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A Local Industry Application of Lean Manufacturing Principals in Benghazi

Tarik H. BADI[1] and Abdulfatah A. ALTUMI[2]

[1] Industrial and Manufacturing Systems Engineering department, University of Benghazi, Benghazi, Libya

[2] Mechanical & Industrial Engineering Department, University of Tripoli, Tripoli, Libya

[1]atbadi@yahoo.com, [2]altumi@tripoliuniv.edu.ly

ABSTRACT

In order to compete in today's highly competitive marketplace, Lean Manufacturing is typically accepted philosophy which helps industry by making them able to compete, face challenges and evolving people for next level of challenges. The purpose of this paper is to increase the awareness level of a local industry in Benghazi to the role that lean manufacturing plays in identifying the type of waste. Also, help to reduce or, if possible eliminate the waste altogether, in order to improve their productivity, efficiency, and profitability. As a result of this study to get benefit from lean as a total system, we need to create the right culture for it.

Keywords: *Lean, Lean Manufacturing, S5, Kaizen.*

1. INTRODUCTION

The competitive company is a manufacturing company that responds to the force of change while using the proper application of technology. It adapts, builds, and redesigns plants, uses lean production principles, makes sure its employees are qualified in IT and using best practices and remembers that satisfying the customer should be the goal of the entire supply chain [Tompkins, 2001]. One way to stay competitive in this globalized market is to become more efficient. Nowadays Libyan industries seek means to survive and succeed since it is now open to the global market. According to Christopher and Towill, (2001) lean focuses on the efficiency of operations and cost savings. Lean manufacturing has been receiving a lot of attentions in the industry. The effects claimed after implementing it are enormous [Wong, et al. 2009].

Scarce studies concerning lean manufacturing have been done in Libya. The decision to implement lean manufacturing is a difficult one because of the significant differences between traditional and lean manufacturing systems in employee management, plant layout material, information flow systems, and production schedule-ing/control methods. These differences make it difficult for organizations that have a history of depending on traditional manufacturing methods to predict the magnitude of the benefits to be achieved by implementing lean principles in their unique circumstances. Due to the lack of understanding the role and benefits of lean manufacturing in Libyan industries, there is a necessity to increase the awareness level of the role that lean manufacturing plays. Also, to provide an overview of the main barriers to applying lean manufacturing in Libya.

The first step in lean thinking is to understand what value is and what activities and resources are absolutely necessary to create that value. The paper begins with providing a literature review related to lean manufacturing and its benefits. This is followed by the methodology developed and used in this study. Insights and results gained from an analysis of case studies that were applied are presented in the next section. To sum up, the paper ends with conclusions.

2. LITERATURE

During the 1980s, organizations discovered new manufacturing technologies and strategies that fit the purpose of reducing costs and competing more effectively in different markets. Strategies such as just-in-time manufacturing, Kanban, lean manufacturing, total quality management and others became popular and significant resources were invested in implementing these strategies [SimchiLevi et al., 2003]. Lean Manufacturing, based on concepts and techniques of the Toyota Production System, is a proven method to decrease cost by eliminating waste. The Japanese were sensitive to waste and inefficiency issues. Womach (2002) asserted that the goal of lean lies on keeping production stable, predictable

and reduce cost and waste in a world of business that is increasingly volatile and unsteady. Waste was identified as anything that interfered with the process or simply did not add value. The ideas behind lean spread to logistics, and from there to the military, to construction, and to the service industry. Lean Manufacturing is already being applied by companies throughout North America. As it turns out, principles of lean thinking are universal and have been applied successfully across many disciplines [Poppendieck, 2002] Those companies that have started on the Lean journey have already reduced their lead-time and are reaping the benefits on their bottom line.

Lean is a systematic approach to identifying waste and other non-valued activities to improve lead times, capacity, and quality. Essentially, Companies are trying to eliminate the activities customers are not willing to pay for [IFS, 2004]. Lean manufacturing is a performance-based process used in manufacturing organizations to increase competitive advantage. The basics of lean manufacturing employ continuous improvement processes to focus on the elimination of waste or non-value added steps within an organization. The challenge to organizations utilizing lean manufacturing is to create a culture that will create and sustain long-term commitment from top management through the entire workforce [Prakash, 2011]. There are far too many definitions and descriptions of lean systems. Some have interpreted lean as merely a collection of tools, such as 5S, JIT, Kanban, and so on. Others have described lean as working people harder, working people smarter, kaizen, or Total Quality Management. Therefore, at a very high level, lean systems gives people at all levels of the organization the skills and a shared way of thinking to systematically drive out waste through designing and improving work of activities, connections, and flows [Folinas and Faruna 2011].

