

A STUDY OF DEFECTS REDUCTION IN  
INJECTION PROCESS OF PRODUCTION LINE

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## **ABSTRACT**

This study was conducted to analyze various factors of defects in injection moulding process of the production line of manufacturing organization. Based on some reading material such as, journal, book and some study states that some factors such as machine, man, mould, method, technology and material caused defects in injection moulding process. The objective of this study is to determine the factors that caused defect in injection moulding process in production line. Interview secession will be conducting with production line and several departments manager to have some discussion and observation about the study. In the nut shell, I wish that this study will be one of the references to be use in future and may be can have some improvement for this study.

## ABSTRAK

Kajian ini dijalankan untuk menganalisis pelbagai faktor kecacatan dalam proses suntikan plastik barisan pengeluaran organisasi pembuatan. Berdasarkan beberapa bahan bacaan seperti, jurnal, buku dan beberapa kajian menyatakan bahawa beberapa faktor seperti mesin, manusia, acuan, kaedah, teknologi dan bahan disebabkan kecacatan dalam proses suntikan plastik. Objektif kajian ini adalah untuk menentukan faktor-faktor yang menyebabkan kecacatan dalam proses suntikan moulding dalam talian pengeluaran. Temuduga pemisahan akan dijalankan dengan barisan pengeluaran dan pengurus beberapa jabatan mempunyai beberapa perbincangan dan pemerhatian mengenai kajian ini. Kesimpulannya, saya ingin menjadi kajian ini bahawa akan salah satu rujukan yang akan digunakan pada masa akan datang dan boleh mempunyai peningkatan untuk kajian ini.

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## **CHAPTER1**

### **INTRODUCTION**

#### **1.1 INTRODUCTION**

In the recent years, the intensifying competition arose in the international economy has caused most organizations to adapt various approaches to manage and prevent any possible defects to better achieve higher competitive advantages. The defect can generally be defined as, frailty or shortcoming that prevents a task from being complete, desirable, effective, safe, or make it to malfunction or fail in its purpose (Business Dictionary). Substantial defect may cause significant losses to an organization, such as rejected quality, wasting resources, wasting of time and so on. But on the other hand, defects can also be a reason for an organization to prevent loss, therefore to improve the work processes, change better working practices, and increase inspection levels to high quality levels have been attained. In this study, we will find out the defect, which happened and effect for the manufacturing companies.

In these recent 25 years, there are more people places great emphasize and importance of green issues. We are all aware that our society has insufficient resources to fulfill all human wants and needs. To fulfill human infinite demand of goods and services with finite resources has become the goal and challenge of every industry. To minimize the chances that might cause wastages at the same time also look after our planet, the management team of a manufacturing company should reduce the organization defects rate. The defect can affect the whole production cycle, therefore a product quality action should include the whole product life cycle, starting from identifying customer requirements and expectations, by the customer services. Every transform process of a product is to satisfy customer, understanding customers' needs is

an essential part of an organization. The organization that focus on quality process approach should also improve the existing quality management system, the defined processes and also their products by implementing the available philosophy (Kaizen, Poka-Yoke method, Six Sigma, TQM), rules (W.E. Deming, J. Juran), quality tools and methods of quality management.

There may be several reasons that one item in a particular product line is defective and the others are not. Human errors, machines breakdown, environmental issues, limited resources and many other factors can cause defects. For instance, the materials used in one injection moulding process with batch may not have met the standard of the materials used in the others production batch. Defects that happened due to human factor can probably ground on misunderstanding of instruction or interpretation, incorrect identification, lack of worker training, good intentions but improper implementation and etc. Once the defect causes have been detected, a solution should be formed to overcome it. “Prevention is better than cure” applies to defects in the manufacturing life cycle as well as illnesses in medical science. Therefore, a set of defect management system should be implemented before defective occur and before the defective problem had become serious. There is an advantage of early defect detection by using software to analyze data. The National Institute of Standard Technology (NIST) published a study in 2002 noting that the cost of fixing one bug found in the production stage of the software is 15 hours compared to five hours of effort if the same bug were found in the coding stage, as well as in production line.

