UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Tool For Mapping Manufacturing Critical-path Time in Job Shop Environment

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

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Tool For Mapping Manufacturing Critical- path Time in Job Shop Environment**

SESI PENGAJIAN: **2013/14 Semester 2**

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ABSTRAK

Pada zaman ini, kebanyakan syarikat pengeluaran mengamalkan paradigma pengeluaran yang baru iaitu amalan pengubahsuaian untuk memenuhi permintaan pelanggan-pelanggan. Dengan ini, syarikat dapat bersaing dengan pasaran yang kompetitif. Walau bagaimanapun, amalan pengubahsuaian memerlukan fleksibiliti yang tinggi untuk menghantar barang kepada pelanggan dengan masa yang tepat. Konsep *Lean* juga dikenalkan sebagai Sistem Pengeluaran Toyota merupakan konsep yang amat sesuai dalam sistem pengeluaran yang banyak jenis tetapi jumlah pengeluaran yang rendah. Permintaan rekaan khas semakin meningkat, aplikasi konsep *Lean* akan menjadi semakin kurang efektif. Konsep *Lean* menganggap aliran pengeluaran lancar dan pengekalan tahap inventori yang rendah sebagai satu cabaran yang besar dalam bidang pengeluaran rekaan khas. Dengan itu, kajian ini ingin membentangkan *Quick Response Manufacturing (QRM)* sebagai strategi alternative untuk bidang pengeluaran rekaan khas. Konsep QRM merupakan satu strategi yang boleh diaplikasikan di seluruh syarikat dan ia mempunyai aspek utama untuk mengurangkan masa. Projek ini akan dijalankan di sebuah syarikat pembuatan komponen. Kebelakangan ini, syarikat ini menghadapi masalah penghantaran lewat. Satu alatan yang baru akan dicipta untuk mempaparkan Manufacturing Critical-path time (MCT) mengikut keadaan semasa syarikat ini. Alatan ini akan menjadikan sebagai masa petunjuk bagi produk utama yang dipilih. Kaedah yang sesuai akan dicadangkan berdasarkan konsep QRM dan maya sell konsep bagi meningkatkan prestasi penghantaran barang. Kaedah yang baru ini akan dikajikan oleh simulasi model. Model ini dibinakan daripada perisian Simulasi WITNESS. Walaupun rekaan yang dicipta untuk memaparkan MCT dan kaedah yang dicadangkan hanya

dicipta berdasarkan kes-kes syarikat tetapi dengan mudahnya ditukar untuk pelaksanaan dalam industri yang serupa. Pada masa depan, semua order yang diterima boleh diagihkan berdasarkan jumlah permintaan dan persamaan prosess. Ia diikuti oleh pembentukan maya sell. POLCA sistem mengaplikasi di dalam semua maya sell. Semasa konsep QRM dilaksanakan di seluruh syarikat, ia dipercayai bahawa jumlah MCT boleh dikurangkan dengan ketara. Dalam kesimpulannya, masalah masa penyampaian yang panjang dan penghantaran yang lewat dapat diselesaikan.

ABSTRACT

Many companies are adopting a new production paradigm of mass customization to meet their customers' future demands and survive in an intensely competitive market. However, mass customization manufacturing requires a high degree of flexibility to deliver customers' orders on time. Lean Manufacturing as exemplified by the Toyota Production System is appropriate when production is characterized by a low mix and high volume environment. As the degree of product customization increases, the application of lean principles to ensure smooth production flow while keeping inventory level low becomes a major challenge. This study presents Quick Response Manufacturing (QRM) as an alternative strategy for a high mix and low volume production environment. QRM is a company-wide strategy with the key aspect of reduction in lead time. The case company, where the study is conducted is a components manufacturing company with a job shop production system. The company, making highly engineered products with variable demands, is confronted with the main challenge of consistently long lead times leading to poor-on time delivery performance to their customers. To mitigate this problem, a tool for mapping the manufacturing critical-path time (MCT) will be developed according to the current situation of the case company. The output of this tool is a lead time and visual indicator for the manufacturing critical-path time of a selected major product family. An appropriate methods based on QRM principles and virtual cell concept will be proposed to improve the MCT for the selected product. This proposed method is tested by a simulation model which built by using simulation software, *WITNESS*. The MCT tool and the proposed method although developed for the case company can be easily converted for

implementation in other similar industries. In future, all the received jobs may be grouped together according to the same demand volume and similarity in process then formed virtual cell respectively. QRM principle such as POLCA system is applied into all the virtual cell. As QRM concept is slowly implemented in the entire chain, it is believed that total MCT can be reduced tremendously. As a result, the long lead time and poor time delivery performance were solved.

