



Faculty of Manufacturing Engineering

**QUALITY ENHANCEMENT IN FAN COWL ASSEMBLY IN
AN AERO COMPOSITE MANUFACTURING COMPANY
USING DMAIC APPROACH**

Saadatunur binti Saari

**Master of Manufacturing Engineering
(Industrial Engineering)**

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SAADATUNUR BINTI SAARI

**A thesis submitted
in fulfillment of the requirements for the degree of Master of
Manufacturing Engineering (Industrial Engineering)**

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2016

DECLARATION

I declare that this thesis entitled “Quality Enhancement in Fan Cowl Assembly in an Aero Composite Manufacturing Company Using DMAIC Approach” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering).

Signature :

Supervisor Name :

Date :

DEDICATION

To my late father, Allahyarham Haji Saari bin Mahamudin, my beloved mother, Hajjah

Rushidah binti Masngat, and my siblings,

Thank you and I love you.

ABSTRACT

Too often quality issues were taken lightly in the production. The organisation put more focus on pinpointing and counting the defect rather than improving the management performance. Hence increasing the number of rework in the production that will eventually increase time of production and cost. This situation will affect the customer's trust towards the capability of the production. Facing quality issues in their production, an aero composite manufacturing company realise in increasing their competitive advantage, there are needs for their company to improve their operations through producing "right first time" quality product. Defects minimisation is the prerequisite to the quality improvement. Hence, this study presents the defects minimisation rate by introducing and implementing DMAIC methodology of Six Sigma into a fan cowl assembly of a selected aero composite manufacturing company. This improvement method from Six Sigma is a customer driven improvement approach that originally started in manufacturing industry. This systematic approach towards defects minimisation have been effectively utilised in many improvement process through five phases of DMAIC methodology named Define, Measure, Analyse, Improve and Control. Through this study, a Six Sigma team was developed to work on this issue. In this study, Pareto chart was used to identify the top occurring defects. Finding shows that quality issues related to sealant has become a great contribution to a high DPU number. Hence, the team has worked together to identify the major cause that led to the defects. Tools and techniques such as brainstorming, cause and effect analysis and FMEA were used to identify the probable causes and the potential root causes. Through data collection and several discussion, the team agreed that, being a manual assembly production would results to higher manual variability that will eventually led to human error. Different technique were used by the worker depending on their experience and also human factor affecting them while working. It was found that, by addressing error and incorporating them into control plan could greatly reduce the human error. Hence, the proper implementation of SOP and control plan were implemented in this study as the control measure in sustaining the improvement in the process. The results shows that this implementation help the workers to be more focus in doing their job. Besides, the record keeping system that has been documented will later greatly contribute in data collection in aiding another continuous improvement process.

