QUALITY CONTROL DEVELOPMENT BASED ON LEAN SIX SIGMA METHOD

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ABSTRACT

Clutch noise that occurs in the engine is a major cause of decreased efficiency of the engine assembly. This phenomenon has been there in such a long time in the production line, and has created a complex cause that requires a structured and systematic method in terms of handling this problem so that it can be reduced or even be eliminated. On the Problem identification, it is known that clutch noise is the result of non standard backlash. By the IPO diagram and fishbone diagram, all the non standard backlash factors are sorted into man, machine, method, and material. For the primary clutch, the value of CP = 0.02 and CPK = –0.31, indicates that the average is outside lower limit and upper limit therefore special attention must be addressed to improve it. For the secondary clutch, the value of CP = 0.22 and CPK = 0.302, which implies that the value within 0 – 1 that described the average is in between upper limit and lower limit, but there are some variance outside lower limit and upper limit. For crankcase, the value of CP = 0,79 and CPK = 1.2 signifies that the process is in control. The CPK value is greater than 1 shows that the process in in between lower limit and upper limit. DPMO target is 50,000 and the actual DPMO is 32,201 and after Lean Six Sigma was implemented, the value has been reduced to 5,487.

Keywords*: Lean Six Sigma, DMIC, CP, CPK, DPMO, IPO diagram and Fishbone diagram.*

1. INTRODUCTION

1.1 Research Background

The policy to do a production activity in every industry is making production flow in a single axis and no repetition which could make a high cost production.

One of the effort to have an effective and efficient production cost is not allowing and making defect products.

Rework activity is a common thing in every production activity, but how many rework activity can be allowed, because it will affect to the production cost.

This paper was conducted in an assembly line of motor cycle engine, which is not efficient.

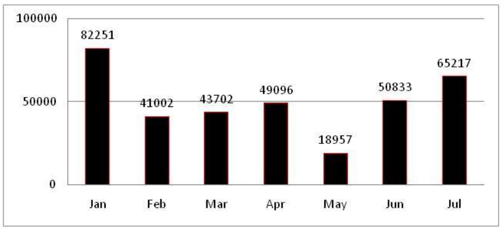

Figure 1.1 The Average of DPMO in Engine Assembly Unit

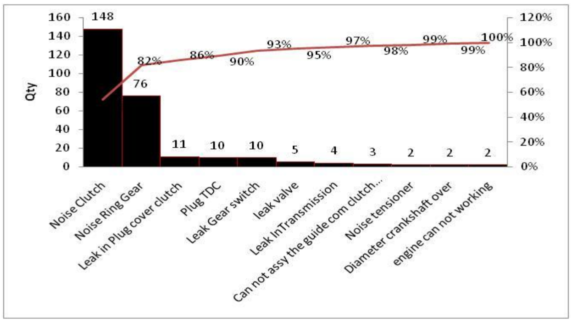

Figure 1.2 Problems Description

Figure 1.1 shows that DPMO (Defect per Million Opportunities) is obtained from not normal engines, or engines that not deliver to the next process – vehicle assembly – divided by number of engines produced multiplied by 1,000,000.

Figure 1.2 shows problem description on the engine assembly process. From this data, it can concluded that noise clutch has a significant share that make DPMO value is high and gives a high contribution of inefficient of production activity.

1.2 Research Identification

1. What the appropriate methodology to solve the related problems.

2. How to formulating the complex problems into a good structure in order to facilitate the decision making process
3. What are the factors in the occurrence of clutch noise.
4. How to control these factors.

1.3 Research Objectives

1. Determining an appropriate methodology to solve the related problems.
2. Formulating the complex problems into a good structure in order to facilitate the decision making process
3. Determining the factors in the occurrence of clutch noise.
4. Knowing how to control these factors.

2. THEORITICAL BACKGROUND

Six Sigma is a business management strategy, originally developed by Motorola that today enjoys wide-spread application in many sectors of industry.

Six Sigma seeks to identify and remove the causes of defects and errors in manufacturing and/or service delivery and business processes. It uses a set of management methods, including statistical methods, and creates a dedicated infrastructure of people within the organization who are experts in these methods. Six Sigma aims to deliver "Breakthrough Performance Improvement" from current levels) in business and customer relevant operational and performance measures.

