Six Sigma and Lean Manufacturing Applications on Facilities Management to Reduce Overtime

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Abstract *— In essence, Six Sigma is a methodology originally designed for manufacturing to understand and reduce sources of variability. This can also be called margin of error when performing any operation or manufacturing of product. When we implement six sigma in facilities management and maintenance it relates to keeping all activities and/or operations to optimum working condition. When applied to facilities management, the concept has been to maximize the uptime of equipment to make them as reliable as possible. Six Sigma Practices try to accomplish this by establishing and enforcing basic business practices. The intention of this document is to provide a guideline that will provide step by step tools and actions on how to make every process more efficient. The scope of the design project is to use Six Sigma methodology to reduce the quantity of overtime hours that has to be worked when having multiple projects running at the same time with limited personnel to work on it.*

Key Terms *— Facilities Management, Lean Six Sigma, Overtime Hours, Six Sigma.*

INTRODUCTION

"Six Sigma" is a methodology which offers to organizations, a series of statistical processes and tools contributing to the increase of quality and reduction of process variability. "Six Sigma" is a long-term process, which generates and supports continuous improvement. The "Six Sigma" approach requires perseverance, focus and commitment.

The advantage of combining Lean and Six Sigma is simultaneously improving the speed of work (Lean) and the quality of work (Six Sigma). This dual approach integrates initiatives to improve process efficiency and effectiveness as measured by quality, speed and cost. Critically important is the vision and leadership of senior management. Without visible commitment from the top management, Lean Six Sigma implementation would be at risk and dependent on all the pressures that endanger all change management initiatives. For the initiative to be successful the attention to it must be consistent and continuous [1].

While both Lean and Six Sigma take a customer first approach the perspectives are slightly different. It is important that a combined program make customer driven requirements, specifications and expectations a key contributor of enterprise culture. Old attitudes must be changed and operational protocols adjusted. Meaning that employees will need to get familiarized with lean processes. This will let us have a smooth transition when standardizing the way we work. No task, job or chore will be worked on without first studying or establishing a process to be followed. By this we make sure that job won't be started without the necessary materials, manpower, workspace etc. Services that once focused on cost reduction alone while maintaining an acceptable level of quality must now deliver customer driven results of higher quality with lower cost. Functional or vertical boundaries must take on open characteristics so that cross-functional improvements can reach the breadth of the enterprise. Attaining this will mean a fundamental analysis and streamlining of every process involved and a willingness to let the facts and data take you where they will.

Being an extension of total quality management, the "Six Sigma" method designates an innovative way to pursue a high level-quality:

- it promotes a mental structure that focuses on continuous improvement;

- it helps gain competitive advantage by increasing efficiency and decreasing costs;
- all “Six Sigma” projects create a measurable effect, increase customer satisfaction and bring financial benefits;
- it helps standardization of the processes throughout all functions and departments;
- it trusts that scientific thinking is capable and fit to transparent decisions;
- “Six Sigma” projects promote working as a team;
- it increases employee satisfaction.

“Six Sigma” is a total quality strategy for achieving what all the other total quality strategies attempt to achieve: superior and continually improved performance.

The “Six Sigma” projects can also be implemented in any field: for example, in HR or marketing, by increasing customer fidelity, which in the end helps reach the Company’s objectives

BACKGROUND INFORMATION

As healthcare and higher education institutions strive for Operational Excellence, facilities management teams are playing a key role in analyzing processes and enhancing efficiencies, and are applying Six Sigma to their strategies. Six Sigma is a methodology that supports Operational Excellence. While it has been known as a business improvement concept for decades in the corporate world, it is still in its initial stages of being utilized within facilities management. Its benefits within this sector include:

- Provides a better understanding of projects, whether they are capital construction projects or facilities-related.
- Improves the safety of the work environment.
- Identifies major wastes.
- Mitigates potential delays.
- Identifies defects and reworks.
- Controls and enhances the quality of work.
- Improves overall investment and benefits.
- Validates results and savings of projects.

As Six Sigma evolves to illustrate its value within facilities management, the demand for certified professionals will only increase, and more specifically for Black Belt and Master Black Belt individuals. These professionals possess advanced Six Sigma knowledge and experience and they are familiar with identifying inefficiencies, developing and implementing innovative solutions and leading those changes.

