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Study of Six Sigma Implementation by Energy Value Stream Mapping In Small Scale Industry: A Review

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Abstract: Lean management and Six Sigma are two concepts which share similar methodologies and tools. Six Sigma (6σ) is a set of techniques and tools for process improvement. It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. Lean management is an approach to running an organization that supports the concept of continuous improvement, a long-term approach to work that systematically seeks to achieve small, incremental changes in processes in order to improve efficiency and quality. Energy value stream mapping is a lean management tool that seeks to identify and eliminate cause of errors or defects in manufacturing process by focusing on outputs that are critical to customers. In this project we will use energy value stream mapping methodology to study the wastage of energy in various processes in a small scale industry.
Keywords: Six sigma, Lean manufacturing, Value Stream Mapping, Energy Value Stream Mapping, VSM symbols, Energy management.

I. INTRODUCTION

A. Six Sigma

Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by engineers Bill Smith & Mikel J Harry while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995.It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.

It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

The term Six Sigma (capitalized because it was written that way when registered as a Motorola trademark on December 28, 1993) originated from the fundamental statistic concept that 'sigma' represents one standard deviation away from the mean; six of theses in the unlikely six standard deviations away, and from terminology associated with statistical modelling of manufacturing processes. The maturity of a manufacturing process can be described by a sigma rating indicating its yield or the percentage of defect-free products it creates.

A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features per million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it. Six Sigma (6σ) is a set of techniques and tools for process improvement.

It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.

It uses a set of quality management methods. Lean management and Six Sigma are two concepts which share similar methodologies and tools. Both programs are Japanese influenced, but they are two different programs.

Lean management is focused on eliminating waste and ensuring efficiency while Six Sigma's focus is on eliminating defects and reducing variability.

II. METHODOLOGIES

DMAIC is used for projects aimed at improving an existing business process.

FIG 1:- The five steps of DMAIC

A. The DMAIC Project Methodology has five Phases

1) Define the system, the voice of the customer and their requirements, and the project goals, specifically.
2) Measure key aspects of the current process and collect relevant data; calculate the 'as-is' Process Capability.
3) Analyse the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
4) Improve or optimize the current process based upon data analysis using techniques such as design of experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability.
5) Control the future state process to ensure that any deviations from the target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process. This process is repeated until the desired quality level is obtained.

III. LITERATURE REVIEW

Topic: Study of Six sigma implements by Energy Value Stream Mapping in small scale industry.

Six Sigma is a strategy that seeks to identify and eliminate cause of errors or defects in manufacturing process by focusing on outputs that are critical to customers. Value stream mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer.

Authors (Kane J., Dupont E.I., 2003) has been applying the Six Sigma problem-solving methodology to a broad array of business, technical, transactional, and process problems across the corporation. One benefit of this culture change has been the way that business units approach energy efficiency. The structured Six Sigma approach, with its strong focus on statistics and data and a proven method for controlling improvements long after they are made, is ideally suited to help drive energy efficiency excellence. Using Six Sigma tools to analyze energy conversion processes such as steam boiler, turbine generator, central refrigeration, compressed air, and HVAC systems, DuPont has been able to capture and sustain remarkable energy savings. Six Sigma has also been applied to energy utilization processes such as manufacturing process heating and refining. Individual Six Sigma energy project savings of over $250,000 per year are not uncommon. To further boost the savings from energy-related Six Sigma projects, DuPonts Energy Technology Network has aided the global sharing of successes by sponsoring routine virtual workshops over the DuPont wide area network. This paper will briefly discuss the Six Sigma methodology and present case studies of several energy efficiency projects that used Six Sigma to succeed. The virtual workshop concept for leveraging successes and key learnings will also be presented.

Authors (Kaushik P., Khanduja D., 2007) noted that six sigma has found place primarily in manufacturing industries as a quality tool. In processing industries no such convenience is available. Working fluids in process industries may not be visible and it's quality is measured by pressure, temperature and flow measurement. In manufacturing industries, production is already operated in 1 or 2 sigma level and by applying SS methodology, it can be raised upto 5-6 sigma level. In process industries, there are many sub processes that operate even at negative sigma level because of being secondry in nature. So in process industries, a quantum jump in sigma value by application of SS tools cannot be expected and it is found that improvement potential is maximum upto 2 3 sigma levels. This paper shows that Six Sigma methodologies improve quality and produce large cost savings. In process industries, no such convenience is available. Working fluid in process industries may not be visible and its quality is measured by pressure, temperature and flow measurement. In manufacturing industries, production is already operating at 1-2 sigma level and by applying Six Sigma methodology, it can be raised up to5-6 sigma level.

