Integrated Of Lean Principles With Sustainable Manufacturing

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ABSTRACT

In this competitive world, any company has to fulfill its customer needs. Lean manufacturing is a technique which focusing on customer needs by delivering the requirements at less time with high quality and cheaper cost by eliminating hidden wastes present in the companies by continuous improvement. Sustainability is the new challenge of engineering due to depleting resources. The integration of eco-friendly techniques throughout the entire lifetime of the product has become more necessary due to the increasing awareness of the effects of traditional manufacturing. This project aims to explain the concept of implement QFD using environment consciousness. This project also integrates lean principles with sustainable manufacturing. As the lean approach saves cost, any future product development is sure to implement the methodology discussed.

1. Introduction

1.1. Lean Manufacturing

This project addresses the application of waste reduction management concepts to the garment production sector with a focus on the export house in India. After World War II, Japanese manufacturers were faced with the dilemma of shortage of material, finance and human resource. Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of Toyota production system, or what is known today in world as “Lean Manufacturing”. The basic idea behind the system is eliminating waste.

The primary objective of lean manufacturing is to assist manufacturers who have a desire to improve their companies' operations and become more competitive through waste reduction management by implementing the related lean manufacturing tools and techniques like 5S and Value Stream Mapping.

Waste reduction management helps the manufacturer to find what is needed by the customer, when it is needed and in what quantity ordered. The manufacturing of goods is done in a way that minimizes the time taken to deliver it, the amount of manpower required and the floor space required. It is done with highest quality with lowest cost.

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1.2. Sustainable Manufacturing

The need for introducing environmental requirements into the design and development of new products has already been discussed for more than a decade. Today there is general agreement on this point in principle amongst researchers and industry. However, the question remains of how important it to apply environmental criteria to a product design, and how we can compare environmental requirements with the traditional design requirements such as cost, function, and quality.

The paradigm of product development towards low cost and high profits is unlikely to change significantly in the near future, if ever. Companies will have to continue to make profits for their existence. However, the integration of environmental requirements into every single stage of product development from the very beginning is a very likely approach, leading to a new paradigm for sustainable manufacturing. Being an integrated approach, it will not purely add-on some constraints, but it will identify new environmental features of a product that have the potential to improve the overall quality of the product in the eyes of the customer, thus creating additional market potential and financial gains.

2. The Concept

Through manufacture and usage to disposal are shown in Fig.1. The traditional approach does not include any environmental aspects in the development process. Environmental requirements can then be introduced to any one of the development stages by applying various tools and methodologies. Fig.1. Methodology of lean sustainable manufacturing for the product lifecycle. Five examples of methodologies that have recently been developed are shown in the figure. They represent the most significant stages of a product’s life cycle, which have an influence on its environmental performance.

They are:

- Introducing environmental awareness to customer requirements (CR);
- Assessing environmental performance as a design objective;
- Performing life cycle assessment (LCA) during the design process;
- Implementing Lean concepts in the manufacturing of the product; and
- Evaluating the product’s potential for reuse and recycling.

There are some additional methodologies that could be applied to the stages of manufacture (clean production processes) and usage (customer behavior). They are not considered in this paper. By applying the above mentioned methodologies we arrive at a new sustainable approach to product development and usage, including environmental requirements in five major stages of the product life cycle:

- Environmentally conscious quality function deployment (ECQFD);
- Sustainable trade-off model for design;
- Life cycle assessment;
- Lean Manufacturing;
- End-of-life options (EOL).
3. Methodology

3.1. Environmental conscious quality function deployment

In the attempt of capturing customers’ requirements for a new product, the problem arises that customers are usually not aware of environmental requirements. Therefore, a specific “Elaboration Process” in personal interviews with customers is used to uncover “unspoken” CR related to environmental issues.