DEDICATION

I would also like to dedicate this report to my supervisor who gave the right advice and guide to me during the period of project development. On behalf of that, I may also thanks to my beloved parents, siblings, and friends for their love and support.

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The special thanks to my supervisor, Associate Professor Dr. Chong Kuan Eng. The supervision, advice and support that he gave truly help the progression of my final year project. I also wish to express my sincere appreciation to the company that I attached in. The co-operation is much indeed appreciated. Great appreciation to the contribution of my faculty, Faculty of Manufacturing in helping us completes this project by providing the project guidelines.

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LIST OF ABBREVIATIONS

TOC	-	Theory of Constraint
FMS	–	Flexible Manufacturing System
TQM	-	Total Quality Management
MCT	-	Manufacturing Critical-path Time
TBC	-	Time-Based Competition
POLCA	-	Paired-cell Overlapping Loops of Cards with Authorization
JIT	-	Just-in-Time
VSM	-	Value Stream Mapping
TPM	-	Total Productive Maintenance
Q-ROC	-	Quick Response Office Cell
QRM	-	Quick Response Manufacturing
MRP	-	Material Requirement Planning
WIP	–	Work-in Process
CNC	-	Computer Numerical Control
OEM	-	Original Equipment Manufacturers
NCL	-	Turning
MI	-	Milling
MC	-	CNC Milling
EDM	-	Electric Discharge Machining
GF	-	Surface Grinding
CNC Grind	-	CNC Grinding
PG	-	Profile Grinding
WC	-	Wire Cut
SD	-	Speed Drilling
TP	-	Tapping
ENG	-	Engraving

HT	-	Heat Treatment (Outsourced)
FTMS	-	Focus Market Target Segment
VBA	-	Visual Basic Application
PL	-	Planner
QC	-	Quality Control
ASB	-	Assembly

CHAPTER 1
INTRODUCTION

In the 21st century, globalization is a driver of the economy for every nation. In recognition of the importance of globalization, the manufacturing sector have made some changes in order to adapt to recent market demands. Today's manufacturers compete on speed to market and varieties of products. To achieve these objectives companies rely on new technologies and new methodologies to gain the competitive advantages.

1.1 Background of Study

In this new era of globalization, a good strategy is very important to compete with other competitors. In nutshell, a good strategic planning always lead a step ahead from others. There are various kind of strategies available for continuous improvement in the manufacturing field. Just for an example, lean manufacturing is one of commonly employed philosophy in industries. The main idea of Lean is to eliminate non-value added activities. However, not all manufacturing system are compatible with the approaches of lean. Beside lean, there are other strategies which also has established in this field. Some of them are Quick Response Manufacturing (QRM), Theory of Constraint (TOC), Flexible Manufacturing System (FMS), and Total Quality Management (TQM).

In brief, QRM is a concept which reduce time simultaneously across enterprise and it is best applied in the high mix and low volume environment. For the TOC concept, it is an organizational change method that is focus on profit improvement. On the other hand, TPM is a management philosophy aimed at continuous improvement in the quality of products and process while FMS is a manufacturing system for producing goods that is readily adaptable to changes.

1.2 Background of Company

This project is conducted in a case company which produces precision tools, die, moulds, puncher, cavity, cores, jigs, fixtures and other products in a job shop environment. The processes involved in the case company include CNC milling, turning, grinding, profile grinding, wire cutting, electric discharge machining, welding, laser marking and tapping. This case company produces an average of 160 product families. Due to different process routes and process time for each of the product, coupled with low volume of demand from customers, the production of this case company is categorized as high mix and low volume. The process flow of this case company is shown in Figure 1.1. Normally, once orders are received from customer, this case company will takes one to two days to do planning for the process flow. Then, the planner will create job order form for each of the order. Part's drawing will be created then will first send to programming if there involve CNC machining operation. Next, jobs will be release to production and start to process. After completing all the process, part is sent for inspection then packaging before shipping to customers. Figure 1.2 shows the overview layout of the case company.