Authors (Kaushik P., Grewal C., Bilga P., Khanduja D., 2008) In a global environment, organisations are under continuous pressure to control costs, maintain high levels of safety and quality, and save energy. Energy conservation is a means to control costs and increase efficiency. Process industries in general are big consumers of different kinds of energy. In this paper, Six Sigma methodology has been applied in a thermal power plant seeking energy conservation. De-mineralised (DM) water in these plants is an expensive input material. It has been found that a 0.1% increase in DM make-up water consumption increases the generation cost by approximately US$0.2 million per annum. DM water is taken as a main Critical-to-Quality (CTQ) factor. It is found that Six Sigma project recommendations brought down the mean make-up water from 0.90% to 0.54% of Maximum Continuous Rating (MCR), accruing with it a comprehensive energy savings of nearly US$0.74 million per annum. Utilising Six Sigma for energy conservation: A process industry case study.

Paper (Valles A.,Sanchezs J., Noriega S., Nunez B 2009) presents the findings of an initial survey conducted in Indian industries. This will help organizations in making right preparations for successful implementation of Six Sigma. This paper presents a Six Sigma project conducted at a semiconductor company dedicated to the manufacture of circuit cartridges for inkjet printers. They are tested electrically in the final stage of the process measuring electrical characteristics to accept or reject them. Electrical failures accounted for about 50% of all defects. Therefore, it is crucial to establish the main problems, causes and actions to reduce the level of defects. With the implementation of Six Sigma, it was possible to determine the key factors, identify the optimum levels or tolerances and improvement opportunities. The major factors that were found through a design of experiments 3 factors and 2 levels were: abrasive pressure (90-95 psi), height of the tool (0.06-0.05) and cycle time (7000-8000 msec.). The improvement was a reduction in the electrical failures of around 50%. The results showed that with proper application of this methodology, and support for the team and staff of the organization, a positive impact on the quality and other features critical to customer satisfaction can be achieved.

Authors (Gahlot P., 2013) Small and micro industries often exist in the form of clusters and act as an important component of Indian economy. Energy being an indispensable input, enhancing its utilization efficiency not only helps in improving competitiveness of MSMEs through cost reduction but also aids in alleviating energy linked environmental pollution. Level of energy efficiency in small industries depends not only on the production technology adopted but also on other non-technology factors. This paper analyzes such factors in energy intensive cluster of textile industries located at Panipat in Haryana. The outcome of the study underlines the need to involve non-technology factors in the prevailing technology-centered energy initiatives in the MSMEs for discernible improvements in the long run. Small and micro industries often exist in the form of clusters and act as an important component of Indian economy. Energy being an indispensable input, enhancing its utilization efficiency not only helps in improving competitiveness of MSMEs through cost reduction but also aids in alleviating energy linked environmental pollution. Level of energy efficiency in small industries depends not only on the production technology adopted but also on other non-technology factors. This paper analyzes such factors in energy intensive cluster of textile industries located at Panipat in Haryana. The outcome of the study underlines the need to involve non-technology factors in the prevailing technology-centered energy initiatives in the MSMEs for discernible improvements in the long run.

Authors (Sihag A., Kumar V., khod U., 2014) states in their paper that Value stream mapping has the reputation of uncovering waste in manufacturing, production and business process by identifying and removing non value adding steps. Value stream mapping is a method of recovering a product's production path from door to door. In a process, non value added actions are identified in each step and between each step by their wastage time and resources. VSM is one of the lean tools to eliminate waste and improved operational procedures and productivity. Current state map is prepared and analyzed and suggested to improve the operational process. Accordingly the future state map is drawn after present study, we come to know about improvement in.tact time by applying the proposed changes if incorporated in future state map.

Authors (Lee J., Yuvamitra K., Guiberteau K., Kozman T., 2014) in their paper says that most companies would like to reduce costs of providing goods and services while the government and society are pushing for more "green" practices. By developing an energy management plan, a company can find a systematic way to reduce energy usage and operating costs at the same time. This article presents a six-sigma based energy management planning procedure, focusing on five major steps: define, measure, analyze, improve, and control. An overview of the major energy-consuming equipment in manufacturing industries is provided. Different energy-saving opportunities are then investigated. The results from this research provide information and a clear understanding for establishing an energy management plan, which can be used as part of the ISO 50001 implementation. The objectives of an EMP are to improve energy efficiency, reduce cost, and conserve natural resources. The specific goals are to (1) continuously

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improve energy efficiency by establishing and implementing an effective energy management plan while providing a safe and comfortable work environment. (2) suggest an action plan with economic analysis.(3) encourage continuous energy conservation through work and personal activities by employees.

