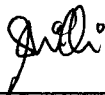




GRADUATE SCHOOL OF BUSINESS (GSB)
UNIVERSITI SAINS MALAYSIA

DECLARATION

I hereby declare that the project is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at USM or any other institutions.



(Signature):

Name: LEONG SHI QI

Date: 29/06/2012

**TECHNOLOGICAL INNOVATION ADOPTION IN MALAYSIA HIGH
TECH INDUSTRY FROM THE PERSPECTIVE OF INTELLECTUAL
CAPITAL AND KNOWLEDGE MANAGEMENT INFRASTRUCTURE:
THE KNOWLEDGE CREATION CAPABILITY AS A MEDIATOR**

LEONG SHI QI

**Research report in partial fulfillment of the requirements
for the degree of Master of Business Administration (MBA)**

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TABLE OF CONTENTS

PAGE		
	ACKNOWLEDGEMENTS	i
	TABLE OF CONTENTS	ii
	LIST OF TABLES	ix
	LIST OF FIGURES	xi
	LIST OF APPENDICES	xii
	ABSTRAK	xiv
	ABSTRACT	xv
	CHAPTER 1 INTRODUCTION	
1.0	Introduction	1
1.1	Background of Study	1
1.1.1	High-Technology Industry in Malaysia	4
1.2	Research Problems	5
1.3	Research Questions	7
1.4	Research Objectives	7
1.5	Significance of Study	8
1.6	Definition of Variables	9
1.7	Organization of Thesis	12
	CHAPTER 2 LITERATURE REVIEW	
2.1	Introduction	13

2.2	Innovation and Types of Innovation	13
	2.2.1 Theory Related to Innovation	16
2.3	Technological Innovation	17
	2.3.1 Radical Innovation versus Incremental Innovation	18
	2.3.2 The Importance of Technological Innovation	20
	2.3.3 Measures of Technological Innovation	21
	2.3.3.1 Radical Technological Innovation	21
	2.3.3.2 Incremental Technological Innovation	22
2.4	Intellectual Capital	24
	2.4.1 Theory Related to Intellectual Capital	27
	2.4.2 The Importance of Intellectual Capital	27
	2.4.3 The Effects of Intellectual Capital on Technological Innovation	28
	2.4.3.1 Human Capital and Technological Innovation	29
	2.4.3.2 Structural Capital and Technological Innovation	30
	2.4.3.3 Social Capital and Technological Innovation	31
2.5	Knowledge Management Infrastructure	32
	2.5.1 The Importance of Knowledge Management Infrastructure	34
	2.5.2 The Effects of Knowledge Management Infrastructure on Technological Innovation	35
	2.5.2.1 Technical Knowledge Management Infrastructure and Technological Innovation	36
	2.5.2.2 Structural Knowledge Management Infrastructure and Technological Innovation	37
2.6	Knowledge Creation Capabilities	38
	2.6.1 Theory Related to Knowledge Creation Capabilities	39

2.6.2	The Effects of Intellectual Capital on Knowledge Creation Capabilities	40
2.6.2.1	Human Capital and Knowledge Creation Capabilities	41
2.6.2.2	Structural Capital and Knowledge Creation Capabilities	41
2.6.2.3	Social Capital and Knowledge Creation Capabilities	41
2.6.3	The Effects of Knowledge Management Infrastructure on Knowledge Creation Capabilities	42
2.6.3.1	Technical Knowledge Management Infrastructure and Knowledge Creation Capabilities	43
2.6.3.2	Structural Knowledge Management Infrastructure and Knowledge Creation Capabilities	43
2.6.4	Knowledge Creation Capabilities on Technological Innovation	44
2.6.5	Knowledge Creation Capabilities as a Mediating Variable	45
2.7	Theoretical Framework	47
2.7.1	Resource Based View Theory	48
2.7.2	Dynamic Capabilities Theory	48
2.7.1	Organization Knowledge Creation Theory	48
2.8	Research Framework	49
2.9	Summary	50
CHAPTER 3	RESEARCH METHODOLOGY	
3.1	Introduction	51
3.2	Research Approach	51
3.3	Sample Design	50
3.3.1	Population and Sample Size	50
3.3.2	Sample and unit of analysis	52

