UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PROCESS DEVELOPMENT OF DIE CASTING IN A PRODUCTION LINE

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **PROCESS DEVELOPMENT OF DIE CASTING IN A PRODUCTION LINE**

Sesi Pengajian: **2021/2022 Semester 2**

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Sekian dimaklumkan. Terima kasih.

Yang benar,

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I hereby, declared this report entitled "Process Development of Die Casting in a Production Line" is the result of my own research except as cited in references.

Signature : .....

Author's Name : AINA DALILA BINTI AHMAD ROZELAN

Date : 12 February 2022

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

.....

(NIK MOHD FARID BIN CHE ZAINAL ABIDIN, PhD)

ABSTRAK

Pada masa kini, kebanyakan industri pembuatan berada di ambang untuk menghasilkan produk pada kepelbagaian tinggi pada kos rendah dengan kualiti yang lebih baik berikutan persaingan yang semakin meningkat dalam sektor tersebut. Isu ini boleh diatasi dengan menyokong proses pembuatan yang paling sesuai untuk industri mencapai pembuatan yang fleksibel dan ramping. Sebuah syarikat perkakasan pintu di Melaka, Malaysia telah melaksanakan fasa 3 Perancangan Kualiti Produk Lanjutan (APQP) untuk meminimumkan kos dan meningkatkan kualiti produk Beacon Baseline 83 (BL83). Objektif kajian ini adalah untuk menyiasat pelbagai faktor, melibatkan dalam tuangan die graviti (GDC) dan tuangan die tekanan (PDC) dalam barisan pengeluaran, untuk menganalisis proses dan kualiti produk yang terlibat dalam tuangan die graviti (GDC) dan tekanan. proses die casting (PDC) dan untuk mencadangkan proses pembuatan yang paling sesuai dalam barisan pengeluaran. Kajian ini hanya tertumpu pada aspek proses dan kualiti. Diagram Ishikawa digunakan untuk menentukan isu proses GDC dengan mengumpul data melalui sesi sumbangsaran. Dengan melaksanakan APQP fasa 3, kualiti produk boleh diperoleh dengan menggunakan beberapa analisis seperti Failure Mode and Effect Analysis (FMEA), Process Capability Analysis (PCA), Control Plan dan Cost-Benefit Analysis (CBA). Oleh itu, proses pembuatan yang paling sesuai ditentukan oleh hasil analisis. Oleh itu, proses PDC ditentukan sebagai proses pembuatan yang paling sesuai kerana proses tersebut mencapai objektif utama untuk meminimumkan kos dan meningkatkan kualiti produk. Pengesahan keputusan membuat nombor RPN rendah dan Nisbah Kos-Faedah (CBR) yang tinggi iaitu 860 dan 1.08. Jelas sekali, kajian ini membuktikan bahawa Perancangan Kualiti Produk Lanjutan (APQP) merupakan salah satu kaedah yang paling berkesan untuk membuat keputusan bagi sesebuah syarikat.

ABSTRACT

These days, most of the manufacturing industry are on the verge to produce products at high variety at a low cost with better quality due to the increasing competition in the sector. The issue can be countered by endorsing the most suitable manufacturing process for the industry to achieve flexible and lean manufacturing. A door hardware company in Melaka, Malaysia has implemented phase 3 of Advanced Product Quality Planning (APQP) to minimize the cost and improve quality of Beacon Baseline 83 (BL83) product. The objectives of this study are to investigate various factors, involve in gravity die casting (GDC) and pressure die casting (PDC) in the production line, to analyse the process and quality of the product involve in gravity die casting (GDC) and pressure die casting (PDC) process and to propose the most suitable manufacturing process in the production line. This study was only focused on process and quality aspects. The Ishikawa Diagram used to determine the issues of GDC process by collecting the data through brainstorming session. By implementing phase 3 APQP, the quality of the product can be obtained by using several analyses such as Failure Mode and Effect Analysis (FMEA), Process Capability Analysis (PCA), Control Plan and Cost-Benefit Analysis (CBA). Thus, the most suitable manufacturing process was determined by the analyses result. Therefore, PDC process was determined as the most suitable manufacturing process as the process achieved the main objective to minimize the cost and improve the quality of the product. Validation of the decision making resulting in low RPN number and high Cost-Benefit Ratio (CBR) which is 860 and 1.08. Clearly, this study proved that Advanced Product Quality Planning (APQP) is one of the most effective methods for decision making for the company.

