Model for integrating Six Sigma in Manufacturing Execution System in industrial production environment

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Abstract. Manufacturing and assembly organizations today and strategically in the following years will put main focus and investment on the implementation of optimization tasks and traceability systems, to be able to trace the path for development, strength and maintenance of quality. Six Sigma is a methodology consisting of defined phases in which main parts are statistical tools and methods. It is a management and metrical methodology, with main target to visualize and eliminate variations in the process and keeping the process in required control limits. Information systems such as MES – Manufacturing Execution Systems provides the opportunities for identify and monitor this variations available in the processes. Merging this two systems gives opportunities for increased effectiveness and efficiency during the processing and achieving increasing customer expectations.

Keywords: information technology, manufacturing, quality, MES, Six Sigma,

1. Introduction

In the modern business world, competitiveness of products and services offered in the market are essential for the survival, growth and development of companies. Because of this, companies that compete in the market are searching for the effective and efficient way to produce as much as possible better quality product or service at a lower production cost. Also, the globalization of the economy and the factors that goes together with this modern phenomenon, as increased efficiency in production, shortening the time needed for one production cycle, ensuring and guaranteeing high quality, steadily increase the pressure on the manufacturing business (Heiko Meyer, Franz Fusch, Klaus Thiel, 2009).

Because future improvements in rival products will be based primarily on strategies that will offer added value to customers such as high flexibility, shorter time to production, short delivery time, high reliability of delivery, a wide range of varieties, shorter life cycle of manufacturing products etc. If the recognition of these improvements can be seen that the improvements are not part of improving production but part of the process improvement. (Kletti str.1-2).
2. Six Sigma – Evolution of quality

Six Sigma methodological approach is an evolution of quality. The first reaction when we mention Six Sigma methodology is that it is complex and modern methodology. But the facts as previously mentioned, has shown that this methodology is part of the evolution of the system for total quality management. In his work (De Mast 2006) explains that this methodology is currently in the development stage where methods and tools are evaluating to improve the quality and efficiency of processes. This methodology is a set of principles, stages and statistical tools. The development of Six Sigma methodology begins in late eighties of the last century by the company Motorola. In that period the company struggled for survival, especially the main cause of the crises was no possibility to achieve the quality required by customers due the complex products the company produced.

After the development and creation of the concept and its application to Motorola, this methodology is becoming very popular, so in the mid-nineties and has been adopted and used by “General Electric” company. Finally the two companies consider Six Sigma as a part of their strategic policy. Starting from then, Six Sigma has become one of the most popular global methodologies applicable in various spheres of industrial production, and in other activities of business and work.

Since the middle nineties until today Six Sigma goes through a number of changes and develop at a higher level (Folaron, Morgan, 2003). If at the beginning it was a concept for solving quality problems based on statistical principles, the next level was a transformation technique for process improvement (i.e. reducing variations in the system through their monitoring and resolution using a number of statistical techniques). According to Harry (1999), Six Sigma is defined as a disciplined method that is based on accurate data collection, their statistical analysis in order to identify the source of the problem and take corrective actions to eliminate it.

In its final phase, in a modern industrial production today, this methodology is recognized as a strategy for continuous improvement. Today this methodology is adopted in various sectors and spheres besides the automotive industry such as finance, transactions, software, healthcare, military industry, and aircraft industry and so on. In the last ten years number of organizations that have shown interest in using Six Sigma as their management philosophy are increasing. However it is important to note that one of the modern companies seek to implement this philosophy proper step by step like Motorola and General Electric provides a solid strategic foundation for a longer period. On the other hand there are those companies that wish to benefit from Six Sigma as a tool for quickly achieving profit, which often lead to undesirable results, inadequate implementation and improper use of statistical tools. This results in a number of projects that are not end-to-end and certainly unable to profit in the long term.

3. Production structures - MESA case study

Manufacturing or production facilities, are a set of processes and systems (normal people), which are designed to transform the (revised) certain materials in products that have increased value. The three main building blocks, materials, processes and systems creates the basis of modern production (Groover, p.7).

To achieve better production is not necessary to increase the demand for products that are produced but also to standardize and improve the processes that are used in production. In parallel with improvements in processing technology and reducing costs for materials and work, target is to improve efficiency initially achieved by improving the structures of production and control procedures. With achieving of these goals - improved movement and track the order through production is gained. For these reasons there have been new approaches that meet the needs for shorter execution of production processes and greater flexibility, particularly in terms of increasing product variants (Kletti p.4).
Association for manufacturing solutions company MESA is the first organization to adopt this concept and is an organization with the most experience when it comes to this kind of systems. MESA access to this concept is very pragmatic and describes twelve functional groups that are required to support effective management of production. These functional groups are:

1. Detailed Planning (Operations / detailed layouts),
2. Resource Management (allocation of resources and their status),
3. Registration and display the current status of resources,
4. Management of the documentation (document control),
5. Management materials (sending generating units),
6. Performance Analysis,
7. Order Management (management of labor),
8. Manage the maintenance in order to maintain and service,
9. Process management,
10. Management of quality,
11. Obtain and data collection,
12. Monitoring of the products and their origin

Figure 1. Functional structure model MESA (from Kletti, Manufacturing Execution System – MES, page 19)
4. Six Sigma and operations costs

According to Murphy (1998), most of the companies are working on three sigma level and in most of them are making an effort to quantify the financial effect of the variability of the sigma factor. According Klefso to reach a level equivalent to the operation Six Sigma, it is the cost of poor quality to less than 1% of total sales, and the level of five sigma cost of poor quality is 15% of total sales, and level three sigma cost of poor quality is equal to 25-40% of total sales. (Six Sigma by Graeme Knowles).

