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A Six Sigma application for the reduction of defects in a rubber products manufacturing industry

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ABSTRACT

A quality improvement program whose methodology is to look at processes with a view to analyze their process steps, determine what elements need improvement, develop alternate strategies for improvement and finally select and implement one is called as Six Sigma. The main advantage of selecting Six Sigma project is that it helps to generate potential savings in improving any process which maybe any for example production, administration, services or engineering.

This paper exhibits an empirical application of Six Sigma and DMAIC in order to carry out the reduction of product defects within a rubber hose manufacturing organization. It sticks to follow the DMAIC methodology to methodically evaluate the root cause of those defects and hand over a feasible solution to reduce or eliminate them.

In particular it was observed that the oven's temperature as well as the speed of conveyer had a significant impact on the number of defects, so it was necessary to evaluate their optimum values in order to accomplish our aim which is to reduce or eliminate the defects. The primary concern of defects was the leakage in the hoses. Hoses are extensively used in automobiles and hence this type of the defect becomes a major concern because it might lead to huge losses to the life of vehicle as well as the life human who are inside the vehicles having defective hoses. After employing Six Sigma and DMAIC, and through analysis the aim was to reduce the number of defects by 50 percent which will hence help the organization to reduce costs.

The study mentioned in the paper helps to carry out a vivid demonstration of how the application of Six Sigma and DMAIC can help any manufacturing organizations to overcome difficulties in production defects and costs associated with their rework and thus achieve

improvements in quality in their processes and continue striving for excellence. In globalization times, the competition between organizations is highly intensified thus its almost absolutely necessary for them to provide with superior quality products in order to gain advantage and stay ahead from their competitors, hence DMAIC, also known as the problem-solving methodology of six sigma is regarded as one of the better techniques used by industries to improve the most important aspect of any product, that is 'quality'.

This paper can also be used as a reference which can guide the top-level management personnel, the managers working under them and also the various engineers working for them in the organization

Keywords : Six Sigma, defects, quality, hoses, DMAIC, manufacturing, leakage.

INTRODUCTION

Due to tough and neck to neck competition and increasing demands and needs of customers, every industry or organization has been forced to work on achieving a single utmost feature of the product which is its quality which might help them maintain their reputation and hold over market. This is an organization which manufactures rubber hoses hence its aim about striving for quality itself should be a big deal for the organization in order to maintain its hold over market and compete in it. There are many general defects which come into the picture as soon as we talk about manufacturing of rubber products namely holes, stains, marks, etc. It is very clear to understand that the consumption of materials, time and manpower increases due to rework which is a direct effect of generation of defects in the product. Along with these things various other parameters like inspection, service to customers, scrap costs, inventory management are all affected due to the

generation of defects in the product.

As much as these factors lead to affect operational costs or manufacturing costs but the most important factor will be customer dissatisfaction, hence it becomes important to supply flawless hoses for the growth of organization

One of the most essential elements of six sigma is DMAIC (define, measure, analyses, improve, control). Alongside with this model, few statistical tools for quality improvement such as Pareto chart, cause and effect analysis, etc. were used and are presented in the paper. Initially the paper focuses on the review of theory of six sigma and DMAIC and principles associated with it plus its advantages and optimistic impact on the growth of the industry. DMAIC are the initials for define, measure, analyze, improve and control. Few terms are also necessary in implementation of six sigma mentioned here:

Define– Understand and define the needs of customer

Identify– Identify the customer and project parameters.

Design– To design the project which meets customer needs. Optimize– To determine various process capability and identify the most optimum

Verify– Validation and review of the design

LITERATURE REVIEW

In quality term, sigma is utilized to measure the variation in the output, however this word is originated from Greek terminology

The Sigma Level generally is an indication about the performance of the organization. Generally six sigma refers to 3.4 defects per million opportunities or in simple language it refers to owning a process which only produces 3.4 units of defects per every one million products produced.

Pundits like Brue and Howes have also regarded Six Sigma as a management strategy and philosophy

Primarily, six sigma narrows down on characteristics which are critical and relevant to customers. Taking this into account, the defects and problems that may affect the performance of process is identified and eliminated.

Bailey in 2001 told that six sigma has the highest record of effectiveness amongst the relevant market approaches like TQM, Lean Management, etc. Important advantages that a company can gain by applying six sigma are improvements in cycle time, elimination/reduction in defects, reduction in costs and a notable rise in the profits made by the company.

Famous pundits like Keller and Pyzdek, Stamantis, Dale, Markarian give their views on the fact that usage of six sigma is not just restricted to improvement of processes in the industries but can also be applied in the field of purchasing, logistics, etc.

In addition to their views Mr. Kumar in 2008 suggested that Six Sigma can also be applied to develop new business models in business processes.

DMAIC is associated with continuous learnings by Deming and the infamous PDCA model (plan, do, act, check)

It gives a step-by-step indication about how the problems need to be addressed, the grouping of quality tools and along with it about the establishment of a standardized and well-formed routine to find the answers to the problems. This well-formed and well-structured plan is what many pundits conclude that is the major characteristic which makes the six-sigma process effective. DMAIC is considered a model used for learning and it also stresses on the importance of data collection and its respective analysis which comes or precedes the execution of the improvement aspect of any product.

