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APPLICATION OF SIX SIGMA TECHNIQUE FOR QUALITY AND SAFETY IMPROVEMENT IN A HOT ROLLING INDUSTRY

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Abstract

Six sigma has emerged as one of the most effective business and quality improvement strategies. Big manufacturing companies and business giants like Motorola already chartered many success stories employing it. Small scale concerns are still not fetching the real benefits from the same. Much is available regarding its techniques but very fewer studies are reported regarding its implementation roadmap for small concerns.

This paper is an attempt to introduce Six sigma to small scale sectors. The paper discusses real life case where six sigma has been successfully applied at one of the Indian small scale units to improve safety and quality in processes. The main aim behind this project lies to overcome those problems of the industries which are causing loss due to defective products and safety. For the purpose of this project we define engineering management as "concerned, effective and efficient management in engineering functions, systems and personnel. It therefore includes the issue of resourcing, process design, safety, deployment and improvement. In the context of this paper, therefore, engineering improvement has fundamentally a management focus covering all aspects of the way engineering work is done, rather than a narrow technical meaning "to be better engineered."

Keywords: Six sigma, D.M.A.I.C. methodology, Defects per million opportunity (D.P.M.O.).

I. Introduction

Six Sigma is gaining momentum as one of the most effective improvement drives among a large number of organizations and its adoption is showing upward trend. It is a business system with many statistical aspects. A statistical term sigma (σ), as we know is a letter Greek alphabet that has become the statistical symbol and metric of process variation. The sigma scale of measure is perfectly correlated to such characteristics as defects per unit, parts per million defectives and probability of failure. Six is the number of sigma measured in the process, when the variation around the target is such that only 3.4 output out of one million are defects under the assumption that the process average may drift over long term by as much as 1.5 standard deviations. The technical concept of six sigma is to measure current performance and to determine how many sigma's exist which can be measured from the current average until the process and customer satisfaction occurs. Six sigma possesses objectives such as,

1 The Vision: drives industries to design and produce product/ services to six sigma standards.
2. The Goal: produce goods and services at six sigma level.
3. Improvements in production, cycle time, safety parameters, Human resource management in industry.

II. Roadmap To Six sigma(The D.M.A.I.C cycle)

- **Define:** Set project goals and objectives.
- **Measure:** Narrow range of potential causes and establish baseline capability level.
- **Analyze:** Evaluate data/ information for trends, patterns, casual relationships and "root cause".
- **Improve:** Develop, implement and evaluate solutions targeted at identified root cause.
- **Control:** Make sure problems stays fixed and new methods can be further improved over time.

III. Application of six sigma in hot rolling industry

The D.M.A.I.C. cycle of six sigma has been applied to a hot rolling industry named "shilpa rerollers" and various aspects causing defects, safety issues are seen. The following aspects of CTQ(critical to quality), CTQ(critical to customer) are taken into account.

Parameters	Requirement
Service time	optimal
Waiting time	As minimum as possible
Cycle cost	As less as possible
Timely delivery	As good as possible
Tolerance	As close as possible
Inspection	Sampling

In order to apply the six sigma for industrial safety concept of CTW (critical to worker) is introduced.

Parameters	Requirement
Material handling tools	As good as possible
Material transfer strategy	As good as possible
Work environment	As good as possible
Safe patient care	As good as possible
Medical facility in case of accident	As good as possible

● Define: This is problem identification phase. The various problems associated with the defects are defined in this phase and cause and effect relationship is established. The various problems and there causes found are,

- Uneven heating due to improper raw material thickness.
- Error in edges due to improper handling.
- Guide way blockage due to variation in clearance.
- Scale formation due to oxidation in inventory.
- Problem in maintaining A-F ratio inside the furnace due to low quality fuel.
- Dimension and tolerance issues due to negligence in operation control.

For safety issues, following parameters are found responsible.

- improper material handling due to improper material handling equipments
- Unsafe and impatient care due to worker negligence
- Problematic material transfer due to faulty material strategies.

●Measure: For measuring the sigma level of industry the data has been collected from the industry and calculations are done in order to get the sigma level. Table shows data of three months collected from company.

Month	Total production (in units)	Defectives found
June	3725	133
July	3775	160
August	3750	157

Calculations for sigma level of company:

No. Of units produced = 11250 No. Of defect opportunities = 6

No. Of defects = 450

Defects Per Unit (DPU) = defects/units produced =450/11250 = 0.04

each unit manufactured has got "m" number of opportunities for nonconformance

Defect Per Opportunity (DPO) = DPU/m = 0.04/6 =0.0066666666

Defects Per Million Opportunities (DPMO) = DPO x 10^6 = 0.00666666 x 10^6

=6666.6666666

Expected Defects (ppm for each step) = DPMO x Number of opportunities (for each step)

= 6666.66666666 x 6 = 40,000

DPMO for completed unit = (Expected defects)/(Total number of Opportunities)

= (6666.6666 x 6)/6 =6666.6666666

Process yield = e^ (-D.P.U) = e^ (-.04) = 96.06 %

Current sigma can be found out with the help of process yield.