One area of facilities management that Lord Company says can benefit well from Six Sigma processes is preventive maintenance [2]. The company says, “It is not abnormal for large universities and hospitals to have 30,000 work orders annually. With that much activity, there is significant potential for inefficiencies. If an institution has someone who can manage out those inefficiencies, there are tremendous savings to be reaped because of the high cost of facilities maintenance.

Six Sigma’s value in facilities management goes beyond preventive maintenance. As Lord Company explains, “Six Sigma can be applied to energy management, technology integration, green building and sustainability and capital projects. I believe that, as more organizations pursue Operational Excellence in all of their operations, and facilities departments have additional pressures put upon them to increase efficiency and save costs.

Reviewing the use of overtime payments on a regular basis and reducing the amount of overtime paid to employees is a positive management practice. The Fair Labor Standards Act (FLSA) requires that overtime (time and a half) shall be paid to non-exempt employees for all hours worked in excess of 40 hours in a calendar week. There are times when overtime is appropriate based on work schedules, increased workload, special projects or staff vacancies. Managers and supervisors should actively manage their operations to include rearranging or flexing work schedules when possible to avoid overtime payments [3].

Overtime can be reduced or avoided through advance communication of schedules and expectations. When possible, managers and

supervisors should plan future scheduling needs and/or conflicts to avoid or schedule overtime hours. All overtime worked should be pre-approved through the manager or supervisor.

Flexibility in scheduling can aid in reducing overtime. Ideas to consider are: flexible scheduling, non-traditional /compressed work weeks, or split schedules. Implementation of flexible scheduling can reduce overtime as well as increase work/life balance for employees.

METHODOLOGY

Figure 1
DMAIC Cycle

The nucleus of "Lean Six Sigma" aims to define, measure, analyze, improve and control, otherwise known as DMAIC roadmap. For each phase, there are associated tools and outputs, presented as follows:

- **Define:** Defining the issues. This means understanding your work order lifecycle from beginning to end, identifying all the bottlenecks and areas where the most maintenance dollars are being spent.
- **Measure:** Establish measurements for the current process. Measurements cannot be established unless there is data to make comparisons. For maintenance management this means having a complete maintenance history of each asset including:
  - Initial condition of the asset
  - # of work requests
  - # of requests that are backlogged
  - # of work orders
  - Cost for each work order
  - Reasons for work requests or work orders
  - Parts used
  - Result of work performed
- **Analyze:** Analyzing the data. Having the preceding information allows reliability and maintenance managers to establish trends, causes, points of failure and bottlenecks.
- **Improve:** Improve the processes. Better asset maintenance and management is going to occur when management commits themselves to continual improvement. Each facility is unique so it would be impossible to list all the types of improvements that a facility might make. But here are some of the more established methods of facilities maintenance management improvement:
  - Engage maintenance staff for their feedback on all changes. The people who actually do the work are a company's most valuable resource for understanding what can be improved.
  - Establish a proactive maintenance program. This may include preventive, predictive, condition based or reliability centered maintenance practices or any combination that works best for a particular facility.
  - Streamline the work order lifecycle by eliminating wasted time on filling out paperwork. In other words, implement a Computerized Maintenance Management System (CMMS) to schedule maintenance, track inspections and record all maintenance activity.
  - Make use of technology such as mobile handheld devices, infrared thermography or vibration analysis if your assets can benefit from these.
  - Develop a knowledge database which can be used for training new employees and as a resource that can be used to develop standard operating procedures.

- **Control:** Control and verify the changes. One of the keys to change management with an EAM or CMMS system is setting up the benchmarks of success. All changes need to be evaluated for effectiveness and adjusted accordingly. Without training, measurement and control, processes will not improve over the long term.

Ishikawa diagram or fishbone diagram method is used to identifying causes an overall effect. The causes are group into major categories to be able to identify the sources of variation. Figure below demonstrate how a fishbone diagram need to be made [4]. For this analysis five categories will be selected. These categories are: Manpower, Environmental, Equipment, Material and Procedure. Each category will have a list of possible reason of why airplanes departure late. When making this type of analysis it is easier to identify certain areas that are affecting our work output.

