Industrial manufacturing technology diffusion of Malaysian manufacturing Small and Medium Enterprises (SMEs)

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Murzidah Ahmad Murad

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Dedication

This thesis is dedicated to:

My beloved husband and sons.
    My dearly parents.
    My siblings.

You are my greatest source of strength and motivation.
Thank you for everything.

This journey is our journey.

****

I hope this will be an inspiration to you my dear Rafa and Ayman. Put your heart and soul to everything that you want to achieve. Persevere and never give up. And put your faith in God.
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Abstract

This thesis is set out to achieve two major objectives. The first is to find the reason why Malaysian manufacturing SMEs are involved in technology. The second objective is to identify and validate the factors that impact the technology decisions in Malaysian manufacturing SMEs.

A mixed methodology has been utilized to answer three research questions. The mixed methodology involves two phases which are the quantitative and qualitative data collection and analysis. The exploratory sequential design is the specific mixed methods design employed in this study. The purpose of the two-phase, exploratory mixed methods study was to explore participants’ views with the intention of using the information to validate the construct developed based on the literature and past researches, investigating new constructs to be included in this study, refining the questionnaire and further testing the hypotheses.

The researcher conducted Study 1, a qualitative pre-study interview of the selected companies to obtain as much information and data as possible to be included in the questionnaire survey to be made useful in Study 2. Study 1 was conducted using semi-structured interview questions. The objectives were to show the reason for Malaysian manufacturing SMEs engagement in technology adoption and to validate the existing variables and determine more variables to incorporate into a choice-based survey questionnaire. The first finding shows that the reason of the technology decision by Malaysian manufacturing SMEs lies in survival. Based on the second major finding, the researcher has found that there are significant factors to be included in the initial theoretical framework for this study; cost and top management commitment. Based on the literature, both factors have been tested empirically in some prior research of technology adoption by other authors. This indicates the importance of these factors to be included in the proposed theoretical framework. Additionally, the researcher builds new hypotheses for both. Further investigation is presented in Study 2.

For Study 2, the researcher has conducted the questionnaire survey with a sample number of Malaysian manufacturing SMEs in order to gauge ample relevant
information required to achieve the research objectives. In Study 2, the researcher analysed the stages using the Factor Analysis and found that from five stages proposed by Rogers (1962), they then became two stages. These were renamed the ‘Initiation’ stage which consists of knowledge, persuasion, and decision stages and ‘Implementation’ stage which consists of implementation and confirmation stages with some items dropped. Furthermore, multiple regression revealed the significant predictors technology decision process by Malaysian manufacturing SMEs. The factors that influence the initiation stage of the technology decision process are: technology attributes (relative advantages, complexity), organizational factors (adhocracy culture, top management support), and external environment factors (environmental dynamism, environmental hostility). The factors that influence the implementation stage of the technology decision process are similar to the initiation stage for organizational factors and external environment factors. The difference technology attributes namely compatibility and complexity that influence the implementation stage of the technology decision process. Based on the Diffusion of Innovation (DOI) theory, Technology-Organization-Environment (TOE) framework, and findings of Study 2, the model for the technology decision process in Malaysian manufacturing SMEs is suggested to illustrate the technology decision process in Malaysian manufacturing SMEs.

This thesis allows the understanding of the technology decision process with the intention to facilitate manufacturing companies’ decision makers to consider and plan potential adoption of industrial manufacturing technologies. At a practical level, the findings from the research provide important implications towards Malaysian manufacturing companies’ decision makers and stakeholders regarding technology adoption. The discussion reveals that the understanding of process behaviour may accelerate technology diffusion and tighten links between technology developers and users/adopters, as well as create and nurture supportive systems and infrastructure for technology diffusion. The outcomes also contribute to the theoretical understanding of industrial manufacturing technologies adoption and diffusion by manufacturing SMEs in Malaysia.
List of publications

Refereed Journal Article


Published Refereed Conference Proceedings


Milestones seminar presentation


CHAPTER ONE: INTRODUCTION

1.1 Introduction

This thesis discusses the importance, process and factors of technology adoption decision by Malaysian manufacturing Small and Medium Enterprises (SMEs). According to Byrne (2000) and Scott (1999) an organization will be at a competitive disadvantage if it is unable to sustain the technology adoption process because it will not be able to adapt to the speed and instability caused by technological change. Recker, Goldsby and Neck (2002) mention that the challenge for today’s business company is to develop capabilities that support the adaptation to technological advancement and increased competition. Technology can be a powerful tool to gain competitive advantage for two primary functions that are: 1) for supporting the business processes to produce products or services which are cost effective, and 2) for the time savings through the improvement of productive yields (Hussian, Sushil and Phatak, 2002).