In the next step, the transfer of CR into technical and design requirements is commonly done by the process of quality function deployment (QFD). The traditional QFD process uses a one-dimensional matrix. In a new approach, ECQFD, a second dimension covering the environmental aspects in form of an environmental metrics (EM) is added to the QFD matrix and Lean principles in third dimension covering the lean concepts (LC) is also added in the QFD.

3.2. Design objectives

Traditionally, three key objectives have been used for decision-making in a design process, namely product performance, product cost, and development cost. In other words, decisions were based on the question: “How much money can we spend in order to develop a product with low cost and high performance?” The advantage of this approach is that the environmental requirements are fully integrated in the process, enjoying the same importance rating as all the traditional objectives. The techniques for evaluating and balancing multiple objectives are well established. The new objective, the Environmental
Performance, can be evaluated by applying LCA, which will be explained in the following section. As a result, the fundamental trade-off rules for sustainable development can be derived from this model.

3.3. Life cycle assessment

LCA methodologies are widely used for assessing the environmental impact of products and processes. A common problem with LCA is that a full assessment is very time consuming, and it needs very specific data, which is normally not available in the early stages of product development. Therefore, a number of simplified LCA methodologies have been suggested for the early estimation of the environmental impact of a product.

For the purpose of the sustainable development model, a simplified LCA methodology was developed. The methodology is based on the principles of Group Technology, applied to a wide variety of industrial products. This leads to a grouping of products according to their environmental behavior in the four phases of a product’s life cycle, the material phase, the manufacturing phase, the usage phase and the disposal phase. A pilot study has proven that a grouping approach is suitable for a simplified assessment.

3.4. Lean Manufacturing

Lean manufacturing is an applied methodology of scientific, objective techniques that cause work tasks in a process to be performed with a minimum of non-value adding activities resulting in greatly reduced wait time, queue time, move time, administrative time, and other delays. Lean manufacturing is a management philosophy focusing on reduction of the seven wastes (Over-production, Waiting time, Transportation, Processing, Inventory, Motion and Scrap) in manufactured products. By eliminating waste (Muda), quality is improved, production time is reduced and cost is reduced. Some of the standard tools, like VSM, production smoothing (Heijunka), continuous improvement (Kaizen), 5S, Single-Minute Exchange of Die (SMED), Total Quality Management (TQM), Just-In-Time (JIT), etc., have been conceived by Toyota Production System (TPS). One of core lean tool VSM is a visualization method that allows us to map the flow of value from raw material to customer.

3.5. EOL Costing

At the end of a product’s life, a decision has to be made on the three EOL re-use, recycling or disposal. These options can be applied either to the whole product or to individual components of the product. The decision is to be made based on two criteria, the technical status of the product and the economic viability of the option. Both criteria have to be integrated in an EOL costing model. With regard to the economic assessment of the re-use and recycling options, it is important to understand the main cost factors. In current economic models, costs are calculated by manufacturers for product development, production and distribution. Once the product has reached the market, the customer pays for usage and disposal. They predominantly represent the environmental costs generated by the product. These costs are not included in any of the current costing models. However, if we want to evaluate the potential of a product for re-use or recycling, the environmental costs are an important cost factor, which has to be included in the cost model.
4. Conclusion And Future Work

A product will identified to implement lean integrated sustainable manufacturing using tools like environmentally conscious quality function deployment, Life cycle assessment, EOL costing. And finally an eco-friendly model is developed by integrating lean technique; the lean system will not achieve the benefits quantified in the project.

Incremental improvement is not enough, however. Industry must be restructured and existing and breakthrough technologies must be more innovatively applied to realize green growth. Short-term relief packages deployed today can stimulate investments in technologies and infrastructures that help innovation and enable changes in the way we produce and consumer goods and services in the future.

After completing the project it carries an evidence of genuine advantages when applying lean principles in sustainable manufacturing. Here, the concept of sustainable manufacturing is discussed. The concept of QFD has been discussed. ECQFD has been created. The theory of life cycle assessment has been performed and end of life option has been explored.

5. REFERENCES


