

THE PROCESS OF IMPROVEMENT WITH THE APPLICATION OF LEAN MANUFACTURING IN A STEEL COMPANY

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Abstract

Achieving and maintaining the high market position requires tremendous flexibility of a steel company in responding to changing market conditions. Only these companies that can take advantage of new functioning opportunities, in particular innovations in management and technology, gain an advantage over competitors. For this purpose, the most efficient methods and management tools are used that eliminate the losses, human errors, and thus - reduce costs.

This paper presents Lean Manufacturing methodology as a popular method of improving organizational processes, waste elimination and cost reduction in a steel company. The article highlights the importance of Lean Manufacturing method and tools in quality increase and sustainability of steel companies in the market. The process of setting these tools began in 1992 due to metallurgy industry restructuring in Poland. Based on its effects a new concept of management was created e.g. of gradual adapting new management methods and tools to enterprises including steel companies (Just in Time, Total Quality Management, Outsourcing, Reengineering, Lean Manufacturing etc.) [1]. ArcelorMittal is one of the examples as well as many other steelworks located in the Silesian area. The article presents the process of implementation in a steel company the elements of production system organized according to Lean Manufacturing (LM) rules.

Keywords: Lean Manufacturing, tools of Lean Manufacturing in a steel company, continuous improvement

1. INTRODUCTION

Competition is an inevitable element of a steel company's functioning. Nowadays it is becoming even dense. New trends in production set its direction. The process is followed by changes in production and changes in management systems of a steel company [2]. An indicator of modern steel company is a number of clients as well as level of their satisfaction, that is why the key factor for every steel company is quality which may be reached by the application of Lean Manufacturing (LM) concept. Application of Lean Manufacturing tools such as: 5S, SMED, TPM, Kaizen, TQM, Kaizen means avoiding all kinds of wasting, reducing interior functions of enterprise to these that are necessary and regarding production process it concerns eliminating all activities which do not create added value. The activities which are useless extend the length of production and are quite frequently the result of organizational disorder that results in poor production quality. According to LM rules a company should undergo such reorganizational process that the time of completing and the effort dedicated to fulfil clients inquires is the shortest possible. It enables to shorten production cycles, increase product quality, cost decrease, rise of morale and involvement of workforce.

Lean Manufacturing is a management philosophy which is run by ongoing reduction of wastage. The clue of Lean Manufacturing is a continuous improvement of work efficiency, it means "slimming" production which is connected to decline of possessed resources (material, final goods, production in progress) and better usage of production halls space. This is the method of improving the way how a steel company functions which by ongoing reduction of any form of wastage optimizes the creation and flow of value within whole process of production [3]. An example of such enterprise is ArcelorMittal. The basics of the LM method are: 5S, Just in Time, Kanban, Kaizen and TQM.

To achieve the high efficiency of the production in ArcelorMittal, a re-organization of work maintenance forces started. The company had to go from the intervention work system to the preventive system involving all the workers of the company in the perfection of the manufacturing process by providing the reliability of machines and devices functioning. Lean Manufacturing is placed within the strategy of steady steel production in the dynamic model of environment protection [4]. All employees take part in Lean Manufacturing actions including the company's CEO and machines operators. With the help of trainers-specialists special teams are created, who gradually, step-by-step analyze current wastage (Muda), plan its reduction and implement already planned actions. By engaging more and more people in team-work activities and providing time for problems solving the company undergoes transformation of its working culture and succeeds in implementing Lean Manufacturing idea.

2. BASIC RULES OF LEAN MANUFACTURING IN A STEEL COMPANY

The aim of Lean Manufacturing is to create simple and clear structures within a steel company and enlarge the importance of human resources in order to use them in the best way possible. The factor responsible for winding up the spiral of continuous development is - five rules (**Table 1**) [5]:

- accurately define value of a certain product,
- identify the values stream for each product,
- guarantee untroubled flow of values,
- implement of pull system in relation of client - supplier (also for internal clients and suppliers),
- drive to be perfect.