In IBM Systems Sciences Institute has reported that the cost to fix an error found after product release was four to five times as much as one uncovered during design, and up to 100 times more than one identified in the maintenance phase. Defect prevention involves a structured problem-solving methodology to identify, analyze and prevent the occurrence of defects. Defect prevention is a framework and ongoing process of collecting the defect data, doing root cause analysis, determining and implementing the corrective actions and sharing the lessons learned to reduce or avoid

future defects. The defect prevention process begins with requirement analysis which is translating the customer requirements into product specifications without introducing additional errors. Software architecture can be designed by using CAD, testing is done to find out the defects, followed by defect documentation. Any defect parts can be detected, identified, tracking or documenting and analysis of defects for arriving at quick, short-term solutions by using the software before producing, so the chance to produce a defect product can be minimized.

Manufacturers have an obligation to test each of their product or by random sampling checking before selling them to the market. Quality check (QC) department is essential in a manufacturing company, in order to maintain the quality by rejecting the defect products. A company may be liable for its defective product if any of its defective products is allowed onto the market and someone is harmed as a result of the use of such defective product, under the Consumer Protection Act 1999. Under the Restatement (Third) of Torts: Products Liability, a product "contains a manufacturing defect when the product departs from its intended design even though all possible care was exercised in the preparation and marketing of the product."

Defects may affect to increase organizational cost. The costs can generally categories into three groups, which are production cost, material cost and tooling cost. The material cost is manipulated by the weight of material required and the unit price of that material. The weight of material can determine the part volume and material density. The weight of material that is required includes the material that fills the channels of the mold. The size of those channels, and hence the amount of material, is largely determined by the thickness of the part. Any variation of the material will effect on the quality, if the quantity of defects increase it will also increase running cost of organization and decrease the productivity. The tooling cost has two main components which is the mold base and the machining of the cavities. The cost of the mold base is primarily controlled by the size. A larger part requires a, the more expensive the mold

base. Nearly every aspect of the part's geometry is affected the cost of machining in the cavities.

The production cost is calculated from the hourly rate and the cycle time. Injection molding machines are typically referred to by the tonnage of the clamping force they provide. The required clamping force is determined by the projected area of the part and the pressure with which the material is injected. The cycle time can be divided into the injection time, cooling time, and resetting time. By reducing any of process times, the production cost will be lower. The injection time can be decreased by reducing the maximum wall thickness of the part and the part volume. The cooling time is also decreased for lower wall thicknesses, as they require less time to cool all the way through. Several thermodynamic properties of the material also affect the cooling time. Lastly, the resetting time depends on the machine size and the part size. A larger part will require longer time for motions from the machine to open, close, and eject the part.

## **1.2 PROBLEM BACKGROUND**

Bharti, P.K.et. al. (2010) said that injection moulding has been a challenging process for many manufacturers and researchers in order to produce products that meet the customer requirements at the lowest cost. Defects have significant costs associated with some of the most obvious being money, time, resources, and lost reputation. Eliminating defects can be expensive, wasting resources and time consuming. Stated by Philip Crosby in 1979, where there are zero defects, there are no costs associated with issues of poor quality, and hence, quality becomes free. Defects are not acceptable, and that everyone should do things right the first time instead of eliminate it.

There are several causes of defects in a production line of a manufacturing organization. Therefore, to minimize the defective rate the manufacturer should find out the exact causes and define ways with the unique method to overcome each problem. Human errors, machinery breakdown, resources with different batch, the changing of

the environment, these entire can cause defective occur. Sometimes, even a mile difference in the materials used can cause defective happened. Production manager play an important role when defective happen, once production operator had reported any defective occurs the action have to be taken immediately.

