A STUDY ON LEAN MANUFACTURING IMPLEMENTATION AT METAL PRODUCTS INDUSTRY FOR SMALL MEDIUM ENTERPRISES (SMEs)

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A thesis submitted is fulfillment of the requirements for the award of the degree of Bachelor of Manufacturing Engineering

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JUDUL: **A STUDY ON LEAN MANUFACTURING IMPLEMENTATION AT METAL PRODUCTS INDUSTRY FOR SMALL MEDIUM ENTERPRISES (SMEs)**

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To my beloved parents

Mr. Othman Bin Hassan

Mrs. Maimunah Binti Bakar

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ABSTRACT

This final year project presents an exploratory study of lean manufacturing implementation in metal product industry for Small and Medium Enterprises (SMEs). A questionnaire is used to explore the extent of lean manufacturing implementation. This study also examines the reasons and critical factors that influence the implementation of lean manufacturing. The survey was performed on ten companies of SMEs. The respondents were chosen from those who are directly involved with producing metal product for large company at Malaysia. The findings show that most of the respondent companies are classified as non-lean manufacturing practice. These non-lean companies have low mean values for each of the fifteen lean manufacturing practices. These companies believe that the main reasons for them to the implementation of lean manufacturing are the desire to improve long term cost competitiveness and to meet customer demand. The results from this survey also revealed the main critical factor that prevent or delay the lean implementation. The main critical factor to implement lean manufacturing system is the lack of understanding lean concepts.

ABSTRAK

Projek tahun akhir ini membentangkan kajian penerokaan pelaksanaan *lean manufacturing* dalam industri produk besi untuk Perusahaan Kecil dan Sederhana (PKS). Soal selidik digunakan untuk mengenal pasti sejauh mana pelaksanaan *lean manufacturing*. Kajian ini juga mengkaji sebab-sebab dan faktor-faktor kritikal yang mempengaruhi pelaksanaan *lean manufacturing*. Kaji selidik telah dijalankan ke atas 10 syarikat PKS di Malaysia. Responden telah dipilih dari mereka yang terlibat secara langsung dengan penghasilan produk besi untuk syarikat besar di Malaysia. Hasil kajian telah menunjukkan bahawa kebanyakan syarikat responden dikelaskan sebagai perlaksanaan *non-lean*. Syarikat-syarikat ini dikategorikan sebagai *non-lean* kerana mereka telah mendapat markah purata yang peling rendah bagi setiap 15 amalan *lean*. Syarikat-syarikat percaya bahawa sebab-sebab utama bagi mereka untuk menjalankan perlaksanaan *lean manufacturing* adalah keinginan untuk meningkatkan daya saing kos jangka panjang dan untuk memenuhi permintaan pelanggan. Keputusan daripada kajian ini juga mendapati faktor kritikal utama yang yang menghalang atau melambatkan pelaksanaan *lean*. Faktor utama yang kritikal untuk melaksanakan *lean manufacturing* adalah kurang memahami konsep *lean*.

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LIST OF ABBREVIATIONS

SMEs	Small and Medium Enterprises
TPS	Toyota Production System
VA	Value add
NVA	Non value add
SPSS	Statistical Package for Social Science
SOP	Standardization of Operation
Kaizen	Continuous Improvement
JIT	Just-in-Time
VSM	Value Stream Mapping
SMED	Single Minute Exchange Die

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides the description of the background of study, problem statement, objectives of the study, and scope of study.

1.2 BACKGROUND OF STUDY

The global industry in 21st century has driven most of manufacturing companies to implement new manufacturing management strategies in order to enhance the companies' efficiency and competitiveness. Manufacturing companies had taken lean manufacturing system as a great management tool and many of them have adopted lean techniques in many different forms and names. Initially it is started at Toyota plant in Japan which is known as Toyota Production System (TPS). This system has been widely known and implemented since 1960. Nowadays, lean manufacturing has become a standard for manufacturing mode especially for automotive industries. Many researcher such as Papadoupulu and Ozbayrak in their study agreed that lean manufacturing could be a cost reduction mechanism and if it implemented in a right way it can be a guideline to be world class organization (Rose et al, 2009).

Lean manufacturing system is a system that consists of the universal set management principles which could be implemented in anywhere, any industries and any company not just in automotive industries only. Small medium enterprises has been encouraged to apply it because it is widely known that organizations that have mastered in lean manufacturing methods have high cost and quality advantages over those who still practicing traditional mass production. Lean manufacturing combines the best features of both mass production and craft production which is the ability to reduce costs per unit and at the same time improve quality of products.

Lean manufacturing is known as manufacturing without waste. The waste is consisting of non-added value. There are seven type of waste which are overproduction, waiting time, transportation, inventory, over-processing, excess motion, and product defects (Liker, 2004). Most of the companies waste about 70% to 90% of their available resources. The Lean Enterprise Reserch Centre (LERC, 2004) at Cardiff Business School have emphasized that in the production process there are 5% is added value activities, 35% necessary non added value activities and 60% are non added value at all. This shows that the organization no matter the sizes (small, medium or large) or industries is important to eliminate waste, in order to increase profit to company.

Many enterprises have been introduced to lean manufacturing system and have made significant achievement. A few of small and medium enterprises (SMEs) have get profit from the implementing lean manufacturing. SMEs play a significant role in the economic growth of developing countries, typically accounting for over 90% of business establishments and about half or more of output and export shares (Pingyu & Yu, 2010). Their entrepreneurship is flexibility and responsiveness to change are essential driving force of economic development. The employment opportunities they create were succeeded in increasing the living standards of thousands of millions of poor people. In many developing countries, SMEs account for as much as 70% of the labor force. Unfortunately, SMEs fail much more often in market competition. Therefore, approaching to effective implementation of Lean production in SMEs is very important.

1.3 PROBLEM STATEMENT

The importance of small manufacturer to take part in lean implementation is to compete with large manufacturer which implementing new management system which is lean manufacturing to improve their performance. Therefore, this will affect the small and medium enterprises (SMEs) which are the suppliers to the large manufacturers. Due to limited resources, it is impossible for SMEs to implement all elements or practices at one time. As been published by past researchers and practitioners, lean manufacturing has been implemented successfully in many large organizations but there is still less documented evidence of its implementation in smaller organizations. The increasing demands from customers that seek for high quality products and also highly capable business processes by large organization has left no choice for the SMEs to consider and implement lean manufacturing.

1.4 OBJECTIVES

The purposes of this study are:

1) To investigate the status of lean manufacturing implementation in metal product industry for small medium enterprises. The lean status can be identified whether the companies are into lean, in-transition towards lean or non-lean.
2) To identify the critical factors to implement the lean manufacturing in the SMEs companies. From that, the companies can overcome the factors in order to compete with larger companies.

1.5 SCOPE OF STUDY

In order to achieve the objectives of this study, the companies that focus on metal products industry were selected as the population. The metal products industry was chosen because it is a heavy industry and used high cost. Normally, this type of industry does not have any system because they perform complex production process. So, it is very suitable to implement lean manufacturing. The database was obtained from Small and Medium Enterprise Corporation Malaysia (SME Corp. Malaysia).

This study is a questionnaire-based. A questionnaire was developed to collect data. The purpose of questionnaires is to collect data and distribute to related department of the company.The questionnaire consists of four sections which are:

- Section A for the general information of the respondent.
- Section B for the lean manufacturing implementation.
- Section Cfor the critical factor for lean manufacturing implementation.

CHAPTER 2

THEORETICAL REVIEW

2.1 BACKGROUND OF LEAN MANUFACTURING

Henry Ford was the first person to truly integrate an entire production process. In 1913, he integrated consistently interchangeable parts with standard work and moving conveyance to create what he called flow production. Ford lined up fabrication steps in process order wherever possible. This was a revolutionary break from shop practices of the American system, which usually consisted of general-purpose machines grouped by process. Ford's problem is he could not provide the variety needed.