DEDICATION

A gratitude to:

My Heaven on Earth

Hj. Ahmad Rozelan bin Hj. Yunus

Hjh. Rokiah binti M. Jahi

for the perfect living and endless love

My Love-Hate Relationship Siblings

Syazwani Nadiah

Late sister Mimi Fariha

Aimi Fatihah

as shoulders to cry on and my stress relievers

My Energetic Supervisor

Dr. Nik Mohd Farid bin Che Zainal Abidin

for the ideas, encouragements, motivations and keeping trust on me

and lastly

the pure heart

Muhammad Syakir bin Mohd Sufi

During the highest and lowest points of this journey.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

GDC	- Gravity Die Casting
PDC	- Pressure Die Casting
DPM	- Dormakaba Production Malaysia
APQP	- Advanced Product Quality Planning
FYP	- Final Year Project
AA	- Aluminium Association
LPDC	- Low Pressure Die Casting
HPDC	- High Pressure Die Casting
BOM	- Bill of Materials
FMEA	- Failure Mode and Effect Analysis
DFMEA	- Design Failure Mode and Effect Analysis
DFM	- Design Manufacturability and Assembly
HAZ	- Heat Affected Zone
PFMEA	- Process Failure Mode and Effect Analysis
RPN	- Risk Priority Number
PCA	- Process Capability Analysis
LSL	- Lower Specification Limit
USL	- Upper Specification Limit
PPAP	- Production Part Approval Process
PCP	- Process Control Plan
CBR	- Cost-Benefit Ratio
CBA	- Cost-Benefit Analysis
BL83	- Baseline 83
SOP	- Standard Operation Procedure
WIP	- Work Instruction Procedure

CHAPTER 1

INTRODUCTION

In this chapter, the background of the study will be covered in this chapter as critical information for resolving the industry's current problems. The issues are identified using a variety of methods, including interviews, surveys, observations, and video recording. Following that, objectives are defined to be fulfilled in the study, with a scope of study that focuses on to study the process of gravity die casting (GDC) and pressure die casting (PDC) in the manufacturing industry. Finally, the study significance is shown.

1.1 Background of Study

In recent years, one of the most important and urgent tasks or goals of the organization has been to pay attention to customer needs and respond to their requests, both in manufacturing and services. One of the most crucial assessment criteria is quality, which is a broad term to which various sections of the company are dedicated. Its aim is to improve the overall performance of the company at a low cost to boost productivity. As a result, the entire range of features required to accommodate customers is available (Fiegenbaum, 1991).

Quality is characterised as the sum of the features and characteristics of a product or service that will meet consumer needs, according to the Society of America quality control. The term "customer-centric" refers to the fact that an organisation can only achieve maximum quality of the goods and services it provides if it meets or exceeds customer standards. (Kotler, & Armstrong, 1999).

This research has been conducted at a Melaka-based door hardware company. Door hardware, which includes door closers, locks, fittings, emergency exit systems, electrified door hardware, and panic hardware, is the company's main product. The study's main goal is to investigate various factors that involve in GDC and PDC process in the manufacturing

industry to achieve the objectives to minimize the production cost together to improve the quality of the product. There are many factors that affecting the decision making of to finalise the most suitable manufacturing process for the company such as quality, cost, and time. As a result, each of those factors will impact the decision-making process. However, the suitable process to analyse decision making for selecting the most suitable manufacturing process for Beacon Baseline 83 (BL83) at door hardware company need to be identified.

