UNIVERSITI PUTRA MALAYSIA

DETERMINING LEAN MANUFACTURING EFFECTIVENESS IN MALAYSIA USING HYBRID INTERPRETIVE STRUCTURAL AND STRUCTURAL EQUATION MODELS

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By

NG TAN CHING

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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Chairman: Tang Sai Hong, PhD
Faculty: Engineering

Lean Manufacturing is well-known to pursue waste elimination and reducing non-value added activities in the manufacturing industry. In Malaysia, lean manufacturing is still yet to be considered as mature state as there are still many private manufacturing companies in Malaysia that are not applying lean system or implementing partial lean. The lack of full-blown and widespread use of LM in Malaysia can be potentially due to many factors such as lack awareness in lean and not knowing the appropriate steps to apply lean in organizations, the research theme that is not well-studied yet. Therefore, it is important to discover the proper steps and important key determinants to effective implementation of LM in Malaysia in order to serve as guiding reference to the current and future lean implementers. By constructing the relationship model of key determinant of LM effectiveness, different lean practices and business performance index, the present study helps manufacturers to have an in-depth understanding of effective lean implementation process that obviously lead to an effective lean outcome. The study begins with the review of a number of reputable journal papers in LM context and then proceed with the interview with a Lean awarded company, in order to obtain the key determinants of LM effectiveness based on their professional perception. The qualitative analysis tool, Interpretive Structural Modelling is used to determine the sequence of key determinants based on the data collected from the interview. This study continued with the questionnaire-based survey of 160 Malaysian manufacturers and analysing the proposed research model of LM effectiveness using Partial Least Square-Structural Equation Modelling. Last but not least, the lean effectiveness model is further validated in a case study company in Malaysia to verify its reliability and applicability. The study concluded that there are seven top key determinants of LM effectiveness that will affect the successful implantation of LM in Malaysia, which are Investment cost, Teamwork, Information technology, Employee empowerment, Employee Involvement, Awareness of latest lean information, and Managerial Leadership and Support. These key determinants are showing essential influence over LM effectiveness when they are being applied with the proper precedence relationship in the organization. By implementing key determinants with proper sequence in the organization, an effective LM system could lead to a significant improvement in the

different dimensions of business performance such as operation, marketing and financial dimensions. The results in effect showed that among Malaysian manufactures surveyed, 47% of improvement in business performance has been due the effective implementation of LM. The model developed offers important theoretical and practical implications to the manufacturers in Malaysia in order to improve the level of effective lean outcome.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia Sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

MENENTUKAN KEBERKESANAN PEMBUATAN LEAN DALAM MALAYSIA DENGAN MENGGUNAKAN HIBRID MODEL UNTUK INTERPRETIF STRUKTUR DAN STRUKTUR PERSAMAAN