Japanese engineers at Toyota Motor Company, Taiichi Ohno reviewed Ford's concepts, and felt that a series of simple solutions might make it possible to provide consistency in process flow in a variety of products. As a result they invented the Toyota Production System (TPS). This system shifted the focus to the flow of the product through the entire process. Toyota adjusted their production capabilities to the actual volume needed, introduced self-monitoring machines to ensure quality, lined up the machines in process sequence, and pioneered quick changeovers, so that each machine could make small volumes of many parts, and having each step sequence notify the previous step of its current needs for materials (called as a "pull system"). This allowed Toyota to obtain low cost, high variety, high quality, and rapid throughput times to meet customer needs. The summarized movement phases in the lean manufacturing evolution are shown in Table 2.1.

Table 2.1: Time line marking the critical phases in the lean manufacturing evolution

1927 and before	• Henry Ford outlines his production philosophy and the basic principles underlying the revolutionary Ford Production System (FPS) in "Today and tomorrow" in 1927.
1945-78 Progress In Japan	• 1937 - Toyoda (later Toyota) Motor Company is established in Koromo, Japan. o Toyoda cousins Kiichiro and Eiji, with Taiichi Ohno study FPS and perfect the principles concepts and tools constituting Toyota Production System (TPS). Just in time (JIT) production method is a key component of TPS. • 1978 – Ohno publishes "Toyota Production System" in Japanese. He credits FPS and the American supermarket behind his just in time thinking. o According to Ohno, the primary goals of TPS is cost reduction (waste elimination), it can be achieved through quantity control, quality assurance, and the respect for humanity. He recommends producing only the kind of units needed, at the time needed and the quantities needed.
1973-99 TPS arrives in North America	• 1973 – Oil crisis hits North America and generates immense interest I the (new) Japanese manufacturing and management practices followed by publication of numerous academic and practitioner books and articles. • 1977 – First academic articles is published by Sugimori ar al.; Narrowly focused articles on topics such as Kanban and just in time production (Monden 1981b), production smoothing and level loading (Monden 1981c) appear. • 1984 - NUMMI, a joint venture between Toyota Motor Company and General Motors opens in California • Mid 1980s – Noteworthy books including Moden's Toyota Production System (1983); Ohno's Toyota Production System: Beyond large-scale production (1988) are published in English. • There is only a piecemeal understanding of TPS and its constituent elements; equivalence between JIT production, kanban and TPS is sugeested (see Table 2).
1988-2000 Academic progress	• 1988 - Krafcik coins the term "lean" to describe the manufacturing system used by Toyota. • 1990 – The machine that changed the world by Womack, Jones and Roos is published o The machine establishes "lean production" to characterize Toyota's production system including its underlying components in the popular lexicon. o The book describes a lean system in detail; but does not offer a specific definition. • Mid 1990s - Articles related to measuring just in time (Sakakibara et al., 1993; Flynn et al., 1995; McLachlin, 1997), total quality management (Ross, 1993; Dean and Bowen, 1994; Sitkin et al., 1995; Flynn et al., 1995), their interrelationships (Flynn et al., 1995; Sakakibara et al., 1997) and the impact of other organizational variables on their implementation are published in the academic journals. • 1994 - Lean Thinking by Womack and Jones is published. The book extends the philosophy and the guiding principles underlying lean to an enterprise level.
2000-present	• Numerous books and articles written by practitioners and consultants, and a few academic conceptual (Hopp and Spearman, 2004; de Treville and Antonakis, 2005) and empirical articles (Shah and Ward, 2003) highlighting the overarching nature of lean production are published; yet no clear and specific definition is available. • 2006 – Toyota Motor Company is projected to become #1 automobile manufacturer in North America.

Source: Shah & Ward (2003)

2.2 DEFINITION OF LEAN MANUFACTURING

The main focus of lean manufacturing was to reduce the cost and to improve productivity by eliminating wastes or non-value added activities. Womack and Jones in their book "Machine that changed the world" (1990) argue that the adoption of lean approach will change almost everything in every industry- choices for consumers, the nature of work, and fortune of industry by combining the advantages of craft and mass production. The lean approach consists of various practices, which aim to improve efficiency, quality and responsiveness to customers. Todd (2000) defines lean production as "initiative, whose goal is to reduce the waste in human effort, inventory, time to market, and manufacturing space to become highly responsive to customer demand while reducing world class quality products in the most efficient and economical manner". While Bahsin & Burcher (2006) has defined lean manufacturing as a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the flow. Lean manufacturing is a manufacturing strategy that aimed to achieve smooth production flow by eliminating waste and by increasing the activities value. Some analysts even pointed out that if an organization ignores the lean manufacturing strategy, the company would not be able to stand a chance against the current global competition for higher quality, faster delivery and lower costs.

Lean manufacturing consists of a large number of tools and techniques. Shah and Ward (2003) identified 22 lean manufacturing practices that are frequently mentioned in literatures and categorized them into four bundles associated with Just-in-Time, Total Quality Management, Total Preventive Management and Human Resource. Some other researchers also categorized the lean tools and techniques according to the area of implementation such as internally and externally oriented lean practices. For example Panizzolo (1998) in his study divided the lean practices into six areas which are process and equipment; manufacturing, planning and control; human resources; product design; supplier relationships; and customer relationships. The first four areas are grouped as internal oriented lean practices, whereas supplier relationships and customer relationships are under external oriented lean practices. The study also confirms that, many firms seem to have difficulty in adopting lean tools that concern with external relationships with suppliers and customers even for high performance

firms. Empirical results from this study also prove that lean tools in internal areas are adopted most widely in the firms, where the operation and management methods are more direct. While Achanga *et al.* (2006) suggested that the success of lean manufacturing implementation depends on four critical factors which are leadership and management, finance, skills and expertise and supportive organizational culture of the organization.

2.3 CONCEPT OF LEAN MANUFACTURING

The key to lean manufacturing is to compress time by eliminating waste and this continuously improving the process. Ohno defines waste (also called 'Muda' in Japanese) as all elements of production that only increase cost without adding value that customer is willing to produce. Sometimes the waste is a necessary part of the process and adds value to the company and this cannot be eliminated for example financial controls. There are seven main types of waste which are overproduction (producing more than needed), waiting (idle operator or machine time), motion (movement of people or machine that does not add value), inventory (any supply in excess of required to produce product), transportation (any material movement that does not directly support value added operations), defects (making defective parts) and over-processing (any process that does not add value to the product). The descriptions of seven wastes explain in Table 2.2. Initially, waste can be easily identified in all processes and early changes can reap huge savings. As the processes continually improve, the waste reduction will be more incremental as the company strives to achieve a waste free process.

Table 2.2: The seven waste

Type of waste	Description	Within the process industry	Example symptom
Over production	- Product made for no specific customer - Development of a product, a process or a manufacturing facility for no additional value	- Large campaign (large batch and continuous large-scale manufacturing processes) - Development of alternative process routes which are not used or the development of processes which do not support the bottleneck - Redesign of parts of the manufacturing facility which are 'standard', e.g., reactors	- The extent of warehouse space needed and used - Development and production organization imbalance - An ever changing process (tweaked) - Large engineering costs/time associated with facility modifications
Waiting	- As people, equipment or product waits to be processed it is not adding any value to the customer	- Storage tanks acting as product buffers in the manufacturing process waiting to be processed by the next step - Intermediate product which cannot leave site until lab tests and paperwork are complete	- The large amount of 'work in progress' held up in the manufacturing process—often seen on the balance sheet and as 'piles of inventory' around the site

Transport	- Moving the product to several locations - Whilst the product is in motion it is not being processed and therefore not adding value to the customer	- Raw materials are made in several locations and transported to one site where a bulk intermediate is made. This is then transported to another site for final product processing - Packaging for customer use may be at a separate site	- Movement of pallets of intermediate product around a site or between sites - Large warehousing and continual movement of intermediate material on and off site rather than final product
Inventory	- Storage of products, intermediates, raw materials, and so on, all costs money	- Economically large batches of raw material are purchased for large campaigns and sit in the warehouse for extended periods - Queued batches of intermediate material may require specific warehousing or segregation especially if the lab analysis is yet to be completed or confirmed	- Large buffer stocks within a manufacturing facility and also large warehousing on the site; financially seen as a huge use of working capital
Over-processing	- When a particular process step does not add value to the product	- A cautious approach to the design of unit operations can extend processing times and can include steps, such as hold or testing, which add no value	- The reaction stage is typically complete within minutes yet we continue to process for hours or days

		- The duplication of any steps related to the supply chain process, e.g., sampling, checking	- We have in process controls which never show a failure - The delay of documents to accompany finished product
Motion	-The excessive movement of the people who operate the manufacturing facility is wasteful. Whilst they are in motion they cannot support the processing of the product - Excessive movement of data, decisions and information	- People transporting samples or documentation - People required to move work in progress to and from the warehouse - People required to meet with other people to confirm key decisions in the supply chain process - People entering key data into MRP systems	- Large teams of operators moving to and from the manufacturing unit but less activity actually within the unit - Data entry being seen as a problem within MRP systems
Defects	- Errors during the process - either requiring re-work or additional work	-Material out of specification; batch documentation incomplete -Data and data entry errors - General miscommunication	- Missed or late orders - Excessive overtime - Increased operating costs

Source: Melton (2005)

In order to eliminate the waste, there are many tools and techniques can be used. Table 2.3 shows a sample of the tools and techniques used by a ‘lean thinker’ as their toolkit.

