# Chapter 1

# Introduction

In the last few decades, industrial sectors effort has been spent in the optimization of internal efficiency, aiming at cost reduction and competitiveness (Hewitt, 1994; J. R. Carter, 1996; Persson and Olhager, 2002; Thomas and Griffin, 1996). Companies respond to this high pressure by re-engineering their operations and management (Dotoli et al., 2005). Many researchers have embraced a wide variety of management programs which are hoped to enhance competitiveness. To overcome the competitors in the same sector, the company has to find suitable strategies in this situation. Nevertheless, finding the best strategy in this complex system is not an easy task. In order to stay competitive, companies have attempted to construct their manufacturing system more efficient and lean.

Lean is based on learning from Toyota who increased market share by improving their shop floor processes (Parry et al., 2010). It is widely recognized that lean manufacturing methods have substantial cost and quality over practicing traditional mass production. Lean production is increasingly being implemented for many organizations, as evidenced by the case study applications presented at the Lean Enterprise Institute (McDonald et al., 2002). Shah and Ward (2007) defined lean production as an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer and internal variability. The performance of lean production improves productivity through reduced lead times, material and staff costs, increased quality etc.

The popularization of lean principle has persuaded many manufacturing organizations covering low, medium and high production and complexity to revolutionize their competence. However, the lean production is applicable directly only to the make-to-stock (MTS) business, but the make-to-order (MTO) product environments has to adapt lean manufacturing principle because a high level of variability with respect to routing and processing times of different orders (Chitturi et al., 2007). Moreover, the key problem facing the MTO organization is that it has the degree of turbulence more than the typical lean manufacturing. “Turbulence” is used to describe behavior which, as a result of variability and uncertainty of inputs, causes the manufacturing system to experience unpredictable and sub-optimal behavior as it struggles to achieve the desired outputs (Bhattacharya et al., 1996). One type of turbulence causal factor can be identified as job scheduling (Jina et al., 1997).

Since 1960, many research have been done on the issue of job scheduling (McKay et al., 1988). An empirical survey of literature on scheduling problems can be found in many scholarly papers (Graves, 1981; Lee et al., 1997). Job scheduling can be applied to the manufacture processing and affect really the production time, the cost of production and on-time delivery for a plant. The main objective of the job scheduling problem is to find a schedule of operations that can minimize the maximum completion time (called makespan) that is the completed time of carrying total operations out in the schedule for n jobs and m machines.

## 1.1 Background

A manufacturer attempts to control its facilities in the most efficient way for each plant. Of course, one of the most important factors is to determine a correlation between product quantity and product variety (Groover, 2008). Product quantity refers to the number of units of a given part or product produced annually by the plant. Also, product variety refers to the different product designs or types that are produced in a plant. There is an inverse correlation between product variety and product quantity, the relationship is stated in Figure 1.1.

The relationship can be used to identify three basic categories of production plants, which comprise of job shop, batch production or cellular manufacturing and mass production. The job shop makes low quantities of specialized and customized products. Another important characteristic of a job shop is the variability in job demand and a constantly changing product mix. Therefore, it is necessary for the system to be inherently flexible (Montreuil, 1999).

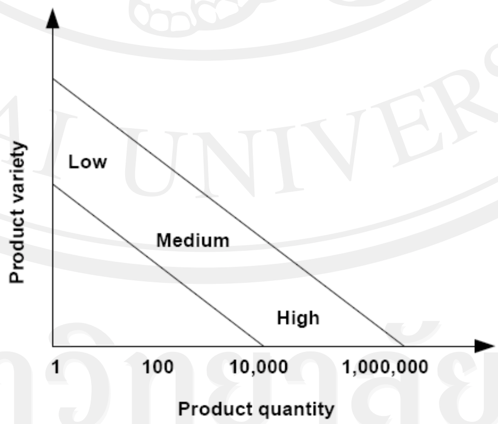


Figure 1.1 Relationship between product variety and production quantity

Source: Adapted from Groover (2008)

Small and medium enterprises (SMEs) are an essential component of Thailand's economic system from the ratio of gross domestic product (GDP) of SMEs to be 37.9% of GDP in 2008 because SMEs accounts for 99% of the overall enterprise number causing them to be an essential foundation of the sustainable development and a key mechanism to promote economic revitalizing and to eradicate poverty as shown in Figure 1.2. Anyway, Thai SMEs are still not fully competitive, their production and management structures are weak. They have low quality labor and use technologies that are not up-to-date etc. (OSMEP, 2009). Many Thai SMEs are vulnerable in their sectors where there are few barriers to new entrants and where they have little power to dictate with suppliers as shown in Figure 1.3 (Porter, 1985).

