Faculty of Mechanical and Manufacturing Engineering Technology

APPLICATION OF SINGLE MINUTE EXCHANGE DIE AND ANALYTICAL HIERARCHY PROCESS CONCEPT FOR SMALL MANUFACTURING ENTERPRISE

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Bachelor Degree in Manufacturing Engineering Technology (Product Design) with Honours

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APPLICATION OF SINGLE MINUTE EXCHANGE DIE AND ANALYTICAL HIERARCHY PROCESS (AHP) CONCEPT FOR SMALL MANUFACTURING ENTERPRISE

LUQMANULHAKIM BIN HANAPIAH

A report submitted in accordance with the requirement for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I declare that this report entitle “Application of Single Minute Exchange Die & Analytical Hierarchy Process (AHP) Concept for Small Manufacturing Enterprise” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently in candidature of any other degree.

Signature	:…….
Student Name	:…….
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APPROVAL

I hereby declared that I have read this and in my opinion this report is sufficient in terms of scope and quality for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

Signature :……

Supervisor Name :……

Date :……

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DEDICATION

This report is dedicated to my parent who so far being my greatest supporter ever, both in material and morale. Also, to my beloved friends who always give me a great degree of encouragements to completing this thesis.

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ABSTRACT

Small manufacturing enterprises are one of the main components of the industrial manufacturing scenes in Malaysia. Operating in small scale, these kind of business are rarely able to compete with the industrial giants when it comes to producing goods in huge scale. Inferiority in equipment and financial supports are always associated with the small manufacturing enterprises when it comes to competition with these huge industries. However, small scale business have one big advantage: lesser investment cost needed for both setup and operations, as many small business tends to invests only on the very critical sectors with costs as less as possible. However, the investor had to juggles whether they had to invest more on the plant to ensure smooth production flow or to simply minimize the cost at a possible price of reduced product quality. Recent developments regarding the Single-Minute Exchange Die is considered a positive new as it enables the investors to reducing their costs on plant setup or re-assembly process as SMED concept intends to reduce setup costs, while maintaining the production momentum. The improvement of plant with the SMED concepts will enable not just reduced cost, but apparently reduces further strain on workers, who had to deal with a long and complex setup process for a long time. Also, the implementation of Analytical Hierarchy Process (AHP) decision-making tool will enables the company to better observe which sector needs critical observation with weightage based on the relevant information on site. The outcome of this project are the designing of a tool that could improve the foolproofing method on the quality inspection, in which the tool also adapted some of the SMED concepts which includes interchangeability and quick maintenance capabilities.

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ABSTRAK

Perusahaan pembuatan secara kecil adalah salah satu komponen penting dalam arena industri pembuatan negara hari ini. Beroperasi dalam skala kecil, kebanyakan daripada mereka tidak mampu untuk menghasilkan output yang lebih besar berbanding saingan mereka dalam arena gergasi industri. Kekurangan dari segi peralatan dan carakerja adalah antara sebab yang kerapkali dikaitkan dengan perusahaan pembuatan kecil-kecilan apabila berkenaan topik persaingan dengan syarikat besar. Walau bagaimanapun, industri kecil sebegini mempunyai satu kelebihan yang signifikan-kurang kos pelaburan untuk pemasangan dan operasi kilang, dimana mereka kebanyakannya melabur dalam jumlah yang secara relatifnya kecil yang hanya puluhan ribu ringgit berbanding syarikat besar yang perlu menanggung kos beratus ribu, adakalanya berjuta ringgit hanya untuk pemasangan dan operasi. Situasi ini bagaimanapun bermaksud syarikat kecil perlu melabur hanya dalam sector-sektor yang paling jelas tahap kritikalnya. Mereka harus mengimbangi pilihan sama ada melabur untuk melancarkan operasi kilang ataupun memotong kos untuk mengurangkan input, walaupuj langkah itu disyaki akan menyebabkan kemerosotan dari segi kualiti. Perkembangan semasa dari segi *konsep Single Minute Exchange Die* (SMED) membolehkan para pelabur untuk menjimatkan kos dari segi pemasangan dan pada masa sama mengekalkan momentum produksi. Ini kerana konsep SMED membolehkan alat pembuatan boleh ditukar dalam masa seminit, sekaligus menjimatkan masa untuk pemasangan dan kos untuk jig baru. Aplikasi konsep SMED dan *Analytic Hierarchy Process* (AHP) membolehkan penambahbaikan di sektor pembuatan boleh dilakukan hanya di sudut-sudut yang kritikal sahaja dengan penilaiannya berdasarkan keadaan relevan semasa. Dapatan daripada kajian ini adalah satu rekabentuk sebuah alat pembuatan yang boleh menambahbaik proses pengawalan kualiti dalam sistem pembuatan selain mengadaptasi sesetengah konsep SMED seperti kebolehtukaran komponen alat dan kebolehan pembaikian cepat.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Single-Minute Exchange Die, or commonly abbreviated as SMED is a concept of setup time under a single digit minutes. Vastly applied in many manufacturing sectors, including aerospace, automotive, even pharmaceutical, this concept is greatly enhanced years by years of researches, starting of the concept pioneering by Shigeo Shingo during 1989 (Joshi and Naik, 2012). The studies on mainly manufacturing systems perfectly endorses the needs to smoothen the system as well as to optimize the available goods in disposal. The SMED concept developed by eventually serves as proponent in ensuring the continuous improvement of manufacturing process via quick part changeover.

