The Green logistics practices and its implementation in Indian Chemicals Manufacturing Industries

Shashi Bala¹, Kamlesh Tiwari²* and Mohd. Shadab Khan³

¹, ² Assistant Professor, FOET, University of Lucknow, Lucknow
³ Associate Professor, Integral University, Lucknow

*tiwari.kamlesh@yahoo.com

Abstract: This paper has tried to explore the various aspects of Green Logistics associated with industry, particularly the chemicals manufacturing industries in India. Greening of industrial processes and practices act as a factor for the survival of industries as well as the environment in a long run. The concept and application of Green Chemistry has been taken into account along with modern practices such as lean, agile manufacturing etc. The various other activities which may act as facilitators for the implementation or adoption of Green Logistics has also been considered. Finally a road map for its implementation is proposed for the Indian chemical manufacturing industries.

Keywords: Green logistics, Sustainability, Reverse logistics, Triple bottom line, Green chemistry, Green packaging, Lean manufacturing etc.

1. Introduction

‘Green Logistics’, the term often stands for a set of sustainable policies and practices implemented to reduce environmental impacts mostly caused by various activities (manufacturing as well as transportation) carried out in modern Industry in this competitive and global business era [1]. The major objective of green logistics is to find a balance between ecology/environment and economy which are two major pillars of the popular triple bottom line (EEE) concept [2]. In the present scenario, the two major challenges which are being encountered by the industry of all genres are – firstly, the deficiency of energy and natural resources and secondly, the tough regulations from various regulatory authorities to counter with or to balance the environmental shifts which are quite evident these days due to the increase in the level of carbon dioxide (CO₂), suspended particulates etc., which is in turn causing an increase in global temperature, health hazards and so on. This phenomena is mostly held responsible for the overall climate change, melting of ice caps resulting in the increase of ocean levels and as per many researches carried out by different researchers across the world, in future a large number of cities which are inhabited by a large population right now may get submerged in the rising sea waters [3]. This is a major cause of concern for the entire humanity.
The Indian industries in general contribute a lot in the national economy and the chemical industries in particular, which is currently worth $147 billion, accounts for about 15% in India’s manufacturing GDP and simultaneously they also contribute approximately 3% in the global chemical markets and proudly they stand at 6th rank in the entire world [Confederation of Indian Industry (CII) report]. Thus, the aim of green manufacturing practices which are not very old in industries is necessarily to save our environment and ecology for generations coming ahead. The green technology involved with this, addresses a number of parameters like, recycling of used material, conservation of ecosystem, waste management, environmental protection, control of pollution and other number of regulatory compliances [4].

The major challenges which the modern industry is facing today in the implementation of green logistics in their supply chains as well as their overall value chains associated are -

- Too much dependence on fossil fuels especially in transportation and warehousing of their raw materials, inventories, work in process inventories and final goods/products which leaves a lot of carbon footprints.
- Lack in infrastructure to apply green logistics.
- Invisible logistics for customers.

Apart from these hurdles or barriers a lot of others are stated and discussed in detail in the literature available in this field [5].

This paper is an attempt to have a systematic and comprehensive review of the existing state or the state of the art of the green logistics in the chemical industries in India and to try to find out some solutions to overcome its implementation and functioning related problem encountered by the industry.

2. Literature Review

There are a good number of articles published in the field of green logistics in many of the world’s leading journals and conference proceedings. As per the available literature, Green manufacturing is a way to fulfill present requirements without harming future generations. Green packing [6], recycling, reduce use of natural sources and green design are some of the many ways to achieve this requirement [7]. As per Porter and Van Der Linde [8], the green supply chain management is a competitive and strategic practice with a finite set of natural resources and elimination of waste material for the improvement in productivity. Similarly, Prashant et al [9] and Christopher et al [10], included practices such as, to reduce loss, acceptance of non-polluting technologies and production processes, which make the process more economically viable with lesser pollution and keeping environmental awareness in mind.

Sarkis [11] reported that green supply chain management is a mode to stimulate the acceptance of green practices to get certification of ISO 14000. Later Sarkis and Dhavale [12], stated that Green supply chain management is not consensual and includes wider acceptance of dimension of social and environmental sustainability. The approach of Triple Bottom Line is also one of the many approaches of the green supply chain management [13]. According to Large and Thomsen [14], the practice of green supply chain management comprises of a set of activities, such as the design, selection of raw material purchases, green manufacturing, green distribution, monitoring of environmental impacts during the life cycle of the product, and the reverse logistics.

Green logistics includes five steps- Green purchasing, Green production, Green transportation, Green packaging and reverse logistics (recycling, remanufacturing and reuse) [15]. Green production is often seen as the implementation of preventive environmental management strategies used in production processes.
and elimination of risks related to the health of human being under consideration. The ideal production of goods with less waste is termed as good production. Green transportation is the distribution of material by managing the movement of all materials in a value chain right from start to end. In all this, business managers are responsible for all the distribution and transportation policies with an intention of saving the environment from their possible adverse effects. Green packaging which is also termed as ecological packaging and it is a method of packaging which protects environment, animal and human health [16]. The packaging is done in such a way, where recycled materials are used and save environment. Reverse logistics includes reuse of all products, component, materials and equipment in supply chain [17].

