

## DECLARATION OF ORIGINAL WORK

“I admit that this report is my own work except the citations which I have mentioned the source”

Signature : .....

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Date : 28 June 2013

## **DEDICATION**

For my mother, Siti Halijah binti Juhari and my father, Samsuri bin Ahmad, thanks for your love and support. This final year project is dedicated to show my truly appreciation for both of you.

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## **ABSTRACT**

Defect and manufacturing industry are like two inseparable entities despite, the defects is a major problem to the manufacturing industry nowadays. Daily production of package devices will tend to produce a large amount of defects. The number of defects and errors should be reduce and minimize to achieve yield equal to 100% as well as to do things right for the first time (Crosby P, 1957). However, it is possible to eliminate 100% defects as stated in Zero Defects. In 1977, Shizuoka plant of Matsushita Electric's Washing Machine Division, Japan, had proved by achieving the continuous record of one month with zero defects in a drainpipe assembly line operation which involving only 23 workers. Undeclared defects can contribute to highest waste disposal which can reduce the yield. This research emphasize about the effectiveness of quality tools method to reduce the quantity product defects and quantity product loss. Surveys and observations are conducted to obtain authentic information regarding this issue and data was collected quantitatively. As a whole, productions costs can be reduced by reducing waste including scrap largely come from product defects itself.

Keywords: product defects, zero defects, reduce, eliminate

## ***ABSTRAK***

Kecacatan dan industri pembuatan adalah seperti dua entiti yang tidak boleh dipisahkan, dan kecacatan merupakan masalah utama kepada industri pembuatan pada ketika ini. Pengeluaran harian peranti pakej akan cenderung untuk menghasilkan sejumlah besar kecacatan. Bilangan kecacatan dan kesilapan harus dikurangkan untuk mencapai hasil sebanyak 100% serta perlu untuk melakukan perkara-perkara yang tepat di dalam proses pengeluaran untuk kali pertama Crosby P, 1957). Walaubagaimanapun, ia adalah tidak mustahil untuk menghapuskan kecacatan 100% seperti yang dinyatakan dalam Konsep Sifar Kecacatan. Pada tahun 1977, loji Shizuoka Bahagian Pembuatan Mesin Basuh Matsushita Elektrik Jepun, telah membuktikan dengan mencapai rekod berterusan selama sebulan dengan mencatatkan sifar kecacatan dalam operasi barisan pemasangan paip laluan air yang melibatkan hanya 23 pekerja. Kecacatan produk boleh menyumbang kepada pembuangan sisa yang tinggi dan boleh mengurangkan hasil. Penyelidikan ini menekankan tentang keberkesanan alat-alat kualiti untuk mengurangkan kuantiti kecacatan produk dan kuantiti kehilangan produk. Tinjauan dan pemerhatian telah dijalankan untuk mendapatkan maklumat yang sahih mengenai tajuk ini dan data dikumpulkan secara kuantitatif. Secara keseluruhannya, kos pengeluaran dapat dikurangkan dengan mengurangkan pembaziran termasuk skrap yang sebahagian besarnya datang daripada kecacatan produk itu sendiri.

Kata kunci: kecacatan produk, sifar kecacatan, mengurangkan, menghapuskan

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## LIST OF SYMBOLS

ZQC	=	Zero Quality Control
SPC	=	Statistical Process Control
AQL	=	Average Quality Level
IV	=	Independent Variable
DV	=	Dependent Variable
SPSS	=	Statistical Package for Social Sciences
N	=	Number of sample
JIT	=	Just-in-time
ME	=	Manufacturing Executives
QC	=	Quality Control
QA	=	Quality Assurance
%	=	Percentage

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1. Introduction**

Manufacturing defect is one of the three types of product liability that states in the United States Law, Section 2 of the Restatement of the Law Third, Torts: Product Liability. This law is about dealing with the liability of commercial product sellers and distributors for the harm caused by the products. Product defects in manufacturing industry are included in manufacturing defects. In order to achieve yield virtually to 100% production, industry need to be focus on defect reduction. Every manufacturing firms in Malaysia has their own ways to reduce the number of defects. One of the key factors to minimize defects is by emphasizing on the reducing of waste disposal that can be practiced at each of the manufacturing firms. Zero Defects Principle is irrelevant as defects will definitely happen on each packages production. With a sufficient number of expertise, proper scientific process, high quality of raw materials and high-tech machines, it also remains impossible to not produce any defects. Moreover, there are many products that manufactured in one day, therefore, a material removal will accidentally happen or vice versa.