Hence along with experience and knowledge, the people using DMAIC are able to take decisions on basis of real scientific facts and methods.

Even though different process improvement techniques and problem-solving methods such as 7 STEP method, QC story, ADDIE, FADE have been initiated and developed by many industries but out of all of them, DMAIC is reputedly titles as one of the best and widely used and this is due to the fact of its essential element six sigma and lean six sigma.

Rubber gloves manufacturing process

Due to the increasing competition in the automotive sector, the demand of good quality rubber hoses has also expanded. For example, JCB has a requirement of rubber hoses having higher strength than standard value because of its application in JCB vehicles. Also, this industry exports the hoses to various countries like the USA, UK, Germany, etc. hence quality of hoses needs to be absolutely premium.

Thus, the company needs to focus on the improvement in their manufacturing environment and standards that should ultimately satisfy the demands and needs of their customer.

The manufacturing of rubber hoses comprises of various processes or steps namely raw material testing, compounding, vulcanizing, quality control, packing, etc.

THE SIX SIGMA APPLICATION AND METHODOLOGY

The following section represents a practical application of Six Sigma and DMAIC, in the rubber hose manufacturing industry. The whole section is divided into various steps that need to systematically carried out for improvement process.

1. DEFINE

The first stage in the six sigma and DMAIC methodology is called as define. Define stage gives information about scope and boundary of the project.

It also aims to identify the voice of the customer means customer requirements and goals of the respective project.

To ensure that the research is effective and in control and it has the strength to focus itself on the problem, we need to decide or define a boundary of the project.

This research has a single purpose to deal with standard hoses of medium size (90 degree bend). We know that in order for any process to get implemented we need the top management on our side in agreement, thus obtaining and

defining objectives of this process becomes necessary. To conclude with this stage, we prepare a project charter, to state all the relevant information and structure of the project.

Miscellaneous	1686	6.38
Dirty	788	3.19
Total	6969	28.47

Detailed project charter methodology:

PROJECT CHARTER-

Project Title: Defects reduction in rubber hoses

Background and reasons for selecting the project:

A large amount of rubber hoses has been rejected by customers due to they were defective. This problem causes several types of losses to the company, for example: time, materials, capital as well as it creates customers' dissatisfaction, which negatively affects the organization's image.

Project Objective: To reduce the defects by 50% after applying Six Sigma into the hoses manufacturing process

Voice of the Customer (VOC): Product's quality

Project Boundary: Focusing the hoses solely on EPDM

Type of defects	% Of defects BEFORE trial	% Of defects AFTER trial
Leaking	18.9	8.05
Miscellaneous	6.38	3.65
Dirty	3.19	2.35
Total	28.47	14.05

hoses of "Medium" (M) size

Team members: Production manager, an experience shop-floor operator and the improvement project leader

Expected Financial Benefits: A considerable cost saving due to defects reduction

Expected Customer Benefits: Receiving the product with the expected quality

2. MEASURE

This phase of DMAIC comprises of obtaining reliable metrics to help the process monitor towards the predefined goal which is to reduce or eliminate defects in the rubber hoses manufacturing process. One of the metrics used was just stating the no. various types of defects. According to the analysis and past records, there were two major types of defects namely the leakage in the hoses and amount of dirt on its surface. Remaining less frequent defects were grouped in the miscellaneous category.

In this specific research we have defined the leakage defect at those hoses which had one or more holes and hence resulted in the leakage when they underwent quality testing. The data was collected for 20 days.

Type of defects	Number of defects	Percentage of defects
Leaking	4495	18.9

3. ANALYZE

This part in the DMAIC model consists of thorough analysis of the system, here the operational processes that is responsible for manufacturing of hoses, this is carried out to reduce the distance between our set objectives and current performances.

There are different tools and techniques used for analysis stage in DMAIC, they include hypothesis testing, design of experiments, cause and effect diagram, brainstorming, etc.

Once the sequence of the process along with its inputs and outputs were decided and understood there was an analysis undertaken to figure out the root cause of the leakage defect. A number of brainstorming sessions took place to identify about the issue as to why the defect is observed.

After taking all factors into account it was found that during the operational stages within the industry had a significant effect on the generation of defect of leakage.

Particularly two process factors namely temperature of oven and speed of conveyer had an effect on the defective hoses. One more interesting thing which was observed was that both these causes had a relationship between each other because the hoses need to be dried by using the heat from oven at the same time when they are being conveyed with the help of rollers.

4. IMPROVE

Now further the DMAIC stage emphasizes on tackling the problem which was identified.

Using ANOVA and hypothesis methodology it was statistically proven that speed and temperature had a significant correlation with the number of defective hoses so now we have to fix an optimum temperature and speed which would help in eliminating and reducing this defect.