ABSTRAK

Isu kualiti kerap di pandang ringan di dalam produksi. Organisasi meletakkan lebih fokus dalam menunjukkan dan mengira kerosakan daripada meningkatkan prestasi pengurusan. Oleh itu, ia telah meningkatkan jumlah kerja semula di dalam produksi yang akhirnya akan meningkatkan masa dan kos produksi. Situasi ini akan memberi kesan terhadap kepercayaan pelanggan kepada kebolehan produksi. Sebuah syarikat pembuatan aero komposit telah mengalami isu kualiti di dalam produksi mereka, dan menyedari dalam meningkatkan kelebihan daya saing, mereka harus meningkatkan operasi dengan mengeluarkan “betul pada pertama kali” produk kualiti. Pengurangan kerosakan adalah langkah yang harus di ambil dalam meningkatkan kualiti. Oleh itu, kajian ini menunjukkan kadar pengurangan kerosakan dengan memperkenalkan penggunaan kaedah DMAIC daripada enam sigma ke dalam pemasangan “fan cowl” di dalam syarikat pembuatan aero komposit. Kaedah peningkatan daripada enam sigma ini adalah pendekatan yang didorong oleh pelanggan yang asalnya bermula di dalam industri pembuatan. Pendekatan sistematik terhadap pengurangan kerosakan ini telah digunakan secara efektif di dalam kebanyakan peningkatan proses melalui lima fasa di dalam metodologi DMAIC iaitu mengenalpasti, mengira, menganalisis, meningkat dan mengawal. Di dalam kajian ini, sebuah kumpulan enam sigma telah dibentuk untuk menyelesaikan isu ini. Di dalam kajian ini, carta Pareto telah digunakan untuk mengenalpasti kerosakan yang selalu berlaku. Hasil kajian mendapati, isu kualiti berkaitan penggunaan “sealant” telah menjadi penyumbang terbesar kepada peningkatan nilai DPU. Oleh itu, kumpulan enam sigma telah bekerjasama bagi mengenal pasti penyebab utama yang mendatangkan kerosakan terhadap panel. Alat dan teknik seperti sumbang saran, analisis sebab dan punca serta “FMEA” telah digunakan untuk mengenal pasti penyebab utama isu ini. Data telah dikumpul dan selepas beberapa perbincangan, kumpulan enam sigma telah bersetuju bahawa pemasangan manual produksi menyebabkan peningkatan kepelbagaian manual yang akhirnya menyebabkan kesilapan manusia. Pelbagai teknik digunakan oleh setiap seorang pekerja yang mana ianya bergantung kepada pengalaman dan juga faktor persekitaran yang boleh memberi kesan kepada mereka. Didapati, dengan menangani ralat dan menggabungkan mereka didalam pelan kawalan dapat mengurangkan kesilapan manusia. Oleh itu, pelaksanaan “SOP” dengan betul dan juga pelaksanaan pelan kawalan didalam kajian ini sebagai langkah kawalan dalam mengekalkan peningkatan dalam proses. Kajian mendapati pelaksanaan ini membantu pekerja untuk fokus dalam melakukan kerja mereka. Selain itu, sistem penyimpanan rekod yang telah didokumenkan akan membantu didalam pengumpulan data untuk proses penambahbaikan yang seterusnya.

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LIST OF ABBREVIATIONS

ANOVA	-	Analysis of Variance
CAD	-	Computer Aided Design
C&E	-	Cause and Effect
CDCS	-	Critical Dimension Check Sheet
CTQ	-	Critical To Quality
DCC	-	Document Control Centre.
DMAIC	-	Define, Measure, Analyse, Improve, Control
DOE	-	Design of Experiment
DPMO	-	Defect Per Million Opportunity
DPU	-	Defect Per Unit
EOP	-	Edge of Profile
EWO	-	Engineering Work Order
FMEA	-	Failure Mode and Effect Analysis
FPY	-	Field Per Yield
GDP	-	Gross Domestic Product
GE	-	General Electric
HBWLED	-	High Brightness White Light Emitting Diodes
ID	-	Identification
IML	-	Inner Mould Line
LED	-	Light Emitting Diodes
LSS	-	Lean Six Sigma
MIDA	-	Malaysian Investment Development Authority
MSA	-	Measurement System Analysis
NCR	-	Non-conformance Report

OFAD	-	Oil Fill Access Door
OML	-	Outer Mould Line
OOT	-	Out of Tolerance
OTAD	-	Oil Tank Access Door
QFD	-	Quality Function Deployment
QN	-	Quality Notification
RHLW	-	Right Hand Left Wing
SIPOC	-	Supplier, Input, Process, Output, Customer
SOP	-	Standard Operating Procedure
SPC	-	Statistical Process Control
TMAP	-	Thought Process Map
TQM	-	Total Quality Management
UTAS	-	United Technology Aerospace System
VMRR	-	Vendor Material Review Request
VOC	-	Voice of Customer

CHAPTER 1

INTRODUCTION

The first section of this report gives the overall view of the study. In this section a brief introduction and problem statement of the study will be explained. The purpose of the study, limitations and boundary of this study will also be explain in this section. This chapter also likewise gives a report arrangement which generally describes about chapter division and related substance to that particular chapter. In general, it summarizes the advancement of the whole project, depicting how the whole investigation has been carried out.