Business or operational measures are elements like:

- Customer Satisfaction Rating Score
- Time taken to respond to customer queries or complaints
- % Defect rate in Manufacturing
- Cost of executing a business process transaction
- Yield (Productivity) of service operations or production
- Inventory turns (or) Days of Inventory carried
- Billing and Cash Collection lead time
- Equipment Efficiency (Downtime, time taken to fix etc.,)
- Accident / Incident rate
- Time taken to recruit personnel and so on

Six Sigma was originally developed as a set of practices designed to improve manufacturing processes and eliminate defects, but its application was subsequently extended to many other types of business processes as well. In Six Sigma, a defect is defined as anything that could lead to customer dissatisfaction and / or does not meet business set specifications.

The elements of the methodology were first formulated by Bill Smith at Motorola in 1986. Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects, based on the work of pioneers such as Shewhart, Deming, Juran, Ishikawa, Taguchi and others.

Like its predecessors, Six Sigma asserts that:

- Continuous efforts to achieve stable and predictable process results (i.e. reduce process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be measured, analyzed, improved and controlled.
- Achieving sustained performance and quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that differentiate Six Sigma apart from previous quality improvement initiatives include –

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support
- A clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.
- The term "Six Sigma" is derived from a field of statistics known as process capability study. It refers to the ability of processes to produce a very high proportion of output within specification. Processes that operate with "Six sigma quality" over the short term are assumed to produce (long-term) defect

levels below 3.4 defects per million opportunities (DPMO).Six Sigma's implicit goal is to improve all processes to that level of quality or better.

In recent years, Six Sigma has sometimes been combined with lean manufacturing (management) to yield a methodology named Lean Six Sigma.

Lean is a philosophy and set of management techniques focused on continuous “eliminating waste” so that every process, task or work action is made “value adding” (the real output customer pays for!!) as viewed from customer perspective. Lean “waste elimination” targets the “Eight Wastes” namely:

- Overproduction – Making more than what is needed by customer / market demand
- Over-processing – Doing more to a product/service (but not perceived as value by customer)
- Waiting – For material, information, people, equipment, procedures, approvals and more
- Transportation – Movement of products / items during or after production
- Defects – Errors, mistakes, non-complying products, services, documents, transactions
- Rework and Scrap – Products, transactions or outputs not meeting specifications and have to be fixed, redone, rectified, marked down or scrapped / unusable.
- Motion – Mainly people, document movement, searching etc.
- Inventory – Buffer stocks or resources (Raw, Work in process, FG, Bench staff etc.,)
- Unused Creativity – People knowledge and skills that are not utilized by the company

Wastes make the organization slow, inefficient and uncompetitive. Lean methods help to remove/reduce waste and contributes to driving “business agility” (velocity) through smooth work flow across the organization resulting in rapid fulfillment of customer needs in an optimum manner.

Six Sigma has two key methodologies:
DMAIC and DMADV, both inspired by Deming's Plan-Do- Check-Act Cycle.

- DMAIC is used to improve an existing business process;
- DMADV is used to create new product or process designs.

<u>DMAIC</u>

The basic DMAIC methodology consists of the following five steps:

- Define process improvement goals that are consistent with customer demands and the enterprise strategy.
- Measure key aspects of the current process and collect relevant data.
- Analyze the data to verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered.
- Improve or optimize the process based upon data analysis using techniques like Design of Experiments.
- Control to ensure that any deviations from target are corrected before they result in defects. Set up pilot runs to establish process capability, move on to production, set up control mechanisms and continuously monitor the process.

DMADV (also known as DFSS – Design for Six Sigma)

The basic methodology consists of the following five steps:

- Define design goals that are consistent with customer demands and the enterprise strategy.
- Measure and identify CTQs (characteristics that are Critical To Quality), product capabilities, production process capability, and risks.
- Analyze to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
- Design details, optimize the design, and plan for design verification. This phase may require simulations.
- Verify the design, set up pilot runs, implement the production process and hand it over to the process owners.

3. RESEARCH METHODS

This paper is using DMIC method and Statistical Quality Control to solve the problems.

