

Enhancement in Sustainability in a Manufacturing System

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Abstract : Manufacturing activities are getting complex day by day which has made it difficult to synchronize the various production, administrative and other such activities. Complexities adversely affect the diminishing of available resources. Consequently sustainability is at stake in manufacturing system. The Present paper is an attempt to enhance sustainability in manufacturing system. Various means of improving sustainability in a manufacturing system have been studied in order to derive the objective.

Keywords : Sustainability, Manufacturing, Zero waste, Resource Efficiency, Recycling

I. INTRODUCTION

Any manufacturing activity is an assortment of 5 M's namely men, machine, material, money, market. These factors coupled together can give rise to efficient output in any manufacturing environment. For carrying out manufacturing operations raw materials are been extracted from the nature. These are transformed into various kinds of products (semi-finished type or finished type) for our use with the help of appropriate machines/ tools/processes in a suitable environment by involving workmen. With the declining stock of raw materials and resources in one hand and the rising business competition on the other there is an urgent need for improving the manufacturing efficiency. As per Patra *et.al* (2015) apart from depletion of natural resources various allied problems for the near future will be scarcity of water especially potable water, fossil fuel, energy, land filling sites in one hand and increase of pollution level, global warming, chronic diseases etc. on the other.

In any manufacturing environment we use various kinds of raw materials like metal, non-metal, wood, cement, sand etc. Some of these are used in virgin raw form whereas others are processed to make them usable for creation of products. These raw materials are converted into some kind of value added products for human use. During this course machine and manpower are involved in a manufacturing process.

The greatest challenge is that apart from the desirable products which we manufacture there are some unwanted by-products in the form of waste and emissions that are always associated with the manufacturing system. The manufacturer should endeavor to minimize all these undesirable dealings. A balance between environment, society and economy is to be established during the course of manufacture. The manufacturing system should be such that it will lead towards development that will be truly sustainable. As per Mohanty (2011) in order to get rid of the scarcity of virgin materials there is an urgent need to focus on the followings:

- To reduce the intake of virgin materials for manufacturing process
- Increase of recycling
- Use "waste" as "resource"
- Improvement in resource efficiency

II. NEED FOR SUSTAINABLE MANUFACTURING

As the natural resources are declining at a fast pace the manufacturers are expected to limit their use and to conserve them. The society, government and the competitors are also forcing the manufacturers to manufacture in a more responsible way than ever before. They are also expected to focus on research and development for further innovation in product and process design to reap the benefit of efficiency during manufacturing. The manufacturers will need to invest a lot of capital for more modern machines and technologies to remain competitive in the global market. The manufacturers should focus on "ZERO WASTE" of materials. As per U.S. Department of Commerce Sustainable manufacturing is 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. The manufacturers will be greatly benefited at least in long run, once they adopt the principles of sustainability because of the following tangible and intangible benefits:

- Minimization of pollution and emission
- Reduced harmful impact on environment/ greener environment
- Improvement of material, product, process efficiency leading to increased productivity
- Reduction of scrap, waste during various stages of manufacture starting from extraction of raw material till the end of product life cycle

- Reduction of harmful waste like toxic substances, chemicals, radioactive substance etc
- Enhancement of product life cycle
- Use of sustainable materials, practices leading to sustainable development
- Compliance to environmental laws, guidelines
- Market leadership and customer satisfaction
- Conservation of fossil fuel, energy
- Development of alternative materials
- Improvement in technology, process for optimization of manufacturing system
- Use of Reduce, Recycle, Reuse, Recover, redesign and remanufacture principles for cleaner environment

Manufacturing in a sustainable manner will help to improve the declining stock of raw materials by reducing waste at various stages during manufacture by optimizing the production process. Not only that practicing sustainable manufacturing will help to refill/recoup our resources that will last for generations to come!