## **1.2. Problem Statement**

Numbers of product defects in some of manufacturing industries in Malaysia are instantly high and increasing. Meanwhile, the current percentages of product defects for daily and weekly production are instantly high because there is no distinct and fixed step to minimize the undeclared product defects. Despite some quality tools have been introduced, product defects still happen and increasing in manufacturing industry. This study is aim to identify the best quality tools that have proven effective in reducing the product defects.

## **1.3. Research Question**

To what extent are the quality tools method are capable and effective in minimizing the product defects in the area of manufacturing industries and how the customization is done?

## **1.4. Research Objectives**

- 1.4.1. To identify the best quality tools to reduce product defects in manufacturing.
- 1.4.2. To explore the current percentage of product defects in daily and weekly production for manufacturing industry.
- 1.4.3. To examine the customization of quality tools in minimizing the number of product defects.

## **1.5. Importance of the Project**

This research is very valuable to manufacturing-based organizations in reducing the production costs (costs for machine maintenance, expertise, resources and raw materials) as well as to increase the customer level of confidence in the products manufactured. Besides that, this project is also important to determine the effectiveness of the Zero Defect Principle in reducing the number of defects and to raise awareness about the importance of controlling the defects percentage. Last but not least, this project is to determine the best quality tools that can minimize the product defects.

## **1.6. Scope and Limitation**

This research encompasses the quality tools used to reduce the waste in manufacturing besides defining what defects are. Other than that, this research includes the studies in identifying the effects of waste in determining the excellence yield performance. This research will not include the types an in-depth study of the defects.

## **1.7. Summary**

As conclusion, the research title, research objective and research question must be interconnected between each other. It is important to conduct my research without contradicting between the research titles, research objectives and research question in choosing the right methodology in the next chapter. Furthermore, I had described the importance of this research which I have to achieve in the end of this research.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1. Introduction**

This chapter will describe about the literature review of quality tools in minimizing the product defects. The introductory topic begins with detail enlightenment theories of books regarding this research with my own analysis. This is followed by theories and application of theories such as journal papers, academic articles, conference papers and thesis, include the founder of those theories together with my own analysis. Last, but not least, application of theories and main focus of this research, review on previous studies that similar as this research, as well as the research method that has been applied is presented. These are important to help focus and construct my research question by articulating the knowledge gap as I am new to this research area. Besides that, this literature review helps to identify my proper research methodologies and build my knowledge by analyzing the theories.

As emphasized earlier in Chapter 1, the aim of this study is to identify the best quality tools to reduce the product defects. Thus, three quality tools had been identified as tools used by manufacturing industries in reducing the product defects. There are Statistical Process Control (SPC), Zero Quality Control (ZQC) and Zero Defects.



## **2.2. Background I (Theories from Book)**

Based on readings, I found three different theories and method used by manufacturer's all over the world to minimize defects. Statistical Process Control (SPC) and Zero Quality Control (ZQC) have same objectives, that are reduce defects and make them do not exists. I use "Poka-Yoke – Improving Product Quality by Preventing Defects" edited by Nikkan Kogyo Shimbun and Factory Magazine as reference for further explanation about both of the theories.

### **2.2.1 Statistical Process Control (SPC)**

Statistical Process Control (SPC) had developed as one of the quality control methods where statistical methods and sampling inspections are applied. It is introduced in the United States by W. Edward Deming. But this method was found by Walter A. Shewart in the early 1920. Based on "Poka-Yoke – Improving Product Quality by Preventing Defects", SPC activities are based on the concept that 100 percent inspection is burdensome, time consuming and can be adequately replaced by sampling inspection and statistics. Because there is always some discrepancy and difference with the reality, the concept of SPC can be conclude as the certain level of defects is tolerated.

SPC, which is categorized by informative inspection and inductive statistics, sounds effective, but because the check-feedback-action-cycle does not begin until after defects occur, it is definitely tolerates defects existence. SPC is exactly a tool of quality control; it could only lower the defect rates, but it cannot eliminate the source of defects. Furthermore, by using sampling inspections, the detection of abnormalities in the products was performed selectively and corrective action took place slowly (Shingo S, 1964). It is said that there is no quality control without control charts, but control charts only help to maintain the accepted of defect rate and cannot reduce defects to zero.

