Quick Response Manufacturing (QRM) In Job Shop Environment

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

by

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ABSTRAK

Pada masa kini, syarikat-syarikat pengeluar perlu membekalkan kepelbagaian jenis produk atau produck kejuruteraan untuk memenuhi keperluaan pelangan-pelangan. Dengan ini, syarikat dapat terlebih dahulu dalam pasaran daya saing yang kuat. Walau bagaimanapun, syarikat-syarikat ini mendapati bahawa konsep *Lean Manufacturing* tidak membantu dalam meningkatkan keperluan mereka dalam persekitaran sedemikian. Sebaliknya, kelemahan seperti lewat penghantaran pesanan pelangan dan tinggi inventori WIP akan muncul jika *Lean Manufacturing* memohon di perbuatan industri yang berjenis membekal produk kebanyakan jenis dan pengeluaran rendah pesanan pelanggan. Satu kaedah yang dinamakan *Quick Response Manufacturing* (QRM) adalah lebih sesuai bagi perbuatan industri yang bejenis begitu. Salah satu teknik daripada QRM adalah *Paired-cell Overlapping Loops of Cards with Authorization* (POLCA) bertujuan untuk mengawal pengerakan bahan di tempat pengeluaran. Dengan ini, inventori WIP and tempoh masa penghantaran pesanan pelangan dapat dikurangkan. Bilangan kad POLCA bagi setiap pasangan memainkan peranan yang penting dalam pelaksaan POLCA. Dalam projek ini, spreadsheet dibangunkan untuk menentukan pasangan gelung POLCA dan untuk mengira bilangan kad POLCA bagi setiap gelung berpasangan. Selain itu, cadangan tentang susun atur mesin berdasarkan kekerapan yang tinggi gelung POLCA berpasangan dicadangkan dan susun atur ini boleh menyumbang kepada kelebihan pengendalian bahan yang lebih baik dan plumbum masa yang pendek.

ABSTRACT

Today, manufacturing companies have to supply high variety or custom engineered products to fulfill customers' requirement and thereby advance to competitive advantage. However these companies found that Lean Manufacturing concepts are not helping improve their needs in such environment. On the other hand, drawbacks such as longer lead times and increased WIP inventories are generated with these lean concepts if applied at those high mix and low volume manufacturing environment. In a high mix and low volume manufacturing environment, Quick Response Manufacturing (QRM) is more suitable to improve company's performance. One of the tools of QRM is Paired-cell Overlapping Loops of Cards with Authorization (POLCA), a technique used to control material movement in order to control the level of WIP and reduce lead time. POLCA card was used to control the material movement and hence shorten the lead time and improve delivery performance. The number of POLCA card of each paired loop is the key role in the POLCA implementation. In this project, a spreadsheet is developed to determine the POLCA paired loop and to calculate the number of POLCA card for each paired loop. Moreover, a suggestion about the machine layout based on the high frequency of POLCA paired loop is suggested and this layout could contribute to the advantages of better material handling and shorter lead time.

DEDICATION

I would like to dedicate this report to my supervisor who gave the right advice and guide to me, to my beloved family who have never fail to give moral supports to me in everything during the time I developed this report.

ACKNOWLEDGEMENT

The special thank to my supervisor, Professor Dr. Chong Kuan Eng. The supervision, advice and support that he gave truly help the progression of my final year project.

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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 ABBREVIATION

CNC	-	Computer Numerical Control
DEBUR	-	Deburring
EDM	-	Electric Discharge Machining
ENG	-	Engraving
GF	-	Surface Grinding
HL/MRP	-	High Level material requirements planning system
HT	-	Heat Treatment (Outsourced)
JIT	-	Just In Time
MC	-	CNC Milling
MRP	-	Material Requirement Planning
ML	-	Milling
P	-	Parting
PG	-	Profiling Grinding
POLCA	-	Paired-cell Overlapping Loops of Cards with Authorization
Q-ROC	-	Quick Response Office Cell
QRM	-	Quick Response Manufacturing
SD	-	Speed Drilling
TBC	-	time-based competition
TM	-	Treatment (Hardness, outsourced)
TP	-	Tapping
WC	-	Wire Cut
WIP	-	Work in Process

CHAPTER 1
INTRODUCTION

This chapter describes the background of this study, and then followed by problem statement of the project, objectives and scope of the project.