Sigma = 3.25

●Analyze: The analysis for each problem is done by understanding how each problem constitutes to the total defects.

Problem	No. of defects caused
Scale formation	57
Improper air fuel ratio	54
Error in edges	67
Operation control	147
Guide way blockage	93
Uneven Heating	32

The failure mode and effect analysis is done to find out the most critical and severe problem as far as quality and safety are concerned.

F.M.E.A. worksheet: (for defects)

Failure	Mode Of failure	Effect	Severity rank(s)	Occurrence rank(o)	Detection rank(D)	Risk priority No.(SxOxD)
Error in edges	Improper handling	Deformed edges	5	5	4	100
Scale formation	Material oxidation	Material loss	1	2	3	6
Improper air fuel ratio	Low grade fuel	Fuel wastage	1	3	1	3

Operation control	Improper dimensions	Inaccurate sizing	1	1	3	3
Guide way blockage	Clearance problem	Miss roll	2	2	8	32
Uneven Heating	Material thickness	Material loss	2	1	2	4

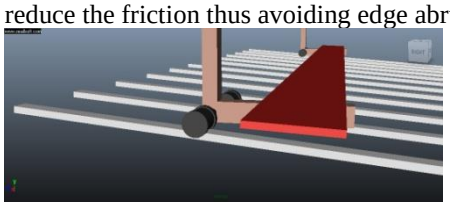
F.M.E.A. worksheet: (for safety)

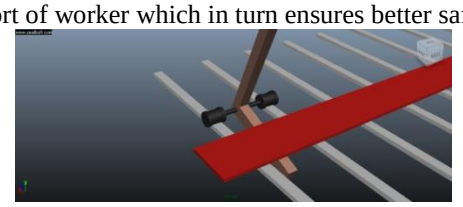
Safety problem	cause	Effect	Severity rank(s)	Occurrence rank(o)	Detection rank(D)	Risk priority No.(SxOxD)
Problematic handling	Handling equipments	Unsafe to handle	5	4	6	120
Problematic material transfer	Material transfer strategy	Accidents	4	2	5	40
Unsafe, impatient care	Worker negligence	accidents	3	3	5	45

Conclusion from FMEA: the problematic material handling and edge error are found to be the major contributors in safety issues and quality issues resp.

●Improve: In this phase the improvement over the current processes were advised to the company. It was found that improper handling is the cause of both major safety and quality issue which was handling problem and error edges resp. faulty handling as shown in picture was responsible for error edges as the edges were getting abrupt due to friction between hot work piece and floor. Also workers had to put tremendous effort to handle the

To overcome both these problems following angle lifter was suggested to the company which would not only reduce the friction thus avoiding edge abruption but also effort of worker which in turn ensures better safety.





The analysis of angle lifter is done using the Ansys software and the design was found to be safe.

Calculations for improved sigma:

No. Of units produced = 11250 No. Of defect opportunities = 5

No. Of defects = 303

Defects per Unit (DPU) = defects/units produced =310/11250 = 0.027555

Each unit manufactured has got “m” number of opportunities for nonconformance

Defect Per Opportunity (DPO) = DPU/m = 0.027555/5 =5.51111x 10^-3

Defects per Million Opportunities (DPMO) = DPO x 10^6

= 5.51111x 10^-3 x 10^6 =5511.1111

Expected Defects (ppm for each step) = DPMO x Number of opportunities (for each step)

= 5511.1111 x 6 =33,066.6667

DPMO for completed unit = (Expected defects)/(Total number of Opportunities)

= 33,066.6667 /6= 5511.1111

Process yield = e^(-D.P.U)= e^(-.027555) =97.28%

Improvement in sigma can be found out with the help of process yield.

Sigma = 3.53

●Control: following are the controls which industry shall employ

The ways to control quality	The ways to control safety
Standardization	recruitment of skilled labors
Inspection of raw material.	use of safety manuals and safety training seminars.

Calibration in instruments in regular interval	
strict monitoring of processes	
Continues evaluation of performance of various processes	

IV. Conclusion

The sigma level in industry could be improved by a fair margin of 0.28 Or 6,933.333 parts per million. Also the control is suggested to company to meet better safety of the workers.

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