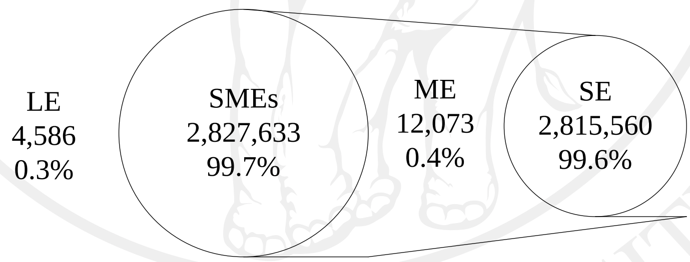


Figure 1.2 Quantity and ratio of SMEs in 2008

Source: National Statistical Office of Thailand, 2009

Analyzed by: Office of Small and Medium Enterprises Promotion, 2009

**1.2 Statement and Significance of the Problem**

The preceding sections said that Thai SMEs should apply lean concept to improve their competence. However, it is not as easy as it seems to becoming lean. Moreover, SMEs are still not certain of tangible and intangible benefits that they may achieve. To promote the use of lean manufacturing within the SMEs is the challenge.

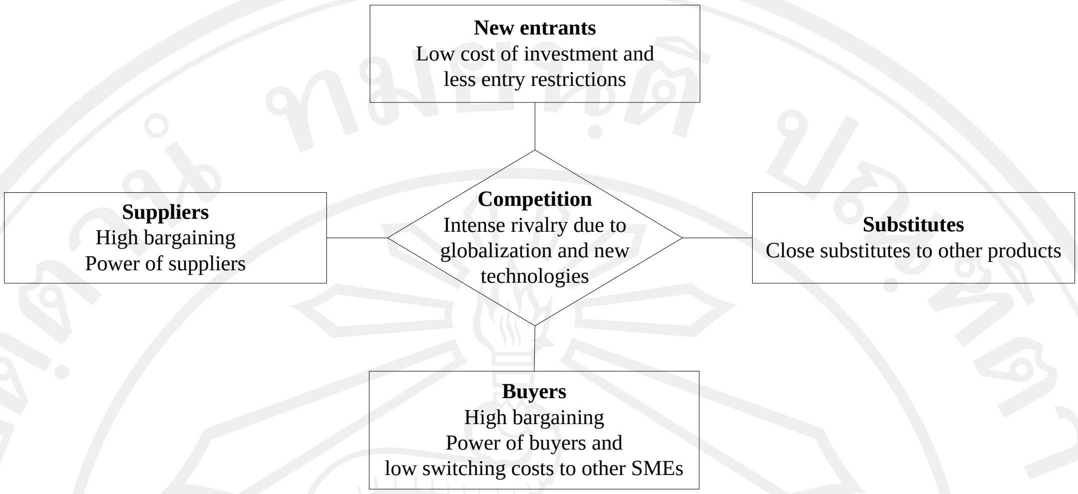


Figure 1.3 Porter's five forces

Source: Adapted from Porter, 1985

The applicability of many techniques associated with lean manufacturing in stochastic environments stumble on a variety of obstacles, primarily due to their diverse product mix with many dissimilar routings. Hence, there is a need for new approaches and specifically suited tools.

Both experts in the field of information technology and business engineering have concluded that successful systems start with an understanding of the business processes of an organization (Aguilar-Saven, 2004). Business processes are designed to add value for the customer and should not include unnecessary activities. The outcome of a well designed business process is increased effectiveness (value for the customer) and increased efficiency (less costs for the company). To become lean, fat or waste must be removed from the business processes to leave just that adds value activity to either the external or internal customer. Supplier selection is a critical activity based on cost, quality requirements and delivery reliability (Dulmin and Mininno, 2003).