A six-sigma approach involving define, measure, analyze, improve, and control is used to describe the five main steps in the energy management plan. The development of an EMP can be considered as the first step to achieve ISO 50001, a world-class energy management standard . While EMP is used to identify energy-saving opportunities and tools, ISO 50001 is designed to help companies evaluate and prioritize the implementation of energy-efficient technology and promote efficiency throughout the supply chain. Superior Energy Performance (SEP) [4] is an ANSI/ANAB-accredited certification program that builds on ISO 50001 to provide industrial and commercial facilities with a pathway to continuously improve energy efficiency while boosting competitive-ness.

Authors (Baswaraj A., Rao M., Kumar A., 2015), through their paper states that The Environment is becoming more and more a key issue for the Steel Industry. Refining of secondary steel making has become an important part in modern steel works. As one of the fundamental pillar industries in global scenario, the iron and steel industry has developed rapidly. Meanwhile, it is an energy-intensive industry, whose energy cost accounts for 20% of the iron and steel-making process. Therefore, efficient use of energy is crucial for reducing total operation cost. As it is subjected to large amount of variability in raw material prices, manufacturers must continuously improve operations and lower costs. The global warming effect and natural resource saving are the general environmental topics nowadays. In such efforts, many firms implement lean practices. It is suggested that, the usage of Six Sigma (DMAIC) may ultimately aid in optimizing energy consumption. Not only the delight of creating products with a wide variety of additional values must be considered, but also the emission of CO_2, the discharge of harmful wastes during manufacturing, the limitation of waste disposal, and many other factors, must be evaluated comprehensively. The Present Paper summarizes the optimization of Energy consumption in secondary steel manufacturing by Six Sigma (DMAIC) Methodology. All the objectives of this paper are to develop advanced energy management systems for an energy efficient and environmentally friendly society and to provide an assessment model for zero emission (of materials) and energy cascade systems. Steel is the world's most used and recycled metal. It is an essential and sizable sector for industrialized economies. Since it is capital and energy extensive, companies have been putting consistent emphasis on technology advances in the production process to increase productivity and to save energy.

IV. VALUE STREAM MAPPING

Value-stream mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. Value-stream mapping has supporting methods that are often used in Lean environments to analyze and design flows at the system level (across multiple processes). Although value-stream mapping is often associated with manufacturing, it is also used in logistics, supply chain, service related industries, healthcare, software development, product development and administrative and office processes. In a build-to-the-standard form, Shigeo Shingo suggests that the value-adding steps be drawn across the centre of the map and the non–value-adding steps be represented in vertical lines at right angles to the value stream. Thus, the activities become easily separated into the value stream, which is the focus of one type of attention, and the 'waste' steps, another type. He calls the value stream the process and the non-value streams the operations. The thinking here is that the non–value-adding steps are often preparatory or tidying up to the value-adding step and are closely associated with the person or machine/workstation that executes that value-adding step. Therefore, each vertical line is the 'story' of a person or workstation whilst the horizontal line represents the 'story' of the product being created. Value stream mapping is a recognised method used as part of Six Sigma methodologies. Value stream mapping is a flowchart method to illustrate, analyze and improve the steps required to deliver a product or service. A key part of lean methodology, VSM reviews the flow of process steps and information from origin to delivery to the customer. As with other types of flowcharts, it uses a system of symbols to depict various work activities and information flows. VSM is especially useful to find and eliminate waste. Items are mapped as adding value or not adding value from the customer's standpoint, with the purpose of rooting out items that don't add value.

A. Summary

We have observed that the major part of energy exploitation lies in the production of a rejected product. So we will use the combination of six sigma methodology and value stream mapping to reduce wastage of energy and create energy saving processes. Value stream mapping is a paper and pencil tool that helps us to see and understand the flow of material and information as a product or service makes its way through the value stream. We will use this to map the various processes in a small scale industry and study the processes in detail where the maximum energy wastage is taking place. After observing those processes we will suggest the major steps that should be followed in order to minimize the energy wastage and hence contribute towards the clean; green and less energy consuming manufacturing processes.