Oleh

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Pembuatan Lean adalah terkenal untuk mengejar penghapusan sisa dan mengurangkan aktiviti-aktiviti tidak bertambah-nilai di dalam industri perkilangan. Di Malaysia, Pembuatan Lean masih lagi dianggap dalam peringkat yang kurang matang kerana yang masih banyak syarikat-syarikat pembuatan persendirian di Malaysia yang tidak mengamalkan sistem Lean atau hanya melaksanakan sebahagian daripada system Lean. Kekurangan matang and tidak luas penggunaan system Lean di Malaysia adalah disebabkan oleh faktor-faktor seperti kekurangan kesedaran lean dan tidak mengetahui langkah-langkah yang sesuai untuk memohon system Pembuatan Lean dalam organisasi, yang masih belum lagi dikaji faktor-faktor berpotensi dalam tema penyelidikan. Oleh itu, adalah penting untuk mengetahui langkah-langkah yang betul dan mengkaji penentu utama dalam pelaksanaan Pembuatan Lean yang berkesan di Malaysia untuk dijadikan panduan rujukan kepada pelaksana Lean semasa dan masa depan. Dengan membinakan model hubungan utama penentu keberkesanan Pembuatan Lean, amalan Pembuatan Lean yang berbeza dan indeks prestasi perniagaan, kajian ini turut membantu para pengeluar di Malaysia dan memberi sumbangan di segi kefahaman mendalam tentang proses pelaksanaannya Pembuatan Lean yang jelas akan membawa hasil Pembuatan Lean yang berkesan. Kajian ini bermula dengan sejumlah kertas-kertas jurnal yang mempunyai reputasi yang baik dalam konteks Pembuatan Lean dan kemudian meneruskan temuduga dengan satu Syarikat yang terkenal dengan pernah dianugerahkan dengan Lean, untuk mendapatkan penentu utama keberkesanan Pembuatan Lean berdasarkan persepsi profesional mereka. Dengan bantuan Alat analisis kuantitatif, permodelan interpretasi struktur digunakan untuk menentukan jujukan penentu utama berdasarkan data yang dikumpul daripada temu bual itu. Kajian diteruskan dengan 160 borang soal selidik pengilang-pengilang Malaysia dan menganalisiskan model yang dicadangkan dalam keberkesanan Pembuatan Lean dengan menggunakan pemodelan persamaan Partial Least Square. Akhir sekali, model keberkesanan Pembuatan Lean ini disahkan dalam Syarikat kajian kes di Malaysia untuk mengesahkan kebolehpercayaan dan kepenggunaannya. Kajian tersebut menyimpulkan bahawa terdapat tujuh penentu utama dalam pencapaian keberkesanan

Pembuatan Lean yang akan menjejaskan keberjayaan implantasi Pembuatan Lean di Malaysia, iaitu pelaburan kos, kerja berpasukan, teknologi maklumat, pemerkasaan pekerja, penglibatan pekerja, kesedaran tentang maklumat Lean terkini, dan kepimpinan dengan sokongan dalam pengurusan. Penentu utama Pembuatan Lean ini menunjukkan pengaruh penting ke atas keberkesanan Pembuatan Lean kepada mereka yang sedang membina hubungan penentu utama yang betul dalam organisasi. Dengan melaksanakan penentu utama dengan turutan yang betul dalam organisasi, sistem Pembuatan Lean yang berkesan boleh membawa peningkatan yang ketara dalam prestasi perniagaan seperti dalam dimensi operasi, pemasaran dan kewangan.Keputusan menunjukkan bahawa antara soal selidik perkilangan Malaysia yang dikaji, didapati 47% peningkatan dalam prestasi perniagaan akibat pelaksanaan keberkesanan Pembuatan Lean. Model yang dibinakan menawarkan implikasi teori dan praktikal yang penting kepada pengeluar di Malaysia bagi tujuan meningkatkan tahap hasil yang berkesan Pembuatan Lean mereka.

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Lastly, I offer my regards and blessings to everyone I have mentioned and not mentioned here, who supported me in any respect during the completion of the thesis. Thousand thanks to them again.

I certify that a Thesis Examination Committee has met on 3rd August 2016 to conduct the final examination of Ng Tan Ching on her thesis entitled " Determining Lean Manufacturing Effectiveness in Malaysia using Hybrid Interpretive Structural and Structural Equation Models" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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Declaration by Graduate Student

I hereby confirm that:

- this thesis is my original work;
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This is to confirm that:

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LIST OF ABBREVIATIONS

A	Availability of equipment
ALI	Awareness of Latest Lean Information
AUT	Automation
AVE	Average Variance Extracted
BP	Business performance
BPI	Business Performance Index
CB-SEM	Covariance-Based Structural Equation Modeling
CI	Customer Integration
CM	Cellular Manufacturing
CUI	Continuous Improvement
EE	Employees Empowerment
EI	Employees Involvement
EI-TW	Employees Involvement and teamwork
FMM	Federation of Malaysian Manufacturers
FMS	Flexible Manufacturing System
HITI	Human IT Investment
HRD	Human resource development
HRM	Human Resource Management
IC	Implementation Cost
IC-ALI	Implementation cost and Awareness of Latest Lean Information
IMechE	Institution of Mechanical Engineers
IMM	Institute of Materials, Malaysia
ISM	Interpretive Structural Modeling
IT	Information Technology
JIT	Just in Time
JSRR	Journal of Scholarly Research Reviews