Lean manufacturing is a comprehensive philosophy for structuring, operating, controlling, managing and continuously improving industrial production systems. It has become a joined system composed of a wide variety of management practices, Shah and Ward (2003) classified these practices into four main categories: just-in-time, total productive maintenance, total quality management, and human resource management. Lean has a very extensive collection of tools and concepts. A good way to start is to review the most important lean tools, with a brief description and reason of how each can improve manufacturing operations. Decision of further exploration of a tool should be pursued based on the interest of current circumstances or future plan. Some essential tools and techniques have been highlighted by several researchers like Sohal and Egglestone (1994), Kasul and Motwani (1997), and Bhasin and Burcher (2006). There are a lot of these tools that can be successfully used on its own, which makes it very easy to get started. Furthermore, the benefits will aggregate as additional tools are used, because they do support and reinforce each other. The following is a collection of some necessary lean tools with a basic description of what each tool is and how it helps [Richard, et al.2000].

Muda is a Japanese word meaning waste, where waste is any activity that does not add value from the customer's perspective. Eliminating muda is the primary focus of lean manufacturing.

Standardized Work is a documented procedures in performing each job and communicate this at the workstation. It should be a living documentation that is easy to change. This document supports eliminating waste by consistently applying best practices and reduce variation between shifts. Forms a guideline for future improvement activities.

5S attentions is to organize the workplace and focuses on having visual order, organization, cleanliness and standardization. The precipices underlying a 5S program are: Sort - the first step in making things cleaned up and organized and eliminate that which is not needed. Set in order (systemize) – organize remaining items, identify and arrange everything in a work area. Shine (sweep) – regular cleaning and maintenance workplace. Standardize – write standards for the previous and make it easy to maintain. Sustain (self-discipline) regularly apply the standards to maintaining what has been accomplished. These steps helps to eliminate waste that result from a poorly organized workplace, such as, wasting time looking for an equipment or tool. This program creates a clean, uncluttered and efficient environment that contributes to a safe work environment and advance the teamwork for improvement and growth.

Total Productive Maintenance (TPM) is a highly powerful philosophy for managing maintenance, operations, and engineering in plant environment. It focuses on proactive and preventative maintenance to maximize the operational time of equipment. It creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. This can be very effective in improving productivity and eliminating shortcomings.

Root Cause Analysis is a process designed for use in investigating and sorting the root causes of events to prevent problem recurrence. It focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. A common technique is to ask why five times – each time moving a step closer to discovering the true underlying problem. It helps to ensure that a problem is really eliminated by applying corrective action to the "root cause" of the problem.

Value Stream Mapping (VSM) A tool used to visually map the flow of production. It is known as material and information flow. It is used to analyze current state and

designing future state of processes in a way that highlights opportunities for improvement. VSM supports identifying inherent waste in the current processes and provides a roadmap for improvement through the future state.

Continuous Flow Manufacturing where work-in-process smoothly flows through production with minimal (or no) buffers between steps of the manufacturing process. Eliminates many forms of waste (e.g. inventory, waiting time, and transport).

Just-In-Time (JIT) is a philosophy means getting the right quantity of goods at the right place and the right time. It is also an inventory strategy companies employ to improve the performance and decrease waste by pulling parts and goods only as they are needed in the production process. The origins of JIT stem from the work of Taiichi Ohno at Toyota Motor Company. Relies on several lean tools, such as Continuous Flow, Heijunka, Kanban, Standardized Work and Takt Time. It is Highly effective in reducing inventory levels and cost and reduces space requirements.

Continuous Improvement (Kaizen) empowered employees, working in teams, contribute both their intellectual and physical talents and seek continuously to improve safety, quality, productivity, and the work environment through the application of formal problem solving strategies. This approach create an engine for continually eliminating waste from manufacturing processes.

PDCA (Plan, Do, Check, Act) is an iterative methodology that is used to improve systems. It has many names in the quality field and has been called the Ishikawa, Deming, Juran, it consists of action by steps - first planning then doing (run experiment), then checking (evaluate or studying the results), and finally acting (review and assess) to modify the plan for the next round.

Takt Time is the speed of production that aligns production with customer demand. Calculated as Planned Production Time / Customer Demand. It helps achieving a steady and continuous flow of production and eliminate the waste of overproduction. Additionally, encourage the development of standardized work instructions, supporting quality and efficiency.