Table 1 Five rules of Lean Manufacturing in a steel company - characteristics [6, 7, 8]

A	Characteristics
1. Accurately define value of a certain product in a steel company	The starting point of "slimming" approach is value. It may be only defined by a client. The client may be a final product user, the following process of production or the following company in a production chain. The value must reflect a particular product (good or service or both) that fulfils needs of a particular client at accepted price, in defined place and time. The client expects not necessarily the product but awaits fulfilling particular needs. They are interested in the result not means - product. Steel company creates value and this is from the client's perspective reason for their existence. However, they have problems with defining the value precisely. The value for a client is the whole set of benefits which they purchase with the product. Overall user's costs include: price of purchase as well as all expenses during period of usage: costs of power, fuel, space, maintenance, repair or liquidation of a good after the time of exploitation. Convenience of placing orders, possibility of tailor made products, producer's help (supplier's) in product's installation as well as in exploitation period when possible problems appear (service), additional bonuses which the client may await and which create customer's loyalty. Appropriate defining of the product's value should start from a dialog between a client and a producer.
2. Identify the values stream for each product in a steel company	The value stream consists of all the activities (both adding and not adding value) required for the product to undergo main flows necessary for every product: steel production flow - from raw materials to client's "hands", designing flow - from concept to market launch, information flow - from order to purchase. Identification of a whole value stream for each product or product family is the following step of the „slimming” approach. Such strategy almost always reveals vast amounts of wastage. Every steel enterprise may work out its own methods but despite how they are named and what tools use being carried property and precisely enough almost always will indicate three kinds of activities in the value stream: <ul style="list-style-type: none"> • added value activities - welding, painting, machining, • non-added value activities, however inevitable in present technologies and production resources, so currently impossible to remove, • activities which do not make any value for a client's perspective (e.g. check) and possible to be immediately eliminated.

<p>3. Guarantee untroubled flow of values in a steel company</p>	<p>A real challenge is to gain in a steel production a continuous flow of a short product series that fulfil individual clients' needs, which characterizes production in a steelwork. Ongoing flow means production of one product in a defined period of time in such a way that each part goes from one process to another immediately without stopping between them. Reaching the continuous flow is possible because of regrouping of steel production activities that concern one product. Reaching the continuous flow leads to growth in efficiency and radical improvement in steel product quality. In order to improve the steel company's quality of product and activity the continuous flow should be implemented in each discipline of its activity e.g.:</p> <ul style="list-style-type: none"> • structure project designing, • taking orders, • production.
<p>4. Implement of pull system in relation of client - supplier in a steel company</p>	<p>It is about going from traditional push system to pull system. In contrary to push system in which products are worked on at a particular post (most frequently in large series) and then "pushing" to another post or to a warehouse despite demand. Pull system should apply to whole value stream from client to raw materials and materials suppliers that create a final good. This system allows a client to "pull" products which are needed and the company does not push its products risking their purchase. Production happens on demand that is why huge inter-operational stocks are not created. In push system, it was necessary to remain stocks of every product which led to rise in costs of stocks remaining and freezing of capital. In pull system orders become more stable because clients know that any time they may get what they really need and they do not order for later creating changing order system with periodical increases and decreases. Slimmed systems will be able to produce in short time every kind of product in defined combination fulfilling changing demand. It allows a steel company to resign from building sales forecasts and produce exactly what clients want.</p>
<p>5. Drive to be perfect</p>	<p>A factor winding a spiral of ongoing improvement of a steel company is four first rules of LM between which continuous reaction happens. Gaining faster value flow always expose hidden in value stream wastage. The faster products are pulled the more obstacles on value stream are discovered and removed. Specialized teams working on particular steel product should constantly carry on a dialog with client and discover ways of more precise defining of values, flow improvement and pulling. A very important factor for perfectionism is clearance (5S), thus it is easier to discover better ways of creating value. Information is immediately used by a person responsible for improvements - it is a key feature of a slimming way of work that enhance to carry on struggling aiming at improvement.</p>

3. LEAN MANUFACTURING TOOLS IN A STEEL COMPANY

The basics of the LM method are: 5S, Just in Time, Kanban, Kaizen and TQM [9, 10]. To identify faulty material of engine pistons it is possible to choose following methods: 5S, Kaizen and TQM in a steel company.

