SPM), oxides of nitrogen (NO<sub>2</sub>) and greenhouse gases (GHGs). Air emissions are primarily generated through the combustion of fuels for energy production. SO<sub>2</sub> is formed when sulphur-containing fuels like coal and oil are burned. In the same vein, NO<sub>2</sub> and GHG emissions are attributed to fuel combustion for energy generation in motor vehicles, power stations and furnaces. GHGs are also emitted as a result of process-based reactions something that is significant in the Cement and Iron & Steel sectors. Emissions of harmful gases by the manufacturing units lead to imbalance in the atmosphere and thus cause acid rain. A study conducted by Central Pollution Control Board in the industrial capital of Kerala viz. Kochi showed the rain water having pH in range of 3.6-6.8 with an average of 4.4 showing high acidity.

- **Water Scarcity and Pollution**

India faces a two-fold issue in water security: decreasing water availability and increasing water pollution in groundwater and surface resources. A major environmental concern in urban centre’s relates of high levels of water pollution due to poor waste management and disposal, inadequate sewerage and drainage, and improper disposal of industrial effluents. The dumping of solid waste in low lying areas contributes to both land and ground water pollution. An increasing population and greater industrial activity is putting pressure on present water sources. Per capita water availability has reduced significantly from 1,816 cubic meters per capita in 2001 to 1,588 cubic meters in 2010. Wastewater from industrial activities is often contaminated with highly toxic organic and inorganic substances, some of which are persistent pollutants and remain in the environment for many years. According to a study much of the stretch of Yamuna which flows through Delhi receives

about 5 lakh liters of DDT waste per day. The river Hoogly is choked with untreated industrial waste from more than 150 major factories around Kolkata. It has been estimated that about 0.5mm<sup>3</sup> of trade effluents are being dumped into the rivers and the tidal waters of Kerala every day. The major pollutants identified are suspended solids, mercury, zinc, copper, lead, ammonia, oil, grease, cadmium and radioactive materials.

**Case Study of Industrial City Ludhiana**

Ludhiana is a major industrial town and has gained the status of Manchester of Punjab due to its highly developed Hosiery, Sewing Machine and Cycle Parts Industry and this has put Ludhiana on the world map. The industrial cluster of Ludhiana has been identified as one of the critically polluted clusters by the Ministry of Environment and Forest. Presently, 200 MLD of wastewater from the industries is generating within Ludhiana city, out of which 150 MLD effluent is generated by small scale dyeing units (130 MLD from 5 clusters of dyeing units and 20 MLD from scattered units), whereas, 50 MLD is generated from the large and medium dyeing units. There are 1060 water polluting industries located in the jurisdiction of Ludhiana city. The category wise detail of the industries is as under:

S.N.	Category	No. of Industries
1.	Dyeing	268*
2.	Hosiery / Washing / Printing	66
3.	Electroplating	482*
4.	Galvanizing units	9
5.	Wire Drawing / Pickling	111
6.	Engineering Goods	12
7.	Milk Plant	3
8.	Pulp & Paper	4
9.	Beverages/ Soft Drinks	2
10.	Brewery	1
11.	Used Oil Refining units	6
12.	Rubber Industries / Tyre & Tube	22
13.	Pesticide Formulation Industries	1
14.	Miscellaneous	73
<b>TOTAL</b>		<b>1060</b>

**Industrial Pollution in Ludhiana**

Though industries play a vital role in the growth of Ludhiana no one can ignore their bad effects on the environment leading to water and air pollution.

• **Air Pollution**

The main stationary sources of air pollution are the industrial units, which are emitting particulate matter, hydrocarbon, sulphur dioxide, oxides of nitrogen, VOCs and acid mist. As

per inventory prepared by the Board, there are 994 no. of air polluting industries in Ludhiana city, which are using fossil/ bio-mass as fuel, thus, emitting the aforesaid pollutants, besides, emitting process/ fugitive emissions. Due to all this, the quality of ambient air quality of the city is deteriorating. As per report of Central Pollution Control Board, the Cumulative Environmental Pollution Index (CEPI) in respect of air has been calculated as 68 for Ludhiana Industrial Cluster, on the basis of which Ludhiana has been declared as critically polluted area.

