Faculty of Mechanical and Manufacturing Engineering Technology

INTEGRATED OVERALL PERFORMANCE EFFECTIVENESS (OPE) AND SIMULATION FOR FLEXIBILITY ENHANCEMENT DURING CHANGEOVER IN PRODUCTION ASSEMBLY PROCESS

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To my beloved parents

ABSTRACT

Todays, the manufacturing industry has come to revolution of Industrial 4.0. This new paradigm has leads the complex market demand, all manufacturers needed to compete in the global market place. Hence, multi-product companies are required to be more flexible in their operation to fulfil the demand of the market. These reveal to companies the necessity of improving the changeover or setup performance to provide fast response to customer demands. This paper aims to highlight the possible improvement for the overall productivity of the production system by lowering the changeover time using Overall Performance Effective (OPE). To that end, an industrial case study is conducted on an electronic and mechanical assembly production plant which is Likom. A 37.58% increment in OPE was attained. To attain the objective of reducing the changeover time, a virtual production plant model is developed by using ARENA simulation to analyse the productivity after the proposed method is applied to the production line. The output of the simulation shows that the productivity is increased by 16.67%. Results therefore indicate that OPE measurement is an effective way to analyse the efficiency of a single setup process. By using the same logic model, analysis of variability is performed to predict the productivity without the need to change the existing line. Decision Support System (DSS) framework are established to assist the company make a decision on improvement planning.

ABSTRAK

Kini, industri perkilangan telah melangkah ke revolusi Industri 4.0. Paradigma baru ini membawa kepada permintaan pasaran yang kompleks di mana semua pengeluar perlu bersaing untuk kekal dalam pasaran global. Untuk menangani permintaan pasaran yang dinamik, syarikat yang mengeluarkan pelbagai produk perlu lebih fleksibel dalam operasi pengeluaran mereka untuk memenuhi permintaan pasaran. Oleh demikian, syarikat perlu meningkatkan prestasi dan mengurangkan masa semasa 'changeover' untuk mengeluarkan produk pada masa yang ditetapkan. Kajian ini bertujuan untuk meningkatkan produktiviti keseluruhan sistem pengeluaran dengan mengurangkan masa 'changeover' dengan menggunakan Overall Performance Effective (OPE). Untuk itu, kajian dijalankan di Likom, sebuah industri pengeluaran pemasangan elektronik dan mekanikal. Selepas OPE digunakan dalam sistem tersebut, pemingkatan sebanyak 37.58% telah tercapai. Untuk mencapai objektif utama dimana untuk meningkatkan produktiviti dengan mengurangkan masa 'changeover', ARENA digunakan untuk menganalisi produktiviti dan keberkesanan OPE. Hasil daripada ARENA menunjukkan peningkatan produktiviti sebanyak 16.67%. Kesimpulannya, OPE adalah cara yang berkesan untuk menganalisis kecekapan dalam proses 'changeover'. Dengan menggunakan model ARENA yang sama, analisis kebolehubahan untuk meramalkan producktiviti tanpa perlu mengubah garis sedia ada. Kerja Sistem Sokongan Keputusan (DSS) untuk membantu syarikat untuk membuat keputusan mengenai perancangan peningkatan.

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FMS	-	Flexible Manufacturing System
OPE	-	Overall Performance Effectiveness
SMED	-	Single Minutes Exchange Die
CMS	-	Contract Manufacturing Service
3D	-	3 Dimensional
CPS	-	Cyber Physical System
IoT	-	Internet of Thing
OT	-	Operational Technology
IT	-	Information Technology
CNC	-	Computer Numerical Control
NC	-	Numerical Control
TQM	-	Total Quality Management
JIT	-	Just-In-Time
OEE	-	Overall Effectiveness Equipment
NVAN	-	Non-value added but necessary
VA	-	Value added
NVA	-	Non-value added
ICT	-	Information and Communication Technologies
WIP	-	Work in Progress
DSS	-	Decision support System

CHAPTER 1

INTRODUCTION

1.0 Introduction

Todays, the manufacturing industry has come to revolution of Industrial 4.0. This new paradigm has leads the complex market demand, all manufacturers needed to compete in the global market place. In global competition, advancement of technology, unpredictable and diversity customer demand are the factor that made the market competitive. Increasing numbers of demand, manufacturing industries have to compete for shorter product life cycles and high degrees of flexibility (Chryssolouris, 2013). Customer demands with low volume but high variety are often highly volatile because of the growing dynamics of today's market. Company is necessary to improve their changeover setup time or setup performance to provide quick response to customer demand which is low-volume production for a high variety of product. The importance of short changeover times has always been critical across all over industries (Ferradas and Salonitis, 2013). This is because setup reduction can significantly affect production time to increase production throughput. As the market became more and more complex, companies have to be more flexible in their operation to fulfil the demand of the market. To survive in such an increasingly competitive world, there is a need of continuous improvement in industry.

