A Review-To Reduce Cycle Time and Process Time Using a Tool of Value Stream Mapping (VSM) in Gear Manufacturing Company

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Abstract
Value Stream Mapping (VSM) tool is being used by various organizations in recent years which mainly focuses on improving the efficiency of production cycle by eliminating and reducing wastages. Value Stream Mapping (VSM) is highly accepted method in practice for improving manufacturing or production systems. In the present case study a production line where gears are manufactured was analyzed. First, an analysis with the use of VSM was undertaken in order to identify processes and a material flow. Then these results were used to optimize the cycle time. This paper aimed to explain the improvement in cycle time in the gear manufacturing company located in Gujarat, India.

Keywords
Value Stream Mapping (VSM), Cycle time, Lean manufacturing, Time waste reduction

I. Introduction

Value Stream Mapping (VSM) is marketed as a basic tool of lean, and just about everybody assumes it means that it was developed within Toyota and is widely used in its operations. In the introduction to learning to see, Mike Rather describes it as a minor tool known within Toyota as "Material and Information Flow" mapping. The belief that productivity can be increased by improving the plant capacity is a thing of the past. In present times, by applying management theories and methods, small changes can results in huge improvements in productivity. Our aim is to reduce cycle time and wastages by eliminating non value added processes by lean principles. Hence, by application of this concept, all resources which do not add value to a product, i.e., the "waste" have to be identified and are to be cut down as much as possible. In present gear manufacturing company there are basically nine processes of spur and helical gear manufacturing. Gear manufacturing passes throughfollowing processes:

- Turning process
- Drilling process
- Hobbing process
- Deburing process
- Heat Treatment process
- Final boring,Facing,OD
- Key way making
- Profile grinding
- Inspection

II. Literature Review

The most common mapping tools used in manufacturing are: Flow chart, Material flow analysis, Value Stream Mapping (VSM). Material flow analysis and VSM tools had been chosen as most appropriate mapping tools to deliver the required objectives [1]. Lean manufacturing enhances production processes and boosts the employee's job satisfaction.Lean manufacturing believes the simple fact that customers will pay for the value of services they receive, but will not pay for mistakes [2]. Value Stream Mapping (VSM), enable companies to focus on the value added and non value added activities and consequently identify waste, this leading to the introduction of continuous improvement [3, 7]. In lean production, developed in 1950s and1960s by Eiji Toyoda and Taiichi Ohno for Toyota [4]. According to Taiichi Ohno the wastages that exist along the production flow are creators of losses and must be removed [5, 11]. A complex or multistage manufacturing system must follow a clearly defined path with very little or no backtracking to produce high quality products within the shortest possible time [6, 10]. Lean techniques are focused on reducing lead time eliminating wastages in all kinds of forms. Its emphasis on reducing parts, rationalizing materials, and reusing components, to help make products more efficient to build [7]. Improvement objectives of lean manufacturing approaches include a reduction of post process times and defects rates [8]. Value Stream Mapping (VSM) is also faces the task of managing in addition to measuring cycle time. This containing the planning, controlling and monitoring of process [9, 11]. Value Stream Mapping method for analyzing complex systems with the following attributes:

- Understanding the value of current system
- Understanding the current system as a collection of components with a focus on interaction and interfaces
- Support the systematic creation of different types of improvement ideas
- Support collaboration across organizational boundaries [10, 27].

The VSM is a graphic method using rich amount of icons presenting each important element within value chain [12]. By applying tools that could identify major sources of waste and then using tools such as production smoothing approach, set up time reduction and others to eliminate waste [13]. A case study was conducted in domestic appliances production industry to reduce the total lead time through eliminating non value added activities [3, 7, 12, 14]. The most critical issue faced by manufacturer today is how to deliver their products or materials quickly at low coast and good quality. Lean manufacturing is one of the important steps that many major businesses have been attempting to implement in order to sustain their competitive in a rising global market [15]. Lean management principles and tools originated on the shop floor to improve manufacturing processes [16]. For sustainable development,lean manufacturing falls under the working area of eco-efficiency or as it is generally defined "doing more with less" [17]. A well built map can give correct information that helps decision makers identify the problems [18]. Cycle time of the manufacturing process is measured in a time study, which gives information about how often one piece of a product leaves a process realized on a workstation [19]. The task of creating profitable growth and long-term survival of organizations has been described in management literature as organizational learning through exploration (Includes: refinement, search, risktaking, flexibility, discovery and innovation) [20]. Cycle time involves different elements that play a key role on production. The relationship