3. METHODOLOGY

The purpose of the study is to increase the awareness level of local industries in Benghazi to the role that lean manufacturing could play an important role in identifying the type of waste and help to reduce or, if possible eliminate the waste altogether, in order to improve their productivity, efficiency, and profitability. To achieve this, an iterative process involving researchers and practitioners acting together in a cycle of activities is required. When the study is related to understanding and improving change processes, Coughlan and Coghlan (2002) acknowledged that action research is an appropriate methodology to use. Braz et al (2011) characterize action research study as follows: it investigates more than actions; it is participatory; it occurs simultaneously with the action; and it is a sequence of events and approaches used to solve problems. A modified form of Action Research was utilized in this research. As a result, the modified form of Action Research merged learning from literature and academic sources with case study based experimentation. The scheme of Figure 1 allows the researcher to make sense of action research and shows the main four steps: plan, act, observe and reflect. To progress towards the aim of this research, another tool used in this study to support identifying different types of waste that exist in the bicycle and pipe plants were visually documenting the existing wastes. Photographs were very effective at visually highlighting the presence of waste and lack of order in a work place. These photos helped in describing the current status and in the development of suggestions to resolve the issues. These wastes can be recognized and explained using two cycles based on the process in Figure 1. These two cycles are described as follows:

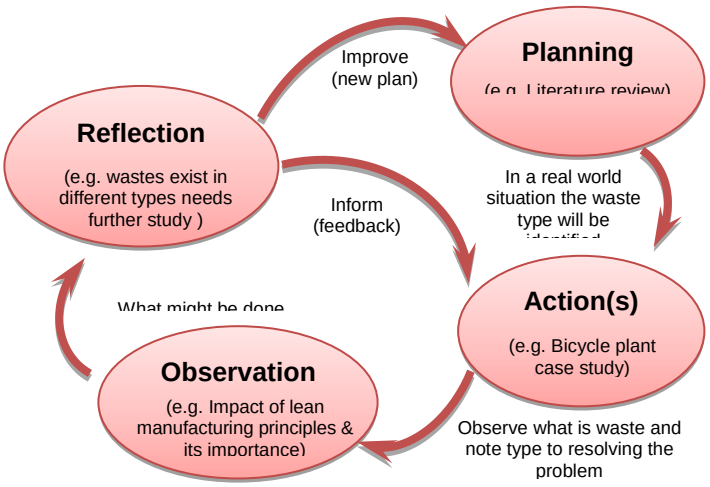

Fig. 1. Adapted action research cycle

Cycle 1: The purpose of this cycle is to describe the major sub-systems that cover Toyota Production System (TPS) "lean manufacturing processes", besides explain the key concepts and tools associated with the system. This cycle's main objective is to introduce the engineer who is in charge of the facility floor with the most important operations management strategy, lean concepts and implementation strategies, that company's worldwide have adopted and are adopting. To familiarize the engineer with these concepts, a background of lean

manufacturing and the purpose of implementing lean was introduced. The lean manufacturing principles and the lean tools and techniques used in implementation were briefly described. These are the foundation steps toward lean thinking to case studies illustrating its power when applied. This understanding will be used in the next cycle to identify the different types of wastes that might exist and choose the best practicable solution to reduce it if not possible to eliminate them altogether, in order to improve their productivity, efficiency, and profitability.

Cycle 2: Exploratory studies have been carried out utilizing the basics of lean manufacturing employ continuous improvement processes to focus on the elimination of waste or non-value added steps within the facility. This is achieved through case studies utilizing the photographs to investigate whether there is a waste at the facilities to give some awareness of the wastes that exist in different types and forms in different areas of the facilities and to understand the impact and analyze the possible risk on the production efficiency and safety. Each case begins with a description and a picture of the task under investigation as it is performed in the work place. The waste type was identified and practicable plans to the problems which cause occurrence of the wastes were suggested.

4. CASE STUDIES AND RESULTS

Two case studies were carried out at local plants to investigate the potential waste available. In this section we are going to provide some awareness of the wastes that exist in different types and shapes at a Bicycle factory and Pipe plant in Benghazi. Different situations were discussed and investigated in different areas of the two facilities. The waste type was identified at each situation based on the discussion and practicable solutions to the problems which cause occurrence of the wastes will be suggested at the end.

Case study 1:

The investigation was carried out by touring the bicycles factory to identify possible workplace that generate waste and also analyze data which has been collected. Most of the operations are using poor methods, workers are left to find the best way to do the job without guidelines. The work areas were found disordered and space area was unutilized.