Technological progress crucially depends on the diffusion and adoption of new technologies (Fuentelsaz, Gomez and Polo, 2003). Thus, managing the process of technology decision is imperative to ensure the implementation of technology (Rogers, 2003). With evidence of the Malaysian Government’s efforts to focus on science, technology and innovation (The Economic Planning Unit, 2010) the researcher studies the technology decision of the high technology sectors that include the machinery and equipment and electrical machinery sectors of Malaysian manufacturing SMEs. The investigation and understanding of this diffusion phenomenon requires the consideration of philosophy, process and factors affecting the technology adoption behaviour in an organization.

This thesis will examine the adoption of industrial manufacturing technology by the manufacturing SMEs in Malaysia and the used of industrial manufacturing technology by Malaysian manufacturing SMEs. The industrial manufacturing technologies are include machinery and equipment in production operations. The Malaysian Government is of the views that the industrial manufacturing technology can be the catalyst for Malaysia to become a high-tech nation (The Economic Planning Unit, 2006). Furthermore, the Malaysian Government exerted a tremendous amount of efforts
towards developing and implementing suitable policies and assistance regarding technology adoption by Malaysian manufacturing SMEs (Secretariat to the National SME Development Council, 2013b). Evidently, technology adoption has been mentioned in every Malaysia Plan since 1996 through the current Malaysia Plan. For that reason, Malaysian Government has introduced the Industrial Technical Assistance Fund (ITAF) to assist SMEs to develop their technology capabilities to ensure their survival in the industry (Secretariat to the National SME Development Council, 2013b). ITAF is a 50 percent matching grant for SMEs engaged in technology development activities. Besides that, Malaysian Government has also introduced Technology Acquisition Fund (TAF) to assist Malaysian SMEs to undertake or use technology in their companies (MASTIC, 2014).

1.2 Justification for the research

Technological progress fundamentally depends on the wide spread diffusion and adoption of new technologies (Scott, 1999). The diffusion of a new technology is a dynamic process (Rogers, 2003). Managing the process of technology diffusion is important to ensure the implementation of technology (Rogers, 2003). It is suggested by Scott (1999), that the inability to sustain the technology diffusion process places an organization at a competitive disadvantage because it will not be able to adapt to the speed and instability of technological change.

Referring to the Malaysian scenario, technology adoption among Malaysian manufacturing SMEs has become an important issue because of its significant contribution to Malaysia’s economic development (Abdullah, 2002). The ability of Malaysian manufacturing SMEs to utilize technology will enable them to be more competitive and sustainable. Furthermore, the Malaysian Government technology policy continues to focus mainly on encouraging innovation and not on the diffusion of technology. Such policy leads to too little adoption of technology (Rosmah, Lo and Hashmi, 2005). (Saleem and Higuchi, 2014) suggest that Government should play a role to support, enhance and push the firm to adopt the latest technology. Malaysian manufacturing SMEs are aware of the potential benefits of manufacturing technologies. Unfortunately, these manufacturing companies lack understanding specific ways in which technology can help their businesses (Rosnah, Megat Ahmad and Osman, 2004).
Moreover, Zaya (2005) finds that although manufacturing companies are aware of a wide range of technologies, they only make use of a few of them. The argument is strengthened by Asgari and Yuan (2007) who identify that one of the barriers to industrialization is the lack of technology adoption by industry. Asgari and Yuan (2007) also suggest that economies as a whole benefit from technology R&D only as it can be spread or diffused to a large number of firms.