### **1.3 PROBLEM STATEMENT**

Malaysia industry can be divided into two sector which is manufacturing and services. This study is focus on manufacturing organization which located in Kluang, Johor, Malaysia. Teong Hin Plastic Industries Sdn Bhd was established in Year 1978, based Teong Hin is original equipment manufacturer (OEM) and replacement equipment manufacturing (REM) manufacturer and supplier of plastic products. Teong Hin Plastic Industries SdnBhd's goal is to provide the best service and maximum quality in the products that manufacture and deliver to their esteemed clients. To build strong and good reputation among the clients quality products are importance to maximize client satisfactory. Therefore, to minimize the defects will be one of the factors to maximize the products quality. In order to achieve the goals of Teong Hin Industries Sdn Bhd, a systematic tools and techniques is vital and essential.

According to Cambridge Dictionary, defect can be defined as a fault or problem in something or someone that spoils them or causes them not to work correctly. Therefore, defect management is an essential task which is aimed to reduce the defective in manufacturing that produce customer required product at the minimize cost and shortest time and the highest customer satisfaction. To achieve the goals Teong Hin do needed to implement a better practice or using better tools and technique to ensure the quality of the finished good.

There are numerous types of defects can be happened in injection process of the production line within the manufacturing area. The use of low-quality materials, improper assembly, supervision oversight, failure to follow safety regulations, use of

hazardous substances, such as mercury or lead in excessive amounts, all these could be the factor that caused defects. Generally defect can be categorized in to four types, which the input factor, machine, process, and mankind are failing. As for the input factors, the common causes are poor-quality materials used and the improper storage of material methods that causes producing unsatisfactory or rejected output such as dirt-mark or black-dot. During the process factor, a defective is happening due to lack of or irregular machinery maintenance. Mankind factors can be human fatigue, carelessness, not enough experience and training of functioning machinery, errors due to the misunderstanding, misinterpretation, and miscommunication. For machinery side, fluctuation runner temperature, empty hopper, blocked feed throat, machinery auto stop can also will caused defects happened.

A manufacturing defect is one that could be made less dangerous, or gotten rid of altogether, if the product were made with better-quality materials or was made by a more careful and experienced worker. In contrast, a design defect makes the product dangerous no matter how well it is made or how carefully it is put together, but it could prevent instead of fetch up when the detective had happened. The renovation cost is much higher than prevention cost.

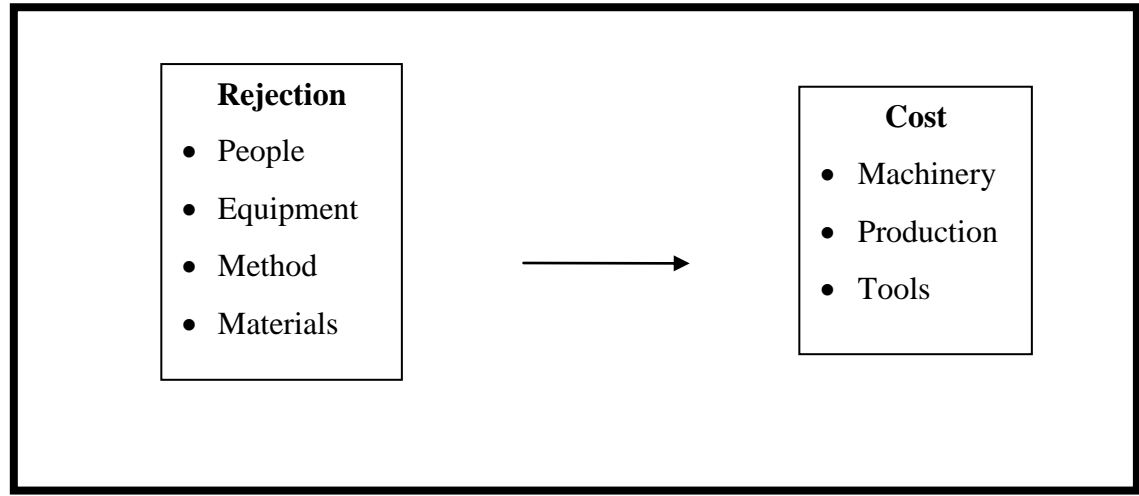
#### **1.4 RESEARCH OBJECTIVE**

1. To determine the factors that caused quality defects in injection moulding process.
2. To overcome the quality defects based on the factors has been found.