KPI	Key Performance Indicator
LM	Lean Manufacturing
MFT	Multifunctional Team
MIT	Massachusetts Institute of Technology
MITI	Material Requirements Planning
MLS	Managerial Leadership and Support
MLS-ALI	Managerial Leadership and Support and Awareness of Latest Lean Information
OEE	Overall Equipment Effectiveness
P	Performance efficiency of process
PDCA	Plan, Do, Check, Act
PLS	Partial Least Squares
PLS-MGA	Partial Least Squares Multi Group Analysis
PLS-SEM	Partial Least Square-Structural Equation Modeling
PM	Preventive Maintenance
PPC	Production Planning and Control
QE	Quality Environment
R	Rate of quality product
SCM	Supply Chain Management
SEM	Structural Equation Modeling
SI	Supplier Integration
SM	Structural Modeling
SME	Small and Medium Enterprise
SRM	Supplier Relationship Management
SS	Six Sigma
SSIM	Structural Self-Interaction Matrix
SU	Setup Time Reduction
TITI	Technological IT Investment
TPM	Total Productive Maintenance

TPS	Toyota Production System
TQM	Total Quality Management
TW	Teamwork
TW-IT	Teamwork and Information Technology
UPM	Universiti Putra Malaysia
UTAR	Universiti Tunku Abdul Rahman
UTARF	UTAR Fund
VIF	Variance Inflation Factor
VSM	Value Stream Mapping

CHAPTER 1

INTRODUCTION

1.1 Introduction

During the last decade, Lean Manufacturing (LM) seems to be a visible trend in most of the manufacturing industries in Malaysia. Today, "lean" may no longer be fashionable but its core principles (flow, value, pull, minimizing waste and etc.) have become the paradigm for many manufacturing (and service) operations (Womack and Jones, 2010). LM is also one of the most well-known systems that could possibly results in shop floor productivity improvement. It is very common to apply Just In Time (JIT), Supply Chain Management (SCM), Total Quality Management (TQM), Total Productive Maintenance (TPM), Kaizen, Kanban, the seven waste concept (MUDA), 5S workplace methodology, and other elements of LM tools in a company (Lai et al., 2003; Herron and Braiden, 2006). The main purpose for the implementation of LM is to increase the productivity by increasing the output product, and to decrease the input factors such as processing time, transportation time, man power, raw materials and other inputs that are involved in the consumption of time and cost of manufacturing. With the aid of LM systems, the improvement will be able to contribute a high profit margin to the company. According to Lapinski (2006), LM constantly adjusts the manufacturing process to achieve savings and quality improvements.

Meanwhile, the physical proof for the profitability of this system is still a major question for most of the manufacturing companies. The lean production performance and the research from certain researchers in the field also raise a number of theoretical and methodological concerns (Womack and Jones, 2010). Even for those who have applied the system, are still considering it as an uncertainty in terms of its effectiveness after few years of implementation (Deif, 2012). The best evidence of the doubt raised against the effectiveness of LM is best described in the paper from Loughrin (2010), published in the *Supply Chain Digest*, which questioned whether Lean would be the main reason that causing the recalling of certain Toyota models, as lean is more focus on the productivity rather than the quality of products produced. Besides, Fliedner (2010), mentioned on the methods to make LM effect longer, but still without clear statement of how long does LM can be actually effective.

