

Lean and Six Sigma Methodologies for Process Improvement

Lloyd P Birkin

University of Wales, Trinity Saint David

Contents

Lean and Six Sigma Methodologies for Process Improvement.....	3
Lean.....	3
Defining Value	4
Map the Value Stream	4
Create Flow	5
Establish Pull	5
Pursue Perfection	6
DMAIC	7
Define.....	7
Measure.....	8
Analyse	9
Improve	9
Control	10
DMADV	11
Bibliography	13

Lean and Six Sigma Methodologies for Process Improvement

This report will focus on the Six Sigma and Lean methodologies implemented within businesses to achieve continuous improvement and eliminate wastes with their processes. It will highlight some of the tools used within the different stages of six sigma and lean, also where possible examples given on how they could be utilised at Tata Steel, Port Talbot.

A simple way to define the difference between Six Sigma and Lean is “The Six Sigma methodology focuses on reducing process variation and enhancing process control, whereas Lean drives out waste (non-value-added processes and procedures) and promotes work standardization” (American Society for Quality, 2019). Whilst there might be a difference between the two methods, they usually need to be used together in order to accomplish positive results.

Lean

As previously described, the Lean methodology looks to eliminate non-value-added processes that the customer does not want to pay for. These non-value-added processes can be put into one of two categories, necessary processes and waste (or Muda). There are typically eight wastes recognised within the manufacturing process:

- **Overproduction:** anything produced prior to it being needed
- **Inventory:** any excess materials or product not being processed
- **Transportation:** movement of product and material that is unnecessary
- **Over-processing:** more work or higher quality than required by customer
- **Waiting time:** time spent waiting for the next step in the process
- **Motion:** unnecessary movements by people

- **Defects:** mistakes which cost additional time, resources and money due to corrections
- **Non-utilized talent:** not utilizing people's knowledge, skills and talents as part of the process

In order to identify these wastes within the process the 5 principles of lean should be applied.

Defining Value

The first step would be to define value and pinpoint the customers exact needs and what they are willing to pay for. This can be achieved by brainstorming or more importantly conversing with the customer and completing a Quality Function Deployment (QFD) for the product. By completing a QFD you can then take those needs and correlate them to the technical aspects of the product and compare them with competitors.

Utilising the QFD tool within TATA Steel for both internal and external customers would be a good way to gauge what they expect from the product or previous process within the works. For example, the Blast furnaces might have specific requirements for the type of iron ore being used in the process and these can be defined in the QFD. An external customer might have specific requirements for the grade of steel, with that information proper targets can be set to deliver on that.

Map the Value Stream

The second step would be to map out the value stream of the product or materials as it goes through the production process and refer to the customers needs to determine what parts of

the process are waste and what adds value. You would do this by first creating a process flow and then from that collect current process data e.g. inventory, cycle time, defect rate. With this data you would then create a timeline and add it to your value stream map to show the lead times and process times and use it to define and eliminate waste such as excessive inventory, long cycle times, low uptime and defects/reworks.

Developing a value stream map within TATA would be beneficial to determine any wastes such as transport, waiting, inventory and motion. The layout of the steelworks is quite poor but there could be improvements made with how materials are moved through the process and create better timing to prevent waiting which creates a lot of work in process.

Create Flow

The third step would be to ensure that there is a continuous flow from the start of the process all the way to the end removing any bottlenecks and achieving consistency through standardisation of work, trying to ensure the necessary nonvalue adding steps are completed with value adding steps if possible – this is known as Heijunka.

As previously discussed, TATA steel would benefit from developing a continuous flow system throughout the different areas within the process to get the steel to the customer more efficiently.

Establish Pull

The fourth step would be to establish a pull system such as Kanban or Just-In-Time. This ensures that the product or materials are being pulled through the manufacturing process as opposed to being constantly pushed through leading to a build-up of inventory and

overproduction. It is achieved by managing the flow of the product by having each step in the process signalling when the product or material is needed. Another method that could be used is Takt time, this requires a calculation to determine the pace of production so that it meets customers' demands.

TATA steel could benefit from lowering their inventory stock of both slabs and raw materials by adopting a pull system. Currently the blast furnaces create as much pig iron as possible when it might not even be needed by the BOS plant. This then forces other processes down the line such as the hot mill and CAPL to continue processing the steel which leads to poor maintenance etc.