One of the reasons why manufacturing companies need to be involved in the adoption of technology is survival (Okada, 2006; Bennet and Bennet, 2004). Competition and adaptation have been issues for any business entity to survive in the business world. Abdullah (2002) stated that one of the important issues in Malaysia’s economic growth is technology adoption among Malaysian manufacturing SMEs to enable them to be more competitive and survive in the global business environment. Kuan and Chau (2001) agree that the manufacturing SMEs’ abilities to utilize technology can render them competitive and sustainable. Realizing the importance of technology diffusion, the Malaysian Government has attempted to ensure that the adoption of technologies which will contribute efficiently and effectively towards the development of competitive Malaysian industries (The Economic Planning Unit, 2006).

Asgari and Yuan (2007) discover that Malaysia has demonstrated economic progress as a result of its industrial development policies. In 1990, the Malaysian Government formulated the Action Plan for Industrial Technology Development to upgrade the manufacturing of high technology and skilled intensive sectors to increase added values. Currently, the Tenth Malaysia Plan stated that Malaysia is developing SMEs’ productivity through the adoption of new technologies and development of entrepreneurship to drive innovation and creativity. Malaysia encourages the adoption of technologies by Malaysian manufacturing SMEs by providing significant funds such as the Technology Acquisition Fund (The Economic Planning Unit, 2010).

Diffusion researchers are primarily interested in finding out how innovations diffuse among the members of a social system, why some innovations are diffused more rapidly than others and what characteristics of innovations facilitate or hinder the adoption of innovations (Damanpour, 1988). Kimberly (1981) suggests that the focus in diffusion research is on innovation, and the practical concern is how to develop and diffuse
innovations to enhance more rapid acceptance. Diffusion of Innovation studies often use the term “diffusion” and “adoption”. Diffusion refers to the process of spreading the technology to the general population, while adoption is the decision to accept the technology (Rogers, 2003). Diffusion and adoption may be seen as two sides of a coin. In this thesis, the researcher will explore into the adoption process and not the diffusion process.

This thesis is expected to provide better understanding of the concept of the technology diffusion in Malaysia. Furthermore, the findings of this thesis will be devoted to identifying and validating the factors that impact the technology decision process of the Malaysian manufacturing SMEs. The outcomes of this research are expected to significantly dictate current and future research, especially in the area of technology adoption and technology decision process by manufacturing companies. The aim of this study is not to showcase best practices in technology adoption cases from the developing country context as has been done by (Scupola, 2009) and others in developed economies. Rather, the study aims to depict the natural environment in which SMEs exist in a developing country scenario, how the SMEs perceived of the usage of technology perceived and how are pertinent issues regarding technology and its development grappled and addressed in their companies.

1.3 Objectives and research questions

This thesis is set out to achieve two major objectives. The first is to find the reason why Malaysian manufacturing SMEs are involved in technology adoption and to investigate the significance of Malaysian Government efforts on technology adoption with Malaysian manufacturing SMEs decision to adopt certain industrial manufacturing technologies. The second objective is to identify and validate the factors that impact the technology decision in Malaysian manufacturing SMEs.

The first objective is achieved by using interviews to find out the Malaysian manufacturing SMEs’ ideas and reasons why they adopt certain technology into their operations and whether or not the Malaysian Government efforts on technology adoption impact SMEs decision to adopt certain industrial manufacturing technologies. The interviewees were also requested to share their opinion on why technology is
important to their companies. By understanding the reasons behind technology adoption by the Malaysian manufacturing SMEs the researcher seeks to recognize their need for technology and also guide the policymakers on deciding certain policies, incentive or assistance they can provide for Malaysian manufacturing SMEs to ensure the growth of Malaysian manufacturing SMEs.

Interviewees were also asked to describe their process of technology decision. Furthermore the factors that impact the technology decision process in Malaysian manufacturing SMEs are examined. Three major factors include the attributes of technology, internal (organization) factors and external environmental factors.