V. CONCLUSION

After thorough study of the research papers based on six sigma, value stream mapping and energy consumption studies on the basis of six sigma methodology and value stream mapping we conclude that Six Sigma tool has been used in industries for lean and green manufacturing since many years , but uses of six sigma on the basis of energy value stream mapping is remain untouched. So there is a scope to use combination of six sigma methodology and value stream mapping to reduce wastage of energy and create energy saving processes.

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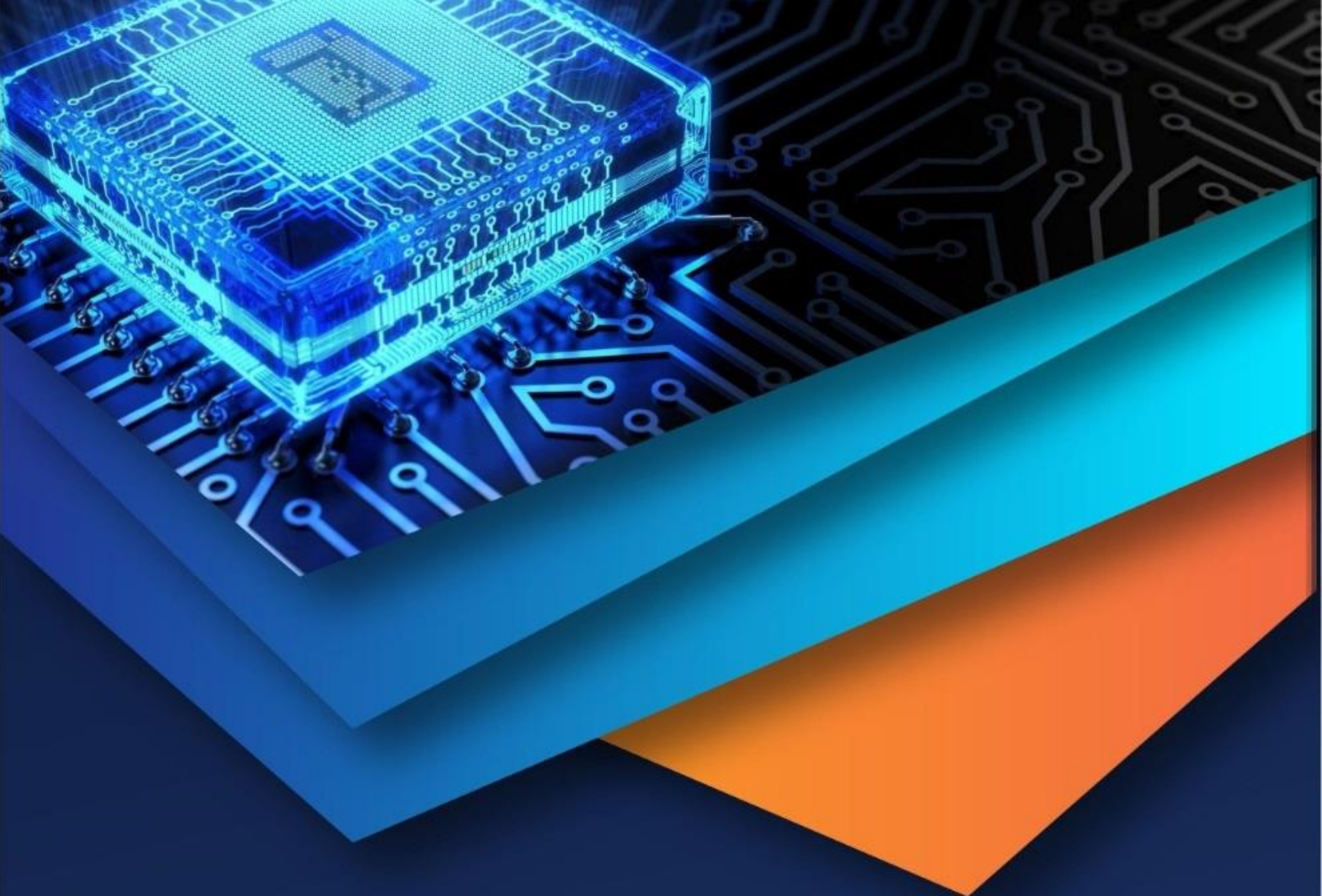

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