The serious issue in the first situation that is shown in figure 2 is that the operator is left to decide to do his job without any guidelines, which leads to unnecessary motions and additional handling. Also, it is very obvious in figure 2 and 3 is that the place is in a disordered condition within the work site. In addition the worker who is operating the machine is not aware of the effect of safety rules and ignoring the hazards.

Fig. 2

Fig. 3

It is difficult to feel comfortable and work effectively in a dirty, disorderly workplace. Previous figures show that the workplace is not clean. This can affect productivity negatively. The management of the factory is not aware of the effects of clean workplaces on workers' productivity. It shows waste of space and material, besides safety hazard. In regards to a guideline for the operators, we constructed a standardized work sheet and established time study using "MOST" (Maynard Operational Sequence Technique) based on the information collected from workers, supervisor and engineer for the current statues. Concerning the disordered work place, a suggestion of using 5S lean tool to clean production floor was proposed.

The second issue during the investigation was that it was obvious to realize at a different area of the production floor that several areas were occupied with: a lot of components (WIP) ready and accumulated as shown in figure 4, many obsolete components and raw material see figure 5, and pieces being thrown on the floor as seen in figure 6.

Fig. 4

Fig. 5

Fig. 6

The results of these practices are that a valuable large floor space area was occupied because of the volume of material around. Also, parts may damage or the quality effected. Double handling created, as well as safety jeopardy because of parts being thrown on the floor. All of these cause a rise in costs and safety concerns. In concern with high volume of components ready for assembly, this is due to the company policy of producing not according to demand. This leads to over production which causes an increase of operating cost. as a solution to this issue, each department should produce according to either a very reasonable quantity or actual demand from the assembly department. For instance by using a communication signal from downstream process to an upstream process (i.e. Kanban systems or CONWIP models) to control production. Also, the company has to decide on the disposal of many obsolete components and raw material that are taking valuable space with no use. In regards to the clutters material, the application of 5S is considered as a solution which includes (Sort) to distinguish between what is needed and what is not needed. In this case we sort the items into 3 piles. (1) What we want to keep, (2) What we want to quarantine (not sure) and (3) What we want to throw away (dispose of). The waste here can be categorized as overproduction, inventory, motion and defectives, which affect the performance of quality, cost and moral. The improvement projects for these wastes are production control, 5S program.

The third situation during the investigation was that unutilized machines were found. Figure 7 shows the process of pins assembling with the metal frame manually assembled done by 4 operators instead of the machine. However, surprisingly a machine for this purpose was available in the factory, but it wasn't used due to the lack of qualified operators. In addition to that, many machines were available but were either broken or obsolete see Figure 8.

Fig. 7

Fig. 8

The waste of space, effort, time and capital were noticeable at the factory. The company has a great opportunity to benefit from lean concepts and tools. The suggested solution is that the management should always check on safety rules for workers and for work place and maintain the site clean and tidy. The company should decide on which machines to keep and which to dispose, they should be stored in a suitable way and place. The benefit they can see from applying 5S includes improvements in safety, quality, productivity, delivery, and employee morale. The company should train the operators on the needed machines to save time and produce quality parts. Also, it was suggested that repairing the wanted machines can save time and effort, or replacing them may be taken into consideration as well if possible.

Most of the operations are using poor methods, workers are left to find the best way to do the job without guidelines. The work areas were found disordered and space area was unutilized.

In this case study, the lean principles on the existing layout was applied. This was achieved by proposing two layouts and reducing the non-value activities or if possible eliminating them altogether in the manufacturing process through the standardize work sheet. Over the course of this study some improvements have been made in utilizing the floor space. Most significantly, the development of a new layout of the chosen department has greatly improved the flow of material and reduced the double handling and minimized the walking distance creating the potential for drastic reductions in cost. The significant improvements are as follows:

- Reduction of floor space required for production of 29%
- Decreased transfer distance between process in average of 68%
- Increased the available area of the components department of 68%
- Decreased the cycle time in average of 2%

Case study 2:

We investigate in this section some of the issues that caused a stoppage in different areas of the production line in-order to offer the company an awareness of the wastes that may exist in different types and shapes in it. The investigation was carried out by touring the pipe factory to identify possible workplace that generate waste and also analyze data which has been collected. Four situations were investigated at this factory. Each situation begins with a description of the case with a photograph of the task under investigation. The waste type will be identified and a practical solution to the cause occurrence of the wastes will be suggested.

The first situation was at the Hydraulic pump. Lost of keeping the raw material under control while it was formed (see figure 9), because of the low pressure; which caused by either not checking the gauge frequently which should be between 100-150 Bar or leak through the hydraulic hoses. In addition to that the deterioration that happen to the hydraulic pump due to the lack of oiling.

