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Energy Value Stream Mapping a Tool to develop Green Manufacturing

Neha Verma[1], Vinay Sharma[2]

[1]*Ph.D Scholar, Department of Production Engg ,BIT, Mesra (Ranchi)-835215, India*
nv5678@gmail.com, Ph 07869435755
[2]*Professor, Department of Production Engg, BIT, Mesra (Ranchi)-835215, India*
vinay1970@gmail.com, Ph 09431382632

Abstract-

Value stream mapping is an effective tool of lean manufacturing to reduce the wastage in any process by segregating value added and non-value added activities. The present work uses the concept of value stream mapping and developed energy value stream mapping to address the non productive energy consuming processes. This paper focuses on achieving Green Manufacturing as overall productivity which has already reached an acceptable value. The main problem identified is that there is a void when it has been looked for a tool to achieve Lean Manufacturing along with Green manufacturing. It deals with the development of a method that allows a first quick, easy and comprehensive analysis of energy and material flows within the production processes. The paper concludes with discussing improvements in the processes.

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Keywords: VSM, EVSM, Energy consumption, Lean Manufacturing, Small scale industry.

1. Introduction

Manufacturing is a leading energy consumer of the world along with being the aspects for prosperity. With rise for the environmental concerns countries are being pressurized to make their industries energy efficient. This has made researcher to analyze means and methods to develop energy efficient machine or reduce the energy consumption in existing methods. Improvement in existing setup can be made by eliminating the processes which consumes energy and replace them with energy efficient and less costly methods. In recent, studies have been made towards achieving lean and green manufacturing which minimize wastes. Lean techniques are focused on reducing lead time and eliminating wastes in all kinds of forms. Green Manufacturing is a method for manufacturing that minimizes waste and pollution. Its emphasis on reducing parts, rationalizing materials, and reusing components, to help make products more efficient to build. Green Manufacturing involves not just the use of environmental design of products, use of environmentally friendly raw materials, but also eco-friendly packing, distribution, and destruction or reuse after the lifetime of the product. Authors in the present work have focused on using value stream mapping (VSM), a tool of lean manufacturing, and used it in reducing energy and making the process energy efficient.

* Neha Verma , 07869435755
*E-mail address:*nv5678@gmail.com

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2. Literature Review

A VSM classifies all the processes into value adding and non-value adding ones. The ultimate goal of VSM is to identify all types of waste (non-value added) in the value stream and to take steps to eliminate them.

Authors (Fawaz & Rajgopal, 2007) state VSM as one of the best tool for Lean Manufacturing. The authors in their work have summarized the calculation of energy as value adding and non-value adding energy to optimize value streams in a more holistic way.

(Murugananthan, et al., 2014) This paper details with the use of the VSM in reducing waste in manufacturing company. The production process path is visualized by mapping the current state value stream mapping .After tracking the entire process, wastage affecting the cycle time has been identified and its causes are analyzed. A future state value stream mapping is developed and improvement ideas are suggested. Value stream mapping is proved as a useful technique to minimize the cycle time and increase the productivity.

The paper (Solding & Gullander, 2009) presents concept using simulation for creating dynamic VSM. Creating dynamic value stream maps makes it possible to analyze more complex system than traditional VSMs are able to and still visualize the result in a language the lean coordinator recognize. The value stream mapping is presented in a spread sheet that can be altered in the way the teams want.

The authors (Fawaz & Rajgopal, 2007) identify that Lean Manufacturing is applied more frequently in discreet manufacturing rather than in the continuous/process sector and they formulate a simulation model which showed the difference between the past and present scenario clearly which is acceptable to the managers who until now are skeptical about the application of lean methods in continuous/process manufacturing.

(Egon, et al., 2014), describe a method to extend VSM to an energy value stream mapping method (EVSM) by maintaining its original character and its inner logic. Also, this paper includes the time and energy input during the transportation processes into the EVSM. This paper goes on to show the application of EVSM in Supply Chain Management to reduce the Energy footprint on a global level. Inclusion of transport into EVSM not only shows the lead time extending effect but also its non-value adding energy consumption.

(Keskin, et al., 2013), in their paper suggest a future oriented energy value stream mapping approach that aims to improve energy efficiency in small and medium sized manufacturing companies.

(Tyagi, et al., 2015), in their paper introduces the concept of VSM to the product development process (PDP) stresses on the importance of faster product development for the right edge on the market. The main focus of this article is to exploit lean thinking concepts in order to manage, improve and develop the product faster while improving or at least maintaining the level of performance and quality.

Authors (Chatterjee, et al., 2014) have first reported the use of energy value stream mapping (EVSM) as a tool to analyze the energy consumption in any manufacturing process. The authors in there research work have used the EVSM tool to analyze energy consumption in production of biodiesel.

(Nassehi, et al., 2012), in their paper, present a framework to validate the introduction of energy consumption in the objectives of process planning for CNC machining. The paper considers the critical aspect of energy efficiency in manufacturing and in particular process planning of products. Computer Aided Process Planning (CAPP) has continued to be developed for over 40 years with its early origins dating back to the1960s.

A good basis for analyzing energy use in machining is through (Gutowski, et al., 2006) mathematical model for direct energy requirement in machining.

2.1: Objective of the research work

Manufacturing of any product in CNC involved following steps in total or partial

a. Work holding process
b. Tool Holding Process
c. Alignment
d. Coolant on & off