Table 2.3: Sample of 'lean thinker' toolkits

Tool	Description	Typical Use
Process flow mapping	- A map showing each process step in the value stream	- A data collection activity - Also used to analyze the VA (value add) and NVA (non value add) steps and as a tool for redesign
Time-value mapping	- A map of the time taken for each process step in the value stream	- A data collection activity - Also used to analyze the VA and NVA steps and as a tool for redesign
5 Why	- Taiichi Ohno (Womack et al., 1990) had a practice of asking why five times whenever a problem was found. In this way the root cause was solved rather than the symptom.	- As a part of the data analysis so that the root cause problem can be solved in the design phase
5S	- Five activities used to create a workplace suited for visual control and lean practices: † Seiri - separate required from unnecessary tools and remove the latter † Seiton - arrange tools for ease of use † Seiso - clean-up † Seiketsu - do the above regularly (maintain the system you've set up)	- Can be used at the start of a lean induction to break down barriers and get a team to own their workspace - Often used during Kaizen as workplace layout and tidiness is often an issue which causes waste (unable to find the right equipment, use what's there, lose key paperwork, and so on)

	† Shitsuke - get into the habit of following the first four S's	
Kaizen	- An improvement activity to create more value and remove waste. Commonly called a breakthrough kaizen	- Kaizen workshops are a common method to kick-off the start of a large step change within an area or value stream - Kaizen would actually start with data collection and continue to do some data analysis, design and even implementation
Kanban	- Japanese for 'signboard'. This is a 'visual' shop floor pull system which means that each supplying work centre does not make anything until the next work centre requests supply	- This is a design solution to materials flow problems within a process (examples within both manufacturing and lab situations have been seen)

Source: Melton (2005)

2.4 SMALL AND MEDIUM ENTERPRISES (SMEs)

SMEs have played incredible role in manufacturing sector all over the world. In year 2007, Malaysia has 96% of establishments of SMEs which contributed 30.7% of total manufacturing output and 26.3% of total value added. This was stated in SME annual report 2007. In addition, more than 400,000or 315 of total Malaysian workforce were employed by SMEs. In Malaysia, an enterprise is considered an SME in each of the respective sectors based on the Annual Sales Turnover or Number of Full-Time Employees as shown in the Table 2.4.

Table 2.4: Definition of SME based on the Annual Sales Turnover or Number of Full-Time Employees

	Micro-enterprise	**Small enterprise**	**Medium enterprise**
Manufacturing, Manufacturing-Related Services and Agro-based industries	Sales turnover of less than RM250,000 OR full time employees less than 5	Sales turnover between RM250,000 and less than RM10 million OR full time employees between 5 and 50	Sales turnover between RM10 million and RM25 million OR full time employees between 51 and 150
Services, Primary Agriculture and Information & Communication Technology (ICT)	Sales turnover of less than RM200,000 OR full time employees less than 5	Sales turnover between RM200,000 and less than RM1 million OR full time employees between 5 and 19	Sales turnover between RM1 million and RM5 million OR full time employees between 20 and 50

Source: SMECorp (2011)

2.5 LEAN MANUFACTURING IMPLEMENTATION IN SMES

In the competitive environment, with the penetration of China and India products into the Malaysian market, it is the best interest of all SME stakeholders, whether employees, customers or suppliers, to adopt the best management practice in order to compete in today's global marketplace. It was predicted that the China manufacturer will be biggest rival to any company in five years time. The best management practice in 21st century was suggested by researchers is lean manufacturing. The overall strengths and weaknesses of SME to adopt lean manufacturing are as listed in Table 2.5. It shows that SMEs still have the potential to success in lean even though there are barrier. SMEs have strengths and advantages to obtain operational and financial benefits, through lean philosophy compared to large company.

Table 2.5: Strength and weakness of SME's

SME's strengths	**SME's weaknesses**
Structure	
Fast decision making	Low specialization
High level of innovativeness	Need outside assistance
Very few interest groups	Owner controls everything
Breeding ground for new business ventures and entrepreneurs	Lack of capital
System, processes and procedures	
Simple system encourage innovation, allows flexibility and speed of response to customer needs/demands	Lack of proper system
	Lack of proper/effective time and cash flow management
Act as training ground for new entrepreneurs and workers	"Gut feeling" approach may result in wrong decisions
	Lack of technology
	Inadequate infrastructure
Culture and behavior	
Looking for new change initiatives	Lack of managerial and technical expertise
High staff loyalty and hard work	Dictatorial owner/manager ethos can damage new initiatives
As a seed-bed from which large companies grow	Danger when loyalties and emotional ties are place above competence and performance
As a group provides significant economic output and savings in foreign exchange	
Human resources	
High authority, commitment and responsibility	Lack of financial support, e.g. no training budget, ad hoc, and small-scale approach can stifle improvement efforts
Innovative environment	
Relationship like in one family	Shortage of skilled workers
Provides employment opportunities	
Market, customers and suppliers	
Faster feedback from customers	Marketing constraints and knowledge
Quicker respond	International marketing expensive, after sales support not as extensive as large businesses
Understand customer needs.	
Stimulate market competition	Pressured and dictated by large companies.
Small lot delivery	Lack of negotiation power

Source: Rose *et al*. (2010)

However, in order to implement lean manufacturing, SMEs may faced many problems compared to large company such as:

i. SMEs may not have negotiating power to ensure suppliers privide frequent delivery and quality standards due to small business
ii. SMEs have limited sources such as manpower and financial to make operational changes for lean implementation
iii. SMEs' management have lack of expsure on lean practices

Apart of that, there are several critical factors faced by SMEs in productivity improvement programme such as top management support, involvement of managers in a team, education and training and empowerment of employees. This was support by Achanga et al. (2006), when they discovered four main fundamental critical success factors to be the successful lean implementation in SMEs are leadership and management, financial, organization structure and skill and expertise.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter will give a brief explanation on the methodology of carrying out the study from start till the end of the whole semester. It consists of flow chart for final year project, selection of company, development of questionnaire, data collection and method of analysis.

3.2 FLOW CHART OF FINAL YEAR PROJECT

Figure 3.1 shows flow chart of the whole final year project from start to the end.