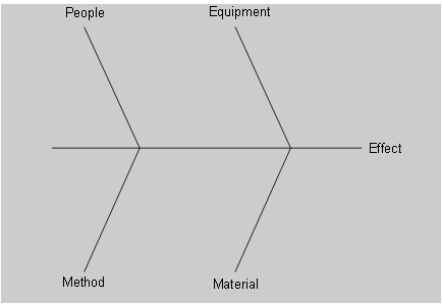

Figure 2
Cause and Effect Diagram

DISCUSSION & ANALYSIS

According to the Labor Code, work performed outside the normal weekly working time is considered overtime. The normal duration of working time (for employees aged over 18) is 8 hours per day and 40 hours per week, achieved through a 5 day-workweek. The maximum legal length of working time should not exceed 48 hours per week, including overtime. There are special situations and jobs where, given the particularity of the activity per se, it is impossible to have an ordinary, daily-work schedule. In these cases, the Company establishes the Internal Rules (developed by the Administration), and specific forms of organization of the working time, such as split or program shifts, such as daily shift schedules [5].

Based on assessment data, overtime and rest day violations are inter-related and are symptoms of other business challenges. No single cause was identified to explain the presence of excess hours. However, some key drivers have been identified as areas of impact: Lack of sufficient manpower to provide needed coverage [6].

- Lack of manpower needed to cover critical or high skill operations, especially during periods of peak demand, vacation, or absences (related to illnesses or other causes) o Lack of sufficient machinery, trucks, or other equipment needed to cover peak demand periods.
- Equipment availability issues – due to maintenance problems, etc.
- Lack of balance in the production process – i.e. a process step forming a bottleneck that creates a systemic need for excess hours for that process or in downstream processes.
- Improper scheduling practices causing uneven demands, lack of available materials, or production of wrong products.
- Poor record keeping practices due to lack of management awareness concerning hours of work requirements.
- Lack of regular management oversight and approval for the overtime that is being worked.
- Staffing based on convenience rather than need.

Not one solution has been singled out to eliminate hours of work violations. However, some of the key drivers that could impact directly this type of issue have been identified to be:

- Map out production flow and identify “bottlenecks”.
- Increases manpower to cover peak periods, vacations, other absences, etc.
- Cross training to increase manpower available for critical skills.

- Implementation of absence controls.
- Adjustments to shift patterns, production floor layout, to help reduce bottlenecks.
- Increases in inventory to help level demands.
- Education of managers and associates concerning the legal restrictions and costs of overtime.
- Implementation of monitoring and approval processes.
- Have patience. The reduction in overtime often takes a period of time to actually happen, this does not happen immediately.

Once initiated management seems to drive far beyond the overtime reductions that would be required to resolve excess overtime and rest day violations, suggesting that a significant cost/benefit has been identified.

One of the most relevant steps when designing a product or process in "Six Sigma" methodology is by utilizing a SIPOC. The purpose of the SIPOC analysis sheet is to paint a clear picture of how the suppliers and processes interact, and how to define the inputs of a process son customers receive consistent outputs.

Table 1

SIPOC Analysis

SIPOC Analysis

Project no.	1	Project Name	Decrease white-collar overtime	
Project leader		Date	Version	1
SUPPLIERS	**INPUTS**	**PROCESS**	**OUTPUTS**	**CUSTOMERS**
Documents responsible	Documents showing reasons for overtime	Doing overtime	No. of hours of overtime	General Manager
White-collar departments	Card punching by white-collars		Percentage of hours of overtime	Budgeting & Controlling Manager
	Reasons for overtime		Average hours of overtime / white-collar	Treasury Department
	Documents showing number of overtime hours approved		Cost of white-collar overtime	HR Manager
	White-collars		Percentaje of cost of white-collar overtime in total salary expenses	Cost Reduction Manager
	White-collars managers		Average cost of white-collar overtime / white-collar	White-collars
	Timekeeper Program			
	Cards			

The purpose of the SIPOC Analysis Sheet is to paint a clear picture of how the suppliers and processes interact, and how to define the inputs of a process so customers receive consistent outputs. Thus, Table 1 illustrates the SIPOC analysis, which depicts the relationship between suppliers, inputs, processes, outputs and customers.

Cause and effect diagram was created to illustrate the possible causes of overtime now that we have a more defined view of our problems and possible solutions we can build a cause and effect diagram that is concentrated on all the variables that take place in this type of environment. This also helps us take a more organized approach when solving our issues. When applied correctly this can help get better results out of the company.