To see the possible solution, the decision-making process necessitates the presence of a decision-making problem that must be completely grasped by the decision-maker. According to the journal (Negulescu, 2014), there are a few decision-making process models that are commonly used for strategic management, particularly to make faster decisions. Depending on the problem, the appropriate process can be selected. Each decision-making model has its own set of conditions and methods. As a result, all relevant data and information related to both processes must be gathered and analysed. Calculate the DFMEA and PFMEA, Control Plan, Process Capability, and Cost Benefit Ratio. As a result, the company may be able to make the best decision possible.

Especially in this epidemic condition, the company must choose the most profitable options. APQP, PPAP, and FMEA are just a few of the analysis methods that may be utilised to compare the two processes in this research.

1.2 Problem Statement

In business, it is critical for companies to be attentive and responsive to their surroundings, particularly when it comes to global policy. If global policy changes, every company engaged must be prepared to deal with the consequences. The decision-making process must take place within the company. Making decisions is an important part of running a successful international business (Nemkova et al., 2012). However, the decision-making process must be specified in detail.

The processes of GDC and PDC are currently being utilized in the factory which is Dormakaba Production Malaysia Sdn Bhd (DPM). The goal of this study is to propose the most suitable manufacturing process in the production line by aiding the Advanced Product Quality Planning (APQP) method. The current issues of this project are, there is an

incremental in the material cost, which is aluminium and the number of scraps of the product for GDC process is higher than PDC process. The facilitating of APQP method in the production line for this project is to improve efficiencies in bringing new products to market as APQP method undergo 5-phase models which are plan and define the program, product design and development, process design and development, product, and process validation and lastly feedback, assessment, and corrective action. Thus, this study will only take part in the phase 3 of APQP which is process design and development as this study only focus on quality and process factors.

Both processes which are GDC and PDC are currently run for the product Beacon Baseline 83 (BL83) shown in Figure 1.1. However, the relationship of weight and the cost of castings are related. If the decision making of to decide to only run one (1) process for the product, the company will withdraw the process that not beneficial in terms of quality, time and cost. However, the withdrawal will only be happened for this specific product and still runs for other small products.

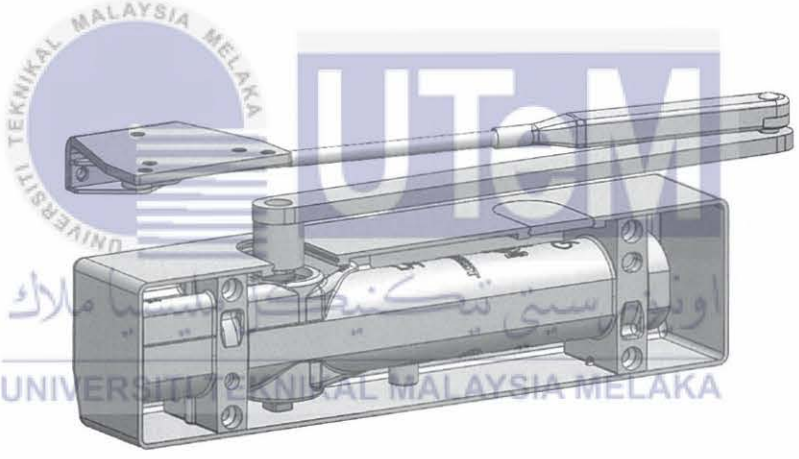

Figure 1.1: Beacon Baseline 83 (BL83)

This project will focus on decision making of the most suitable manufacturing process for the BL83 product. The analyses to be made are important to prove and to ensure the company will gain benefit based on the decision that will be made. Currently, the company is having difficulty picking amongst the several possibilities presented. As a result, the purpose of the project is to assist the company in making decisions by analysing possibilities and recommending appropriate approaches. The study' findings will be used to recommend the best manufacturing process for BL83 in the production line, ensuring that the casting process runs smoothly and improve in terms of quality, time and cost.