#### **1.5 RESEARCH QUESTION**

1. What are the factors that caused quality defects in injection moulding process?
2. How to overcome the quality defects based on the factors has been found?

## 1.6 RESEARCH FRAMEWORK



**Figure 1.1:** Research Framework

## 1.7 SCOPE OF STUDY

This study is formed to reach the objective of the study. It is aimed to determine the factors that caused quality defects in injection moulding process and overcome the quality defects based on the factors has been found in the injection moulding process of production line in Teong Hin Plastics Industries Sdn Bhd. The causes will be defined at the end of this study and to get the solution to overcome the causes. The effective way to reduce quality defects will be obtain based on the interview to the management of the Teong Hin Plastic Industries Sdn Bhd. Open-ended question style will be carry out in this research to get the more accurate and immediate response. The scope research will be conduct at Teong Hin Plastic Industries Sdn Bhd, located in Kluang, Johor, Malaysia. Interview question will be distributed to the cluster samples, which are the workers of production department and top management team.



## **1.8 SIGNIFICANCE OF STUDY**

This research is intended to determine the factors that caused quality defects in injection moulding process of the production line in Teong Hin Plastics Industries Sdn Bhd and also to minimize defects in the organization. Moreover, this study will also address issues like types of defects occur in the injection process. Defect might cost in machinery, tools and production. Every stakeholder is concern to the organization's performance. A customer will not accept any rejected part or component of a product. A defective product might subsequently bring mishap to the manufacturer. The most suitable system will be used to analyze the data that has been collected in order to product accurate result at the end of the study.

## **1.9 OPERATIONAL DEFINITION**

The purpose of operational definition is used to define the important keyword and term in the research so that this research can easily be understood.

### Defect

- In manufacturing area it is a non-conformance of a product with the specified requirements, or non-fulfillment of user expectations including the safety aspects. Defects can generally effect an organization's reputation, increase cost, product quality and so on.

### Defect Reduction

- It is a process or solution used to reduce or solve the problem of nonconformance in a manufacturing organization. There are many types of solution used to solve the different defect in the manufacturing organization, for example, product defect, production defect, and so on.

### Injection molding process

- Injection molding process is the most commonly used manufacturing process for the fabrication of plastic parts. A wide variety of products are manufactured using injection molding, which vary greatly in their size, complexity, and application. The injection molding process requires the use of an injection molding machine, raw plastic material, and a mold. The plastic is melted in the injection molding machine and then injected into the mold, where it cools and solidifies into the final part. The steps in this process are described in greater detail in the next section.

### Production Line

- Production line is a set of system in the operations established in a factory where process the input into output. For example, the system of processing the rubber into plastic chair is a system of production line.

### Total Quality Management

- Total quality management is a philosophy of management for continuously improvement in the aspect of quality of products. TQM is a good way used to reduce to product defect in process of production.

### Poka-yoke

- The aim of Poka-yoke is to eliminate defects in a product by preventing or correcting mistakes as early as possible. Poka-yoke has been used most frequently in manufacturing environments.

## Kaizen

- Kaizenin Japanese term is meaning of improvement, or change for the better. It refers to philosophy or practices that focus upon continuous improvement of processes in manufacturing, engineering, and business management.