3.4	Data Collection Method	52
3.5	Pilot Survey	52
3.6	Questionnaire Design	53
3.6.1	Technological Innovation	54
3.6.2	Intellectual Capital	55
3.6.3	Knowledge Management Infrastructure	57
3.6.4	Knowledge Creation Capabilities	58
3.7	Statistical Analysis Techniques	58
3.7.1	Factor Analysis	59
3.7.2	Reliability Analysis	59
3.7.3	Descriptive Statistics	60
3.7.4	Correlation Analysis	60
3.7.5	Control Variables	60
3.7.6	Multiple Regression Analysis	61
3.8	Summary	62

CHAPTER 4 DATA ANALYSIS AND RESULTS

4.1	Introduction	64
4.2	Response Rate	64
4.3	Profile of Respondents	65
4.4	Goodness of Measures	69
4.4.1	Factor Analysis	69
4.4.1.1	Factor Analysis of Intellectual Capital	70

4.4.1.2	Factor Analysis of Knowledge Management Infrastructure	73
4.4.1.3	Factor Analysis of Knowledge Creation Capability	76
4.4.1.4	Factor Analysis of Technological Innovation	77
4.4.2	Reliability Analysis	80
4.5	Descriptive Statistics	81
4.5.1	Means and Standard Deviations of Study Variables	81
4.5.2	Correlations Analysis	83
4.6	Multiple Regression Analysis	84
4.6.1	The Relationship between Intellectual Capital and Radical Technological Innovation	86
4.6.2	The Relationship between Intellectual Capital and Incremental Technological Innovation	88
4.6.3	The Relationship between Knowledge Management Infrastructure and Radical Technological Innovation	89
4.6.4	The Relationship between Knowledge Management Infrastructure and Incremental Technological Innovation	91
4.6.5	The Relationship between Intellectual Capital and Knowledge Creation Capability	92
4.6.6	The Relationship between Knowledge Management Infrastructure and Knowledge Creation Capability	93
4.6.7	The Relationship between Knowledge Creation Capability and Radical Technological Innovation	95
4.6.8	The Relationship between Knowledge Creation Capability and Incremental Technological Innovation	96
4.7	Test of Mediation	97
4.7.1	The Mediation Effects of Knowledge Creation Capability on the relationship between Intellectual Capital and Technological Innovation	98

4.7.1.1	The Mediation Effects of Knowledge Creation Capability on the relationship between Intellectual Capital and Radical Technological Innovation	98
4.7.1.2	The Mediation Effects of Knowledge Creation Capability on the relationship between Intellectual Capital and Incremental Technological Innovation	99
4.7.2	The Mediation Effects of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Technological Innovation	101
4.7.2.1	The Mediation Effects of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Radical Technological Innovation	101
4.8	Summary	102

CHAPTER 5 DISCUSSION AND CONCLUSION

5.1	Introduction	108
5.2	Recapitulation of the Study Findings	108
5.3	Discussion	110
5.3.1	Intellectual Capital and Technological Innovation	110
5.3.2	Knowledge Management Infrastructure and Technological Innovation	112
5.3.3	Intellectual Capital and Knowledge Creation Capability	114
5.3.4	Knowledge Management Infrastructure and Knowledge Creation Capability	115
5.3.5	Knowledge Creation Capability and Technological Innovation	116
5.3.6	The Mediating Role of Knowledge Creation Capability on the relationship between Intellectual Capital and Technological Innovation	117

5.3.7	The Mediating Role of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Technological Innovation	119
5.4	Implication of the Study	120
5.4.1	Theoretical Implication	120
5.4.2	Practical Implication	121
5.5	Limitations and Suggestions for Future Research	123
5.6	Conclusion	124
	REFERENCES	125
	APPENDICES	132