5S method is an excellent way to create and maintain jobs that characterize good organization, maintenance and keeping order, high efficiency and quality both for production and offices in a steel company. By using this method, you can also improve the efficiency of that position in terms of safety and ergonomics. This is in spite of appearances, an important factor, as disorganized and disordered workplace can lead to time loss, waste, and consequently to increased costs. It allows to organize posts and processes while building the first steps in using Kaizen, or continuous improvement philosophy by small steps in a steel company [11]. The implementation of 5S rule is also the first step to confer wider powers and new responsibilities to enable the use of competences and skills possessed by each employee [10]. Kaizen (from Japanese kai - change, Zen - good) means continuous improvement. This is the philosophy of implementing simple and small changes using small steps. Kaizen is a way of action relating to a specific place, a philosophy of everyday, systematic action [12]. Employees each day should look for new solutions, improvements, maintain order in their workplace and avoid wastage through: identifying an area for improvement, data collection and analysis, identify the causes of problems, search for solutions, planning actions to improve, implement improvements in a steel company. The essence of the concept of Just in Time (JIT) is organisation of the supply, generation and distribution processes, and then managing them in such a way so that they are completed on time, and the time of their implementation is as short as possible in a steel company. The JIT aim is to manage the order fulfilment cycles and eliminating waste. It involves the formation of shortened cycle of the product, to minimize any stocks of

materials and consequently maximize the speed of material flow, reduce costs and increase operational flexibility businesses, especially in terms of timeliness and delivery time. JIT is a general philosophy, the concept, the idea to organize activities that bring out the essence is the time factor. One aspect to look at the time factor in JIT comes down to the total consideration of timing, quantity, assortment and space. JIT aim is to prepare the right products: on the right time - neither too early nor too late, in the right amount - neither too little nor too much, to right place. Total Quality Management (TQM) is a philosophy of continuous improvement achieved through constant focus on customers, processes and commitment, using the principle of the best implemented leadership through education and training, measurement, flow of information and recognition in a steel company. The basic principles of TQM philosophy is: to meet requirements of internal and external customer, confirmation of the customer's requirements and the client - organization relation, customer - supplier, quality improvement in order to reduce wastage and total operating costs, enhance market position, focus on planning and prevention, recognizing that each work must increase the value of a product, service - eliminate work not to lead to added value, emphasis on measurement and quality information - using tools and techniques, the emphasis on creativity, work in quality circles, continuous improvement - education and training, satisfaction of employees [12].

LM system in fact is a management philosophy that is about continuous wastage reduction of - time, material, human resources, energy, understood as all activities, processes or investments which do not add value to a product from client's perspective. Examples of wastage in a steel company are: overproduction, waiting, walking - unnecessary movements, unplanned stop of machines and technological lines, stocks over minimal state, excessive product transport, improper productive methods, shortages, mal-production, reorientation.

4. PLAN OF LEAN MANUFACTURING IMPLEMENTATION IN A STEEL COMPANY

In the analyzed steel company the production cycle is supported by integrated management system. Before implementation of LM a lot of production problems had existed. The production system caused many downtimes which resulted in wastage. The quality control took place in the final stage of production and the faulty goods were shifted back or scrapped. Problems connected to the production quality frequently repeated.

The capital was frozen in stocks of raw material and final goods. Thus, the enterprise management decided on improvement of all processes taking place in the company. Regarding technology and production organization it was stated that the improvement of parts flow during technological processes should contribute to increase of economical results and final goods quality. The author of the article consulted some of the activities in the presented case study of LM implementation with a company.