With the questions keep rising among the industries, the understanding on the efficiency level of LM practices is crucial to the current and even future implementation of lean system. The analysis of LM effectiveness level is not only for the benefit of the current manufacturing industries, but also affecting the development of future LM system. Other than that, Holweg et al. (2007) mentioned that LM is a huge management topic that consists of collective of lean tools to solve different problem encounter by different industry. However, with the lack of needed information regarding the LM effectiveness level in the overall manufacturing sectors in Malaysia (Wong et al., 2011; Nordin et al., 2010), there is an urgent need to scrutinize the relationship between LM practices and Business Performance Index (BPI) by doing

analysis over the current lean system implementer. With the studies on an adequate amount of current lean implementer, a rather accurate conclusion can be done against the doubt on profitability of LM. This study will analyze the effectiveness level of Malaysia's LM system in different categories of manufacturing industries by using Interpretive Structural Modeling and Structural Equation Modeling. At the end of the study, the mechanism of LM effectiveness level in Malaysia will be determined.

1.2 Problem Statement

Some evidence regarding the advantages of LM implementation can be found within literature and practice. There are many popular tools of LM such as Kaizen, 5S. Kanban are mainly for the reason of improving productivity in the shopfloor. It is commonly known that LM is an efficient tool to enhance the shop floor productivity by eliminating the popular seven wastes (Fliedner, 2010). Even the ways of Toyota Company utilized the well-known lean system are clearly described in the article by Dawson, 1994. However, there are also doubts on the efficiency in production achieved from this system. Wilson (2009) stated that "the classical lean's tools like Kaizen, visual control, value stream mapping, etc are ways to work around with certain types of problems but they do not solve them for you." Besides, some of the companies are not sure on the further contribution (other than productivity) of LM system after implementing it. The information gathered shows that even a small furniture production company who has integrated lean tools is still keen on finding the ways to preserve the valuable resources in maintaining their productivity system (Miller et al., 2009). Other example is the Toyota Company, who is also suffered from their slumping sales and is keen on finding the ways to improve the lean implementation system, which seems to be one of the main reasons (Wartzman, 2007).

LM tools focus on elimination of wastes which lead to obvious improvement of productivity after the change. As time goes by, the environment, the manufacturing process and product, the human factors, or even the customers' requirements may be varied from what they have in few years time back. Nevertheless, there is still lack of researcher doing studies on measuring the efficiencies of LM system after years of implementation. Herron and Braiden (2006) once did an investigation to 15 Small and Medium Enterprises (SME) upon LM tools implementation with the generation of an initial 1-year improvement plan for the particular manufacturing unit. In that research, they found out that some of the company's initial stage for the implementation takes more than one year time, and the results are not as good as predicted. Fliedner and Majeske (2010) mentioned that researchers should also start to recognize the importance of long term lean efficiency in his 2010 paper. Meanwhile, the long term lean effectiveness topic is rapidly spreading from a fringe to become a popular practice to mainstream (Langenwalter, 2006). Therefore, in the long term global perspective, an effective strategy is the best, and perhaps the only opportunity to achieve a greater level of LM. Despite professionals worldwide are still concerned with the effectiveness of lean (Karim et al., 2013; Ghosh et al., 2012), Very limited studies have tried to document a one-size-fit-all strategy for the success of LM implementation, particularly in terms of product and process efficiency.

This lack of guideline on ensuring the effectiveness of LM is more crucial among Malaysian manufacturers. Manufactures in developing countries are also aware of the importance of the LM efficiency and effectiveness level. In Malaysia, LM system is very popular even among smaller firms. Malaysian manufacturing companies are also being very alert to the effective level of LM system that they have already implemented in their companies. Hence, there is a necessity to figure out the efficiency level of lean systems in those manufacturing companies, to assure the benefits obtained from the lean tools implemented are long lasting (Jamian et al., 2012). Since the awareness of long term effectiveness are now the worldwide concern by many organizations (UNEP, 2011), therefore the requirement of knowing the lean efficiency level in Malaysia's is getting higher among the implementer. With the cost of lean system implementation being high, manufacturers are curious if the system would be able to maintain satisfying results in their productivity, or the system can only last for a short period of time. Data is needed in order to shed some light on the rising enquiries from the manufacturing industry. Yet, there are very limited practical studies on the overall effectiveness of LM in Malaysia and how effectiveness of LM can result in business performance improvement. In addition, there is no research relating to lean key determinants in Malaysia with its precedence relationship being defined.