LIST OF TABLES

Table No.	Title of Table	Page
Table 2.1	Characteristics of radical and incremental innovation	19
Table 2.2	Determinants of Technological Innovation	24
Table 2.3	Intellectual Capital by Scholars	26
Table 2.4	Knowledge Management Infrastructure by Scholars	34
Table 3.1	Distribution of high-tech Companies by state and industry type in Malaysia	52
Table 3.2	Measures of the study	55
Table 3.3	Items pertaining to Technological Innovation	56
Table 3.4	Items pertaining to Intellectual Capital	57
Table 3.5	Items pertaining to Knowledge Management Infrastructure	58
Table 3.6	Items pertaining to Knowledge Creation Capabilities	59
Table 4.1	Profile of Participating Companies	65
Table 4.2	Profile and Descriptive Statistics of Respondents	67
Table 4.3	Descriptive Statistics of Participating Companies	68
Table 4.4	Results of Factor Analysis on Intellectual Capital Items	71
Table 4.5	Results of Factor Analysis on Knowledge Management Infrastructure Items	74
Table 4.6	Results of Factor Analysis on Knowledge Creation Capability Items	76
Table 4.7	Results of Factor Analysis on Technological Innovation Items	78
Table 4.8	Reliability Coefficients for Variables of the Study	81
Table 4.9	Mean Scores and Standard Deviations for the Study Variables	82
Table 4.10	Pearson Correlations Matrix of Study Variables	84
Table 4.11	Regression Results of the Relationship between Intellectual Capital and Radical Technological Innovation	87
Table 4.12	Regression Results of the Relationship between Intellectual Capital and Incremental Technological Innovation	88

LIST OF TABLES

Table No.	Title of Table	Page
Table 4.13	Regression Results of the Relationship between Knowledge Management Infrastructure and Radical Technological Innovation	90
Table 4.14	Regression Results of the Relationship between Knowledge Management Infrastructure and Incremental Technological Innovation	91
Table 4.15	Regression Results of the Relationship between Intellectual Capital and Knowledge Creation Capability	93
Table 4.16	Regression Results of the Relationship between Knowledge Management Infrastructure and Knowledge Creation Capability	94
Table 4.17	Regression Results of the Relationship between Knowledge Creation Capability and Radical Technological Innovation	95
Table 4.18	Regression Results of the Relationship between Knowledge Creation Capability and Incremental Technological Innovation	96
Table 4.19	Summary of the mediation Test of Knowledge Creation Capability on the relationship between Intellectual Capital and Radical Technological Innovation	99
Table 4.20	Summary of the mediation Test of Knowledge Creation Capability on the relationship between Intellectual Capital and Incremental Technological Innovation	100
Table 4.21	Summary of the mediation Test of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Radical Technological Innovation	102
Table 4.22	Summary of Hypotheses Testing	103

LIST OF FIGURES

Figure No.	Title of Figure	Page
Figure 2.1	Research framework of the study	50
Figure 4.1	Mediation Model	97

LIST OF APPENDICES

Appendix No.	Title of Appendix	Page
APPENDIX A	Introduction of Letter	132
APPENDIX B	Research Instruments	133
APPENDIX C	Factor Analyses of Intellectual Capital	140
APPENDIX D	Factor Analyses of Knowledge Management Infrastructure	148
APPENDIX E	Factor Analyses of Knowledge Creation Capability	152
APPENDIX F	Factor Analyses of Technological Innovation	154
APPENDIX G	Reliability Test of Study Variables	158
APPENDIX H	Descriptive Statistics	168
APPENDIX I	Correlation Analysis	169
APPENDIX J	Regression Analysis of Intellectual Capital on Technological Innovation (Radical Technological Innovation)	170
APPENDIX K	Regression Analysis of Intellectual Capital on Technological Innovation (Incremental Technological Innovation)	174
APPENDIX L	Regression Analysis of Knowledge Management Infrastructure on Technological Innovation (Radical Technological Innovation)	178
APPENDIX M	Regression Analysis of Knowledge Management Infrastructure on Technological Innovation (Incremental Technological Innovation)	182
APPENDIX N	Regression Analysis of Intellectual Capital on Knowledge Creation Capability	186
APPENDIX O	Regression Analysis of Knowledge Management Infrastructure on Knowledge Creation Capability	190
APPENDIX P	Regression Analysis of Knowledge Creation Capability on Technological Innovation (Radical Technological Innovation)	194

LIST OF APPENDICES

Appendix No.	Title of Appendix	Page
APPENDIX Q	Regression Analysis of Knowledge Creation Capability on Technological Innovation (Incremental Technological Innovation)	198
APPENDIX R	The Mediation Effect of Knowledge Creation Capability on the relationship between Intellectual Capital and Technological Innovation (Radical Technological Innovation)	202
APPENDIX S	The Mediation Effect of Knowledge Creation Capability on the relationship between Intellectual Capital and Technological Innovation (Incremental Technological Innovation)	206
APPENDIX T	The Mediation Effect of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Technological Innovation (Radical Technological Innovation)	210
APPENDIX U	The Mediation Effect of Knowledge Creation Capability on the relationship between Knowledge Management Infrastructure and Technological Innovation (Incremental Technological Innovation)	214