1.1 Motivation of Study

Manufacturing is a path of development. For most of the country, manufacturing has been the most profitable sector that contribute the most in their economic growth. Through manufacturing, Malaysia also has showing a significant growth in the economic state. On March 2016, Malaysian Investment Development Authority (MIDA) official website has published the total investment in the country for 2015. For the first quarter of 2015, RM57.4 billion of investment has been accepted in the primary, services and manufacturing sectors, with 58.5% of the total led by manufacturing sector, followed by 38.95% by services sector and the rest of 2.6% by the primary sector. These investments do not just help in increasing the opportunity in developing the technology, it also help in increasing the job opportunity.

This has been proven as Department of Statistic Malaysia (2016) has recorded manufacturing sector as the second largest after wholesale and retail trade that offering employment according to the industry with 2,174.1 thousand in 2015.

1.2 Research Background

In order to accomplish Wawasan 2020 as a fully developed nation, Malaysia has gone for enhancement in manufacturing industry. The development of manufacturing has seen Malaysia as a promising country, in 1998 Malaysia was identified as a country that has been able to go through hardship of deindustrialisation that has been going through around the developing world since 1980s (Chang, 2012). Meanwhile, in 2016, Department of Statistic Malaysia has presented the performance of manufacturing sector which shown 4.0% output grew in December 2015 after registering a growth of 4.1% in November 2015. However, with the current economic crisis, Malaysia are going through financial difficulties, thus, forcing them to reduce their imports. This is putting pressure on the Malaysian government to strengthen their manufacturing industry.



Figure 1.1: Malaysia GDP annual growth rate (Trading Economics, 2016).

As presented by the Department of Statistics Malaysia, the annual gross domestic product (GDP) growth rate from January 2013 until January 2016 shown a decrease in the Malaysia GDP annual growth rate as shown in figure 1.1. It has recorded that Malaysia was having the weakest expansion since the second quarter of 2013 by 4.5 percent year-on-year in the December 2015. Service sector has being the largest contributor sector accounting 54 percent of GDP, followed by manufacturing sector that has been growing through the years by 25 percent of GDP and more than 60 percent of total exports. While the other sectors; mining and agriculture, each contributed 9 percent of the GDP. This issues has been worrisome and inflicted a concern to the sectors especially manufacturing sectors. Thus, there are many ways are being implemented in manufacturing to keep increasing the Malaysian growth of economy.

Quality are the best term described in order to fulfil customer satisfaction. This standard of quality is differ from each of the product as per customer requirement, and it is

critical for every company to produce products in high quality, thus increasing customer satisfaction. Other than that, for each company, in producing high quality products, the productivity also needed to be take care. Chi et al. (2011) state that, among the issues faced by the manufacturer in maintaining competitive performance, there are three critical issues that were needed to be handled efficiently, which are, increasing productivity, speed up product delivery and produce good quality at low cost, hence increasing the competitive advantage. Handling these issues need a thorough process that surely troubled the management of the production. It will surely become a challenge in the process of strengthening the manufacturing industry. Nevertheless, these processes are required so that wastes that can contribute to the cost incremental and longer production time can be eliminated.

One of waste that contribute the most in the loss in manufacturing is defect. Defect product is very critical as there are additional process needed in order to recover the product. These additional process will require another additional cost and extra time after the initial time projected for the product. It does not comply with the meaningful substance of the industry that depend on several aspects, which are the quality of the product produced, the optimization of cost, time and serviceability during the course of operation (Gopalakrishnan Nair et al., 2012). This was a major situation faced by lots of company in Malaysia. Thereby, this is crucial for defect prevention to take place. Defect prevention can enhance both quality and productivity. Lesser number of defects passed on the next process improve the quality as there are lesser residual defects. Besides, lesser defects delivered means lesser defects need to be taken out. This will ultimately led to less process of removing defects, thus increasing productivity (Jalote and Agrawal, 2005).