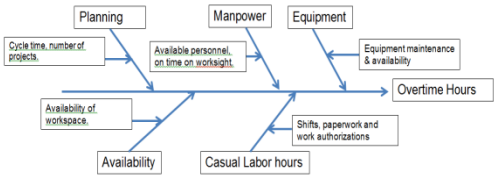

Figure 3

Cause and Effect Diagram

Different factors were taken into consideration when building the cause and effect diagram. When speaking about planning, this being the first step of each project that takes place in the facility can be the source of many of day to day problems encountered by managers, supervisors and even technicians.

Cycle time must be taken into consideration when establishing the order in which this projects are going to be worked. Also the impact and importance that these will have upon the facility. Different types of projects require different measures to have positive results. When time is an issue then the magnitude of the project that is wanted to be made must be highly considered. Taking big projects when having little time to finish the can result on excessive over time. This is an approach that is usually utilized unless the project comes as an emergency. It is important to always have record of jobs being done, jobs that are already finished and jobs that will be done in the future. When taking into consideration the preventive maintenance aspect of facility management this can be a big help to keep the process organized. The type of information and documents should be passed from the manager to the supervisor so the workgroups are maintained on point and maintenance scheduled can be formed.

The availability of workspace often has a big toll on the jobs that must be realized. When having to do any type of remodelation, moving or expansion of any sort the workspace is a very important factor due to the fact that one cannot do any type of work that can put the health of the people going through the area in danger. If is were to be done with people o passengers by that matter near the work area certain precautions must be taken into considerations and done by any means. Having to wait to do a job because of people around the area can also result in overtime hours.

Manpower should be the most important factor when discussing overtime hours. Different jobs require different qualities and disciplines. Having a group of people well rounded can often work in our favor. This way personnel rotation can be done to keep the workflow with the less interruptions possible. It is often seen in facilities that the workload if far greater than the manpower available to take care of the issues and work order. Giving employees and supervisors trainings discussing different work areas can help the way a team works together. It is important that when having a limited count of employees to run a facility, shift rotation is taken into considerations. When having big projects it is help full to have people working on the on 3 recurrent shifts. Bad organization and distribution of employees can also delay jobs. It is good when having a group of people working together that each is specialized in different matters (electricity, plumbing, etc.) this way the number of stops and pauses within jobs due to lack of knowledge will reduce, thus eliminating the possibility of jobs being detained due to things that cannot be done by the team at hand.

Casual labor hours also play a big role when trying to have a smooth rate of progress in our day to day projects. Shifts must be made for all employees including rotations for each and every one of them. By this way ensuring that the employees are costumed to work round the clock. This approach is mainly done due to the fact that the employees must be able to produce the same work output working the first shift of the day than when working the third shift. By implementing this type of approaches we can be certain that the progress made during the day can be the same progress during the nighttime shifts. When Implementing shifts at first there are certain peak hours when talking about work productivity. The focus is to have a uniform work productivity around the clock.

When talking about equipment this should be considered as important as planning, man power and the other factors that have been discussed. It is often seen that jobs have to be stopped due to not having the necessary tools or materials at hand. It cost the company time and money each time work is paused due to having to go buy tools or materials. This is seen on a daily basis on facility management and preventive maintenance. It should be a best practice to have an inventory always at hand. The quantity of equipment that a facility needs to operate designate it this way. When having faulty water pumps ie, if the necessary components are not at hand the operation of the facility is being compromised and by this also the quality that the company is compromised offering our customers. It is also important that before starting any type of job an inventory is done regarding any type of equipment and/or tool that might be utilized during the process of this project. It is also often seen that different type of tools tend to break or stop working due to the daily usage that these receive. This is why it is also important to have spare tools and equipment that is at hand when needed.

CONCLUSION

After doing the necessary research it is evident that though it is not often applied, the DMAIC approach of lean six sigma can have big positive results in a facility management environment. It is often seen on a daily basis how a company suffers from bad organization and work procedures and has an excess in overtime hours to prevent projects from being delayed. Work processes should be implemented as a day to day best practice to prevent variations from groups when working. By

having a uniformity it will be easier to identify the faults and troubles encountered by the employees and supervisors. It is important to give important to every detail that is involved in the work process of a facility environment. When maintenance operations are taking place every detail counts. If lean six sigma principles are applied correctly the quantity of setbacks due to bad organization and bad planning will be reduced. The positive changes won't be seen immediately. But after all the personnel receives the necessary trainings and orientations the job process will be improving daily until the desired result is achieved thus having complete control of the overtime hours being worked by employees.

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