SMED in small-scale manufacturing industries is not new. Researches made by Gobinath et. al.(2015) and Joshi et. al. (2012) proves that SMED methodology application will improved productivity via quick part changeover and reduced non-value added activities (Joshi and Naik, 2012; Gobinath, Elangovan and Dharmalingan, 2015). The practical application of SMED opens up opportunities for small-batch manufacturing, allowing flexibilities and reduced wastages. SMED application via jig/design improvement also may contributes to reduced tool setup times prior to manufacturing lines (Xian, 2016). The fact that jig/fixtures are main components of SMED methodology, the research focus based on these two items may, in fact, unlocks another improvement in SMED-related tool utilizations.

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1.2 Problem Statement

The current manufacturing trends are rapidly changing as the increasing demands and competitiveness require companies to basically quick in adapting to the change. As automation of industry is the main topic of the current manufacturing industry, the small scale manufacturing firms had to improvise with whatever they had while keeping up with the latest technology and, of course, demand. Mass-production usually carried out in large scale, and usually in large batch, hindering any flexibility due to the fixed yet large amount of products. Quality maintenance also an issue, considering small-scale manufacturing usually operates with human-operated conventional machines, which is known for its inability to produce consistent part parameters in large quality.

To basically retort or at least, address these disadvantages, companies usually resorts to depends on cheaper tool in markets to alleviate the strain on tool cost. However, this came at cost of quality, as well as tool life, as poorer quality tools will produce poorer quality products. Initiatives are also done via outsourcing to reduce strain on manufacturing lines but outsourcing is not cheap, especially in large volumes as hiring costs as well as additional external costs will resulted in much greater damage for the firm, even though direct maintenance cost is not implicated upon the firm. Expanding the workforce menpower would be an option but also will increased financial strain as upkeeping cost increase would reduce the overall effectiveness of the manufacturing lines.

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1.3 Project Question

- Is the current tool equipment in use is relevant for the selected plant?
- Is there's any relevant needs for a tool design/redesign in the plant?
- If there's needs for a tool design/redesign, which analysis tool must be used to evaluate the design proposal?

1.4 Project Objectives

- To analyse potential process for tool design/redesign, in which a plant must be selected, screened and analysed for a potential tool design or redesign.
- To specify the design requirement of the tools in which after a process are selected, the process must be analysed for any required tool design.
- To design proposals in which the design requirements obtained then are visualized in the form of model design by using a Computer-Aided Design (CAD) software.
- Evaluating the features and functionality of the designed model concepts in which the assembled model concepts are then analysed for evaluations.

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1.5 Project Scope

There are few scope that is listed here in order to achieve the above objectives. Firstly, this project focused on small-scale manufacturing company, which mainly utilizes conventional manufacturing process. The previous study mainly focus on reducing non-value added activities (Joshi and Naik, 2012) in which the focus was on improving productivity also on a small scale industry. The research did not focusing on the tool design or redesign as the only aim was to maximize tool utilization in disposal.

Apart from this, the selection of the company is based on its product variance. In the selected company, the number of product type, or the number of process involved, may influence the type of tool required for the operation to begin. The kind of jigs and fixtures, for example, depending on the geometry of the workpiece in order for the operation to proceeds with smoothest as possible. In this case, the company selected is Restu Berkat Services, a small-scale manufacturing firm based in Bandar Teknologi Kajang, which has been operated since 2012. The company so far only produced 2 parts, in which the basic design is a hexagonal steel blocked with hole along the horizontal axis of the block (a model with a through-all hole, while another model with a specified hole length).

Besides that, another scope of this project only includes the tool design based on the existing process. This project, however, did not cover the further analysis regarding the impact of the new tool to the existing process. This project only covers the SMED-related product design. This project only covers the specified existing process for tool design, instead of the whole manufacturing nodes or processes. Analysis regarding the line efficiency will not be included in this project.

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Other than that, another scope of this project involved tool model design and not involving fabrication of the intended design as restriction of time and material capacities only rendered the research to only extend to theoretical scope, in which all the analysis will be conducted in respect to the design models generated by the CAD software. Therefore, all results were basically based on the theoretical analysis made for the design proposals.

1.6 Significance of the project

The output of this project may offer some potential benefits towards:

- The information regarding relationship of tool designs and SMED are being documented as knowledge for further research.
- The other small scale industries can realize about how maximum tool utilization can be achieved via SMED methodology as well as tool redesigning.
- This project can produces new references and methods for the future project to make researches that related to SMED application in small scale industrial scopes.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explained on about how the application of SMED methodology improves the productivity in industries through past researches. This compartment is briefly described the case studies related to this project regarding each subtopics given. Several references such as journals, books and articles will be deployed as a manual to determine the purpose and direction of this project. The literature review is extremely critical as it serves as a path for new study and researchers can able to divert from making past mistakes. Additionally, the literature review can assists in creating a better research.