Due to the increasing acceptance of the lean production paradigm, the performance of supplier becomes a key component in a company's success or failure. Unlike traditional purchasing systems where price considerations dominate, suppliers are evaluated and selected on a combination of factors such as: quality, service, delivery performance as well as price (Wilson and Roy, 2009). Thus, a selection procedure is required to handle several complex factors including with uncertainty associated with subjective judgmental errors in a better sensible and logical manner. Supplier selection criteria procedures affect production planning and control, inventory management, etc. (Narasimhan, 1983). Moreover, Aissaoui et al. (2007) reviewed the impact of the selected supplier on various functional areas of a business from procurement to production and delivery of the products to the final customer.

Finally, it is clear from many studies on the subject that under different market demand environments, different production and materials flow control mechanisms must be implemented to fulfill specific needs of a company (Fernandes and Carmo-Silva, 2006). Many mechanisms like material requirement planning, Kanban, constant work in process (CONWIP), paired-cell overlapping loops of cards with authorization (POLCA) etc. have been reviewed to find gaps for optimized makespan time in a job scheduling problem. The job scheduling problem is one of the existing combinatorial optimization problems and it has been demonstrated to be an NP-Hard problem (Garey et al., 1976). Therefore, a designed mechanism for turbulent manufacturing system is needed. Moreover, the lean system in stochastic environments requires a simple control system as present in the form of card-based system such as Kanban which is dedicated to traditional lean system.

### 1.3 Research Objectives

Existing lean tools are mainly dedicated to MTS industries. SMEs have faced problems that have been receiving attention from practitioners and others in the academic field. Nevertheless, lean tools may result in additional resource wastages when misapplied. Considering this, three objectives will be pursued within this thesis:

1. To design and develop supplier selection and workload control for job scheduling in stochastic environments using lean systems.
2. To identify and analyze factors influential to product delivery and variation reduction.
3. To improve makespan time by using a hybrid algorithm.

### 1.4 Research Questions

It is clear from the above-mentioned review that the Thai SMEs require the knowledge in evaluation to be leanness, and then many questions are arisen. Three questions will guide this research as

Main Question How will lean manufacturing system practices affect on delivery in stochastic environments?

Sub-Question 1. What factors will have influence effect on product delivery and variation reduction?

Sub-Question 2. Which approach should be suitable to find a job shop scheduling of minimum length for stochastic lean system environments?

## 1.5 Scope and Education/Application Advantages

The questions display in the line of lean application for the stochastic environments. An empirical study is motivated by a problem faced from an engineering department of gold and gems company. Its name has not been disclosed in order to protect the confidentiality. It is referred to as a XYZ company where locates in Lamphun. The case study has limited sources for data, thus the quantitative analysis of this research made with certain assumptions. If such assumptions are wrong, the results would be misleading. In addition, this research applies MCDM, simulation technique, business process management, hybrid algorithm to develop lean tools. The main education/application advantages are as follows

1. Lean tools for the stochastic environments are presented.
2. Influential factors of lean manufacturing system for stochastic environments are informed.
3. A scheduling procedure is stable that directly effects to overall business performance.

## 1.6 Definition

(1) Lean manufacturing

A philosophy that when implemented reduces the time from customer to delivery by eliminating a number sources of waste in the production flow

(2) Small and medium enterprises in term of manufacturing sector

A small enterprise employs up to 50 workers and invests on fixed asset up to 50 million baths. A medium enterprise employs from 51 workers up to 200 workers and invests on fixed asset more than 50 million baths up to 200 million baths.

(3) Stochastic environments

Stochastic environments play a fundamental role in mathematical models of phenomena in many fields of science, engineering and economics. They have the degree of variability and uncertainty of inputs causes the manufacturing system to experience unpredictable and sub-optimal behavior as it struggles to achieve the desired outputs.

## 1.7 Thesis Outline

The subsequent chapter briefly reviewed related literatures. Consequently, some theoretical considerations for this research are proposed before developing them to bridge the gap of current research problems. Chapter 3 provides a detailed research framework for lean manufacturing system by integrating lean tools. This framework triggers the main research question that drives the initial development of an effective production system in Chapter 4. Chapter 4 presents a lean manufacturing roadmap for the stochastic environments. Supplier selection problem has been solved in two different approaches presented in Chapter 5. A hybrid algorithm for a card-based system which meets the requirements of the stochastic environments is proposed in Chapter 6. Finally, Chapter 7 presents the final conclusion and suggestion.