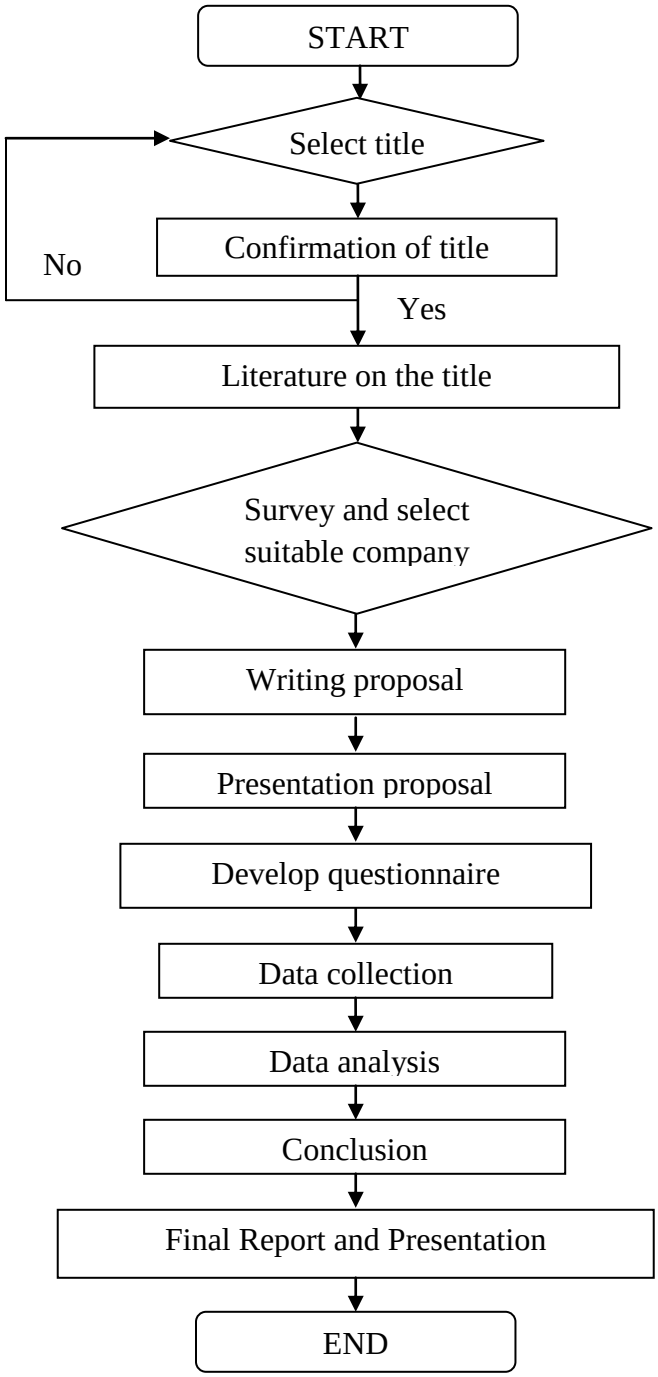

Figure 3.1: Flow chart of Final Year Project

3.3 SELECTION OF COMPANY

Company that involved in metal product industries was chosen to conduct this study. In Malaysia, basic metal product industry include the iron & steel industry and the non-ferrous metal industry, have seen significant developments since the last three decades in tandem with the country's industrial development. Metal industries were selected because these industries involved with complex process in their production. It also required huge investment to buy equipment.

The database was obtained from SME Corp Malaysia directories. According to the database there are 1426 companies that involve in metal products industry in Malaysia (excluding Sabah and Sarawak). But for this study, 10 companies were selected randomly. List of selected companies shown in Table 3.1. The company was selected based on number of full time employees which are not more than 150 employees and annual sales turn over not more than 25 million.

Table 3.1: List of metal product companies

No	Name of Company	Product
1.	AEM Moulding Engineering Sdn. Bhd.	- Aluminum mould
2.	Autokeen Sdn. Bhd.	- Stamping - Sub-assembly of metal components
3.	Brimal Stampress Engineering Sdn. Bhd.	- Engines - Brackets
4.	Duramex Industries Sdn. Bhd.	- Server rack
5.	Ecomould Technology Sdn. Bhd.	- Making mould
6.	KCL Metal Industries Sdn. Bhd.	- Shock Absorber - Car Front Grille - Metal Stamping Product
7.	NSK Micro Precision Sdn. Bhd.	- Miniature ball bearings - Anti-corrosion bearings
8.	Tahiti Technology Aluminium Sdn. Bhd.	- Aluminium Composite Panel - Aluminium Solid Pane
9.	TSA Industries Sdn. Bhd.	- Supply ferrous materials (Stainless Steel, Mild Steel, Carbon Steel, Galvanized Steel)
10.	ZincAlu Casting Sdn. Bhd.	Crankcase Covers Power Steering Pumps Housings

Source: SMECorp (2011)

3.4 DEVELOPMENT OF QUESTIONNAIRE

A questionnaire was developed to collect data for this study. The purpose of questionnaires is to collect data and distribute to the selected companies.The questionnaire were consists of three sections which are:

- ✓ Section A for the general information of the respondent. This section consists of 5 question which to know gender, age, position in company, experience of working at the company and lean implementation. The purpose of this section is to identify whether the company implement lean manufacturing or not.
- ✓ Section B for the lean manufacturing implementation. There are 15 question in this section which and was divided into two which are to know respondent perception of lean practices either it is important or not and the implementation lean practices at their company either it is implemented or not implemented. The questions were set up on five point Likert scale to measure the extent of implementation described by each of items. The scale was ranged from 1 to 5 where for perception: 1 is highly not important, 2 is not important, 3 is not sure, 4 is important and 5 is highly important. Whereas scale for implementation of lean manufacturing: 1 is highly not implement, 2 is not implement, 3 is not sure, 4 is implement and 5 highly implement. Answer from this section will be used to determined lean status at the selected companies.
- ✓ Section C is the critical factor for lean manufacturing implementation at the company. This section consists of 12 questions and will be used to identify the critical factor faced during implementation lean manufacturing and the barriers that prevent the company to implement lean.

Most of the questionnaire for this study was conducted in close ended type. A closed type question would ask the respondent to make choices among the set of alternatives given by researcher. Closed question helped the respondents to make quick decisions to choose among the several alternatives before them. They also help the researcher to code the information easily for analysis data. The main consideration of the design of this questionnaire was to keep it short and focused in order to obtain an adequate response rate.

3.5 DATA COLLECTION

The questionnaire was distributed to the selected company through email and by hand. The email for the respondents was obtained through the company website and also phone call. The questionnaire was distributed to the top management of the company which are supervisor level and above. This was support by Wong *et al*. (2009) when they state that "The questionnaires were addressed to the General Managers or Managing Directors of the companies. They were considered to be the best address because they were likely to be the thought leaders in charge of lean manufacturing. However, it was up to the organization to assign the most appropriate person who has knowledge to answer the questionnaire".

3.6 METHOD OF ANALYSIS

After data collections process, the collected data from questionnaire was analyzed to determine the level of lean manufacturing implementation in the companies by using Statistical Package for the Social Sciences (SPSS) software. SPSS software was chosen because it is a comprehensive and flexible statistical analysis and data management solution. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts, and plots of distributions and trends, descriptive statistics, and conduct complex statistical analyses. In addition, SPSS are available from several platforms such as Windows, Macintosh, and the UNIX systems.

SPSS conduct this analysis quite simply when the investigator nominates the item to be includes and provides a statistics called Cronbach's Alpha Coefficient. The closer the reliability coefficient gets to 1.0, the better. In general, reliabilities of less than 0.6 are considered to be poor, those in the 0.7 range are acceptable and those over 0.8 are good. To know about difficulty factors to implement and maintain the lean manufacturing and which lean tool or method mostly be used in the companies, the average mean values was analyzed.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter discusses result from data collection. 100 questionnaires were distributed to 10 selected SMEs metal product companies. Some was sent through by hand and some through email. After two and half month of sending and following up the questionnaire, 67 answers have been received in total.

4.2 RESPONDENT PROFILE

The first aspects to be investigated were the general information of the respondent involved. Table 4.1 shows the general background of respondent such as gender, age, job position and years of employment in the company. It was found that the respondent mainly from male (69.4%) workers. Most of them are at executive level (41.9%) and have been working in range 1 to 5 years (40.3%) at the particular company.

Table 4.1: General information of the respondents

		Frequency	Percent	Valid Percent
	Gender			
Valid	**Male**	**43**	**69.4**	**69.4**
	Female	19	30.6	30.6
	Total	62	100.0	100.0
	Age			
Valid	< 20 years old	4	6.5	6.5
	21-30 years old	**37**	**59.7**	**59.7**
	31-40 years old	16	25.8	25.8
	> 41 years old	5	8.1	8.1
	Total	62	100.0	100.0
	Position			
Valid	Manager	7	11.3	11.3
	Asst. Manager	4	6.5	6.5
	Executive	**26**	**41.9**	**41.9**
	Supervisor	25	40.3	40.3
	Total	62	100.0	100.0
	Years of employment			
Valid	< 1 year	12	19.4	19.4
	1-5 years	**25**	**40.3**	**40.3**
	6-10 years	18	29.0	29.0
	>10 years	7	11.3	11.3
	Total	62	100.0	100.0

4.3 LEAN MANUFACTURING IMPLEMENTATION

. In order to identify the status of implementation lean manufacturing at the company, respondents were asked whether at their company implement lean manufacturing or not. Table 4.2 shows the percentage of selected SMEs metal product companies involved in this study that implementation of lean manufacturing at their company. It was found that 60% of the companies implement lean manufacturing at their organizations.