All of the actions taken in the enterprise were aimed at: gaining new clients, high quality goods production, Just in Time system production, minimizing of production costs, warehouse stocks and on-going works, enlarging technological and production capacity as well as improving company's competitiveness. Reaching these objectives was possible to happen due to quality control implementation at every level of production process, launch of modern management methods of stock maintenance and production process, installation of computer numerical controlled machines and IT system supporting production preparation, organization of training to improve employees' qualifications. The examples of implementation of new management and production process control methods are 5S and TPM system.

The phase that precedes LM implementation is cycle of trainings preparing workers for the launch. First, the workforce that control the implementation is trained next, medium-level managers responsible for the implementation. Next step is an audit that search for weakest spots within a company in regard to bad work organization. Slimmed production may be implemented in whole company or in chosen, ideal departments. The implementation starts from the work organization system 5S which may be combined with implementation of TPM. Time of implementation is determined by size of enterprise and employees' attitude towards changes. After time defined in schedule an audit of efficiency of actions taken should be carried out and a term for

removing nonconformities planned. In second half the process of cleanness and TPM elements implementation begins. After this stage another audit is carried out and appoints time for correction actions. Then two last 5S stages are launched and an audit of system functioning take place. After initiation of last two 5S stages the shortening of time for SMED method setup and finally production nests are created. **Table 2.** presents the scheme of Lean Manufacturing implementation in the steel company.

Table 2 The scheme of Lean Manufacturing implementation in the steel company

Initial Training	10 days	Stages of preparation for implementation (39 days)		Overall time of implementation LM (379 days)
Initial Audit (after Initial Training)	6 days			
LM Implementation Plan and Motivational System Development (after Initial Audit)	23 days			
Stages of implementation (340 days)		5S (selection, systematics)	60 days	
		5S (cleaning) + TPM	60 days	
		5S (standardization, self-discipline) + SMED	130 days	
		Production Nests	90 days	

5. CONCLUSION

Lean Manufacturing is not a sort of a project which immediately leads to return on investment without further work. It is more about journey to an objective which is never possible to achieve. Even when steel companies precisely define value and identify value stream and succeed in making added value activities for each product permanently flow and allow clients to pull, it turns out that it is not over. Workers should be aware that the process of decreasing amount of work, shortening time of good production, limitation of stock, costs, space needed and defects elimination is a never-ending process and the offered product become close to an ideal according to client's expectations. Permanent improvement is the fifth rule of slimmed thinking. Lean Manufacturing is a management system in a steel company created to undertake activities in order to satisfy clients, such as lowering the costs, improving the quality, shortening the time with lower employees effort, lower company's resources engagement, by improving the productivity, focusing on rationalization of main processes in the steel enterprise and elimination of process losses. The term of Lean Manufacturing means reducing of production which is connected with decreasing of possessed resources (material, final goods, work in progress) and better usage of a steel company halls space. This is a method of improving the functioning of an enterprise which through elimination of various forms of waste optimizes value creation and flow in whole production process. Its purpose is to implement quality into the production process and simultaneous costs limitation [15]. Decreasing of production costs is the aim of every steel company thus Lean Manufacturing is willingly used by steel companies successfully eliminating the activities which do not add value to a product. The term "slim production" results from using fewer amount of some elements in a production process: half of work effort, half of production space, half of funds invested in equipment and tools, half of engineers' time that design new product which is launched in half shorter time. Moreover, "slim" production requires remaining half lower stock and as a result leads to reduction of half a number of defects and allows to enlarge the assortment of produced goods. In contrary to common perception launching of Manufacturing does not mean reduction in employment but it is continuous increasing of work efficiency and decreasing of wrong products production that allow the steels company to compete on the market and its ongoing company's development. The concept of Lean Manufacturing is applicable in all steel company's departments also in these connected directly to production e.g.: sales, accountancy, technical service, etc. Everywhere, where there is a process of Lean Manufacturing may and has to be implemented [13, 14].

The key element in these activities is the ability to gather and process exact information on production, possibility to assess times and costs of particular processes completing [16].

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