It is vital to offer manufactures, particularly in Malaysia, with a guideline that can assist by ensuring the effectiveness of LM. The literature recommends that LM effectiveness can be, in some way, interpreted as successful implementation of LM. There are many factors that determine an effective implementation of LM. Rubio and Corominas (2008) for example stated the importance of the initial cost to implement a successful LM system. Despite the initial cost to develop effective lean system, the marketing involvement and management's framework that allows the company to fine tune its technological and operational capabilities with its overall strategic vision are other factors that will directly and indirectly affecting the efficiency level of lean (Pham and Thomas, 2005). Yet, there is significant research gap on key determinants that can result in an effective lean implementation in Malaysia. Key determinants are the essential part for lean implementation to be effective in an organization. Effective implementation of LM can lead to reduction of wastes, increase in competitiveness of company, and even improvement on different business performance in.

There are two particular research gaps regarding the determinants of LM implementation and effectiveness. First, there are some researches on determinants of LM implementation within the literature. However, these studies have mainly focused on manufacturers in developed countries, and each of them have introduced a group of determinants particular to the setting of their study. Thus, their results cannot be freely generalized to Malaysian manufacturers. There are many factors highlighted as potential determinants, but, it cannot be expected from Malaysian manufacturers to simply ensure the existence of all potential facilitator of LM implementation. It is clear that the requirements of LM are significantly costly, and entail significant changes in the organizational structure of firms, manufacturing technologies, and daily operations. Thus, a blind effort to facilitate all determinants of LM, regardless of their potential effect within Malaysian manufacturing industry, is ill-advised. Therefore, there is a significant need for exploring the key determinants of LM implementation among Malaysian manufactures.

Secondly, there is an inexistence of knowledge on interaction among key determinants with regard to their impact on LM effectiveness. This particular gap is not merely limited to Malaysia, and to the best of the researcher's knowledge, no study by far has tried to understand the precedence relationships among determinants of LM implementation. Even though the potential determinants of LM implementation might be known, the precedence relationships are important as well due to unknown order of these determinants should be facilitated (Womack et al., 1990). For instance, the company have to know that employee involvement should be emphasized first followed by employee empowerment or vice versa in order to maximize the impact. If the companies or organizations have lack of informative knowledge and experience on organizing these key determinants, issues such as wrong financial strategies, miscommunication among different departments, and wrong HR management strategies will barricade the implementation of LM, reduce its effectiveness, and decrease the competitiveness of the business (Al-Aomar, 2011).

Last but not least, it is well-known that there are many types of lean tools available, but there is still a lack of research (both statistical and anecdotal) about which lean tools are essential and critical when it comes to the effectiveness of LM, especially in Malaysia. It is well agreed that the true implantation of LM means the simultaneous implantation of all LM practices. However, smaller firms may start their journey toward leanness through implementing of one or a few of simpler LM practices. But, the impact of partial or full implantation of LM over business performance improvement is not well studied yet, particularly in Malaysia. Proper and proven guidelines could have assisted the current and future lean manufacturers in Malaysia to achieve high efficiency lean outcome with least resources involved, which means reducing unnecessary wastes (Shetty et al., 2010), unfortunately, such guidelines are lacking.