ABSTRAK

Focus kajian ini adalah untuk: (a) menyelidik kesan langsung intelektual kapital dan teknologi inovasi; (b) menyelidik impak langsung pengetahuan pengurusan infrastruktur dan teknologi inovasi; (c) menyelidik samaada keberkesanan pengetahuan cipta keupayaan sebagai pengantara kepada hubungan di atas. Teknologi inovasi boleh dikonsepsikan dalam dua dimensi yang mengandungi radikal teknologi inovasi dan tokokan teknologi inovasi. intelektual kapital mempunyai tiga dimensi yang mengandungi manusia kapital, sosial kapital dan struktur kapital. Pengetahuan pengurusan infrastruktur dioperasikan sebagai dua dimensi yang mempunyai teknologi pengetahuan pengurusan infrakstruktur dan struktur pengetahuan pengurusan infrakstruktur. Pengantaraan pengetahuan cipta keupayaan diilustrasikan sebagai satu dimensi. Tujuh hipotesis dipostulat dan diuji dengan 110 sampel dari Malaysia industri berat organisasi yang merangkumi 34.60 peratus kadar responden di kajian ini. Data dikutip dengan soalan kaji selidik. Analisis regresi berhierarki diguna untuk menguji ketepatan hipotesis yang dicadangkan. Kajian menunjukkan manusia kapital dan sosial kapital mempunyai hubungan positif dan signifikan dengan teknologi inovasi. Selain itu, struktur pengetahuan pengurusan infrakstruktur didapati mempunyai hubungan positif dengan teknologi inovasi. Di samping itu, pengetahuan cipta keupayaan bertindak separa terhadap hubungan antara intelektual kapital dan teknologi inovasi dan juga antara pengetahuan pengurusan infrakstruktur dan teknologi inovasi. Kesimpulan kajian ini digambarkan dengan implikasi teori dan praktikal dan juga disertakan cadangan bagi rujukan kepada kajian di Malaysia pada masa akan datang.

ABSTRACT

The aims of this study were to: (a) examine the direct effect of Intellectual Capital and Technological Innovation; (b) Understand the direct impact of Knowledge Management Infrastructure and Technological Innovation; and (c) investigate whether knowledge creation capability acts as a mediator role in the above relationship. Technological innovation was conceptualized into two dimensions of radical technological innovation and incremental technological innovation. The intellectual capital comprise of three dimensions of human capital, social capital and structural capital. The knowledge management infrastructure was operationalized into two dimensions of technological knowledge management infrastructure and structural knowledge management infrastructure. The mediator of knowledge creation capability was illustrated as single dimension. Seven broadly hypotheses were postulated and tested using a sample of 110 Malaysia high technology organizations representing 34.60 percent response rate in this study. Data were collected through self-administrated questionnaires. Hierarchical regression analysis was conducted to test the validity of the proposed hypotheses. It shows that human capital and social capital have a positive and significant relationship with technological innovation. On the other hand, only structural knowledge management infrastructure was found to be positively related to technological innovation. Furthermore, knowledge creation capability partially mediates the relationship between intellectual capital and technological innovation as well as knowledge management infrastructure and technological innovation. The conclusion of the study was provided with theoretical and practical implications as well as suggestions for future conduct of the studies in Malaysia.

CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, it will discuss on the background of the study, research problem, research question, definition of the key variables, significance of the study and organization of the study.

1.1 Background of Study

Over the past 50 years, Malaysia has experienced an economic transformation from the initial agriculture based economy to resource based economy and recently to innovation knowledge based economy. Efforts have been gather to uplifting Malaysia from developing countries to upper middle income country. However, Malaysia runs on the risk of being stuck in the upper middle income country with the rise of the industrial nations and emerging giants of India and China. To survive in the age of knowledge-based economy, there is a need for Malaysia to escape from the middle high income to high income nation. Simply put, knowledge economy is characterized as an economy fuelled with innovation, technology and talent which lies on the nature of quick change and respond to the market opportunities. Therefore, innovation definitely becomes the vital ingredient in the transformation agenda.