“Prevention is better than cure” applied to the situations in most of the manufacturing company. By means of preventions, there are few methods in preventing defects, such as six sigma. Six sigma has been used widely in manufacturing industry as an approach of defect elimination. Chakravorty and Shah (2012), Näslund, (2008) state that the used of six sigma can reduce the variations in any process, hence reducing the manufacturing cost. It also help in measuring defects in the process while improving the product quality. Six Sigma is a well-established statistical approach for strategic process improvement focusing on the process performance characteristics, in order to identify and eliminate the defects or errors (De Mast and Lokkerbol, 2012). It also can be defined as a management system build from values, methodologies and tools that continuously developed considering a reduced amount of input while striving in increasing the internal and external customer satisfaction, (Hellsten and Klefsjö, 2000). The six sigma implementation means a strict monitoring and designing the everyday activities, eventually assist the enhancement of the bottom line of a business. This is due to the fact that these designing and monitoring things does involve in minimizing waste and input, hence increasing customer satisfaction (Andersson et al., 2006).

1.3 Company background

This project is focusing mainly on the Six Sigma philosophy that would be implemented to identify the current quality issues faced by an aero composite manufacturing company. The company realise in order to maintain and increase their competitive advantage, they have to seek for a way in enhancing their production efficiencies. To ensure a high production performance, the quality of the product produced is vital in fulfilling customer satisfaction. The quality of the product is very important since it is related to

manufacturing cost such as rework, defects and complaints. The major challenges for the company is to increase the productivity while minimizing costs at the same time. The importance of this study is to investigate the impact of quality to the production, hence, through implementation of the Six Sigma methodology with the aim to reduce the rejection rate of the product, which will subsequently increases the productivity of the company.