In the light of the discussions mentioned above, existing problems in the research context of this study can be summarized as follow:

1. Lack of understanding on the impact of level of LM implementation on improvement of business performance;
2. Lack of knowledge on the key determinants of LM implementation among Malaysia manufacturing sector;
3. The lack of knowledge on how the interaction among key determinates of LM can result in LM implementation effectiveness.
4. Lack of understanding on the precedence relationships among different determinates of LM within Malaysia manufacturing sector.
5. Lack of knowledge on the mechanism through which Malaysian manufacturers can achieve business performance improvement thanks to use of LM.
6. Lack of successful statistically proven lean model based on the existing Malaysia's LM trend that can be used as a reference for the existing and future lean organization towards a successful lean outcome.
7. Lack of guidelines assisting Malaysia's manufacturing companies with achievement of successful lean system in terms of BPI improvement

1.3 Research Questions

As for the outcome of this research, with the combination of the existing theoretical and practical gaps in the context of LM efficiency level for manufacturing firms, particularly in Malaysia, these research questions are be answered by the of end this study:

1. What is the relationship between the level of LM implementation and improvement of business performance?
2. What are the key determinants of LM implementation among Malaysia manufacturing sector;
3. How the interaction among key determinates of LM can result in the effectiveness LM implementation?
4. What are the precedence relationships among different determinates of LM within Malaysia manufacturing sector?
5. What is the mechanism through which Malaysian manufacturers can achieve business performance improvement thanks to the use of LM?
6. How to improve LM efficiency level among Malaysian manufacturers?

1.4 Objectives of the Study

The aim of this study is to carry out the LM effectiveness analyses in the manufacturing companies in Malaysia, which come from different industry areas. The reason for this is to figure out the factors that affected the effectiveness of LM and the effectiveness period of lean system. The objectives of this study against the problem statements mentioned in the previous section are shown as below:

1. To model the mechanism through which manufacturers in Malaysia can improve their LM practices;

2. To determine how well the proposal model can results in an effective implementation of LM in a real case company.

3. To provide practical guidelines for Malaysia's manufacturers with a successful implementation of LM.

1.5 Significant of the Study

LM is famous among the industry as it can go well beyond the cost-cutting while bringing benefits to the organizations at the same time. Poduval et al. (2013) claimed that LM, when successfully implemented, can help in enhancing an organization's productivity, produce high quality goods and minimize wastes thereby reducing costs (Poduval et al., 2013). Competitiveness of organizations could be significantly improved as LM implementation increases the effectiveness and flexibility of production line. In addition, well-implemented LM enables them to have rapid response towards customer request, which can deliver considerable benefits to the

organizations (Melton, 2004). Therefore, the findings of this study, as guidelines for achievement of LM effectiveness, not only provides necessary steps for successful implementation of lean, but also help lean companies to achieve higher level of lean cost and time savings, while increasing their BPI in terms of productivity, market share and Return of Investment (ROI).

Muslimen et al. (2011) suggests that implementation of LM can be seen clearer by examining effectiveness of LM in the company. Besides, Muslimen et al. (2011) also suggested conducting surveys in various industries to have a better understanding in lean performance in order to enhance further investigation. Different areas can be targeted to refine organizational norms and cross-functional coordination in order to prevent survey biases (Eng, 2006). However, lean efficiency level in Malaysia has yet to be investigated during recent year, and this lead to the commencement of this research (Nordin et al., 2010; Wong et al., 2011). Through collecting data from 400 manufacturing companies in Malaysia, interview with experts from a lean awarded local manufacturers, and an in-depth case study, the present study enlightens how manufacturers, particularly in Malaysia, can achieve business performance improvement, while ensuring adequate generalizability for the findings. Hence, the local lean trends such as key determinants of lean efficiency, lean tools most adopted by Malaysia's manufacturers and the effectiveness of LM in terms of BPI will be discovered within this study.

The findings of this study are expected to make important contributions to research and practices. The research will be beneficial to Malaysian manufacturers as its findings will provide other Malaysian manufacturers with good knowledge about pros and cons of LM in Malaysia. In addition, the research can serve as general reference for Malaysia manufacturer before implementing LM. Thus, the proposed guidelines can assist companies by avoiding wrong business strategies and offering clearer understanding on LM implementation, LM effectiveness, and its impact of BPI. The guidelines and model developed at the end of this study will assist the current lean implementer to improve their lean efficiency. Moreover, it can also be served as step by step guidelines to help the future non-lean companies to commence their lean journey in an efficient way with least wastes involved. Furthermore, this research will reveal the key factors that could lead to the successful implementation of lean. More importantly, the steps needed to manage these factors correctly will be proposed in this research. Malaysian manufacturer can be benefited from this research as its findings can be used as a step by step guideline of successful LM implementation.