• **Water Pollution**

As per report of CPCB, the Cumulative Environment Pollution Index for land (soil and ground water) has been observed to be 64.75 for Ludhiana city. The high index value suggests that the ground water and soil of Ludhiana are susceptible to contamination. The Punjab Pollution Control Board is monitoring ground water at six locations in Ludhiana city under National Water Monitoring Program (NWMP). The data is being sent to Central Pollution Control Board through Environmental Data Bank (EDB), which is being examined by them regularly. The major contributors towards water contamination are textile units working in Ludhiana. Textile wastewater includes a large variety of dyes and chemicals additions that make the environmental challenge for textile industry not only as liquid waste but also in its chemical composition. Main pollutants in textile wastewater came from dyeing and finishing processes. These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure. Dyes contributed to overall toxicity at all process stages. Also dye baths could have high level of BOD/COD, colour, toxicity, surfactants, fibers and turbidity and may contain heavy metals. Because all of them are not contained in the final product, became waste and cause disposal problems. They can contaminate water with oils, grease, and waxes while some may contain heavy metals such as chromium, copper, zinc and mercury. Dyeing process usually contributes chromium, lead, zinc and copper to wastewater. The effluent characteristics of textile mills, most of which are cotton-fabric, polyester, wool, and acrylic refining mills were investigated in the study conducted by Davinder, Vasundhra and Agnihotri ( Study of textile effluent in and around Ludhiana district in Punjab, India) The wastewater from 7 textile mills in the woven fabric and knit fabric finishing industry and one highly polluted drain, locally known as Buddha Nala, which receives discharge from many such industrial units, were collected for the study. The concentrations of BOD, COD, SS, TOC, TDS, pH, Colour were analyzed according to standard methods.

<b>Table 2: Characteristics of wastewater Samples Name of Industry</b>	<b>BOD mg/l</b>	<b>COD mg/l</b>	<b>TOC mg/l</b>	<b>TS mg/l</b>	<b>TDS mg/l</b>	<b>pH value</b>
A	552.35	1040	7784.0	2780	2560	4.30
B	210.0	3050	563.5	51450	49440	11.9
C	108.0	590.0	119.6	898.5	816.6	8.2
D	790.0	1230	535.6	1770	1590	7.22
E	245.0	970.0	158.0	6510	5690	9.80
F	548.0	550.0	211.6	2300	2120	8.16
G	156.0	195.0	101.1	450	430	8.03
Buddha Nala H	317.57	120	44.01	1570	1470	7.06 Table No.1 represents the complete picture obtained from the textile

Table2 represents the complete picture obtained from the textile wastewater sample analysis. The most frightening values are BOD, COD, TOC, pH value and TDS and cause a real threat to the environment

**Policy Measures for Sustainable Manufacturing**

The search for competitive advantage is an ongoing quest for companies in the world. As new technologies continue to develop at a lightning fast rate and efficiencies are gained in all area of production on relatively new endeavour is becoming increasingly important i.e. companies around the world are looking for ways to become more sustainable. Indeed, the quest for sustainability is already starting to transform the competitive landscape, which will force companies to change the way they think about products, technologies, processes, and business models. The key to progress, particularly in times of economic crisis, is innovation. Even so, many companies are convinced that the more environment-friendly they become, the more the effort will erode their competitiveness. They believe it will add to costs and will not deliver immediate financial benefits. There is a paradigm shift required in manufacturing sector from traditional manufacturing model, in which environmental activities in a business were seen only on cost; natural resources are viewed as freely available. Sustainable strategies have been growing in popularity over the last several decades. Now as companies face increasing problems in trying to achieve profitability, managers are looking for ways to decrease cost while still maintaining quality product and services. Managers are looking for ways to survive. This is where the concept of sustainability becomes important. The country will need to ensure that the environmental impact and effects arising from this increase in manufacturing activities is addressed and controlled without affecting increased industrial growth. The Working Group advocates the need for India to achieve “Rapid Ecologically Sustainable Industrial Growth”, which would require a transformation towards green manufacturing and adoption of environmental sustainability practices by manufacturing companies, and has accordingly identified 4 cross-cutting strategic paths where immediate focus is required to align environmental sustainability within the manufacturing industry:

- a) Maintaining and Promoting Green Business
- b) Protecting Natural Resources
- c) Organized Waste Management and Recycling Industry
- d) Strengthening & Reforming Regulatory Institutions

• **Maintaining and Promoting Green Business**

Green business denotes that an organization employs efficient and clean practices, technologies and processes within its operations to lessen its adverse environmental impacts. R&D Departments of manufacturing units should work 24X7 to develop green and sustainable products. Companies are often startled to discover which products are unfriendly to the environment. When Procter & Gamble, for example, conducted life-cycle assessments to calculate the amount of energy needed to use its products, it found that detergents can make U.S. households energy guzzlers. They spend 3% of their annual electricity budgets to heat water for washing clothes. If they switched to cold-water washing, P&G reckoned, they would consume 80 billion fewer kilowatt-hours of electricity and emit 34 million fewer tons of carbon dioxide. That’s why the company made the development of cold-water detergents a priority. In 2005 P&G launched Tide Coldwater in the United States and Ariel Cool Clean in Europe. The trend has caught on more in Europe than in the United States. By 2008, 21% of British households were washing in cold water, up from 2% in 2002; in Holland the number shot up from 5% to 52% of households. The key suggestion in promoting green products is to enhance and empower the consumers to make informed choice. Consumers need to be made aware of the availability and importance of purchasing green products. This can be built through having an institutional framework & market mechanism that would support the empowerment of consumers.