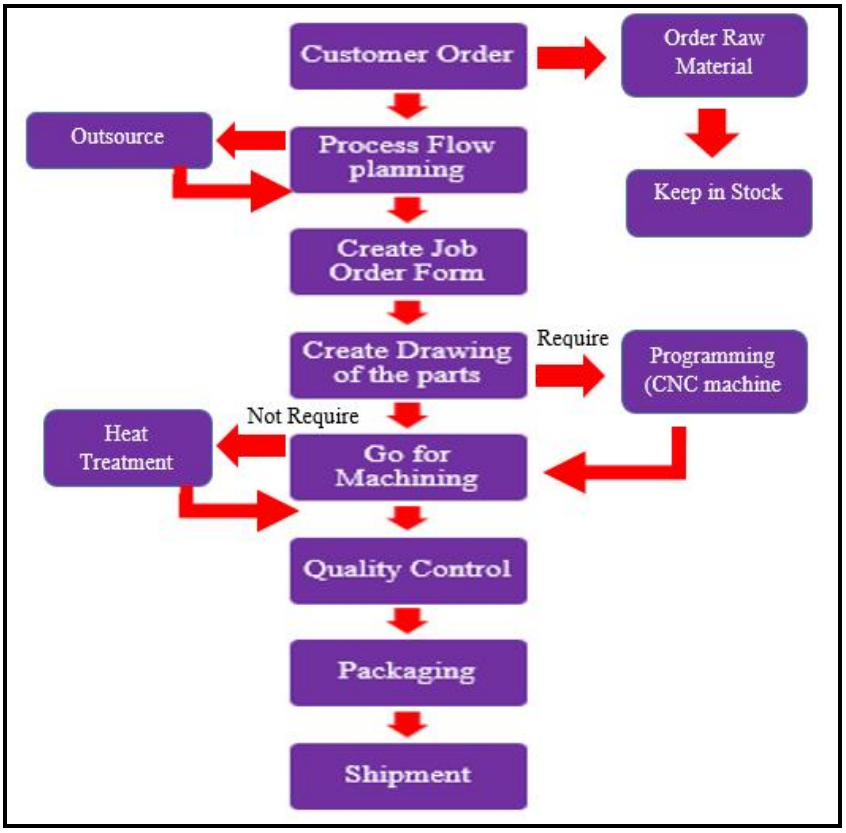

Figure 1. 1: Overview Process Flow of the Case Company

Turning	Squaring		Milling	
CNC Turning CNC Milling	EDM	Grinding	Profile Grinding CNC Grinding	Wire Cutting Super Drilling

Figure 1. 2: Overview Layout of the Case Company

1.3 Problem Statement

According to the general manager of this company, the company is facing around 30 percent of late deliveries. This is due to long pre and post process queuing time during production. As a consequence, it contributes a long lead time for an order. Through this project, the general manager would like to reduce the waiting time for production. Furthermore, it is believed that reducing the waiting time will reduce the manufacturing critical-path time.

1.4 Objectives

The aim of this project is to reduce the manufacturing critical-path time (MCT) for processes in the case company.

This project embarks with the following objectives:

i. To develop a tool to map the MCT for the selected products.
ii. To propose a QRM method to reduce the MCT for the selected products
iii. To develop a simulation model for testing of the proposed method

1.5 Scope

The scope of this study is limited to the major product families determined by the volume of sales. The data for the selected products for the demands and cycle times are based on historical data collected from company. The proposed method will be only implemented in shop floor and does not include activities in office operations and the supply chain. In addition, this project does not focus on cost and quality.

1.6 Benefits to the company

At the end of this project, a MCT Tool to map the critical-path times will be developed. This MCT tool helps to identify the time taken for non-productive activities of the selected product families. It acts as an indicator for the case company to identify the areas in the production line that requires improvements. This tool not only benefits to solve the current late deliveries issues but also useful for mapping MCT in the future. Besides, a suitable method based on QRM principles will be proposed to reduce the non-productive activities such as waiting time of the case company which strongly emphasized by the general manager. As a consequence, development of MCT tools and proposal of QRM principle will result in a reduction of late deliveries for the case company. This will subsequently increase the degree of customers' satisfaction and also reduced the cost of the products.

1.7 Organization of the Report

This report is organized as follow. Chapter 1gives description of the background of this study, problem statement, objectives, scope and benefit to the company. Chapter 2 provides the literature review of the related subject. Following the outline of the problem in Chapter 1, Chapter 3 describes the design of methodology employed for this project. Chapter 4 discusses about the development of MCT Tool and simulation model. Result and discussion will discussed in chapter 5. In chapter 6, it will discuss the conclusion of the study. This chapters will also discuss the limitation and recommendation.

CHAPTER 2
LITERATURE REVIEW

This chapter provides an overview of production system characteristics, lean manufacturing, time-based competition (TBC), QRM concepts, MCT, and paired-cell overlapping loops of cards with authorization (POLCA). This chapter acts as the guideline in the methodology design and the information summarized here are the evidence to support the methodology in the next chapter.

2.1 Production System Characteristics

Specific manufacturer can be identified through the four key major production system characteristics which are mix, volume, demand variability and degree of customization (Matthew, 2004).

Mix defines as the different number of product that are produce. What makes the "different" between products? Well, the difference is between the number of parts, functionality and appearance in the end product. Indeed with the same appearance but travel with the different process route, different process time and unique set up could still contribute significantly to the factory mix (Matthew, 2004). Product mix refers to the total number of product line offers to its customers (Suttle, 2009).