This study aims to reduce the changeover setup time in the assembly process by incorporating a developed performance measure. The developed performance measurement used to evaluate the effectiveness during the setup process is Overall

Performance Effectiveness (OPE). OPE is a measurement used to show the effectiveness of the setup process improvement. This paper presents how the productivity can be improve by flexibility approach which is the improvement in changeover setup time. This approach will be validated by using ARENA and provide Decision Support System (DSS) to the company. In the wave of Industry 4.0, simulation can aid the company to make a decision without the need to change the existing production line.

1.1 Background

In order to improve the productivity and flexibility in a manufacturing process, a specified element in the system must be determined to figure out the main problem in the production. To make the manufacturing flexible to the demand uncertainty, FMS came into existence. The main advantage of an FMS is its high flexibility in managing manufacturing resources to manufacture a new product. Production of small batches of products is the best application of FMS rather than a mass production. Applying FMS also required the aid of Lean manufacturing to eliminate the waste. Lean is widely used as a method for eliminating the waste in the production to improve productivity. There is lots of lean tools are introduced for the purpose of different type of waste reduction.

In the previous study, Shahrul et al. (2014) argued that Single Minutes Exchange Die (SMED) introduced in 1950 by Shigeo Shingo to boost the productivity by improving the setup operations. SMED could be a setup reduction concept in a continuous improvement method that helps companies dramatically reduce their changeover times. The integration of SMED and predetermined time system results in a better improvement of setup operations based on the setup activities. Moreira and Pais (2011) proposed that SMED is an excellent concept for improving setup operations in the mould-making industry. Implementation of SMED allowed to determine the possibility to productivity

improvement and to enhance the flexibility in setup process by reducing waste operation. These previous study verified that SMED is capable of improving setup activities in various industries.

Setup improvement can be measured through other measurement such as process capability analysis, setup cost, and distance travelled by operators during the changeover process. However, none of the works on setup reduction focused on improving setup operation from the perspective of performance effectiveness. This method can differentiate the issues, problems, and potentials to improve the setup process in a short time.

1.2 Problem Statement

Likom CMS Sdn Bhd is a multi-product company with fully integrated Contract Manufacturing Service (CMS) provider of IT related electronic and mechanical assemblies. In this project, the field will be focuses on mechanical assemblies where it offers the assembly process of mini cassette and big rack. They also manufacture metal and plastic components as well as assemblies.

Increasing in the demand of customer of mini cassette and big rack which is low volume but variety type of part number product reveals that Likom must be flexible in production. They need to produce the product simultaneously to fulfil the demand of the customer. Hence, rapid changeover in the production is necessary for the multi-product companies like Likom. The ability to affect quick changeover in the production line, from one product to new product, is a key prerequisite to enhance the flexibility, cycle time reduction and responsive manufacture.

After the changeover setup takes place, some problems occurred such as wrong part number is transported into the production line and longer time in setup drags the production to smoothly run. When the operator realise that the part number is incorrect,

they need to ask for advice from the production team leader. Hence, production team leader needs to wrap up this situation and took some time to handle it. This problem occurred twice in three times observations. Activities in the changeover such as finding the correct part and excessive movement cause additional cost to Likom through resource, energy and time losses.

1.3 Objectives

The purpose of this study is as follow:

i. Apply Overall Performance Effectiveness (OPE) to enhance the flexibility during changeover process.

ii. Improve productivity through the reduction in changeover setup time.

iii. Measure the output and effectiveness of OPE by using ARENA simulation.

1.4 Project Scope

This project basically focuses on the flexibility in the changeover workstation to decrease the setup time and hence increase the productivity of the production. FMS and Lean Manufacturing will be study simultaneously to find the problem and solution for the changeover setup time. For instance, to aid the proposed method to solve the solution, simulation, one of the technologies in industry 4.0 will be used to conduct this project. A virtual production plant model is developed using Arena Simulation Software to analyse the productivity before and after an approach is applied in the workstation. For instance, ARENA simulation acts as the model-driven Decision Support System (DSS) to aid in decision making.

1.5 Expected Result

This study is expected to increase the productivity of the production system through flexibility in the changeover. Reduction in changeover setup time can reduce the non-value added activities which can increase the overall productivity.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss related information on research gap about industry 4.0 (simulation), productivity, flexibility (OPE), changeover setup time and Decision Support System (DSS). These 5 terms are highly related to each other. Technology in industry 4.0 and smart factory play an important role so as to increase productivity and improve flexibility.

2.1 Industry 4.0

The first three industrial revolutions spanned almost 200 years started from 1780s (first industrial revolution). According to the German Federal Ministry of Education and Research, the term Industry 4.0 was first introduced in 2011 to promote the digitalization of manufacturing (Santos et al., 2017). It corporates with advanced sensors, machine-to-machine communication links, 3-D printing, robotics, artificial intelligence, big data analytics and cloud computing technology. Heck and Rogers (2014) stated that the features of industry 4.0 is increased the competitive through smart equipment, making use of data and information. While based on Lee et al. (2015), the aim of Industry 4.0 is to create smart factory where manufacturing technologies are upgrades and transformed by cyber physical system (CPS), the internet of thing (IoT), and cloud computing.

