Implementation of Six Sigma for Automation of Broaching Machine

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Abstract-Automation using latest technological tools for new product development is an increasing need of industry as it reduces cycle time, increases productivity and reduces labor cost. The main challenge for industries is providing a better quality, specifications to meet consumers increasing demands, and meet financial goals of organization. Design for six sigma deals continuous improvement of new or existing process using tools which are extensively used such as DMAIC and DMAIV. The main objectives of this research paper is designing and developing a Hydraulic Broaching Machine using Design for Six sigma technology replacing with existing conventional Broaching Machine. For replacing the existing conventional Broaching Machine DMAIC and DMAIV is used. DMAIC briefly defines the problem and analyzes it thereby finding a suitable technique to control the arising problem. By implementation of Design for Six Sigma Methodology speed variations, gradual loading, good surface finish, shorter cycle time can be achieved including waste management. The cost required for replacing the Broaching tool which used to break due to wobbling is also reduced. In this way the maintenance cost is reduced. The heat generation problems and vibration issues will also be controlled.

Keywords-Automation, Financial Goals, DMAIC, Broaching Machine, Six Sigma

I. INTRODUCTION:-

Hydraulics is an effective way to manufacture any component with greater efficiency. The purpose of this paper is to replace a Conventional Broaching machine which consists of a rack and pinion arrangement with a Hydraulic system. Hydraulics is preferred over Pneumatics because of various reasons. The main reason is that gradual load is obtained from hydraulics whereas pneumatics gives impact loading and for broaching operation gradual load is preferred. The cutting force for broaching should be in discrete steps and should be varied as per requirement thus gradual loading is best suited for broaching. The technology rich environment does enable new ideas and new capabilities. They also create new ways of working.

Also the paper focuses on the knowledge of work and new ideas implemented on the hydraulic broaching machine. In the manufacturing content, this can include technical troubleshooting a problem, supervising it and analyzing it. We can define the knowledge of work as analytical work and problem solving. It can also be combined with physical work too. Knowledge works do include action on it.

The main objectives of the project were grouped into three category namely measurement, failure analysis and improvement. For measuring equipments, the aim was to determine the current measurement system which provides an estimate of the defects in the quality and to assess the tests performed. The methods of failure were determined and many objectives were established, the technical failures were evaluated and a procedure was developed, sampling was performed for defectives and obtained results were evaluated.

The analysis of the problems and objectives were to identify the factors that were responsible and which affected the quality feature in the question, identifying the level of the parameters in which the effect of the sources of variations will sum up to be minimal and to develop new proposals for improvement with implementing and monitoring the proposed improvements.

A hydraulic system with the help of oil is governed by the basic law of fluid flow. This

law is very well known as “Pascal’s Law”. The industrial hydraulic system is a power transmitting module which uses oil to carry the power. To design hydraulics and applying effectively a clear understanding of work, energy and power must be obtained. The main objective of the project is to gain gradual force and to minimize the losses and to avoid future defects. It also deals with the application of DMAIC for existing system. The application of six sigma that is, mistake proofing in 3.4 defects per million was also used the project.

The existing system was encountered with flaws which were unacceptable for the end product. There were multiple experiments performed and suitable analysis were picked and implemented. The project strictly follows the route of DMAIC tools. The tools are Design Measure Analyze Improve and Control. The defects in the existing module were analyzed and the output of this implemented work will be on the new system.

II. SIX SIGMA TOOLS WITH DMAIC

Six Sigma (6σ) is a set of tools and techniques that is used for process improvement. Six sigma strategies seeks to improve the quality of output of a process by identify and remove the causes of the defects and minimizing impact in manufacturing and business processes. It also uses a set of quality management methods, mainly statistical methods, and creates a special infrastructure of people

Six sigma as a methodology for process has involved a vast library of tools and the knowledge which will be covered. At the most basic definition, six sigma is a statistical representation for which all many experts call a perfect process. Technically in a process of six sigma there are only 3.4 defects per million. In the percentage it will sum to 99.99966% of the product from a six sigma defect without a product. At just one level below, i.e. 99.97 percentage accuracy-processes experience 233 errors per million opportunities. In all the simpler terms there’s going to be many more of unsatisfied customers.

According to the National Ocean and Atmospheric Administration, air traffic controllers in United States are handling 28,537 commercial flights daily. In an year, there is approximately about 10.416 million flights. Based on all the five sigma air traffic control, errors of the same type occurs in this process. With the six sigma process the risk drops down to 35.41 errors. Six sigma has been a powerful quality improvement that boots up the employee job satisfaction and also increases profits.