Table 4.2: Lean implementation at SMEs metal product companies

		Percent	Valid Percent	Cumulative Percent
Valid	**Yes**	**60.0**	**60.0**	**60.0**
	No	40.0	40.0	100.0
	Total	100.0	100.0	

To the further verifying the extent of lean manufacturing implementation in SMEs metal product companies, the respondent of companies were asked to rate the level of their perception of importance lean manufacturing practices and level of implementation of lean manufacturing practices listed based on their current manufacturing practices.

4.3.1 Reduced Machine/Tooling Setup Time

Table 4.3 illustrates the level of perception and implementation of reduced machine or tooling setup time at SMEs metal product companies. As shown, the respondents assume reduced machine or tooling is important to be implemented at the companies because this range have higher percentage which is 45.2% but they not do not sure (37.1%) whether this lean manufacturing practice was implemented or not at their company. This shows that the workers of SMEs metal product companies do not practices reduced machine or tooling setup time at their companies.

Table 4.3: Level of perception and implementation of reduced machine/tooling setup time

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	1	1.6	1.6
	Not important	5	8.1	8.1
	Not sure	9	14.5	14.5
	Important	**28**	**45.2**	**45.2**
	High important	19	30.6	30.6
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	2	3.2	3.2
	Not implement	9	14.5	14.5
	Not sure	**23**	**37.1**	**37.1**
	Implement	19	30.6	30.6
	Highly important	9	14.5	14.5
	Total	62	100.0	100.0

4.3.2 Cell Layout

Cell layout is an organization of a production facility which having similar processing requirements together in a group. Table 4.4 illustrates the level of perception and implementation of cell layout at SMEs metal product companies. As shown, the respondents assume cell layout is important to implement at the companies because this range have higher percentage which is 33.9% and it is implemented (25.8%) at their organization.

Table 4.4: Level of perception and implementation of cell layout

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	3	4.8	4.8
	Not Sure	16	25.8	25.8
	Important	**21**	**33.9**	**33.9**
	Highly important	19	30.6	30.6
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	5	8.1	8.1
	Not implement	15	24.2	24.2
	Not sure	15	24.2	24.2
	Implement	**16**	**25.8**	**25.8**
	Highly implement	11	17.7	17.7
	Total	62	100.0	100.0

4.3.3 Standardization of operation (SOP)

Level of perception and implementation standardization of operation (SOP) at SMEs metal product companies is shown in Table 4.5. As shown, the respondents assume cell layout is highly important to implement at the companies because this range have higher percentage which is 50% and it is also highly implemented (38.7%) at their organization.

Table 4.5: Level of perception and implementation standardization of operation (SOP)

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	1	1.6	1.6
	Not Sure	11	17.7	17.7
	Important	16	25.8	25.8
	Highly important	**31**	**50.0**	**50.0**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	1	1.6	1.6
	Not implement	4	6.5	6.5
	Not sure	19	30.6	30.6
	Implement	14	22.6	22.6
	Highly implement	**24**	**38.7**	**38.7**
	Total	62	100.0	100.0

4.3.4 TAKT Time

TAKT time is the rate at which the customer requires a company to manufacture products. It also can be described as the number of work minutes per day divided by the number of orders per day. Table 4.6 illustrates level of the perception and implementation TAKT time at SMEs metal product companies. As shown, the respondents assume TAKT time is highly important to implement at the companies because this range has higher percentage which is 32.3% but it was not implemented (24.2%) at their organizations. There are a few factors that can influence the implementation of these practices at company such as fully support does not given to employee to involve in lean practices or the company facing a financial problem.

Table 4.6: Level of perception and implementation of TAKT time

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	6	9.7	9.7
	Not Sure	16	25.8	25.8
	Important	17	27.4	27.4
	Highly important	**20**	**32.3**	**32.3**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	6	9.7	9.7
	Not implement	**15**	**24.2**	**24.2**
	Not sure	**15**	**24.2**	**24.2**
	Implement	13	21.0	21.0
	Highly implement	13	21.0	21.0
	Total	62	100.0	100.0

4.3.5 Continuous Improvement (Kaizen)

Kaizen is one of the keys to implement lean manufacturing. Table 4.7 shows the level of perception and implementation kaizen at SMEs metal product companies. As clearly seen, perception of respondent to implementation of kaizen is highly important (48.4%) and it was implemented with percentage 41.9%.

Table 4.7: Level of perception and implementation of kaizen

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	1	1.6	1.6
	Not Sure	8	12.9	12.9
	Important	20	32.3	32.3
	Highly important	**30**	**48.4**	**48.4**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	7	11.3	11.3
	Not implement	0	0.0	0.0
	Not sure	5	8.1	8.1
	Implement	**26**	**41.9**	**41.9**
	Highly implement	24	38.7	38.7
	Total	62	100.0	100.0

4.3.6 Small Lot Sizes

Small lot sizes or ideally called one piece is an important component of many Lean Manufacturing strategies. Lot size directly affects inventory and scheduling. The perception and implementation of small lot sizes at SMEs metal product companies was shown in Table 4.8. The perception level of small lot sizes is important which is 41.9% as same as level with the implementation at the company which also was implemented with 35.5%.

Table 4.8: Level of perception and implementation of small lot sizes

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	2	3.2	3.2
	Not important	8	12.9	12.9
	Not Sure	13	21.0	21.0
	Important	**26**	**41.9**	**41.9**
	Highly important	13	21.0	21.0
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	5	8.1	8.1
	Not implement	7	11.3	11.3
	Not sure	20	32.3	32.3
	Implement	**22**	**35.5**	**35.5**
	Highly implement	8	12.9	12.9
	Total	62	100.0	100.0

4.3.7 5S

5S is a basic fundamental of lean manufacturing. It consists of five activities which are seiri (sorting), seiton (straightening out), seiso (shining), seiketsu (standardizing), and shitsuke (sustain). As shown in the Table 4.9, the perception of respondents and implementation of 5S at SMEs metal product companies is highly important (53.2%) and highly implemented (37.1%). This is shown that both respondent and management of the company understand the concept of 5S.

Table 4.9: Level of perception and implementation of 5S

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	2	3.2	3.2
	Not important	4	6.5	6.5
	Not Sure	9	14.5	14.5
	Important	14	22.6	22.6
	Highly important	**33**	**53.2**	**53.2**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	1	1.6	1.6
	Not implement	9	14.5	14.5
	Not sure	10	16.1	16.1
	Implement	19	30.6	30.6
	Highly implement	**23**	**37.1**	**37.1**
	Total	62	100.0	100.0

4.3.8 Multifunction/Multi Skilled Employee

Multifunction or multi skilled employee can be defined as one worker has many skilled and can do many tasks. Table 4.10 demonstrates level of the perception and implementation multifunction or multi skilled of employee at SMEs metal product companies. As shown, the respondents assume multifunction or multi skilled employee is highly important to implement at the companies because this range has higher percentage which 46.8%. But respondents of this study do not sure (35.5%) whether multifunction or multi skilled employee is implemented or not at their organization. This clearly shows that the respondents have of knowledge multifunction or multi skilled employee but they do not really understand about the knowledge.

Table 4.10: Level of perception and implementation of multifunction/multi skilled employee

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	1	1.6	1.6
	Not important	1	1.6	1.6
	Not Sure	12	19.4	19.4
	Important	19	30.6	30.6
	Highly important	**29**	**46.8**	**46.8**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	0	0.0	0.0
	Not implement	9	14.5	14.5
	Not sure	**22**	**35.5**	**35.5**
	Implement	13	21.0	21.0
	Highly implement	18	29.0	29.0
	Total	62	100.0	100.0

4.3.9 Preventive Maintenance Programme

Preventive maintenance is a procedure of inspecting, testing, and reconditioning a system at regular intervals according to specific instructions, intended to prevent failures in service or to retard deterioration. As shown in Table 4.11, level of respondents' perception is highly important which 33.9% but the level of implementation preventive maintenance programme is not sure which 37.8%. This was shows that the respondents had knowledge about preventive maintenance programme but they still cannot identify the programme yet.