Costs in the company come for defective products are called "costs of poor quality." For the first time these costs mentioned James Harrington in his book “Poor Quality Costs” (1987). These costs include the costs that fill the gap between current and desired quality of the product or process.

These include repair costs, labor participating in the repair of defective materials, resorting and made drawback of the product. These costs do not include the cost for detection and prevention.

The overall share of the cost of poor quality because it consists of:

- Labor costs which works on repairing defects,
- Costs of material that was used,
- The cost of additional services,
- The cost of lost opportunities:

1. Losses on sales (revenues),
2. Potential loss of market share,
3. Low level of service to customers,

Insufficiently clear picture of the costs for poor quality in an industrial system may lead to the prevention of improvements for an extended period. Six Sigma methodology directly estimated cost of poor quality based on the principle of working project by project, providing a solid base for improvement and achievement of goals set up as an organization target. Even the smallest improvement in terms of prevention of defects provides significant benefit in terms of reduction of costs they cause if they arise.

5. Model for integrating Six Sigma in MES systems in industrial manufacturing (accent on Automotive Electronics Industry)

In the picture below you can recognize the processes that one MES system can offer:
Figure 2. MES processes that can be achieved

MES system, through built-in application programming interfaces (Application Program Interface - API) that are integrated into process machines through MEC customers fully covers all the processes that are essential for DMAIC phases of 6 Sigma methodology. In the MES system, through the work plans system will be able to define the processes that would be subject to improvement. Through standardized API functions that are implemented separately on the machines along the processes that need to be improved, they will gather the necessary records from the measurements of the machines and to forward it to the MES system. This will be a centralized location for the collection and processing of data. Further through 6 Sigma tools will be implemented in the MES system can analyze data collected from individual machines that previously sent measurements. Based on the analysis of the measurements MES system with 6 Sigma tools are implemented in the MES system, we will be able to present the summarized data processes to show bottlenecks in processes and propose directions in which the process could be improved. The control of the entire cycle will also be monitored by the MES system in order to avoid unwanted side effects such as:

1. Some of the products cannot be processed or tested to the appropriate workstation defined by standard during the process,
2. Double or multiple processing of a product on the same station,
3. Bad performance measured values on the testing or a processing station,
4. Inadequate Setups of machinery and working posts,
5. Gaps in repair products, increased scrap and defect rate etc.
Primarily in terms of monitoring capability of the processes in order to meet the requirements and criteria for quality, defining capability factor Cpk is essential. This section refers specifically to the testing of products in terms of functionality. All measurable values obtained for each component of the product is transferred to the MES system. The same, using the conversion results as variable values makes calculation Cpk coefficient and defines the ability of the process – Capability. If this is applied for a longer period of time, gives a clear picture of stability and level variations that occur within that process.

Benefits:

- Reduction of the production cycle time,
- Reduce errors in processing orders,
- Reduction of time for working posts settings
- Reduce work in process (WIP),
- Reducing the time for managing schedules,
- Reducing the time from initialization to completing of the products,
- Reduction of orders waiting time to be produced,
- Reducing transactions for stock,
- Reduce paperwork between shifts,
- Reducing the possibility of loss of technical documentation,
- Reduce the need for data entry,
- Reducing wastage of materials,
- Reduce procedural errors,
- Increase of production capacity (utilization of machines),
- Reducing the inventory of raw materials and finished products,
- Empowering employees,
- Reduce operating and other expenses,
- Improving quality (defects reduction),
- Centralized and real-time tracking, and to control of production,
- Beneficiaries of the planning process,
- Fast preparation of customer orders,
- Provides the flexibility to respond to customer demand,

5. Conclusion

Six Sigma is effective way to get a clear picture of the manufacturing process, with all their variations, waste and constraints that appear. With this approach all weak side of the process could be visualized, measured and directly faced to be optimized, in effective and efficient way. Using statistical approach and measuring the process is the most precise and accurate way to get a real status of the process. Their combination with appropriate tools enables choosing right counteractions and making correct decision during the everyday work. Six Sigma is methodology and set of tools that can enable a
manufacturing organization to improve performance systematically. For this type of organizations to continue making breakthroughs and meet the expectation of their stakeholders, they must master the skills to plan, control, and improve quality. MES system by itself gives extended range of benefits that allows for production, as well as for the organization, customers and suppliers evidence that the industry and the company will be able to continuously improve and to compete. This enables to position themselves in the competitive place in the business of interest and also to ensure the future of the industry and the company. Through all the benefits offered by the use of MES systems can reliably conclude that MES systems play a key role in improving production processes and production, and it is heavily influenced by the improvement of the company.

Merging of MES system and Six Sigma methodology is an approach for integrating the power of Six Sigma Tools and information technology to create the fastest rate of improvement, maximize value, and increase customer satisfaction in manufacturing and production plants.

References