between them and implication of these relationships, give clear vision of the subjects to be addressed and help to determine the methods and technologies applied as well as terminologies used to contextualize the field of study [21]. Each continuous improvement held in any work environment, lean manufacturing can be carried out in order to adapt the improvements to the executor of activities [22]. Production leveling enhances production volume as well as production efficiency by means of reducing waste, unevenness and over burden of people or equipment [7, 23]. Lean manufacturing can be achieved by using less human effort in the factory, lessspace, less financial resources and less material for producing the same product [2, 24]. An application of lean methodologies to product service system should be integrated between agent technology and with web based technologies and grid computing for successful implantation of application in the industry in a near future [25]. The continuous improvement that some companies are embracing today in order to achieve operational and service excellence are a consequence of the increase in competition, of internationalization and of an economic conjuncture that makes consumers more demanding regarding the cost of what they buy. Therefore, companies feelthe need to adjust their management strategies and to continuously improve performance in all areas (e.g., operations, organization) keeping up with competitors or, if possible, overtaking them [8, 26]. The Institute of Production Systems and Logistics (IFA) in Hanover didactically leverages these unusedpotentials in a new concept which interlinks Lean Production and Lean Administration and shows why this holistic training approach is required [28, 20]. In order to redefine the interrelationship between institutional knowledge, economy and regional administration (broadly speaking it can be Government), it is necessary to focus on enhancement of the local innovative development conditions by linking research activities with other innovative activities. In the first stage of regional economic development it is necessary to create a business environment and to encourage measures for concentration of innovative activities. Two other stages, consensus and innovations comprise ideas and strategies of multiple reciprocal relations between university, economy and regional administration [29]. Lean is traditional management philosophyfocused on reducing the seven mains types of waste (over-production, waiting, time, transportation, over-processing, inventory, motion and defects). Lean is basically all that concerns getting right materials at the right place in the right amount, minimizing waste, being flexible and open to change. Thus, it is ensured that only produces what is needed, when needed, as appropriate. In this domaincould be applied the Lean, as tools that help in innovation and responsiveness to market changes. These new approach generates an impact on society: less use of raw materials, a reduction of resource consumption, increased productivity and, consequently, a reduction of environmental impacts [30, 6, and 10]. In the context of Lean Management, "Lean" essentially means flexible, agile or light. Lean is a bundle of principles, methods and actions for the effective and efficient configuration and examination of the whole supply chain. Goalof Lean Management is to create value without producing waste ("Muda"). Value is any action or process that a customer would be willing to pay for. Lean tools therefore help toidentify and to eliminate waste. As waste is eliminated, quality improves while production time and costs are reduced [7, 31]. Lean trend, completely new opportunities arearising from new and modern technologies today. The term" Industry 4.0" was created about five years ago and describesthe potential based on the introduction of web technologies, an increased digitalization and the networking of virtual andphysical value chains. Aim of "Industry 4.0" is to realize notonly smart, intelligent and cognitive manufacturing systems orfactories but also to generate smart products and services. Therefore, also product development has to leave traditionalways coming closer to the development of "Industry 4.0" [32]. Critical success factors (CSFs) on lean implementation are well defined in existing literature. Much research hasalso been done on identifying barriers in an organizationtrying to implement lean [33]. The department is also responsible for the contact and monitoring ofthe suppliers, in order to ensure that the orders are fulfilled and delivered on the agreed schedule. In parallel, exhaustive analyses have to be done by departmental planners to support proper departmental functioning and organizational objectives. The department is composed by nineteen elements distributed in three subcategories: Electric group; Mechanical group and Reception team. However the project was developed jointly with Electrical and Mechanicalgroups planners since they work in an administrative context while the Reception team is an operational group responsible for handling raw materials at the company´s inbound process. These elements are supervised by adepartment head [34]. Most of research studies have proven that lean principles matchsustainability's main objectives and achieve its main agendaregarding processes, owing to the potential of lean in eliminating wastes, improving the whole process and reducing the negativeimpact of construction projects. Firstly researchers studied therelation between lean and sustainability theoretically to concludethat lean achieve the main agenda of sustainability while, lean isconsidered a short-term concept as it affords high performanceprocess, while sustainable construction is classified as a long termthrough the whole building operational cycle [35]. In the Lean Learning Factory, following diversity of activities are done or in process:

- Education of students,
- Workshops for foreign student groups and professors
- Implementation of the lean and green concept in economy through seminars,
- Scientific research activities,
- Innovative products developments [36].

Thekey topics under investigation was the existing lean implementation frameworks presented up to now and the keystudies presented on SMEs and lean manufacturing. Several lean implementation frameworks have beenpresented in the last 20 years. These frameworks are usuallyroadmaps, guiding the organizations on how to implement lean manufacturing, highlighting the sequence of the lean tools to be introduced in the organization, and in some casesthe success criteria [37]. In the following, five requirements for the concept of the Continuous Improvement Process, are described:

- On the one hand every employee that works in the plants should have the possibility to insert measures into a well structured process. A fast and steered realization of the measures needs to be ensured. On the other hand it has to be ensured that the identification of new measures is not only a randomized process. Therefore, the concept must provide some methodical approaches to identify improvement-measures.
- The optimization of an existing system in small steps ("evolution") is heading to a natural limit. Due to that, it is necessary to make some structural changes ("revolution")from time to time. With a fundamental improvement, it is possible to obtain the next optimization-level. Therefore, the concept needs to ensure the realization of such high complex measures

as well as the realization of "small but smart" measures. High-Complex measures are measures which effect many department or plant in the production network and which have a big changing-impact for the organization.

- Another requirement for the concept of the CIP is that it needs a scientific base to ensure the application and repeatability in different situations, in different plants all over the world, as well as in different departments. To achieve that, it is necessary to embed the CIP in the daily operations of a methodical approach.
- It needs to be ensured that the concept focuses the sustainable Lean-implementation.
- The concept has to be holistic. Therefore, it is necessary to ensure that all Lean-principles are addressed in the concept and additionally, that all departments (not only production and logistics) are involved [38].

Due to the integrated learning environment of the learning factory the 5S method, which is often implemented first in companies, can be taught in the second learning unit at existing, real work stations. This method is very easy to use and has the possibility to be linked to existing content already available. These real work stations (e.g. CNC miller etc.) are transferred into different initial situations (5S levels of maturity). In addition to the 5S method, topics and techniques such as audits, Maturity, waste, Waste walk and Chalk circle are also taught in the learning units. To get an overview of the interlinking of workstations with shared material and information flows, the value stream

method is taught with the help of the manufacturing of a real product (bottle cap). In this case there are mechanically produced parts (on site) as well as purchased parts available. The components are assembled and prepared in a packing station for delivery. The participants can increase their theoretical knowledge by applying an actual value stream [39]. Lean Management is the management of the company through the implementation of Lean principles with the targetto obtain products/services faster and with fewer costs for the customer. Lean Management defines 5 Lean Principles [1]:

- Value
- Value stream
- Flow
- Pull
- Perfection

The value is determined by the customer and refers toeverything he is willing to pay for. Theopposite of value is the definition of waste (Japanese "Muda"): waste is all activities and processes that add no value to the customer. We distinguish two main categories of Muda: there are some not value adding activities that are necessary to generate output and there are other activities creating waste that can be eliminated immediately. The Lean philosophy aims to maximize the value and minimize waste [1, 7, and 31]. One of the individuals at the forefront of lean, Taiichi Ohno, enumerated seven forms of waste found in physical production: overproduction, waiting, transportation, incorrect processing,excess-inventory,unnecessary movement and defects [5,11,40]. A team is formed from functions including production supervisor, product engineer, process engineer, R&D engineer, planning officer, team leader, and lean engineer. Each member from different function would give ideas from different points of view. This helps to easier to discuss, as well as make decision. Some activities should be done as followings:

- Task Analysis
- Value Stream Mapping
- Draw Spaghetti Chart
- Find out Wastes and Improvement Opportu-nities
- Consider to Change Some Process Steps

The results of basic analysis would give an overview picture of production line current state, improvement opportunities and desired targets [41]. Most of the tools used in Lean thinking aim to change a company in order to adapt it to the customer's need. Some of the techniques used are: Tact Time, Kaizen, Statistical Process Control, Poka-Yoke, 5S, Value Stream Mapping (VSM), Total Quality Management, Kanban, and Jidoka, among many others. Plenert (2007) emphasizes the significance and usefulness of the VSM as a key tool of Lean thinking [7, 31]. A VSM helps on identifying opportunities for Lean improvement by spotting activities dad did not add value to the process. VSM is a visual representation of processes within a pathway and can be considered as a visual map of all the activities, illustratinghow they linked to each other, and information such as timing and resources. It aims identifying all the value-add and non-value-add (waste) activities, as an opportunity to remove non-value-add steps and eliminate waste throughproblem solving, to standardize and improve value-added processes but mainly to eliminate waste[3,7,31]. It had four stages, beginning with preparation, current map, future map, and finally, an improvement plan [42]. The development of strategy is based on the following hypotheses:

Concepts of Lean Management (LM) and Agile Enterprise (AE) are taken as meta-concepts of management andat the same time as the development strategies of the organization.Meta concepts are embodied with a use of multiple more detailed concepts, methods and tools of management. As mentioned in the introduction, an assumption was made that organizations can be agile in varying degrees where on one end of the scale there is a Lean organization and on the other the virtual organization. Despite the fact that at the operational level, both business development strategies partially use common methods and tools of management, which means that some of the separated segments will use the same methods and tools of management, still the order, importance, manner and purpose of using particular management tools in specific business conditions will build business advantage in different ways.

Implementation of modern management methods is effective when with a strong market orientation and highinstability of the industry we use Agile Organization strategy.

Implementation of modern management methods is effective when with a weak market orientation and high stability of the industry we use Lean Management strategy [43]. Although the beginning of Lean management is associated to the automotive industry, the validity of Lean solutions has been demonstrated by the successes experienced by many companies from a wide spectrum of industrial sectors; Toyota Motors Corporation (TMC), Dell and Zara have reported significant profits through the implementation of Lean principles [4]. Nevertheless, a successful Lean company cannot rely totally on the tools inherent to the Lean production system; it must nurture its own principles. Lean thinking implies a change in the management of operations, and all changes begin in the mind. It is therefore essential for everyone to participate in this transformation process, and this must be prompted by the management of the upper levels of the company's hierarchy. Ultimately, one is dealing with a culture of training and practice, which resorts to methods and tools to eliminate waste, motivate staff, optimize equipment and increase productivity [44].

III. Summary

In this paper, different methods as lean manufacturing and Value Stream Mapping (VSM) have been summarizedto reduce cycle time. From this paper we have anticipated that lean manufacturing and VSM has wide range of application in manufacturing or production companies also in business organization in order to reduce cycle time and wastages in the organizations.Lean manufacturing and VSM are most commonly used techniques in the manufacturing organizations.One more point derived from this paper is that the issue of cycle time in any organization depends upon working environment, interrelation between different departments in the organization, communication, training, education, awareness of workers.Above parameters optimizes cycle time andreduces wastages inorganization.Lean manufacturing contains all the above parameters.Thus by applying lean manufacturing concepts,cycle time as well as wastages in any manufacturing organizations is reduced.

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