TEMP •C	ORDER	SPEED IN RPM				X
		600	650	700	750	
220	1	278	189	156	147	2
	2	244	154	193	108	6
	3	253	173	129	83	8
	4	214	147	101	113	2
225	1	212	120	101	78	1
	2	152	85	62	28	7
	3	200	71	94	71	8
	4	166	106	83	152	0
230	1	189	41	78	232	2
	2	150	60	127	173	1
	3	168	74	133	193	0

	4	147	44	94	202	5
235	1	78	97	242	299	2
	2	127	85	205	292	7
	3	87	147	170	219	4
	4	94	99	223	278	2
		2758	1691	2192	2668	top

$X = \text{TOTAL NUMBER OF DEFECTS (UNITS)} = 18616$

Although the management was pretty sure about an existing relation between the two variables, temperature of oven and speed of conveyer by seeing the number of defective hoses, they gave allowance to conduct a design of experiment which would help in validating the optimum values of the responsible variables. Hence the experiment was carried out to investigate or come to conclusion whether the combination of factors had a negative sort of effect on the process. A two-way analysis of variance ANOVA was used, it is a statistical model used for comparing differences among average of two or more parameters

After stating the optimum values there was a trial performed in order to verify them. A certain sample size of hoses was taken as a base for investigation. The below table gives a result which is nothing but a comparison in before and after setting up the new values

Hence it can be concluded that by considering the values of temperature of oven at 230°C and conveyor's speed at 650rpm, every type of defect showed a significant decline in defection.

The process carried out to improve with the utilization of six sigma and DMAIC problem solving method was able to prove effective and also it efficiently minimized the number of defects in order to improve and enhance productivity.

5. CONTROL

The main purpose of this phase is to enable sustainability from profits generated from the improved processes. For monitoring these improved processes various design controls can be used which ensures that they remain in control. In this industry of rubber products manufacturing, various control charts were also implemented in order to detect any kind of variation in ongoing improved processes and if detected then certain actions might be taken to correct them and ensure reduction in defects and improved quality of product. Control charts are nothing but a statistical tool used to monitor a process and identify whether any specific kind of variation is affecting the improved process. In addition to these, in order to monitor the performance of manufacturing of rubber hoses, p and np charts were also used. All these tools allow an organization to sustain in the market and ensure that the improvements they made also sustain for a longer period of time.

RESULTS AND CONCLUSION

We can concur that our research presented a successful case study about elimination / reduction of defective hoses in the rubber products manufacturing organization by six sigma principles and problem-solving methodology called DMAIC. This paper shall be used as a reference or for guidance towards application of six sigma methodology by top management personnel, owner or managers of the organization for improvement in processes, projects and thus working towards the growth of the organization.

After observing the analysis, we got the results that oven's temperature and speed of conveyer were primary reasons for the production of defects and by modifying their values to an optimum value we found that there was a considerate reduction in defects. The company realized SIX SIGMA AND DMAIC problem solving methodology is effectively helping the organization to reduce the number of defects.

Hence we conclude that long term benefits such as increase in productivity, cost benefits, cost savings, customer satisfaction, quality, etc will be achieved if the organization implements six sigma methodology continuously

1. REFERENCES

- [1] Mr. Mohit Chhikara (2017) "Implementation of Six Sigma in Indian Manufacturing Industries" International Journal of Advanced Research, Ideas, and Innovations in Technology ISSN: 2454-132X Impact factor: 4.295 (Volume3, Issue1).
- [2] Anup Kumar Rajak (2016) "In Pursuit of Lean Six Sigma: A Systematic Review" International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 1 (2016) pp 547-556.
- [3] Kunal Ganguly (2015) "improvement process for rolling mill through the dmaic six sigma approach" International Journal for Quality research UDK- 378.014.3(497.11) Short Scientific Paper (1.03).
- [4] Riddish Thakore (2014) "Quality & Productivity Improvement using Six Sigma – A literature Review" International Journal for Quality research UDK- 378.014.3(497.11).
- [5] Hassan Rangriz (2014) "study of organizational factors affecting Implementation six sigma in system Group Company" A Journal of Multidisciplinary Research Vol. 3 Issue5, May 2014, ISSN 2278-0637, 57-76.
- [6] Mohit Taneja, Arpan Manchanda (2013) "Six Sigma an Approach to Improve Productivity in Manufacturing Industry" International Journal of Engineering Trends and Technology (IJETT) – Volume 5 Number 6- Nov 2013, pp281-286.
- [7] Everton Drohomerski (2013) "Study of DMAIC methodology & Various Techniques/Methods to implement it" International Journal of Production Research, Taylor & Francis 52:3, 804-824.
- [8] Celep Oguz (2012) "Implementing lean six sigma: A case study in concrete panel production" <https://www.researchgate.net/publication/265233571>.
- [9] Dr. P.Ramasubramanian (2012), "Six Sigma in Educational Institutions", International Journal of Engineering Practical Research IJEPR, Volume1, Issue 1, August 2012, PP. 1-5.
- [10] Padhy, R.K. Sahu, S., and Das, R.K. (2011), Implementation of Six Sigma in Indian industries – a Delphi study, Int. J. Computer-Aided Engineering and Technology, Vol. 3, No. 1, pp.19–33.
- [11] Breyfogle, F.W. (2010), Process Improvement Projects shortcomings and resolution, International Journal of Lean Six Sigma, Vol.1, No.2, pp. 92-99.