### **1.10 EXPECTED RESULT**

In the end of research, the result expected is able to reduce the defects in manufacturing organization successfully, such as avoid produce low quality product, reduce cutting error, avert molding error and so on. The objectives of this study which is finds out the factors of defects happened and to overcome the defects in based on the factor has been discovered in manufacturing organization. Reduction of defects is aiming to reduce the cost and time consuming, in addition to eliminate the waste in the production of manufacturing organization. The most suitable tools and technique will be used to conduct this research and suggested to the organization.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

This chapter represents theoretical background of the past researcher on journal. Literature review shows the process of reading, analyzing, evaluating, and summarizing scholarly materials about a defects reduction, and all methods that able to reduce defective. The results of a literature review may be compiled in a report or may serve as part of a research article, thesis, or grant proposal. Since, the review is done so that this present study attempt can appropriately adapted to include to the present literature in order to fulfill the scope and support this present study materials.

In this chapter will overview the philosophy about the method that can helps in reducing defects in the production line, there are, Poka-Yoke method, Six sigma, KAIZEN, TQM and Zero defects. Otherwise, the factor that might cause defective also will be discussed in this chapter. To prescribe the right medicine to the illness, the method applying must be chosen based on the reasons in order to confine the defects. In this study, the method can helps in overcome the cause-and-effect will be determine base on the manufacture organization phenomenon and interview feedback. According to Fouad and Rami Hikmat (2005) a term typically uses a causes-and-effect diagram to identify and isolate causes of the problem. The causes-and effects will be show in fishbone diagram in the following chapter.

Those methods mention in above are presented and have been applying in many organizations, for example Toyota. These methods are necessary for every manufacturing company because they always face defects problem comparing with

service sectors. Those methods are efficient and effective in solving the defects problem, such as product defects, quality defects.

## **2.2 CAUSES OF DEFECTS**

Defects may happen in any stage of the transforming process, input, process, and also output. The causes of defects can be simply categorized into three types: there are materials, human and machinery. To lowest the defective, firstly need to know well about the cause factor. By utilized different method of way to overcome the different cause will be more effective and efficiently. Defects results from allowing a mistake to reach at the customer end, therefore the organization reputation will be ruin because of the defect product. Quality control department play a main role to checking the products carefully and have a good cooperation with production department.

### **2.2.1 Materials**

The variability of each batch of material is dependent variable, which is uncontrollable. In principle it is not possible to improve on the variability in either mass or unit area properties or fiber straightness, so the variability in the incoming materials sets the minimum variability (Potteret al., 2006). Because of the material is dependent variable that cannot be change and no possible to be improved, therefore the only thing can do is adjust machinery setting to fit to the variability of the material rather than using the same setting to produce defect product. Any solution will be tried to reduce defects and also minimized the cost.

Defect and quality of the material have a strong relationship between each other. The higher quality of the materials, the lower defective happened. Otherwise, the low quality materials will cause high defective. Production line operator should look-out when using different batch of material, if there is variability operator must report to production manger. Then, production manager have to discuss with the organization

engineer either doing adjustment in the machinery or forgo that batch of material, leaving until suitable chance to use it.

### **2.2.2 Man**

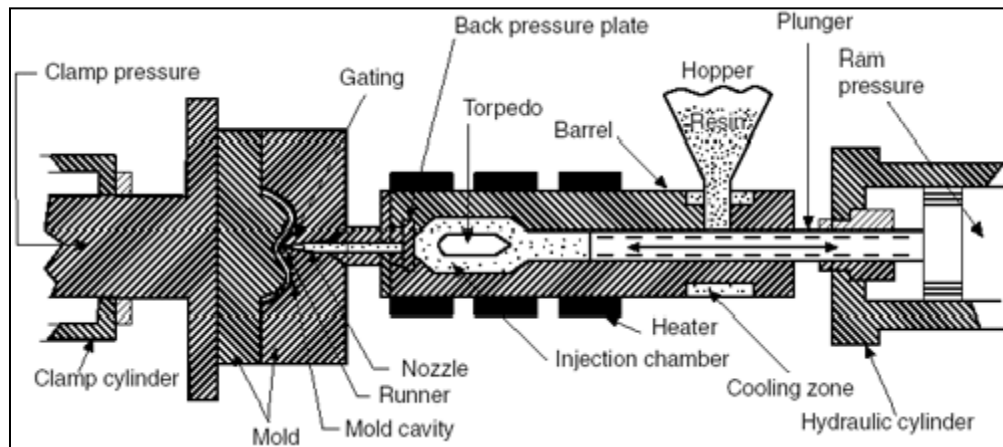
Employee, human is the main assets of an organization. They able to used their intelligent to help organization generate wealth by using their strength to get wage. Normally, the defects caused by human resources because they are lack of skill and related knowledge, especially in this modern era. Using high-tech machines require related professional knowledge, without the knowledge, workers may not manage well in the production process and it may causes defects happened. Training can be given by organization to enhance their require skill in order to manage the machinery well.