Pursue Perfection

The final step is to pursue perfection through the implementation of continuous improvement or "Kaizen" ideology within the workplace. After the waste has been identified and removed, repetition of the different stages would be undertaken to always strive for improvement within the process. This ideology can be implemented into an action plan and using tools such as Plan-Do-Check-Act which promotes ideas and solutions and puts them into practice, from that you can determine the results and improve the idea/solution and repeat the cycle.

By implementing Kaizen and a continuous improvement ideology within TATA across all the areas would lead to a much more efficient plant and allow to perform much better than it currently is. People should look to make improvements where possible and follow up to ensure they are made to create a better workplace.

DMAIC

DMAIC is a problem-solving method that uses data and a variety of tools to produce solutions for a process that is already in place. It is the foundation of six sigma methodology. It contains five different steps:

1. Define
2. Measure
3. Analyse
4. Improve
5. Control

Define

In the define stage the problem within the process, how it can be measured, and its severity is established and from this a problem statement will be created. From that a goal will be set to determine what is trying to be achieved from the project. Both the problem statement and goal would be updated on a Project charter which shows the aims of the project, projected timeline of completion and the team involved also the scope of the project and any boundaries that are made. From this the team will need to map out the process either using a Value stream map as previously discussed or using SIPOC (Suppliers, Inputs, Process, Outputs and Customers) which highlights who's involved and what occurs within the different stages of the process. The next stage would be to define the customer and what they require from the product. One of the tools used for this is a Voice of the customer translation matrix which identifies any issues and priorities the customer has or any comments they make regarding the product. From

this a measurable requirement can be developed to work towards and improve. Data collection can then begin.

By using the SIPOC tool in TATA they could define the process as a whole and identify key areas of the problem as there are a large quantity of different suppliers of materials, inputs, processes, outputs and customers. This would help with making it clearer to help with data collection.

Measure

In the measure phase the first stage would be to gather data of the process as it currently is to create a baseline which the project team can measure against in the future to determine if there is improvement. The project team would initially create a data collection plan to determine the means in which they will gather data and define operations against the measure to ensure the data captured is reliable. From that different tools would be used such as a Check sheet, which is a simple method of data capture to record defects and the frequency they occur. Another type of tool that could be used is a Process capability analysis which assesses whether the process meets its specification and determines how well the process is currently performing by process capability index (Cpk). Another tool used in this phase is Measurement System Analysis (MSA) which would highlight any variations within a process and analysis the processes current measurement system to determine if it is satisfactory against specifications. Once enough data has been collected the project charter will be updated and then the analysis phase would begin.

The process capability analysis and the measurements system analysis tools would benefit TATA massively by determining how capable their old equipment is and whether it should be improved or upgraded. It would also help with the newer equipment to see if it could be run more efficiently, a similar project was implemented in the power plants and they managed

to generate roughly 15MW more electricity using the same equipment. The measurement analysis would help in places such as the rolling mills to ensure there are tight tolerances for the coils which is a massive requirement from customers.

Analyse

During the analyse phase the team would then apply a variation of tools to interpret the data that was previously collected about the process. The data could be plotted into histograms and pareto charts to help give a better understanding of data and make it clearer. From that the team could apply root cause analysis tools such as a Fishbone diagram and 5 whys to uncover the root causes the problems highlighted from the data. A Failure Mode and Effects Analysis (FMEA) could be constructed to determine the effects of process failures and can be updated later within the project. Another tool that could be utilized is a Root Cause Hypothesis which is used after the root cause analysis to create an educated guess to what could be causing the problem within the process. Correlation and regression charts could also be created in order to find any trends within the data. The team would then update the project charter as necessary

FMEA is currently used in TATA along with 5why investigations but they could utilize Fishbone diagrams and the Root Cause Hypothesis tools to further improve the problem solving.