1.3 Objectives

The objectives of this study are as follows:

a) To investigate various factors, involve in gravity die casting (GDC) and pressure die casting (PDC) in the production line.
b) To analyse the process and quality level of the product involve in gravity die casting (GDC) and pressure die casting (PDC) process.
c) To propose the most suitable manufacturing process in the production line using Advanced Product Quality Planning (APQP) method.

1.4 Scopes of Study

The scope of this project involves the elements that needs to be considered which is:

1) Investigate on the factor of quality and cost for both processes in production line by using Ishikawa Diagram as guideline. In this investigation, it is more focus on observation and discussion with the manager of quality of the company about the main issue that arise.
2) Applying the phase 3 APQP method and cost study for both processes in production line. However, there are specifications and data that need to be analysed appropriately before applying the methods.
3) Proposing the most suitable process by summarize all the results obtained according to all the analyses that have been done.

1.5 Significant/Important of Study

Regarding the completion of this report, the industry will be able to obtain some possible benefits. The most suitable manufacturing process will be determined and will

impact the framework product and process of development. Additionally, by aiding the APQP method helps to improve the efficiencies in bringing the most suitable process. Thus, the productivity of the industry will escalate tremendously in terms of costing, time etc.

1.6 Organization of the Report

The project organization was created based on the Final Year Project (FYP) to have a clearer vision and a brief overview of the whole project. The following is the report's structure for this study that categorised in five (5) chapters:

Chapter 1: **Introduction**

The background of the study as well as the background of the company are discussed in the introductory chapter. Several methods, such as surveys, observations, video recording, and questionnaires, are used to identify current issues. The aims to be accomplished and the scopes of the study are then discussed to narrow down the field of expertise. The importance of studying is also stated.

Chapter 2: **Literature Review**

This chapter discusses a literature review on the study's history or basic facts, which was gathered from a variety of sources including the internet, books, papers, and journals. The most suitable process is defined. The overview of the approach used to solve the problems and suggest alternatives is given in these contents.

Chapter 3: **Methodology**

This chapter explains the study's experimental approach in detail. Project flowchart, observations of current changeover operation, data collection, time study, and APQP implementation will all be included.

Chapter 4: **Result and Discussion**

This chapter described the result based on the analysis that have been done. This includes an overview result to compare the manufacturing process that can be used at the production line. Further discussion also will be made to ensure the efficiency of the productivity.

Chapter 5: **Conclusion**

This chapter concludes the overall of the project about the process development of die casting in a production line in the door hardware manufacturing industry.

CHAPTER 2

LITERATURE REVIEW

In Chapter 2, the summarised information research is organised into linked fields of study that are needed for this study. For this study, general concepts, important material, previous research papers, and journal articles by researchers are gathered. From the methodological stage through the finish of Final Year Project (FYP) 2, this chapter will guide through the planning and implementation of the full research.

2.1 Die Casting

2.1.1 Cast Metal

Zinc, aluminium, magnesium, copper, lead, and tin are the most frequent die casting alloys, which ferrous die casting is also feasible, though it is unusual (Degarmo, p. 328). Zinc aluminium; aluminium to The Aluminium Association (AA) standards: AA 380, AA 384, AA 386, AA 390; and AZ91D magnesium are examples of specific die casting alloys (efunda Incl, 2008). The following is an overview of each alloy's benefits:

1) Zinc is the simplest metal to cast; it has good ductility and impact strength, is easily coated, and is cost-effective for tiny components. It also has a long die life.
2) Aluminium is lightweight, has great dimensional stability for highly complicated designs and thin walls, is corrosion resistant, has good mechanical characteristics, and has high thermal and electrical conductivity. It also keeps strength at high temperatures.
3) Magnesium is the easiest metal to manufacture, has a high strength-to-weight ratio, and is the lightest die-cast alloy.
4) Copper has a high hardness, a strong corrosion resistance, and the highest mechanical qualities of any die-cast alloys. It also has outstanding wear resistance, dimensional stability, and strength comparable to steel components.