Fig. 9. Hydraulic pump

The types of waste identified in this case were waste of time, raw material and effort. The suggested solution was that the operator needs guideline for his operation and a standardized work sheet is suitable for that. Also, set a regular check to the gauges and oiling the pump as frequent as required.

The second situation was at the conveyer belt. Based on the information collected regarding the work stoppage, the conveyor belt (see figure 10) was one of the stations that was stopping caused by the scraped materials that was longer than it should be. This was because of the dull cutter or the jam-packed of material caused by the conveyor speed.

Fig. 10. Conveyer belt

The types of waste determined were Waste of time, raw material and effort. The suggested solution for this situation was that the operator must ensure that the cutters are in good working condition and the conveyor is set on the appropriate speed continually.

The third situation was caused by the welding head. Due to the operator neglecting monitoring his task on the machine, the welding head (see Figure 11) is sticking on the pipe. This is because of improper adjustment of the distance; which should be (2 – 3 cm). Also, the welding head goes off the pathway.

Fig. 11

The types of waste identified in this case were, waste of time, raw material and efforts. It was suggested that the welding head is to be lifted and adjusted in accordance to the required distance. Since the monitoring task is a tedious job, the company should develop a rotation program among the operators to solve this issue.

The forth situation was caused by the hose and joints. The hoses and joints (see figure 12) that were worn-out or not suitable for use caused improper function of the hydraulic system.

Types of waste were identified: waste of time, raw material and effort. It was suggested as a solution that the company should have the operator check the hoses and joints daily to ensure that there are no leakage and they are in an acceptable condition. Also, the company must ensure that the hose's and joint's material are in accordance with the specifications.

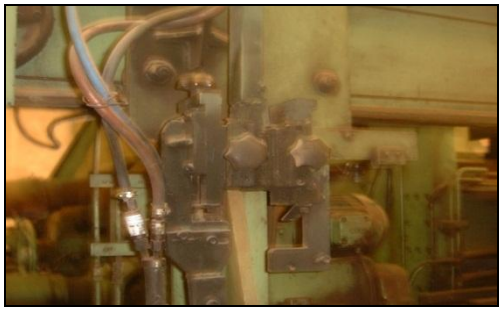

Fig. 12

Based on the available data, the OEE was calculated and found to be 3.83% and the availability was to be 31.3%. These results were very low because of unavailable raw materials which reached 80%. If the stoppage data related to the unavailable raw materials were removed from the calculations and repeating the calculations we found that

the availability increased to 52.9%, and the OEE increased to 6.09%. For this reason, there was a stress on the critical position that the factory was in and a number of solutions were proposed. To improve the operation efficiency it was suggested that the plant applies the TPM five fundamental functions. It was proposed that the stoppage would be reduced significantly and the average OEE will attain to at least the acceptable worldwide range between 45 & 60 percent. So, it was believed that if the plant was able to adapt the change and use proper inventory control technique the total mechanical, electrical and other stoppage would be reduced by 50% and the stoppage caused by raw material shortage will be eliminated.

5. CONCLUSION

The findings of this study proved clearly that lean manufacturing principles of workplace design for eliminating or reducing waste were not taken into consideration within the two local industries. Types of waste such as time, motion, transportation, over production, process, defectives, and inventory were found everywhere. The main reason for this as it was indicated by supervisors and workers is the lack of understanding of the principle of lean manufacturing and its effects on improving productivity and reducing cost. As a matter of fact, most people in the management of the two factories do not know the basic principle of lean manufacturing and think that the only type of waste is waste of material. The workplaces visited were found to contain large amounts of waste of every type. Even though solutions for these problems may be simple and not costly the awareness of management to the principle of lean manufacturing to these problems was lacking significantly.

To pull a facility from effectively no process to a lean development system is similar to performing a cultural revolution. The individuals are not used to the level of discipline it requires. Based on previous work experience, and discussions and negotiations with the workers, engineers and managers of the two facilities, the authors anticipated obstacles when implementing the lean manufacturing principles. This is expected because of the education gaps within the local workforce, work styles and lack of responsibility, negligible employee training practices and negative work cultural restrained the lean implementation.

They also have to learn and understand that lean is the elimination of non-value-added activities from a process in order to improve efficiencies. It is not planned to eliminate people, however to maximize their talents and free up capacity. The authors believe that if people started seeing benefits and results of implementing lean, they will accept it, then it becomes easy to influence and convince them. However, It should be understood that lean is a journey not a destination. That is because it is a culture change to the way a facility does business.

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