3. Discussions and Proposals

In many of the literature available in different sources, the authors have emphasized a lot on the application of green chemistry and some of them have even proposed it as one of the many ways to achieve and enhance green logistics practices in the industry [18]. Many papers have discussed about their benefits and some of them are focused on advance principles of green chemistry. The 12 principles of Green Chemistry [19] are as given as:

1. Prevention
2. Atom Economy
3. Less hazardous chemical synthesis
4. Designing safer chemicals
5. Safer solvents
6. Energy Efficiency Designs
7. More use of renewable feed stocks
8. Reduce use of catalysts
9. Design for degradation of effluent waste products
10. Reduce time analysis for control pollution
11. Reduce environment
12. Use safer chemicals to reduce accidental issues.

To accommodate 12 green chemistry principles in the production systems of chemical industries, with an approach to have a continuous manufacturing processes/systems without affecting environment and economy, the strategy given by the American Chemical Society can be followed. The strategies proposed by the organization are as follows:

1. Atom Economy – It encourage us to have minimal by-product formation which reduces the burden on environment and facilitates reduction in cost as under this scenario more we get from the lesser materials.
2. Reduction Solvent – It makes us to use less amount of solvents thereby reducing its wastage and this results in the overall reduction of the cost as well as the associated environmental burden.
3. Optimization of Reagent – It promotes us to keep the Stoichiometry low and try to use optimum catalyst which reduce, time, cost of reaction and also the environmental pollution.
4. Convergency – Includes more efficiency in less operations, thus results in reduction of cost as well as the reduction in the use of natural resources.

5. Reduction in Energy consumption.

6. Safety.

7. In-situ Analysis.

Metrics are required to be checked to analyze and understand the impact of new methods on any chemical industry. Preference should be given to that metrics which is higher in number. Process Mass Intensity (PMI) and E-factor should be most favorable [20]. PMI is defined as the total mass in a process used to produce a certain desired product. This PMI, can be taken as a green manufacturing approach in the entire process. Manufacturing companies, with the advent of time, have realized that amount and nature of wastes in industry including waste products such as toxic wastes, if decreased increases the extent or possibility of green manufacturing [21]. So industry should must try to involve life cycle assessment tools to increase their overall economic and society value. Higher environmental impact by drugs manufacturing pharmaceutical industries are reported as compared than the most chemical industries because of regular and continuous operation such as dry blending, granulation etc.

The lean manufacturing philosophy [22] which enables an industry to reduce its waste production in all the followed steps and improves its efficiency too. The idea was propagated by Koskela in the year 2000. This can be easily applied in many industries like in construction, automobiles etc. and has given positive results [23] and chemical industries are no exceptions. Main focus in lean manufacturing is on the elimination of non-essential or non-value adding steps during the entire manufacturing process and it includes five major steps:

- Value steam mapping- it is based on the value added, non-value added, time involved in changeover and number of machine involved.
- Continuous flow of desired product from one machine to another machine without any delay or disruption.
- Addition of value for user with higher standard of quality.
- Pull system so that quantity of product can be made as per the demands in existing market.
- Continuous improvement in final products by step by step procedure as per the requirement.

The lean concept is symbolic with the removal of waste also [24]. Agile manufacturing which is another highly customized and fast process of manufacturing and agility is related to the swift response in flexibility as well as adversity [25]. Whereas resilient manufacturing is another concept of manufacturing which helps in risk management by keeping strategic safety stocks and it is an overall opposite idea of lean manufacturing which is based on Just-In-Time manufacturing [26]. They all together can contribute a lot in the field of green manufacturing. Green manufacturing is a total environmental friendly practice without compromising on the cost, operational reliability performance, efficiency and cost of product and also try to minimize the damage to our ecosystem. Hence in order to have an increased operational efficiency and lesser damage to environment, green and lean practices both are equally required in order the facilitate the overall green logistics of any firm or industry. After having a consultation with experts and some managers of pharmaceutical/chemical industries a roadmap for the adoption of green logistics was as proposed as shown in the figure below:
Figure 1: Road map for adoption of Green Logistics

The figure 1 shows how practices related to the application of green chemistry in industrial processes can act as a facilitator (named facilitator 1) for attaining visible effects in greening the entire manufacturing process. The various modern manufacturing process such as lean, agile, JIT manufacturing etc. (named facilitator 2) along with wise and efficient management policies such as green purchasing, transportation etc. (named facilitator 3) can together help a lot to the industry to achieve green practices and logistics in their overall framework. The three facilitators collectively bring overall effects such as achieving triple bottom line approach, pollution reduction, overall safety etc. in the concerned industry. The three facilitators as shown in figure 1, can together bring overall effects which leads towards achieving green logistics and practices.

4. Conclusion:

The above sections of this article give us an idea about, and some suggestions for the Indian chemical industries to produce chemicals without harming environment and ecology by modifying themselves and introducing green practices in their manufacturing, designing, processes, supply chain and disposal of wastes processes. A roadmap for its adoption was also proposed after having consultations with the industry people. The three facilitators together can bring an overall effect on the industry. Green manufacturing model reduce the impact of chemical industry on environment without sacrificing the cost, quality, reliability and performance of their products. Green logistics and green practices have now become necessity of industry due to their inherent commercial benefits and regulatory obligations. It should not be seen as an overall cost addition step which only the bigger companies can afford, but it should be considered or seen as a value addition process and the management of the firms must include it, right at time of their planning or making blueprints for their future production. They should make it as a part of their supply chain and value chain management. It also makes the relationship between suppliers and buyers more powerful and reliable. This article also shows the way to researchers to carry out future research in this field such as analysis of the impact of individual factors associated with various facilitators on the overall implementation of green logistics in industry.
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