A model or framework that can be used as a tool to guide practitioners, policymakers and those involved in the Malaysian manufacturing SMEs specifically regarding decision on technology adoption will be developed from this research. At a practical level, this study will provide important implications for Malaysian manufacturing SMEs’ managers, and indirectly to technology providers or suppliers to understand their customer behaviour in the technology decision to adopt certain technology into their operations.

This research’s ultimate aim is to answer the following questions:

1. Why are Malaysian manufacturing SMEs involved in technology adoption?

2. What are the factors that influence the technology decision process by Malaysian manufacturing SMEs?

3. What is a suitable model for the technology decision process for Malaysian manufacturing SMEs?
1.4 Organization of the thesis

The thesis comprises of seven chapters. The thesis structure is shown in Figure 1.1.

Chapter One contains the overview of this research, including the purpose of the research, justification of the research, objectives and research questions, organization of the thesis and limitations of the research.

Chapter Two provides a review of the literature related to the study. The chapter highlights the discussion on Malaysian manufacturing SMEs and technology, the surviving philosophy, views on technology diffusion and the theoretical reviews.

Chapter Three presents the theoretical conceptualization and framework underlying this thesis. Extensive reviews of the variables used in the theoretical framework are investigated.

Chapter Four introduces the research philosophy, approach and justification for its adoption. The discussion of the data collection and analysis technique is provided in this chapter.

Chapter Five presents the data analysis and results from the qualitative study. This chapter seeks to answer research questions one and two:

1. Why are Malaysian manufacturing SMEs involved in technology adoption?

2. What are the factors that influence the technology decision process by Malaysian manufacturing SMEs?

The findings were divided into two crucial topics. In the first section, the findings shows the importance of technology decisions through the reasons of technology adoption by Malaysian manufacturing SMEs. The second topic presents the results obtained that is essential in order to present the independent variables for the study. There are factors that influence technology decisions by Malaysian manufacturing SMEs and automatically, they strengthen the hypotheses developed earlier in chapter three.
Chapter Six presents the data analysis and results from the quantitative study. Four stages of analyses were conducted:

1. Frequencies and descriptive analysis to justify the respondent profile and data description;
2. Factor analysis to determine the initial patterns and number of factors loading;
3. Reliability testing to see Cronbach’s alpha loading >0.6 as the threshold for being a reliable scale; and
4. Multiple regression analysis to find the relationship between factors that influences the technology decision process and determines the hypotheses.

This chapter is to answer research question three:

3. What is a suitable model for the technology decision process in Malaysian manufacturing SMEs?

Chapter Seven concludes the thesis and discusses the contributions made by the study and the conclusions drawn from the research.
CHAPTER ONE
• INTRODUCTION
  • Introduction to the topic and general context of the research, objectives and research questions, the thesis structure and limitations.

CHAPTER TWO
• LITERATURE REVIEW
  • In depth literature review on Malaysian manufacturing SMEs, survival and technology diffusion and adoption.

CHAPTER THREE
• CONCEPTUAL FRAMEWORK
  • Literature review on technology decision process and factors influences technology decision process.

CHAPTER FOUR
• METHODOLOGY
  • Discuss on methodology approach, data collection, analysis technique and ethics conduct.

CHAPTER FIVE
• QUALITATIVE ANALYSIS AND FINDINGS
  • Discussion of reason, process and factors influence the Malaysian manufacturing SMEs technology decision

CHAPTER SIX
• QUANTITATIVE ANALYSIS AND FINDINGS
  • Frequencies analysis, descriptive analysis, factor analysis, reliability testing, multiple regression analysis.

CHAPTER SEVEN
• DISCUSSION AND CONCLUSION
  • Discussion and conclusion of the research.

Figure 1.1: Thesis Structure
1.5 Limitations of the study: Key assumptions

Like any other theses, this thesis cannot escape from having its own limitations. The limitations regarding this research require identification and they are as follows:

- This study is germane to the Malaysian context; therefore the implication may not be generalized to other countries. Furthermore, the research findings in this thesis were only on Malaysian manufacturing SMEs;

- This research only looks into the case of SMEs. The future research may consider larger types of company; and

- The study is only limited to the manufacturing industry and industrial manufacturing technologies. The implications from the study may not be generalized to other types of industries and technologies.