Table 4.11: Level of perception and implementation of preventive maintenance programme

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	1	1.6	1.6
	Not important	5	8.1	8.1
	Not Sure	16	25.8	25.8
	Important	19	30.6	30.6
	Highly important	**21**	**33.9**	**33.9**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	1	1.6	1.6
	Not implement	11	17.7	17.7
	Not sure	**24**	**38.7**	**38.7**
	Implement	15	24.2	24.2
	Highly implement	11	17.7	17.7
	Total	62	100.0	100.0

4.3.10 Inventory Management

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures. Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and must be control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments.

Table 4.12 shows the level of respondents' perception toward inventory management is highly important which 41.9% but the level of implementation at their company is not sure which 32.3%.

Table 4.12: Level of perception and implementation of inventory management

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	1	1.6	1.6
	Not important	3	4.8	4.8
	Not Sure	15	24.2	24.2
	Important	17	27.4	27.4
	Highly important	**26**	**41.9**	**41.9**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	2	3.2	3.2
	Not implement	8	12.9	12.9
	Not sure	**20**	**32.3**	**32.3**
	Implement	18	29.0	29.0
	Highly implement	14	22.6	22.6
	Total	62	100.0	100.0

4.3.11 Kanban

Kanban is a visual process management system that tells what to produce, when to produce it, and how much to produce at a time. Table 4.13 shows level of the perception and implementation kanban at SMEs metal product companies. As shown, the respondents assume kanban is highly important to implement at the companies because this range has higher percentage which 33.9% and it was highly implement (25.8%) at the company. This shows that SMEs metal product companies clearly understand and implement kanban at their organization.

Table 4.13: Level of perception and implementation of kanban

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	2	3.2	3.2
	Not important	8	12.9	12.9
	Not Sure	13	21.0	21.0
	Important	18	29.0	29.0
	Highly important	**21**	**33.9**	**33.9**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	14	22.6	22.6
	Not implement	11	17.7	17.7
	Not sure	13	21.0	21.0
	Implement	8	12.9	12.9
	Highly implement	**16**	**25.8**	**25.8**
	Total	62	100.0	100.0

4.3.12 Just-in-Time (JIT)

JIT is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs. Table 4.14 illustrates level of the perception and implementation of JIT at SMEs metal product companies. As shown, the respondents assume JIT is highly important to implement at the companies because this range has higher percentage which is 32.3%. But the respondents do not sure (32.3%) whether JIT is implemented or not at their organization.

Table 4.14: Level of perception and implementation of JIT

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	4	6.5	6.5
	Not Sure	16	25.8	25.8
	Important	19	30.6	30.6
	Highly important	**20**	**32.3**	**32.3**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	6	9.7	9.7
	Not implement	12	19.4	19.4
	Not sure	**20**	**32.3**	**32.3**
	Implement	14	22.6	22.6
	Highly implement	10	16.1	16.1
	Total	62	100.0	100.0

4.3.13 Value Stream Mapping (VSM)

Value stream mapping (VSM) is a tool that used to map the value and non-value added stream of processes, material or information flows for any manufacturing or administrative process. VSM enables to identify and help to eliminate waste, thereby streamlining work processes, reducing lead times, reducing costs, improving space utilization and increasing product quality. Level of perception and implementation of VSM at SMEs metal product companies is shown in Table 4.15. As shown, the respondents do not know the VSM because both perception of respondent and implementation at the company are not sure which are 25.8% and 27.4%.

Table 4.15: Level of perception and implementation of VSM

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not implement	11	17.7	17.7
	Not implement	15	24.2	24.2
	Not sure	**16**	**25.8**	**25.8**
	Implement	12	19.4	19.4
	Highly implement	8	12.9	12.9
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not important	6	9.7	9.7
	Not important	8	12.9	12.9
	Not sure	**17**	**27.4**	**27.4**
	Important	16	25.8	25.8
	Highly important	15	24.2	24.2
	Total	62	100.0	100.0

4.3.14 Single Minute Exchange Die (SMED)

Table 4.16 shows the level of the perception and implementation of SMED at SMEs metal product companies. As shown, the respondents do not know the SMED because both perception of respondent and implementation at the company are not sure which are 41.9% and 30.6%. These clearly show that the respondent does not have knowledge and experience about SMED

Table 4.16: Level of perception and implementation of SMED

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	3	4.8	4.8
	Not important	5	8.1	8.1
	Not Sure	**26**	**41.9**	**41.9**
	Important	11	17.7	17.7
	Highly important	17	27.4	27.4
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	9	14.5	14.5
	Not implement	8	12.9	12.9
	Not sure	**19**	**30.6**	**30.6**
	Implement	16	25.8	25.8
	Highly implement	10	16.1	16.1
	Total	62	100.0	100.0

4.3.15 Visual Control

Visual control is helping the organization to display all the process at the production line and detect abnormalities. Level of perception and implementation visual control at SMEs metal product companies is shown in Table 4.17. As shown, the respondents assume visual control is highly important to implement at the companies because this range have higher percentage which is 40.3% and it is also just implemented (33.9%) at their organization.

Table 4.17: Level of perception and implementation of Visual Control

		Frequency	Percent	Valid Percent
	Perception			
Valid	Highly not important	2	3.2	3.2
	Not important	5	8.1	8.1
	Not Sure	11	17.7	17.7
	Important	19	30.6	30.6
	Highly important	**25**	**40.3**	**40.3**
	Total	62	100.0	100.0
	Implementation			
Valid	Highly not implement	2	3.2	3.2
	Not implement	8	12.9	12.9
	Not sure	14	22.6	22.6
	Implement	**21**	**33.9**	**33.9**
	Highly implement	17	27.4	27.4
	Total	62	100.0	100.0

4.4 LEAN STATUS

In order to identify the lean status of each respondent company, SPSS analysis was performed to classify whether company are into lean, in-transition toward lean, or non-lean. SPSS can compute from the average values of lean practices variables for all the firms and signifies the extent of lean manufacturing implementation of that group. Companies were classified as non-lean, in-transition toward lean, or lean based on their mean score for each individual lean practices. Table 4.18 shows the mean score for the lean variable practices.

Table 4.18: Mean Value for Lean Practices

Lean Practices	Non-lean (A)	In-Transition (B)	Lean (C)
	n=50%	n=40%	n=10%
Reduce machine/tooling set up time	2.45	3.3	4.41
Cell layout	2.40	3.36	4.71
Standardization of operation (SOP)	2.50	3.51	4.3
TAKT time	2.36	3.68	4.57
Continuous improvement (Kaizen)	2.57	3.38	4.39
Small lot sizes	2.15	3.38	4.43
5S	2.50	3.59	4.29
Multifunction/Multi skilled employee	2.75	3.50	4.31
Preventive Maintenance Programme	2.53	3.40	4.57
Inventory Management	2.65	3.39	4.36
Kanban	2.45	3.90	4.34
Just-in-Time (JIT)	2.73	3.32	4.48
Value Stream Mapping (VSM)	2.24	3.47	4.30
Single Minute Exchange Die (SMED)	2.05	3.28	4.00
Visual Control - Display Charts	2.65	3.35	4.33

As a result, the first group (A) has 50% of respondent's companies and it is characterized having low mean values for all 15 lean practices variables because mean score for this group is less than 3.00. This suggests that the company implement little lean manufacturing practices and for this reason they are categorized as non-lean company. The second group (B) has 40% of respondent's companies, and is characterized having moderate mean values for each of the 15 variables because mean score for this group is more than 3.00 but less than 4.00. This group is categorized as in-transition towards lean manufacturing system. Finally, the third group (C), which has only 10% of respondent's companies, is classified as lean company because they have higher mean values which are more than 4.00 of each lean manufacturing practices variables. The values suggest that in these firms lean manufacturing practices are extensively implemented in their organization's operation and management.