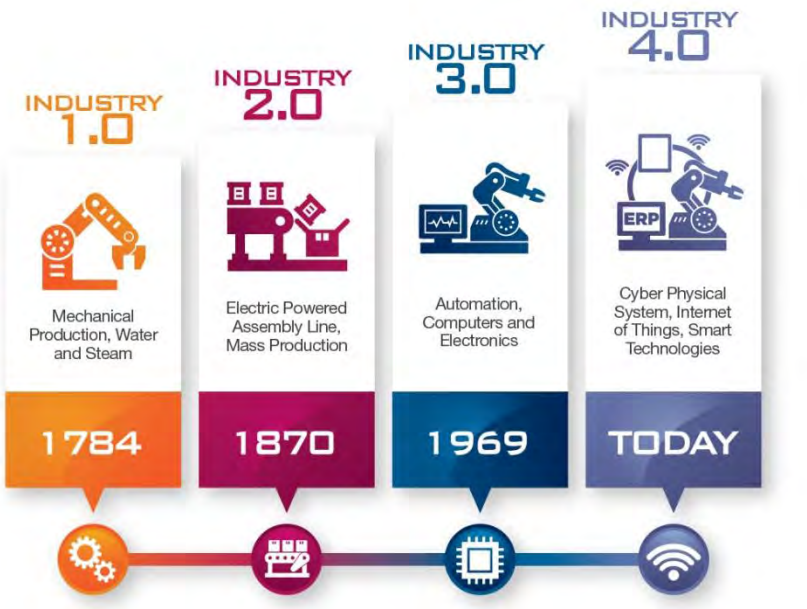

Figure 2.1: Revolution of the industry (Jackson, 2019)

Henning et al. (2013) stated that Industry 4.0 as the current industry toward automation and data exchange in manufacturing technologies toward smart industries. Industry 4.0 is the view of the industrial production of the future which consisted of 9 technologies that are aiming to transform the current industrial production to automated world.

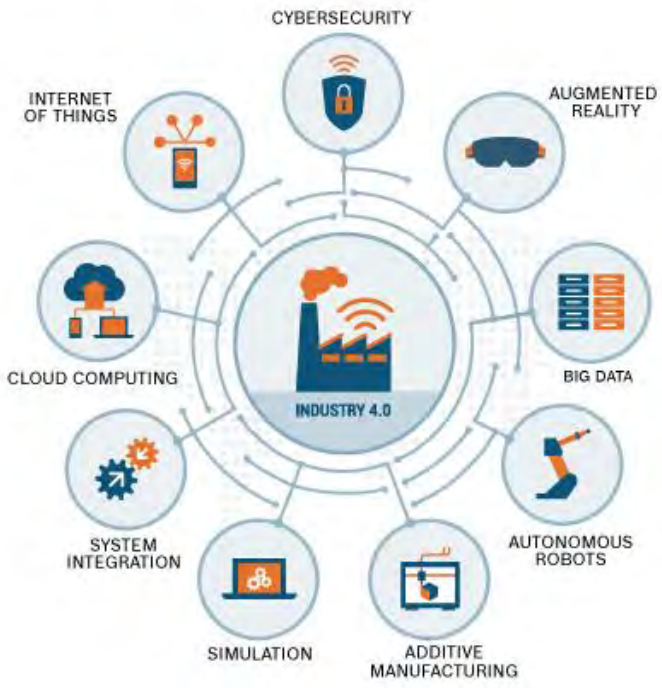

Figure 2.2: 9 pillars of technologies in industry 4.0

2.1.1 Cybersecurity

Ideally, the industry 4.0 requires a completely interconnected reality, but this same characteristic uncovers and unexpected vulnerability (ESA, 2017). This is because according to Cleverism (2017), with the increased connectivity in manufacturing, the risk of cyber threats and cyber attacks grow as well. It is therefore crucial for companies operating in industry 4.0 to focus on protection of computer systems from damage to information hardware or software and from disruption of the services provided (Booth Welsh, 2018).

2.1.2 Augmented Reality

Augmented reality is defined as a technology which combines real and virtual imagery, interactive in real time and registers the virtual imagery with the real world system. This can help in fast decision-making and for improving work processes (The Hive, 2018). The technology use to perform augmented reality such as mobile phone or tablets will provide more flexibility, adaptability, improvement and competitiveness of the human factor and continuous improvement (Cleverism, 2017).

2.1.3 Big Data

There are still massive sets of untapped data in the industrial world (The Hive, 2018), these data need to gather and organise in a coherent manner (Alasdair, 2016). With big data and analytics, the collection and comprehensive can be used to evaluate the data set from different sources to support real time decision making (Bahrin et al., 2016). The analysis will optimize service and production quality, save energy, and reduced costs as well (Cleverism, 2017).