With six sigma techniques based on the statistical process control, the sigma tools are used to identify and eliminate the defects, waste and quality control problems. The DMAIC implementation initiates the quality improvement strategy for an organization and now a day it is being used in many industries. The six sigma is a forward thinking initiative designed to basically change the way corporation do the business. The objective of DMAIC technique is fundamentally to reduce the rejections due to poor quality. It increases the customers’ retention, satisfaction.

III. METHODOLOGY

The methodology used in this project is applying most of the six sigma tools. The Six Sigma is a forward thinking initiative. Considering the advantages of Six Sigma it is implemented on Conventional Broaching Machine. There are various issues associated with the conventional machine therefore Six sigma is used to solve all these problems. The problems associated with the conventional machine were that the broaching tool used to break frequently due to wobbling of tool. The rack and pinion arrangement caused the generation of heat and friction. To overcome these problems faced by the conventional machine this has to be implemented.

3.1 **Define**:-

This being the first step it basically defines the problem faced by the existing. It also defines the resources available for improvement. It basically is the most basic step to be followed. There are several questions which help define the problem clearly.

1) What is the problem?
The main issue with the conventional Broaching Machine is that broaching tool breaks due to wobbling action. The wobbling action is result of rack and pinion arrangement. The heat is generated in rack and pinion due to friction between them. All this causes error in manufactured products.

2) How often does it happen?
It happens after a certain amount of jobs are broached. The problem doesn't arise immediately after the broaching is started. It happened roughly after 5-6 parts are broached.

3) What is the impact of problem?
The main and the important impact of all the problems are that the job manufactured has less accuracy and has high chances of rejection. The broaching tool too breaks quiet often.

4) What are the expectations with the new system?
The new system should be created such that breakage should be reduces. The errors should be minimized and the accuracy should be increased. The rejection rate should be reduced.

3.2 **Measure:-**

This is the stage where data is to be collected in form of graphs and documents which support the data that is found out in define phase. It comprises of various charts and graphs which represent the data in clear form. The data is collected from past performance of the machine and thus this is a critical stage of DMAIC.

1) How do we measure the problem?
The problem is measured with the help to various graphs and the data is collected from the industry over months.