4.5 CRITICAL FACTORS FOR LEAN IMPLEMENTATION

To implement lean manufacturing is not an easy task. For any change in organization to take hold and success, the critical factors or barriers need to indentified and understood. Failure to access organizational and individual change readiness may result the management to spent significant time and energy. Dealing with resistance to change requires a lot of risk and hard work (Barker, 1998).

Table 4.19: Mean score of critical factor for lean implementation

Critical Factor	N	Mean
Management always gives full support to employee to involve in lean initiatives	62	1.19
Management encourages employees to make decision at workplace	62	1.26
Company provides lean training to top management and employees	62	1.29
Employees always give commitment in all activities organized	62	1.27
Company provides notice boards/visual display for displaying lean information	62	1.29
Management provide reward scheme for task accomplishment that give cost saving	62	1.37
Company provides funds to buy equipment for new project	62	1.23
Everybody accountable for quality of product	62	1.06
Employees are aware on lean implementation	62	1.34
Use Statistical process control (SPC) for monitoring product quality	62	1.42
Always solve the priority problem first for continuous improvement	62	1.06
Suppliers always deliver part on time	62	1.45

Table 4.19 shows mean scores of critical factor lean implementation at SMEs metal product companies. From the table, it is clearly seen that the highest mean scores is 1.37 for factor management provide reward scheme for task accomplishment that give cost saving. The lower score is 1.06 for everybody accountable for quality of product. The mean score for all critical factors is less than 2.00. This indicates that all those critical factors have been overcome at respondents companies but lean status at their companies still categorized as non-lean. Thus, what can conclude from this analysis is the main critical factor at SMEs metal product companies is lack of lean understanding. This is because lean manufacturing requires new knowledge and cultural change during the transition. Lean manufacturing should be applied comprehensively and holistically in principles and concept (Crute *et al*. 2003).

4.6 SUGGESTIONS FOR IMPROVEMENT OF LEAN STATUS

SMEs must implement lean manufacturing at their companies in order to compete with larger companies. In order to improve lean status at SMEs, some activities must be organized in the organization such as top management must encourage motivation and innovation in the work culture and employees attitudes. Besides, provide appropriate communication and training on the concept and basic principles of lean manufacturing system to give better understanding about the system. This training may be conducted once a week. The companies also can provides activities that related with lean manufacturing at their plant like kaizen activities. These activities can be carried out by forming small groups among workers and these small groups are responsible to carrying out kaizen activities in their workplaces. Then, top management must perform weekly or monthly audit to monitor and make sure the activities are done continuously. By doing that, management can ensure all employees are involved with the activities and indirectly improve the lean status at the companies.

4.7 CHALLENGES OF STUDY

There are some challenges have been faced while conducted this study. Firstly, most companies cannot give cooperation as expected. This is because they are busy with their daily work. Besides, they are misunderstanding during respondents answer the questionnaire. Some respondents just answer the questionnaire without read and understand the question first. These affect the process of analyzing data because some answers cannot be taken into consideration.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter provides conclusion of finding for this project and summarization by of overall progress taken and discussion of the project. For future reference, some recommendations are listed as a topic in this chapter for enhancement of knowledge continuing this study of improvement lean manufacturing implementation at SMEs.

5.2 CONCLUSIONS

The purpose of this study is to investigate the status of lean manufacturing implementation in metal product industry for SMEs. The result shows the most of the respondent companies have implement lean manufacturing system up to certain extent. SPSS analysis is performed to classify the respondent firms in groups to signify the extent of lean manufacturing implementation or their status from 15 lean manufacturing practice categories. Majority of the respondent firms are classified as non-lean because of having low mean values for each of the 15 variables. The companies should aware and understand the lean concept and purpose, because the main critical factor of these companies is the lack

of real understanding of lean manufacturing concept. This finding has implication for the companies as it provide a mean to help them to identify the factors that hinder or delay the implementation process. The management should understand and emphasis the importance to overcome these resistance for the successful implementation of lean manufacturing system in their firms.

5.2 RECOMMENDATIONS FOR FUTURE RESEARCH

From the previous study, there is recommendation that could be implemented as improve results and discussion which is this study should contribute more respondents and companies. It is because when there are more respondents, there are various requirements. So, it will have many things to analyze and at the same time it can improve the quality of the result. In addition, focus of the study can be more specific such focus on the main barriers that obstruct the implementation of lean manufacturing at SMEs.

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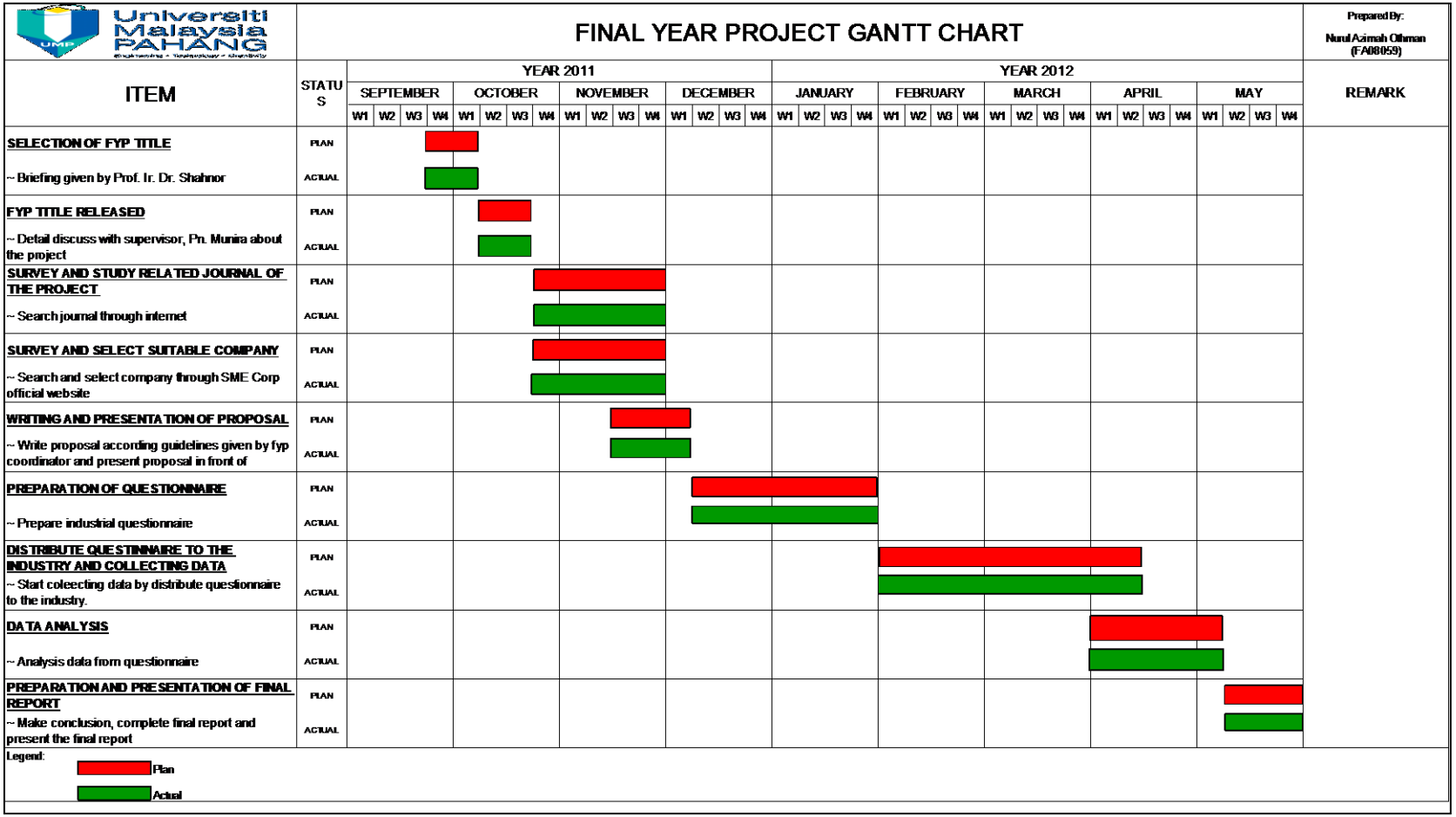
APPENDIX A

GANTT CHART OF FINAL YEAR PROJECT



APPENDIX B

SAMPLE OF QUESTIONNAIRE

Serial No: _____
Company Name / *Nama Syarikat*: _____

Purpose of study / Tujuan kajian:
This Studical Project aims to study lean manufacturing implementation at metal product industry for Small Medium Enterprises (SMEs)
Kajian Ilmiah ini bertujuan untuk mengkaji perlaksanaan 'lean manufacturing' di industri produk besi untuk Usaha Kecil dan Sederhana.