This theory seems reasonable because SPC only effective to identify sources of variation and to control the whole of manufacturing process so as the process can operates with the maximum potential but it is less effective to control the product defects. I would say that sampling inspections is not really best method to reduce defects because the sampling inspections concept is based on the notion that a certain level of defects is inevitable and defects cannot be avoided. Not only that, the statistical basis used in sampling inspections only provide inspection techniques more rational by accepting a certain level of defects, but it did not represent a rationalization of goals to eliminate defects.

Basically, sampling inspection is at the same level as 100% inspection as their role is to reduce the product defects. But, since 100% inspection method require a great deal of trouble and involve a high labor costs, most of manufacturing firms choose to implement the sampling inspection. Sampling inspection is based on sample size that indicate on acceptable quality level (AQL) charts. This means, the size of the sample is determined by how often defects occur. Based on AQL approach, the defect rate is high when the sample size is low and the defect rate is low when the sample size is increase. This type of method can minimize the labor costs and make the inspections more considerable.

It is true that we could save time by using the sampling inspections method, but does this means that one of the thousands consumer will get the defect products? For example, if one item is taken out of 35 items for sampling inspection, or, if sampling is random, it is difficult to match the sampling with the occurrence of abnormalities of defects. Sampling inspection will make sense only from the manufacturer's view, but not from the consumer's perspective.

### **2.2.2 Zero Quality Control (ZQC)**

In a ZQC system, 100 percent inspection is achieved through poka-yoke, an approach that is inexpensive and requires little effort. Poka-yoke method which was introduced by Dr. Shigeo Shingo plays a major role in ZQC as tools for 100 percent inspection. Meanwhile, ZQC has three components that lead to elimination of defects:

#### **2.2.2.1 Source inspection**

This inspection is about checking the factors that cause the errors, not the resulting defects. Source inspection is also an inspection that discovers the errors in conditions that give big potential to defects and performing feedback and action at the error stage detected to keep those errors from turning into defects. Zero defect can be achieved if errors in production process do not turn into defects. So, source inspection is effective to eliminate defects based on how this system is functioning.

#### **2.2.2.2 100 percent inspection**

100 percent inspection uses inexpensive poka-yoke method (mistake-proofing) devices to inspect the errors automatically or defective operating conditions. The mistake can be corrected before it becomes the defect through 100% inspection. It is sometimes claimed that 100% inspection generally take a great deal of trouble and increase the risk of oversights (Shingo S, 1964).

### **2.2.2.3 Immediate action**

Immediate action is when the operations are stopped instantly or for a while, when a mistake is found and not resumed until the mistake is corrected. In addition, time should be minimizing for corrective actions when the abnormalities are occur.

ZQC is a method that can lead defects to zero by following the proper procedures. Once again, poka-yoke must be really understood as a tool to achieve ZQC. Dr. Shigeo Shingo is the person who transformed the poka-yoke idea into useful tool for achieving zero defects and eventually eliminating quality control inspections. Besides that, if abnormalities of products occur, poka-yoke system can carry out immediate feedback and action. Meanwhile, the effectiveness of poka-yoke system in reducing the defects depends on the inspection systems with which they are combined; source inspection, self-checks or successive checks.

As researcher, I have the confidence that ZQC is the best method to reduce as well as in eliminating defects. It is not impossible to achieve zero defects, if workers supported by proper training and by a production system based on principle that errors can always be prevented. Each of the manufacturing factories must have the intention and attitude for not giving any chance to have defects as well as do not tolerate to any single defect and organize the production so that 100 percent of the products can be inspected easily. Consumer confidence can be destroyed by only one defective product and to stay competitive, a company must supply good products.

## **2.3 Background II (Theories from Journal)**

### **2.3.1 Journal: Lean Production, Six Sigma Quality, TQM and company**

From the journal written by Jens J. Dahlgaard and Su Mi Dahlgaard Park, it states that another famous system to reduce waste is Just-In-Time (JIT) and Kanban System. By implementing JIT or Kanban System, much waste could be reducing. First of all, a large space was not necessary to keep a large number of parts. Second, only the product that needed was produced. Third, if defects were produced, it was immediately discovered, thus the system prevented a large number of defects to be produced (Dahlgaard J, Dahlgaard P, 2006). However, implementing this new system was not an easy task, especially if the system often produced defects. That means, if just one small part of the whole production system failed with defects, the entire production system should be stopped.