Improve

The improve phase would focus on creating solutions to the problems found within the analyse phase. Its at this stage the team would implement the Lean principles that I've mentioned previously like eliminating waste through Kaizen projects, creating a To-Be value stream map to visualise the desired quality of the process, introducing a pull system such as Kanban, 5S

improvements and visual management boards, using poke yoke to mistake proof the process etc. This can be achieved by creating an implementation plan which will define what actions will be taken, who is responsible and the due date of said action

To determine what improvement tools they should implement first to get the best result an Impact effort matrix can be used which highlights easy high impact solutions and hard low impact solutions so you can prioritize the easy solutions first. The team would then test their hypothesis created in the analyse phase to determine if it was true or false and verifying that through data proof.

Once all the solutions have been implemented, the process must then be measured against the data that was collected during the measure phase to determine if there has been in improvement and to what extent.

TATA could create a To-Be value stream map and then implement different Kaizen projects across site to work towards continuously improving the process and customer satisfaction. Using Poka-Yoke they could help mistake proof the process in key areas like the BOS plant and the Mills by preventing any actions being taken out of the standard operating procedures and thus leading to issues with the Steel.

Control

The control phase is maintaining the new standard of process through the improvements that have been made in the previous phase. A monitoring plan should be created to ensure the process operates within the defined parameters which is also monitored by a control plan to determine what actions should be undertaken if the process begins to fail. The process capability analysis can now be undertaken after improvements have been made to see how effectively the

process can run. The team would ensure that all aspects of continuous improvement are implemented such as Visual management, 5S and mistake proofing. The team would then want to ensure that there are standard operating procedures in place where necessary to prevent variations within the new improved process which could cause problems. The team should then implement a Total preventative maintenance plan which attempts to obtain the highest efficiency possible from the process equipment through planned maintenance, autonomous maintenance, quality maintenance etc. The team should update the FMEA analysis in accordance with the improved process.

The final step is to then look over the project charter and determine if the goals that were set were achieved and to continuously improve the process using the Lean principles discussed previously and using tools such as Plan-Do-Check-Act meetings. The team could look to then improve a different area of the workplace using the methodology and experience learned within the project.

DMADV

DMADV (Define, Measure, Analyse, Design, Verify) is a similar methodology to DMAIC except it focuses on the design aspect of a new product or process that focuses on the needs of the customer. The define stage in DMADV also focuses on the project goals and the demands of the customer. The measure phase is used to determine the exact needs the customers has and the specifications for the new product or process. The analyse phase then highlights the different options in how to achieve the goals from the define phase. The design phase is where the product or process will be created, and prototypes and multiple simulations ran to predict the

outcome before it is created or implemented. The verify phase is then used to certify that the performance or quality is up to the standard of which is required by the customer.

DMADV should be followed if TATA were to produce a new process or product. This methodology would have proved useful in the design for the new power plant that is currently being built to ensure the correct specifications and needs were in place.

Bibliography

American Society for Quality. (2019). *What is Six Sigma?* Retrieved from asq:

<https://asq.org/quality-resources/six-sigma>

Do, D. (2017, August 5). *The Five Principles of Lean*. Retrieved from theleanway:

<https://theleanway.net/The-Five-Principles-of-Lean>

Earley, T. (n.d.). *Creating A Value Stream Map*. Retrieved from leanmanufacturingtools:

<http://leanmanufacturingtools.org/551/creating-a-value-stream-map/>

fppt.com. (2019). *House of Quality Template*. Retrieved from free-power-point-templates:

<https://www.free-power-point-templates.com/articles/free-house-of-quality-template-for-powerpoint-qfd-template/>

GoLeanSixSigma. (2019). *DMAIC – The 5 Phases of Lean Six Sigma*. Retrieved from

[goleansixsigma.com: https://goleansixsigma.com/dmaic-five-basic-phases-of-lean-six-sigma/](https://goleansixsigma.com/dmaic-five-basic-phases-of-lean-six-sigma/)

iSixSigma-Editorial. (2018). *DMAIC Versus DMADV*. Retrieved from isixsigma:

<https://www.isixsigma.com/new-to-six-sigma/design-for-six-sigma-dfss/dmaic-versus-dmadv/>

Pyzdek, T., & Keller, P. (2014). *The Six Sigma Handbook, Fourth Edition*. McGraw-Hill

Education.

Voehl, F., Harrington, H., Mignosa, C., & Charron, R. (2013). *The Lean Six Sigma Black Belt*

Handbook: Tools and Methods for Process Acceleration (Management Handbooks for Results). CRC Press.