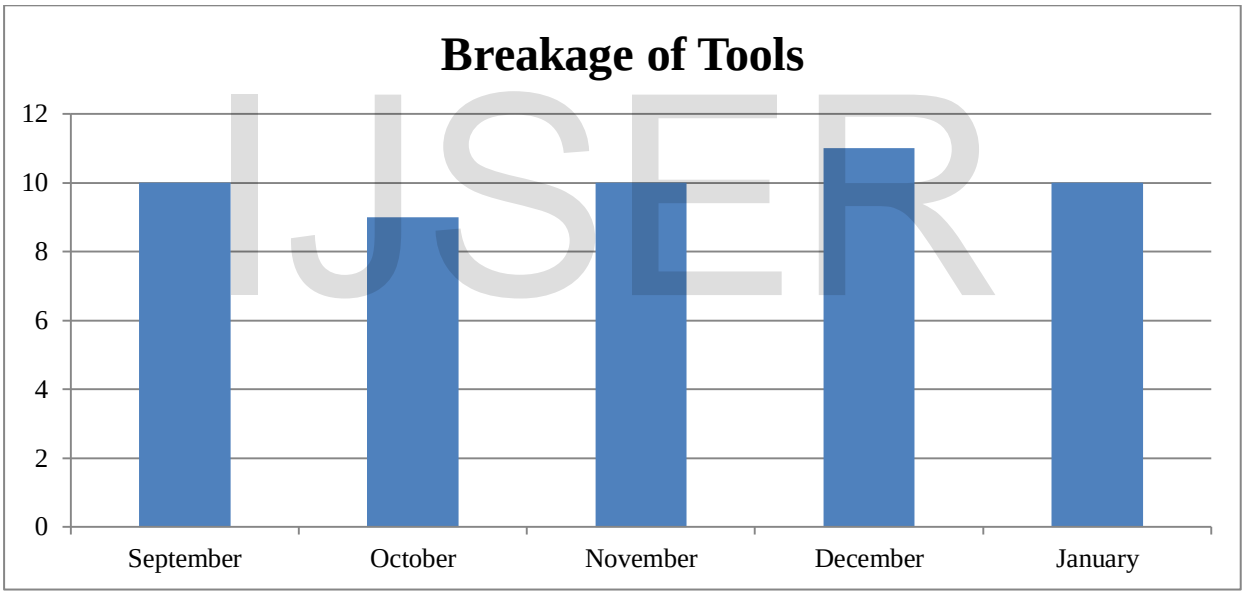


Fig 1 Number of tools that broke since 5 months

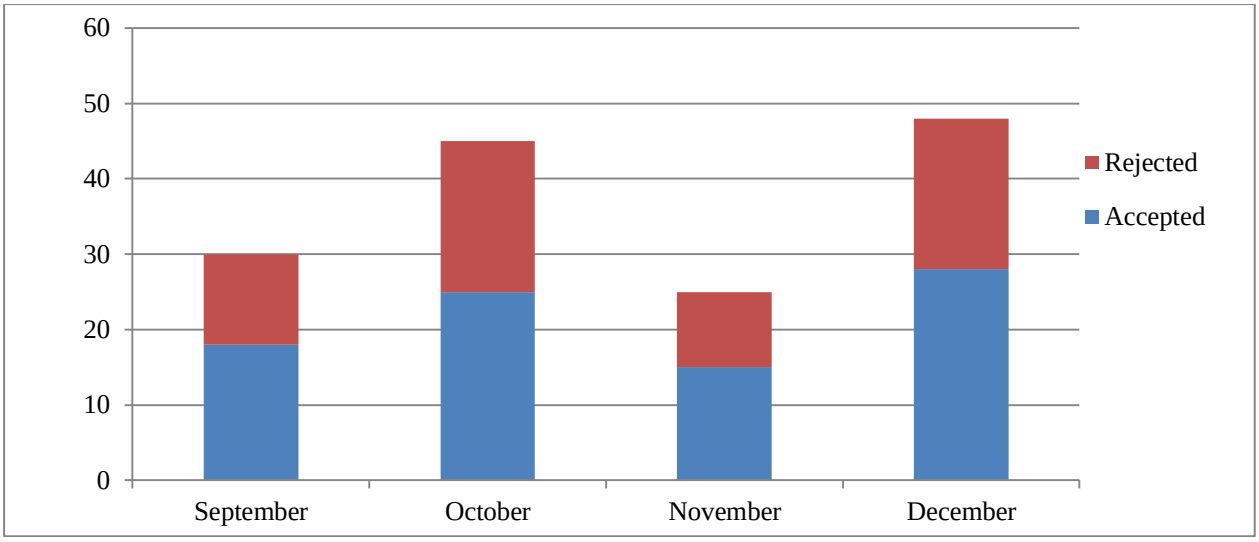


Fig 2 Total number of accepted and rejected parts

2) What data do we collect?

The data such as how many tools broke for certain months, the rejection and acceptance rates from total products manufactured is to be collected.

3) Is the data reliable?
As the data is collected from the company itself the date is highly reliable.

3.3 Analyze:-
This stage analyzes the data that is collected in measure phase. This is a decision making phase as the problem is analysed and then a suitable solution is found out. The solution should be such that all the issues should be solved and better system should be built.

1) How does the existing process actually work?
The existing conventional system works on rack and pinion arrangement with are driven by a motor

2) What does the existing knowledge about the system tells us?
The knowledge of existing tells that rack and pinion arrangement should be replaced with some other system so that all the issues arising will be cleared.

3) Can we use the result to create the new system?
The new system can be created as we have all the parameters that are to overcome and thus the new system will not have any defects.

3.4 Improve:-
After the data is analyzed we don't need to go back to the problem again , instead we should find ways to improve the system even more. The team is most likely collecting improvement ideas throughout the project, but this phase belives in innovation and this provides good ideas to improve.

1) What are the possible solutions?
There could one solution to overcome all the issues faced by the conventional system. The system can be replaced by Pneumatic system which used air as working fluid or Hydraulic system can be impaired which uses fluid as the working medium.

2) Which of the following will work the best?

We require gradual loading for broaching operation as if impact loading is used the broach may not be accurate. That's why it is clear that the conventional system can be replaced by Hydraulic system.

Hydraulic	Pneumatic
1.uses oil as working medium	It uses air as working medium
2.generally designed for closed system	It is designed for open system
3.Leakage can be controlled easily	Leakage is difficult to control
4.gives gradual loading	It gives impact loading
5.Automatic lubrication is provided	Separate component is to be provided.

3) How can we implement the solution?
The conventional system can be replaced by Hydraulic system by designing and calculating the cylinder and base dimensions. A power pack is to be selected which can be done by cylinder dimensions.

3.5 **Control**:-
This phase is a mini version of process management. The team has been building a form of infrastructure throughout the life of the project, and during the Control Phase they begin to document exactly how they want to pass that structure on to the employees who work within the process.