2.2 Single Minute Exchange Die

The concept of Single Minute Exchange Die was developed by Shigeo Shingo in 1950's in response to the increasing demands for a smaller lot size in order to meet the required flexibility for customer needs (Joshi and Naik, 2012),although it is said that Ohno from Toyota also developed the similar concept as stated by Yash Dave and Nagendra Sohani, 2012.The concept was aimed at reducing waste in order to optimize the financial gain of a company or an organization. The waste, in which can be in the forms of unused raw materials or damaged products can basically reduce the efficiency of a manufacturing operations, much more fatal if not being treated in a proper manner. The "single minute" term doesn't mean that the entire assembly or machining operations had to take less or equal to minute in time duration, but that they should take less than 10 minutes (in other words, "single-digit minute").

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The basic concept is to make as many activities as possible from internal to external and also summarized that setup reduction is a tool which is applicable universally. There has been lot of work done in detail for the SMED methodology in a many industries and also suggest that the effective implementation of SMED precisely required a number of fundamental needs, these are: team work, visual factory control, performance measurement, Kaizen and discussed about the role of manufacturing environment in execution of SMED concept. The relationship between changeover and production levelling has also been studied and it was concluded that as the batch size decreases, the cost of each part will increase, since the changeover time will be spread over fewer parts. This leads to a rising manufacturing costs when changeover times are high and it also discussed the detail changeover analysis and concluded that in making a part, every degree of freedom of the machine must be specified and fixed (Yash Dave and Nagendra Sohani, 2012).

In its earlier phase, the SMED method was generally used to reduce changeover process time, and it has been promoted by many lean managers and academics (McIntosh et al., 2007). This concept is considered as the best way to lower industrial changeover times. Nevertheless, there have been many changes and reforms of the original SMED concept. McIntosh et al. (2001) suggested the integration of the SMED method and TPM (Total Productive Maintenance). According to Perinić, Ikonić, and Maričić (2009), the application of the SMED method should be assisted by a simultaneous implementation of 5S. The need to implement the basics of visual management and proper workplace organization has also been recognized by other authors (Bikram & Khanduja, 2010; Moxham & Greatbanks, 2003).

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2.2.2 SMED Implementation

According to Shigeo Shingo in his book of *"A study of the Toyota Production System, Productivity Press"*, the following eight techniques should be considered in implementing SMED (Shingo, 1989):

Table 2.1: Eight techniques of the Single Minute Exchange Die (Shingo,1989).

Techniques	Description
Separate internal from external setup operations	Internal operations had to be executed when the machine is not operational while external operations can be done while the machine is in production phase. Analysis and identification of current operational setup must be carried out into 2 phases: to which operation must be performed while the machine is running and which operation must be executed while the operation is taking to a halt.
Convert internal to external setup	There are some possibilities that some internal setup operations can be changed to external setup operations. For example is die preheat for die-casting, which cut short the heating die by trial shot step after it was placed in machines.
Standardize function instead of shape	Standardization of the die shape and size can reduce setup time duration significantly. However, shape standardization is not preferably sustainable, as all dies had to ultimately confirm to the largest size used, which would unnecessarily increase costs.
Use functional clamps or eliminate fasteners altogether	Bolts are commonly used in fixing the die or to attach the die to ram and machine body. However bolt tightening can be very time-consuming as the number of motions during fastenings determined about how "wasteful" the overall procedures are.Shingo's approach is only the last turn tighten the bolt while the first loosen it-considering the rest of the motion as wasted motion.
Use intermediate jigs	This is the approach in which an operation is divided between 2 jigs in which as the workpiece attached to one jig is being processed, the next workpiece is attached to a second jig that is mounted on the machine in order to pre-prepare the workpiece for the next operation.
Adopt parallel operations	Parallel operation is an approach in which an operation that requires movement is simply reduced by additional workforce that works simultaneously in order to reduce the motion magnitudes and durations, thus reducing setup time.
Eliminate adjustments	Adjustments are one of the contributing factor to the lengthy internal setup time and needs to be reduced, to best, eliminated off the list. Adjustments are typically run before any process is carried out to ensure proper calibration of the entire system is entirely fit for the entire procedures to be carried out. Of course, the best kind of adjustment is no adjustment at all.
Mechanization	Mechanization is one of the SMED component in which the assembly and disassembly is being mechanized .In general,it is usually only considered after the first 7 SMED techniques has been considered and applied as mechanization is not cheap, although reduced changeover times are indeed possible.

Thus SMED is a critical lean tool to minimize waste and heightening flexibility in manufacturing processes allowing lot size reduction and manufacturing flow improvements. SMED minimizes the non- productive time by streamlining and standardizing the operations for exchange tools, using simple techniques and easy applications. Streamlining all aspects of the setup operation is needed to shorten the setup

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