• **Protecting Natural Resources**

It is the need of the hour that companies should be more sensitive towards the use of natural resources. Focus should be on reducing the consumption of non renewable resources such as coal, petroleum, and natural gas along with renewable resources such as water and timber. The drive to be more efficient extends from manufacturing facilities and offices to the value chain. At this stage, corporations work with suppliers and retailers to develop eco-friendly raw materials and components and reduce waste. It is a clear understanding that natural resources have to be prolonged to their fullest use to maintain the aim for continual economic growth and lessen environmental impacts

• **Organized Waste Management and Recycling Industry**

A consequence of India's higher economic growth is increased consumption of the natural resources and increased waste generation that contributes to ecological degradation, which is estimated at around 5% of India's Gross Domestic Product (GDP). Some of the key areas of waste generation are liquid waste, Industrial waste including hazardous wastes, municipal wastes and e waste. The opportunity and market potential for waste management & recycling in India is very high but can only be achieved through an organized recycling industry driven by proper policy guidance from the Government. An organized waste management and recycling sector can lead to environmental benefits through reduced virgin material consumption, waste generation and waste disposal leading to reduced air, water or land pollution. Reduced waste generation should be targeted in a two fold manner of Developing and implementing strategies for their recycle, reuse, and finally environmentally benign disposal and promoting biodegradable recyclable substitutes for non-biodegradable materials. At present, annually 50,000 tons (approx) of wastes are used as alternate fuel, which is less than 0.1% of total thermal energy consumption in cement industries in India. The scope to increase this use is extremely high. The usage of high-calorific value wastes (hazardous / non-hazardous) as alternate fuel in cement industries should be promoted and encouraged. Non-hazardous wastes, namely fly ash, bottom ash and red mud should be utilized for the manufacture of cement and construction materials.

- **Strengthening & Reforming Regulatory Institutions**

In the short term, independent committee/s to be setup to assess the existing regulatory regime at all levels and recommend legal and institutional reform as well as a detailed agenda for strengthening the institutions. The outcome of the committee's deliberations should be to develop an action plan for strengthening and reforming the existing regulatory institutions at both the Centre and the state-level. There is a need to reform and strengthen the current environment clearance process and its enforcement, including the process of public participation, transparency and disclosure. There is need to prepare guidelines on process types, inputs (specific energy, raw materials, and water), pollution output and waste handling for major industrial processes in consultation with other ministries, governments, industry, educational institutions and NGOs. As part of this regulatory tool, project developers will be asked to submit technology. Setting up a regulatory process to assess all chemicals, register and phase-out toxic chemical products and replace them with non-toxic/less-toxic substitutes is required. The insights from registration, Evaluation and Authorization of Chemicals (REACH) programme of the European Union could be of help while developing the frame work. In the short term, the task will be to identify and phase out and ban obsolete or highly polluting chemicals. In the medium and long term, this mechanism will help in promoting and incentivizing green chemicals and green chemical industries assessment of their new projects as per guidelines during the appraisal process. The guidelines will have to be updated every three years.

## Conclusion

While the Industrial Revolution was the cause of positive change for the industrial world, there is no question that it has wreaked havoc on the environment. The depletion of natural resources, the carbon emissions, pollution and human health problems that have resulted directly from the Industrial Revolution's accomplishments have only been disastrous for the world environment. In international social and political discourse, there are some subjects that should be considered universally important. Without doubt, human impact on the environment is one such subject. Though it has taken many years for global warming to capture public awareness in a way that truly reflects the urgency of the situation, it now finally seems as though most people have recognized the degree to which we are responsible for our environmental problems, and the degree to which we will have to change in order to resolve these problems. Though many of us are reluctant to lower the quality of our lifestyles, the truth is that if we want to make a significant effort to save the environment and ourselves, we all need to be willing to make changes in every aspect of our lives. The economy of high consumerism has supported the growth of industry, which has in turn contributed to global warming. The need of the hour is to develop an environmental friendly approach and find ways and means for sustainable manufacturing.

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