1) Is the solution implemented working?
The replaced Hydraulic machine has improved the broaching operation in all aspects. All the problems are overcome too. Greater accuracy is obtained.

2) Is the consumer satisfied?
As the problems are overcome and rejection rate is reduced the consumer is satisfied and happy with the work

Fig 3 shows the fish bone diagram

The fishbone chart gives complete information of all potential causes to recognize the root cause of the problem. The main advantage of this technique is that a clear understanding of the problem its causes and how much the problem is affecting the final output. It is also gives possible remedies to eliminate those root causes up to certain extent. After analyzing all the defects through Pareto chart, we came to know finishing defects, discrete force defects, where maximum rejections were occurs. Therefore, we are mainly focus on the main defects and try to analyze all the possible root causes through fish bone diagram.

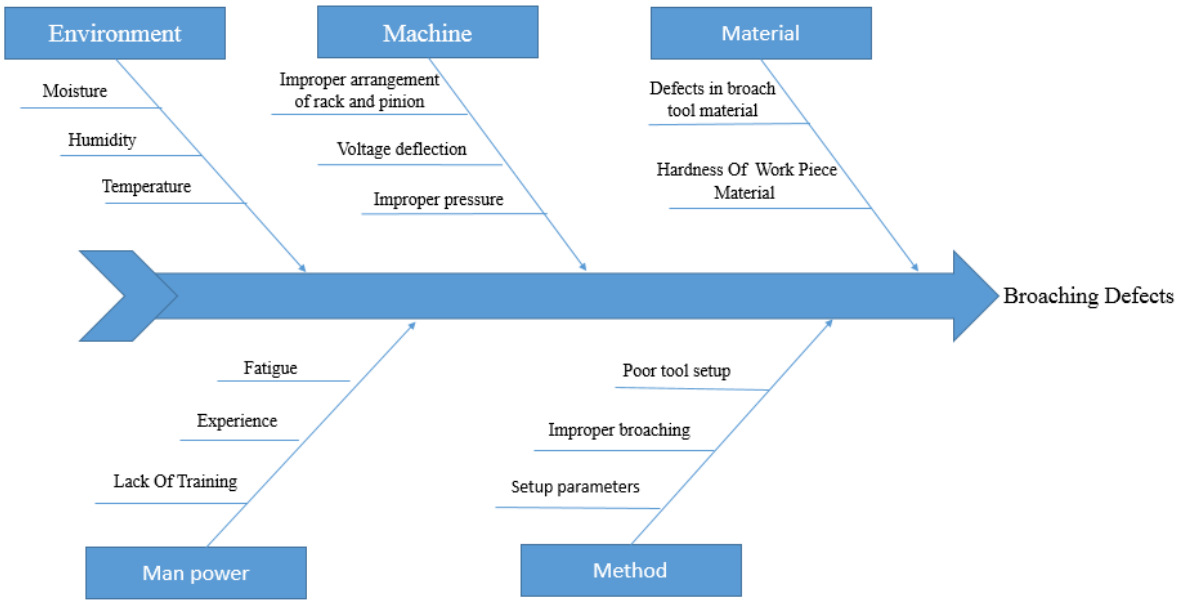


Fig 3 Fish Bone Diagram

After analyzing the major root causes through fish bone diagram, we came to know that all the problems are due to force, broaching requires gradual force, therefore to achieve gradual force.