1. Define; Problem Identification, Customer Specification Identification, Determining

Theme and Target, Determining Repairing Schedule.
2. Measure; Problems Validation, Problems Measurement and Analyzing.
3. Analysis; Determining Affection Factors.
4. Improve; Determining Ideas, Monitoring Implementation
5. Control; Monitoring

4. RESULT AND DISCUSSION

Problems Identification:
The main point is noise clutch which is the effect of backlash from vary clutch pairs, there are standard backlash and non standard backlash

Customer Specification Identification:
1. High perform and quality motor cycle
2. Smooth sound motor cycle engine with no noise clutch

Theme and Target:
Theme; preventing noise clutch by reducing non standard backlash variation.
Target; reducing DPMO in engine assembly caused by noise clutch from 50151 to 5000 DPMO

Table 4.1 Repairment Schedule

No	Lean Six Sigma Activity	Mont #1	Mont #2	Mont #3	Mont #4	Mont #5	Mont #6	Mont #7
1	Define	●						
2	Problem Identification	●						
3	Costumer Specification Identification	●						
4	Determining Theme and Target	●						
5	Determining Repairmen Schedule	●						
6	Measure	●						
7	Problems Validating	●						
8	Problems Measurement and Analyzing		●					
9	Analysis		●					
10	Determining Affection Factors		●					
11	Improve		●	●				
12	Determining Ideas			●				
13	Monitoring Implementation			●	●			
14	Control				●			
15	Monitoring				●	●	●	●

Measure:
Outter Ball Diameter (OBD) for secondary clutch, sampling for 120 pcs, the average is 123.84 mm., with UCL = 123.86 mm. and LCL = 123.82 mm., and CPK = 0.247
Outter Ball Diameter (OBD) for primary clutch, sampling for 120 pcs, the average is 41.069 mm., with UCL = 41.714 mm. and LCL = 40.936 mm., and CPK = 0.79
The out of control indication it is clearly be seen when the value of process capability is less than 1 due to measurement error by supplier.

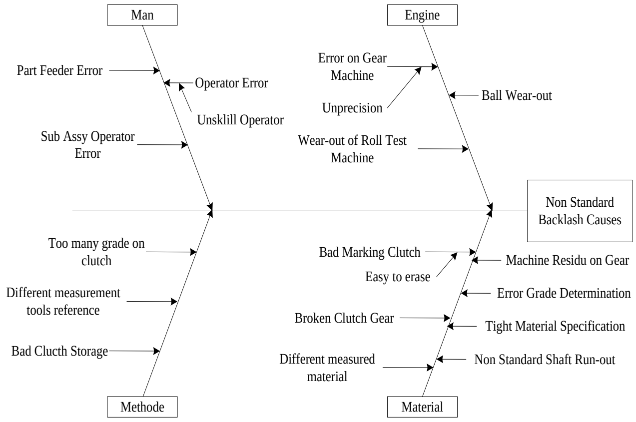

Figure 4.1 Fish Bone Diagram for Non Standard Backlash

Improvement
This stage is realizing of solutions after why-why diagram was made, which are
1. Clutch delivery order and clutch storage
2. Specification modification on gear of clutch, downgrading one step.
3. Standardizing marking to be permanent
4. Clutch flow process improvement, sampling inspection on gear whether in shop quality or shop floor.
5. The addition of finishing processes.

Control

	Month #1	Month #2	Month #3	Month #4	Month #5
Number of production	1486	1333	773	729	263
Defects					
Ring Gear Noise	33	22	0	0	0
Clutch Noise	14	7	1	4	1
Leak from plug cover clutch	1	6	0	0	0
Number of Defects	48	35	1	4	1
DPMO	32301	26257	1294	5487	3682

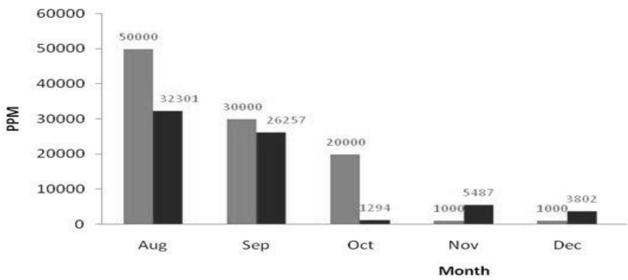

Figure 4.2 DPMO graphs for 5 months

5. CONCLUSION

The factors which are causing non standard backlash are sorted into man, machine, method, and material.

1. Man aspects the causes are, unskilled operator of grade measurement, sub assembling operator were took the wrong pair of clutch, unskilled operator roller test machine, and human error.
2. Machine aspects the causes are, imprecision gear machine, wear-out or clutch measurement tools, wear-out of roll test machine.
3. Methode aspects the causes are, mixed up delivery set of clutch, mixed up clutch storage, there are many grade on clutch, the different reference of measurement tools,.
4. Material aspects the causes are, easy to erase clutch marking, defect on clutch's gear, residue of machining, non standard center distance from gear box, non standard run-out in every shafts, thight material specification.

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