In addition, the finding of study and related contributions are not only limited to Malaysia, given the study strives to understand the precedence relationships among determinants of LM implementation, and map them for the first time. Keeping in mind the limited generalizability of the findings, the model and guidelines obtained can still be a solid and useful starting point for LM scholars and implementers worldwide, given researchers and practitioners could follow the methodology proposed in this research and further modify and improve it based on the particularities of their study settings.

1.6 Scope of the Study

This study will basically analyze the effectiveness of level of LM implementation in different categories of manufacturing industries by using both Interpretive Structural Modeling and Structural Equation Modeling. The methodology involves interview section with a lean awarded company, data collection via cross-sectional survey and final evaluation of model in a local case study company.

Based on the comments received from a local well-known lean awarded company, and after a comprehensive review of literature a draft of survey questionnaires will be created by using a qualitative analysis tool, Interpretive Structural Modeling (ISM) in order to find out the precedence relationships among the key determinants information obtained from the company interview. According to the available research, the target plants are usually taken within specific industries in one country. Therefore, this study will focus on over 400 manufacturing companies in Malaysia. The respondents are targeted to be the manufacturers in Malaysia including apparel, food, automotive, semiconductor, air-conditioning, printing, packaging and other manufacturing companies.

The survey questionnaires will focus on the factors that influence the efficiency of LM after its implementation. Therefore, with the purpose of finding out the current efficiency level of LM system in Malaysia, a questionnaire will be developed and will be given to at least 400 manufacturing companies in Malaysia in order for addressing research gaps highlighted. Questionnaires are distributed via email and face to face meetings. Besides, this study tends to find out the efficiency of total quality management (TQM), total productive maintenance (TPM), Supply Chain Management (SCM), and Just In Time (JIT), within 3 years period of 2009 to 2012, from the survey respondents. Information on potential respondents will be obtained from some organizations such as Institute of Materials, Malaysia (IMM) and Institution of Mechanical Engineers (IMechE), and assistance will be given by the organizations in order to get sufficient amount of respondents for the questionnaire.

Analysis will be conducted upon receiving sufficient amount of responds from the manufacturing companies. Each question in the questionnaire will be analyzed using statistical tools such as bar charts and graphs. Other than that, SPSS and Partial Least Squares Analysis will be used as tools to analyze and identify the validity and reliability of the study.

1.7 Organization of the Thesis

This report consists of introduction, literature review, methodology, results discussion and conclusion. At first, chapter 1 which consists of background and problem statement about this project will be discussed in the introduction part. In addition, objectives, scope and significant of the study will included in introduction part. Besides, research questions used in this project will be concluded in introduction part.

Next in chapter 2, there are several lean tools such as Just in Time, Total Productive Maintenance, Total Quality Management and Supply Chain Management be mentioned in the literature review part. Furthermore, BPI, interpretive structural modeling and statistical analysis tool such as Partial Least Square analysis will be described and explained in the literature review part.

Chapter 3 is research methodology. Research methodology explains in details the step to carry out this project including assessing modeling structure. Besides, this chapter describes the case study selection as well.

Chapter 4 consists of detailed explanation of results and analysis obtained from the collection of survey questionnaires. All the data collected will be analyzed using Interpretive Structural Modeling for qualitative data (interview section with lean awarded company) and Structural Equation Modeling for quantitative data (survey questionnaires). At the end of chapter 4, the outcome for the local case study company for before and after the implementation of research lean model will be discussed. Lastly, chapter 5 concludes the findings and suggests recommendations for future research purposes.

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