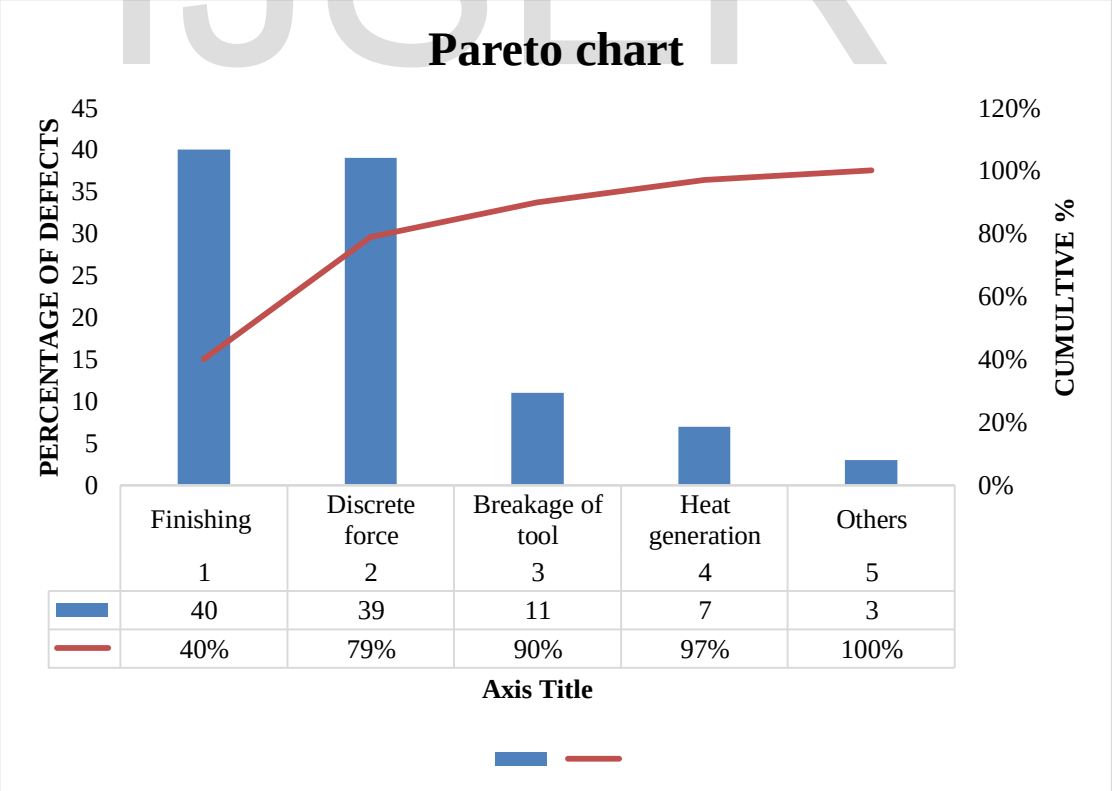
Pareto charts

A Pareto Analysis is a way through which we can study the causes of the problem in any organization so that it can be analyzed and after that improvement could be taken place. It is based on the 80/20 principle, which says that 80 % of the output comes from the 20% inputs. It is the statistical approach in which we select those limited factors that would cause the problem in the production. Since there are various factors that would have an effect the outputs of the process but through Pareto analysis, we would sort some of the major factors that would contribute maximum to the defect.

To identify the main problems, which cause frequent defects of manufacturing process. Six months of data had been collected .As discussed in the above, the pareto analysis is a simple tool to shows the various defects and help to identify most likely defect, months wise data has been collected and shown by the below table. 1

Table 1. Defects analysis

Sr. No.	Type of defects	Defects Percentage
1	Finishing	40.0
2	Discrete force	39.0
3	Breakage of tool	11.0
4	Heat generation	7.0
5	Other	3.0



If we analyze the above pareto chart, we would observe what are the major causes of defects

in the six months and among the various defects finishing, discrete force have the most significant effect. Finishing has the total defect of 40% and discrete force t need to be controlled which has the defect percentage of 39% The line that would start from the bottom left corner and ending in upper right corner, showing cumulative percentage. So analyze all the two major defects through fish bone diagram and try to find the proposed solution to counter it.

CONCLUSION

The successful implementation of six sigma on this project has done.We have designed and fabricated the hydraulic broaching machine which effectively increases productivity and minimizes the errors produced in the product. The waste management is also under control with the help of six sigma tools. This thereby increases the demand and satisfies the end users.

REFERENCES

1. Adan Vellas and Jaime Sanchez "Implementation of six sigma in a manufacturing process "*International Journal of Industrial Engineering* Published in Year 2009.

2. Justin Faust "Increase Efficiencies Using Six sigma Methodologies" *American Psychological Association* Published in year2009.

3. Andrea Sujova "Sustainable Process Performance By Application of Six sigma Concepts "*MDPI* Published in year 2016

4. Rahul Pandhare and Rajesh Metkar" Design, Development and automation of Hydraulic Broaching Machine" International Journal of Innovative Research in Engineering Published in Year2017.

5. ZhichengXua and Yanxiong Liu "Energy analysis and optimization of main hydraulic system" *Energy Conversion and Management181* Published in Year 2019.

6. Mr.S.B.Herwade and Prof.A.M.Nainwadwkar "Reliability Analysis of Vertical Broaching Machine by Fault Tree Analysis (FTA) Method" *International Journal Innovative Research in Engineering* Published in Year2016.

7. Hydraulics and Pneumatics by S.R.Majumdar

8. Vikrant Nichit, Sarang Khandarkar Nikhilesh Karwa, et all, Ovality Correction In Manufacturing of The Valve Seat, IJSART - Volume 5 Issue 5 –MAY 2019, ISSN [ONLINE]: 2395-1052.