III. DISCUSSIONS

There may be several factors in a manufacturing system that affects the sustainability. Their relative importance and weight-age with regard to sustainability may be different. It may not be easy to quantify their relative importance in a sustainability scale. Study of various manufacturing practices and review of literatures have suggested various important factors and ways that will be able to improve the sustainability of any manufacturing system. These can be broadly categorized as below:

- Reduce/ Reuse/Recycle

The focus under sustainable manufacturing is to minimize the use of raw materials in order to conserve it for the future generations which are the basic thought for sustainability. Materials that are easily recyclable are iron, glass, paper, aluminum, lead-acid batteries etc. Metal industries need to focus towards recycling of scrap to increase sustainability. It has been found that manufacturing cost also reduces drastically in many cases if recycling practices are brought in practice. Many EAF (Electric Arc furnace) during the course of producing steel uses a mix of scrap (generated as by-product) along with solid/liquid pig iron to improve the productivity as well as quality and to reduce cost. Aluminum industries also focus on recycles Aluminum scrap for making new aluminum.

- Waste elimination/disposal system

The system should focus towards "Zero waste". This should be with regard to raw materials, energy and other resources. Not only has the generation of waste/scrap been to be minimized but also the wasteful consumption of raw materials especially energy is to be minimized. For this purpose the product design or the process itself may need to be changed or may have to be revamped. In this context the generation and disposal of solid waste, liquid waste and more importantly e-waste is very much critical from sustainability viewpoint.

- Energy optimization

Energy in various forms is required for carrying out various manufacturing operations. The wasteful energy is to be minimized and the useful energy is to be optimized. As energy efficiency will increase, the cost of manufacture will decrease. Moreover the impact of energy (primarily obtained from fossil fuel) on environment will reduce leading to rise of sustainability. Energy loss at various stages is to be minimized as it will also reduce cost of manufacture. Rajat Parda, B.B. Arora et al. (2012) distinguished between energy analysis and exergy analysis. They explained the importance of exergy analysis in quantifying the quality of energy.

- Control of emission/ pollution

With the stricter environmental regulations the manufacturers have to upgrade their system towards efficient pollution and emission control. A manufacturing industry may choose bag house, ESP, cyclone cleaner, scrubbers or some other kind of pollution control systems. Generally steel industries use high temperature bag house (having bag filter or fabric filter) or ESP because of their high efficiency. Other industries/manufacturers may choose suitable systems that will suit their requirement in a optimal way.

- Automation/ technological enhancement

Technological up gradation is a must to enhance the sustainability in manufacturing. Advanced technology followed by automation will help to reduce waste, emission, pollution, energy requirement etc. This will also reduce the consumption of raw material and thus the impact of raw material on the environment will be drastically reduced.

- Measurement of Sustainability

In order to increase the systems sustainability a systematic approach is to be followed. For this purpose any suitable sustainability measuring indices can be used. The indices are based on various factors like environmental impact factor, economic factors, compliance to government regulations, working environment, social factors, employee health and safety etc. Meaningful insights can be obtained from such indices that will further improve the performance of the manufacturing system.

Shaw C. Feng et al. (2009) mention some of the sustainability indicators and matrices that are in common practice. Some of these are: GM Metrics for Sustainable Manufacturing, Global Report Initiative (GRI), 2005 Environmental Sustainability Indicators, Wal-mart Sustainability Product Index, Dow Jones Sustainability World Index etc.

- Life cycle Assessment

Life Cycle Assessment (LCA) analysis can be carried out to systematically evaluate the environmental impact of a product throughout its lifetime. The study will be helpful in improving the process and the system. As per Heilala et al. (2008) LCA assessment will not only identify but also quantify the product requirements for energy and materials as well as the emissions and waste released into the environment.

IV. CONCLUSION

Any kind of manufacturing system is a complex one. In order to increase the sustainability of a system or to renovate a non-sustainable system to a sustainable one it is imperative to study the system in totality. There are hundreds of process

parameters that can adversely affect the efficiency of the system. It is therefore essential to know nitty-gritty of the system before we focus on improving the sustainability of the system. For sustainable manufacturing certain issues to be addressed have been listed in order to give future direction for research.

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