SECTION A : GENERAL INFORMATION
BAHAGIAN A : MAKLUMAT UMUM

This section attempts to identify general information of respondent and company. Please **tick (√) the answer** which are best represent you and your company.
Seksyen ini bertujuan untuk mengenal pasti maklumat umum responden dan syarikat. Sila tandakan (√) jawapan yang terbaik mewakili anda dan syarikat anda.

1. What is your **Gender**?
   *Apakah **jantina** anda?*

☐ MALE *Lelaki* ☐ FEMALE *Perempuan*

2. What is your **age**?
   *Berapakah **umur** anda?*

☐ < 20 years old *< 20 tahun* ☐ 21-30 years old *21-30 tahun* ☐ 31-40 years old *31-40 tahun* ☐ > 40 years old *> 40 tahun*

3. What is your **position** in your company?
   Apakah **jawatan** anda di syarikat ini?

☐ Manager *Pengurus* ☐ Asst. Manager *Pen. Pengurus* ☐ Executive *Esekutif* ☐ Supervisor *Penyelia*

4. How many **years you have working** in the company?
   *Berapa **tahun anda telah bekerja** di syarikat ini?*

☐ <1 year *<1 tahun* ☐ 1-5 years *1-5 tahun* ☐ 6-10 years *6-10 tahun* ☐ >10 years *>10 tahun*

5. Does your company **implement** lean manufacturing?
   *Adakah syarikat anda **melaksanakan** 'lean manufacturing'?*

☐ Yes Ya ☐ No Tidak

SECTION B : LEAN MANUFACTURING IMPLEMENTATION
BAHAGIAN B : *PERLAKSANAAN 'LEAN MANUFACTURING'*

This section attempts to determine the **level of lean manufacturing** implementation in your company. Please **circle the number** of the response which best represents the **level of perception and implementation** in your company based on the last 3 years, according to given scale.
*Seksyen ini adalah untuk menentukan **tahap pelaksanaa 'lean manufacturing'** di di syarikat anda. Sila bulatkan nombor yang paling sesuai untuk menunjukkan **tahap tanggapan dan pelaksanaan** di syarikat anda berdasarkan 3 tahun yang lepas mengikut skala yang diberi.*

Scale / Skala:

Perception/*Tanggapan*
[1] ---------- [2] ---------- [3] ---------- [4] ---------- [5]
Not Important — Not Sure/don't know — Highly Important
Tidak penting — *Tidak pasti/tidak tahu* — *Sangat penting*

Implementation/Perlaksanaan
[1] ---------- [2] ---------- [3] ---------- [4] ---------- [5]
No implementation — Not Sure/don't know — Highly Implementation
Tidak dilaksana — *Tidak pasti/tidak tahu* — *Sangat dilaksana*

No	Lean manufacturing practices *Lean Manufacturing yang di amalkan*	Perception *Tanggapan*					Implementation *Perlaksanaan*				
1	Reduce machine/tooling set up time *Kurang masa memasang mesin/alat*	1	2	3	4	5	1	2	3	4	5
2	Cell layout *Susun atur sel*	1	2	3	4	5	1	2	3	4	5
3	Standardization of operation (SOP) *Penyeragaman operasi*	1	2	3	4	5	1	2	3	4	5
4	TAKT time *Masa TAKT*	1	2	3	4	5	1	2	3	4	5
5	Continuous improvement (Kaizen) *Penambahbaikan yang berterusan*	1	2	3	4	5	1	2	3	4	5
6	Small lot sizes *Pengeluaran dengan kuantiti rendah*	1	2	3	4	5	1	2	3	4	5
7	5S *5S*	1	2	3	4	5	1	2	3	4	5
8	Multifunction/Multi skilled employee *Pekerja pelbagai fungsi/kemahiran*	1	2	3	4	5	1	2	3	4	5
9	Preventive Maintenance Program *Program pencegah Penyelengaraan*	1	2	3	4	5	1	2	3	4	5
10	Inventory Management *Pengurusan inventori*	1	2	3	4	5	1	2	3	4	5
11	Kanban *Kanban*	1	2	3	4	5	1	2	3	4	5
12	Just-in-Time (JIT) *Just-in-Time*	1	2	3	4	5	1	2	3	4	5
13	Value Stream Mapping (VSM) *Value Stream Mapping(VSM)*	1	2	3	4	5	1	2	3	4	5
14	Single Minute Exchange Die (SMED) *Single Minute Exchange Die (SMED)*	1	2	3	4	5	1	2	3	4	5
15	Visual Control – Display Charts *Kawalan visual - Carta Paparan*	1	2	3	4	5	1	2	3	4	5

SECTION C : CRITICAL FACTORS FOR LEAN IMPLEMENTATION
BAHAGIAN C : FAKTOR KRITIKAL UNTUK PELAKSANAAN LEAN

This section attempts to determine the **critical factors** on lean manufacturing implementation in your company. Please **tick (√) the answer** which best represents your answer.
Seksyen ini adalah untuk menentukan faktor kritikal mengenai pelaksanaan 'lean manufacturing' di syarikat anda.Sila tandakan (√) jawapan yang paling sesuai untuk menunjukkan jawapan anda.

1.	Management always gives full support to employee to involve in lean initiatives. *Pihak pengurusan sentiasa memberi sokongan penuh kepada pekerja untuk terlibat dalam usaha lean.*	☐ Yes *Ya*	☐ No *Tidak*
2.	Management encourages employees to make decision at workplace. *Pihak pengurusan menggalakkan pekerja untuk membuat keputusan di tempat kerja.*	☐ Yes *Ya*	☐ No *Tidak*
3.	Company provides lean training to top management and employees. *Syarikat menyediakan latihan lean kepada kakitangan atasan dan pekerja.*	☐ Yes *Ya*	☐ No *Tidak*
4.	Employees always give commitment in all activities organized. *Pekerja sentiasa memberi komitmen dalam semua aktiviti-aktiviti yang dianjurkan.*	☐ Yes *Ya*	☐ No *Tidak*
5.	Company provides notice boards/visual display for displaying lean information. *Syarikat menyediakan papan notis /visual untuk memaparkan maklumat lean.*	☐ Yes *Ya*	☐ No *Tidak*
6.	Management provide reward scheme for task accomplishment that give cost saving. *Pihak pengurusan menyediakan skim ganjaran untuk pencapaian tugas yang dapat menjimatkan kos.*	☐ Yes *Ya*	☐ No *Tidak*
7.	Company provides funds to buy equipment for new project. *Syarikat menyediakan dana untuk membeli peralatan bagi projek baru.*	☐ Yes *Ya*	☐ No *Tidak*
8.	Everybody accountable for quality of product. *Semua orang bertanggungjawab terhadap kualiti produk.*	☐ Yes *Ya*	☐ No *Tidak*
9.	Employees are aware on lean implementation. *Pekerja maklum dengan pelaksanaan lean*	☐ Yes *Ya*	☐ No *Tidak*
10.	Use Statistical process control (SPC) for monitoring product quality. *Gunakan Statistical process control (SPC) untuk memantau kualiti produk.*	☐ Yes *Ya*	☐ No *Tidak*
11.	Always solve the priority problem first for continuous improvement. *Sentiasa menyelesaikan masalah utama dahulu untuk penambahbaikan yang berterusan.*	☐ Yes *Ya*	☐ No *Tidak*
12.	Suppliers always deliver part on time. Pembekal sentiasa menghantar barang tepat pada masa yang dijadualkan.	☐ Yes *Ya*	☐ No *Tidak*

Thank you for participating in this study. All responses will be treated with highly confidential and no single set of responses will be identifiable.
Terima kasih kerana mengambil bahagian dalam kajian ini. Semua jawapan adalah sangat sulit dan tidak satu set jawapan akan dikenal pasti.