Sometimes, the defects caused by humanity are because of human fatigue, carelessness, forgetfulness and errors due to the misunderstanding, misinterpretation, miscommunication and so on. Mistakes are in evitable, people are human beings and cannot be expected to concentrate all the time on the work or to understand completely the instructions. To overcome the humanity causes, sign board or memo board can be built to remind worker for the important issue. Tolerance should be given because humanity is not perfect. Communication and teamwork are to avoid misunderstanding, misinterpretation, miscommunication also vital in producing low defect products

### **2.2.3 Machinery**

While the machine runs for 24 hours every day, defects might happen because of non-stop producing products. So, the maintenance of the machinery is important to an organization. The maintenance should be executed regularly like monthly, semi-year or yearly, to maintain the machinery is in the top performance and lowest defects. Quality control department have to inform to the mechanic if defects are happened frequently, that might because some of the machinery setting or parts goes wrong.

Skillful technician and operator are required in producing high quality finished goods. The machinery using in injection moulding process is plastic injection moulding machine. The machine clamping end with moving platen takes half of the mould tool. This opens and closes the mould and supplies sufficient force to keep the mould closed when molten plastic is injected under pressure. Therefore, the material will also affect the quality of the products, the material should be chosen to match and suit the mould.



**Figure 2.2.3 Injection moulding machine**

#### 2.2.4 Mould

The mould or die refers to the tooling used to produce plastic parts in molding. Plastic injection molds have the ability for producing high volumes of plastic parts, due to the capable of making multi-cavity injection molded parts, where multiple parts are made with one cycle. Molds are typically constructed from aluminum, hardened steel, pre-hardened steel and beryllium-copper alloy. The choice of material to build a mold from is primarily one of economics. Generally, the steel molds cost more to construct but offer a longer lifespan that will offset the higher initial cost over a higher number of parts made before wearing out. Pre-hardened steel molds are less wear resistant and are primarily used for lower volume requirements or larger components. Mould is a shaped

cavity used to give a definite form to fluid or plastic material. Oxford Dictionary defined mould as a hollow container used to give shape to molten or hot liquid material when it cools and hardens. The liquid hardens or sets inside the mold, adopting its shape. A mold is the counterpart to a cast. Injection moulding process does have some advantage and disadvantage. Some advantages of injection molding are high tolerances, repeatability, wide range of material selection, low labor cost, minimal scrap losses, and little need to finish parts after molding. Some disadvantages of this process include an expensive tooling investment and the need to prototype, as some custom complex parts may encounter problems during the injection molding process such as warp or surface defects. Therefore, injection molded parts must be designed with careful molding consideration. Mould is one of the assets of the organization, every mould will be costly to organization. To maintain the mould always in good condition is essential task of the production operator. Dusty mould and low melt mould temperature will make defects happened.

### **2.2.5 Causes and Effects Analysis Tools and Techniques**

It is important to explore all of the things that could cause before start thinking about a solution, when there is a serious problem occurred. That way can solve the problem completely, first time round, rather than just addressing part of it and having the problem run on and on. This diagram-based technique, which combines brainstorming with a type of mind map, pushes to consider all possible causes of a problem, rather than just the ones that are most obvious. Diagram based techniques also can state out the percentage or the frequency of the causes. Probably, tools and technique will be used to conduct this study would be Pareta Chart, Ishikawa Diagram and Scatter Diagram.