1.1 Background of Study

Lean Manufacturing is a popular welcome philosophy almost implemented in every industry or even in office operations. The core idea of lean is to reduce costs, improve quality and reduce product cycle times in many manufacturing environments. The ultimate goal of lean is to provide perfect value to customer through perfect value process steps that without any wastes. Lean is considered as successful when the production is characterized by high volume such as in assembly line. Normally there is the stable demand in assembly production line.

However, the 21st century market is not usual as the former market. Customers today expect high variety and custom engineered products. And yet those high variety or custom engineered products are ordered in low volume with unstable. In this case, lean manufacturing is not suitable to improve production meanwhile drawbacks are introduced in the production line.

Today production managers are expected to find a new ways to support the increase in product variety and meet production targets with minimal inventories, shorter lead times and lower costs. While, production engineers are seeking the new ways to rapidly introduce new products to exploit emerging market opportunities. Across the

enterprise, supply chain managers are seeking new ways to complement their in-house operations with a supply base that has the capacity and ability to quickly respond to fluctuations in customer requests.

The concept of Quick Response Manufacturing (QRM) introduced by Professor Rajan Suri from University of Wisconsin is shown to be more suitable for high mix and low volume manufacturing environment. QRM concept is focused on lead time reduction across the enterprise and provides organizations the competitive advantages.

1.2 Problem Statement

This project is conducted in a case company which manufactures high precision components in a job shop environment. There is high mix production and low volume demand. The processes involved in this company are CNC machining, turning, milling, surface grinding, and wire cutting. Lead time and speed play a crucial role in this company. Speed to delivery customer order, speed to competition market are emphasized by the company. Long lead time within the processes or supply chain would make a company failure in term of speed.

The general manager of the company said the company has facing around 30 percent of late deliveries. Furthermore, he would like to reduce the overall processing time of an order. For instance, a lead time for a component A could be reduced from 10 days to 6 days. Lead time reduction is the object of interest of the company.

1.3 Objectives

The objectives of this project are:

i. To study current processes and products in the case company.
ii. To propose Quick Response Manufacturing (QRM) by using Paired-cell Overlapping Loops of Cards with Authorization (POLCA) technique to improve the lead time in shop floor.
iii. To develop a method by using spreadsheet to determine the possible paired loops for POLCA implementation and to determine the number of POLCA card for each paired loop.

1.4 Scope

The project is limited to a specific family of product. The product family is selected based on the profitability and demand. The overall process flow of manufacturing a product family is study before attempts to implement the POLCA. The method to determine the possible paired loops and the number of POLCA card is developed for this project. The proposed method only implemented in shop floor and does not include activities in office operations and supply chain. This project does not focus on quality and cost.

1.5 Organization of the Report

The report is organized along the following outline. This report consists of five chapters as described below:

i. The first chapter introduces the background, problem statement, objectives, and scope of the project.
ii. Chapter two presents the literature review of the related subject.
iii. Chapter three describes the methodology of the project.
iv. Chapter four explains the spreadsheet development.
v. Chapter five shows the result of spreadsheet testing and discusses the obtained result.
vi. Chapter six is the conclusion of the report.

CHAPTER 2
LITERATURE REVIEW

This chapter provides the summary of searched information from journals, articles, technical report, books and other related resources. This chapter covering the background of lean manufacturing, QRM concepts, POLCA technique, the difference between POLCA and others production control method such as Push and Pull system, and also the case study of POLCA implementation. This chapter acts as the guideline in methodology design and the information summarized here are the evidences to support the result and discussion in next chapter.

2.1 Production System Characteristics

The four major production system characteristics are mix, volume, demand variability and degree of customization are plotted on a continuum as shown in figure 1.