1.4 Problem Statement

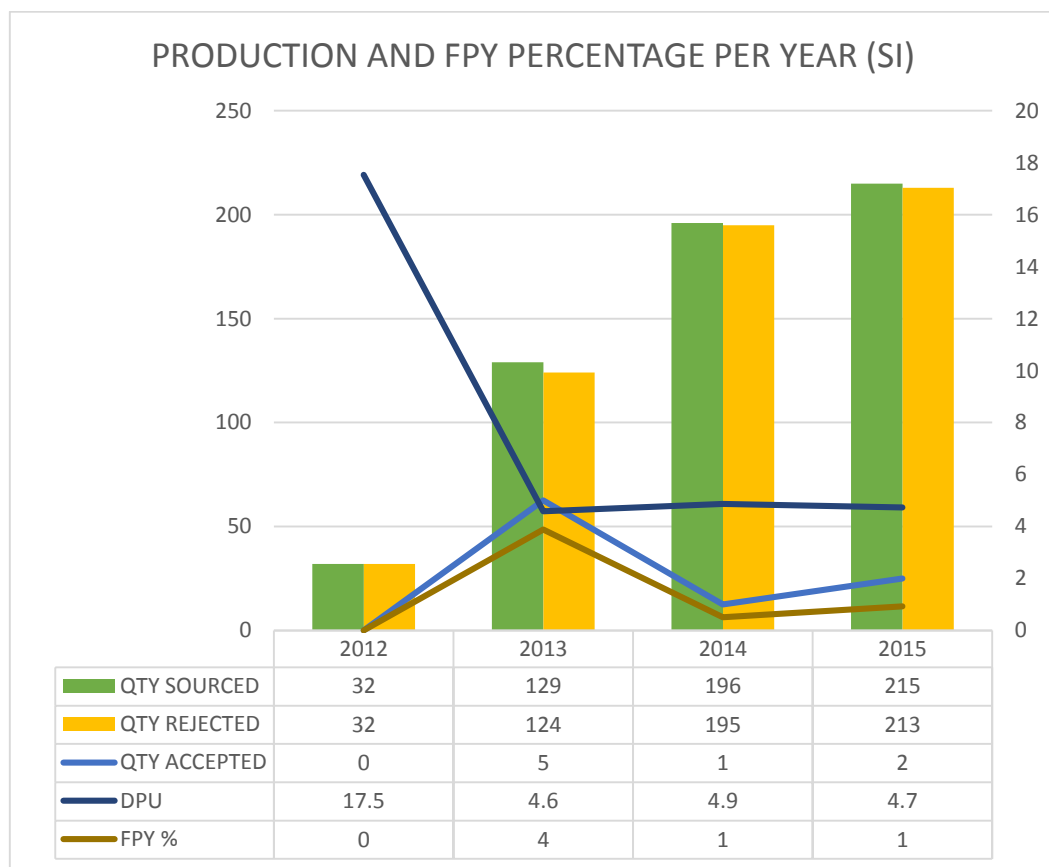


Figure 1.2: Production and FPY percentage from 2012 to 2015

Figure 1.2 shows a poor performance by an aero composite manufacturing for the last four years. The data is based on field per yield (FPY) of fan cowl manufactured for

General Electric (GE) shown that there are inconsistent value of FPY and these value are not pleasing as well. The company has targeted to achieve FPY by 100 percent yet the value of FPY achieve through these years are still far-fetched from the FPY targeted. The value of defect per unit (DPU) of the fan cowl were still quite high thus, lead to a lower FPY. The problem arise when there are higher DPU, which will go for rework. This will definitely increasing production time, eventually increasing manufacturing cost, which are absolutely not preferable in manufacturing concept.

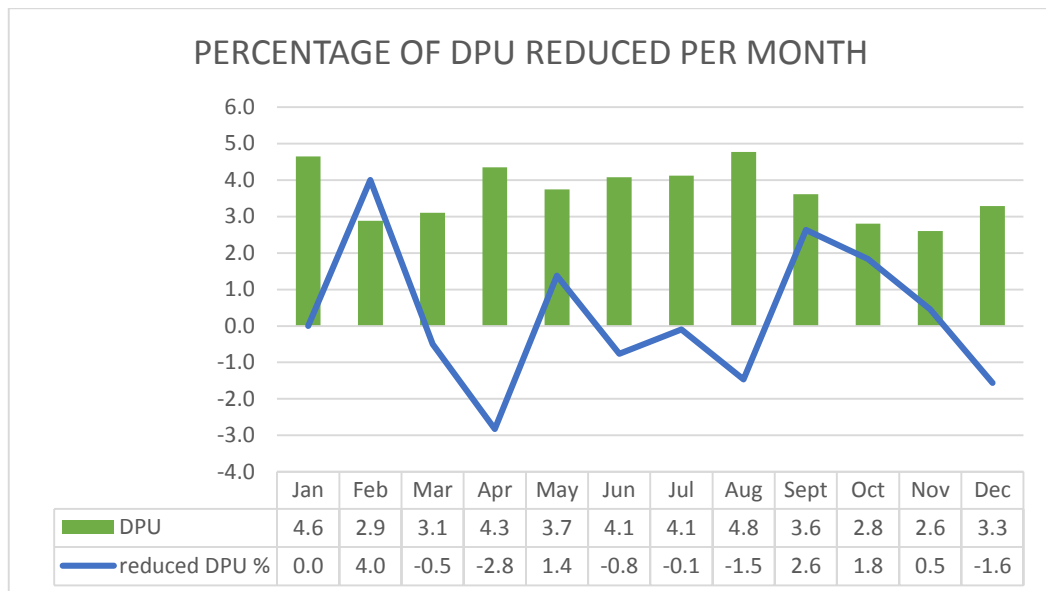


Figure 1.3: Percentage of DPU reduced per month in 2015

Figure 1.3 shows that in 2015, the DPU reduced from each month were inconsistent. The percentage of DPU reduced were decreasing and hardly increased to the significant amount. Hence, this study is perform by using six sigma as an approach in disclosing the factors that lead to the defects and providing the appropriate solution to overcome this problems, thus enhancing the quality.