These theories can be explained as part of ZQC system. This is because, both of authors wrote, if one small defects was discovered, the whole part of production system should be stopped. This system could be implemented but many factors should be considered. It could be wasting not only space and time, production costs, human power costs, inventories costs and also raw materials costs. For the industry that manufactured a lot of products, this system is not an easy task to be implemented. Every single production could produce some small defects and the production is 24 hours. So, if some defects happen, and the entire production should be stopped, it could disrupt the smoothness of production. However, it is not impossible to implement this system as factors such as time, space and expertise can be considered.

### **2.3.2 Journal: Process Improvement by poka-yoke**

This journal that was written by Michael Fisher, is about poka-yoke. Poka yoke (pronounced POH-kah YOH-kay) is Japanese for mistake proofing and the approach is based around the removal of the cause of the defects, or, where this is impossible, the simple and inexpensive inspection of each item to determine that it passes the quality threshold-with no defects (Michael, 1999). The concept of poka-yoke is to prevent the mistakes that causes to the defects. Mistakes and defects are the two different elements and many people got confusion between those two words. Mistakes are unavoidable and usually come from human weaknesses. We cannot expect that human can fully concentrate and always to understand completely the instructions given as mistakes can always happen. Defects are identities that allowing the mistakes from process to reach the consumer and defects can be avoid.

The goal of poka-yoke is to reconstruct the process, so that mistakes can be prevented and defects can be eliminated. SPC is not effective enough to zero defects operations. The zero defects can be achieved when the mistakes are prevented. This is based on Matsushita's Washing Machine Division that had succeeded sustainable for one month with zero defects on a drainpipe assembly line with the involvement of 23 workers using the ZQC system.

Theories from books also stated that SPC is not helpful for zero defects operations. Personally, I tend to support the ZQC (poka-yoke) system in order to eliminate defects as well as reducing mistakes from human. Based on poka-yoke method, there are three types of inspection; judgment inspection, informative inspection and source of inspection. These three types of inspections are proven for contribute to successful zero defects achievement while there is no information about the successful of SPC in eliminating the defects.

## **2.4 Background III**

### **2.4.1 Article: Reducing Manufacturing Waste, The Dupont Way**

This article was written by Katrina C. Arabe. She states that there are three types of waste produced in manufacturing section (Katrina, 2001). The first type of waste is, process wastes, which are the result from transforming lower-value materials into high value added materials. Utility wastes are the second type of waste that result from the utility systems which provide the power to the manufacturing system. The third type of waste is the result from the starting process until finish which involved the machine shutdowns, maintenance and other operations. Defects can be categorized as process wastes and the third type of waste as stated above.

According to this article, the process waste is the most costly among these three types of wastes. By reducing the process waste, manufacturer can save the cost for making products also can reduce the potential of product defects. There are many types of wastes in manufacturing world that can contribute to product defects. There are:

#### **2.4.1.1 Overproduction**

Overproduction always happen when manufacture the products more than necessary. This can contribute to major wastes in product defects.

#### **2.4.1.2 Waiting**

Waiting is one of weakness when implementing the poka-yoke method. When defects occur, the whole process should be stopped and it can delay the process flow.

#### **2.4.1.3 Excess inventory**

Excess inventory can be determined by more supplies than needed to cover inefficiencies.

#### **2.4.1.4 Motion**

Motion is an example of ergonomic issues.

### **2.5 Summary**

There are many ways to reduce the waste as well as preventing the mistake in manufactured the products. But not all are suitable in reducing waste in manufacturing industry. Both of SPC and ZQC methods are applicable, but ZQC method is more proven and efficient to prevent defects. Based on all theories above, I will come out with my own theoretical framework. No matter how it will work, the waste still can be reduced and defects can be eliminated. These are the steps for preventing the defects according to my analysis:

Firstly, use high quality raw materials. Second, use the services of experts in accordance with their respective skills along the production process. Next, plan the process flow carefully and cautiously. After that, use source inspection to detect errors at their source before they cause defects (ZQC method). Fifth, use 100% inspection to recognize defects using a device such as sensor and buzzer (ZQC method). 200% inspection is also important in detecting the defects that cannot be