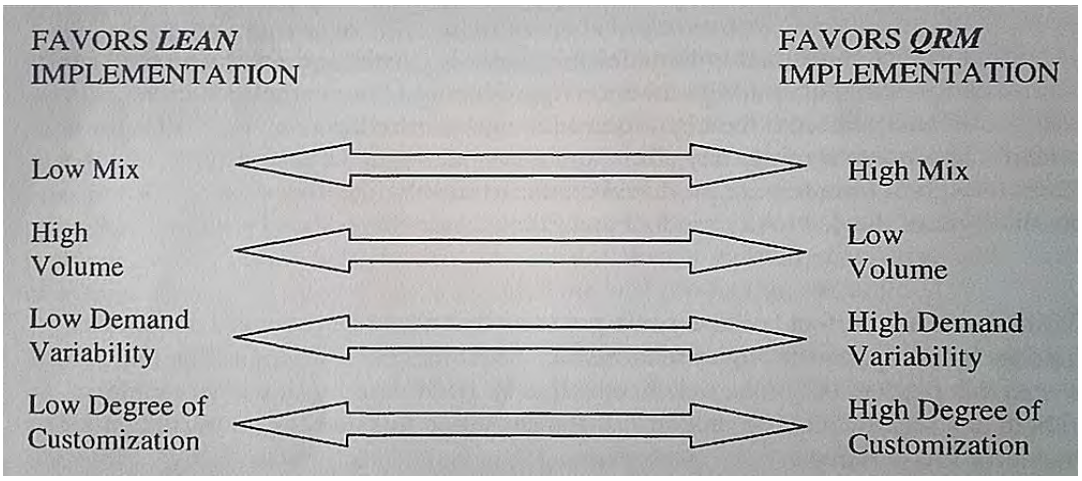

Figure 2.1: Key production system characteristics continuum (Matthew, 2004).

When starting an improvement, the first thing must be known is where a particular manufacturing system is located along this continuum for each key system characteristics. From Figure 2.1, Lean Manufacturing fall to left handside four system characteristics. However, Quick Responses Manufacturing is designed for systems whose key characteristics fall to the right on the continuum.

2.1.1 Mix

What means by Mix? Mix refers to the number of different products that are produced within a certain production system (Matthew, 2004). The differences are number of parts, functionality, appearance, etc. Moreover, the different on processing times of the products could contribute significantly to the factory mix.

2.1.2 Volume

Volume is the quantity of a product to be produced over a specified period of time. Definition of high volume or low volume is difficult to define because it depends on one's perspective. Let's say a company produces millions of a product in a year

overtly fall into high-volume category while for a product with a 100 unit per month would be considered low volume.

2.1.3 Demand Variability

Demand variability means changes in customer demand from period to period. The more demand for specific products fluctuates from order to order, the higher the demand variability (Matthew, 2004). The demand variables may base on effort in marketing or promotions, seasonality, holidays, special events and other extrinsic factors (Matthew, 2004).

2.1.4 Degree of Customization

Customization refers to providing products that are created to the customer's specifications and the product may produce only once. Matthew (2004) stated in his study, "the international space station is such a product: although some components might have other uses, this is a one-of-a-kind product that is highly customized".

2.2 Lean Manufacturing

The most significant operations and supply management approach of the past 50 years is lean production (Jacobs and Chase, 2011). Lean production or lean manufacturing focuses on eliminating wastes as much as possible. The wastes indicated by Jacobs and Chase (2011) are unnecessary movements, unnecessary processing, and excess inventory. These are the target for improvement and to make sure anything steps are create value (value-added), and removes all those do not create value (non-value added).

The basic of lean thinking came from just-in-time (JIT) production concepts pioneered in Japan at Toyota. In lean manufacturing is to emphasis on cut out the "fat" or waste in the manufacturing process. Value added is the activities transform materials and information into the customer want, the value is something that customer willing to pay for. Whereas, non-value added also called as waste, is defined as activities consumes resources and do not directly contribute to the end product desired by the customer, in other words, there is anything does not add value from the customer's perspective. These wastes are to be eliminated by lean.

2.2.1 Lean Concept

In additional, lean concepts are contrasts with the corresponding principles in QRM discussed by Suri (1998). The three lean concepts are:

1. Elimination of *Muda*
2. Implementing flow
3. Implementing pull

2.2.1.1 Elimination Muda

In JIT, elimination of *muda* through eliminating non-value-added waste, resulting in reduced lead times, improved quality, and reduced costs. However, QRM emphasis on reduction in lead time, resulting in the elimination of non-value-added waste, improved quality and reduced costs. Since wastes are caused by long lead times, Suri (1998) said that once adopt the QRM approaches, more wastes are identified compared to JIT approaches. Another different between JIT and QRM is JIT system requires inventory in many intermediate stages of the materials replenishment system and QRM is not to introduce any inventory into the system until there is the customer order. QRM found that the inventory is one types of the waste.