Nevertheless, the country innovation is still lagging behind as compared to the other Asia countries such as Singapore, Japan, Korea and Taiwan. This can be expressed by the innovation Capacity Index from corresponding from year 2010 to year 2011, Malaysia is clustered as upper middle income country with the ICI rank and score of 39 and 56.4 respectively. In promoting the innovation across nation, Innovation Capacity Index (ICI) is featured as a tool for assessment the extent to

which a nation has succeeded in cultivating and nourishing innovation climate and potential. The index enables the policymakers and entrepreneurs around the world evaluate the country-specific factors contribute to innovation capacity by better formulation of framework and policies for the creation of innovation supportive environment.

Although the Global Competitiveness Report 2011-2012 revealed that Malaysia rank at the 21st position with an improvement of 5 places from 26th position in year 2011, Malaysia still categorized under efficiency driven stage with GDP per capita of US\$ 3000-9000 (MPC, 2012). Toward the innovation driven vision (more than GDP per capita of US\$ 17 000), Malaysia not only have to efficiently producing advanced products and services but also have to compete through innovation by creation new value added and different products and services (MPC, 2012).

To remain competitive, concentrated efforts have been made to put the cultivating nation innovation effort in place. This was first done by introduction of National Innovation System (NIS) with the main drivers of technology driven innovation and market driven innovation which serves as a roadmap for innovation-led economy development. As Malaysia envision in becoming a high income nation by year 2020, the nation has to be strengthen in its resource base, excellence infrastructure and diligent workforce. The knowledge-based economy will accelerated Malaysia movement from input-driven to productivity-driven growth strategy follow by innovation driven strategy which, in turn, will unleash the nation productive capacity. To unleash the nation potential towards knowledge nation, the tenth Malaysia plan is drawn on the foundation of 1Malaysia concept and developed upon the Government Transformation Program and New Economic Model through the

elements of high income, inclusiveness and sustainability. In the Tenth Malaysia plan, the innovation system is promoted by four key dimensions as follow:

- Shaping a supportive ecosystem for innovation.
- Creating innovation opportunities
- Putting in place innovation enablers
- Funding innovations

Based on the above discussion, innovation is the key priority in embrace Malaysia knowledge-based economy growth. To survive in the knowledge-based economy, the organization no longer depends on cost reduction and profit maximization, but highly depends on its organization resource and capability to instill and cultivate innovation in product and process. By doing so, the firm will become pertinent and move along the value chain with the niche created products in sustaining the competitiveness. Nonetheless, studies in determinants that contribute to innovation specifically technological innovation is still in the infancy stages.

Moving into the era of innovation, it was thus apparent that organization resources, capabilities and knowledge management potentially influence on the organization technological innovation efforts. Intellectual capital have always recognized as the determinants for organizational performance in various industry rank from pharmaceutical, manufacturing to service industry (Kamath, 2008; Kianto, Hurmelinna-Laukkanen, & Ritala, 2010; Martín-de-Castro & López-Sáez, 2008; Sharabati, Jawad, & Bontis, 2010). According to resource-based view, the company no longer can achieve competitive advantage without fully utilize its resources and capabilities (Newbert, 2008).

In the knowledge-based economy, knowledge recognized as a source and input that will expand the span of influence on the technological innovation which in

turn, will enhance the productivity as well as generation of new sources of growth. Since knowledge ground as a foundation base for the upgrowth of innovation, greater knowledge will enable new creation of new ideas which resulted in greater innovation effort. In order to fully leverage and utilize knowledge, an organization expects to grow its infrastructure and possess knowledge creation capability for accomplishment of the organization's goal and vision (Chuang, 2004; Kamhawi, 2010; Miguel, Franklin, & Popadiuk, 2008).

Therefore, giving the fact of the contribution of innovation in embracing Malaysia economic growth, the potential influence of intellectual capital and knowledge management in accelerating innovation deemed necessary to be carried out to evaluate the current Malaysia context.

1.1.1 High-Technology Industry in Malaysia

According to MOSTI (2010), high technology manufacturing products are considered as main outcomes origin from R&D and innovation. High technology products refer as products that embody advanced technologies and that possess high level of R&D intensity. In term of high technology industries, according to OECD, it was characterized by either comparing industry R&D expenditures or number of people employed under the industry production (MOSTI, 2010). In Malaysia context, high-technology industries not only include of manufacture of aircraft and spacecraft; pharmaceuticals; office, accounting and computing machinery; radio, television and communications equipment; and medical, precision and optical instruments but also medium-high technology industry includes electrical machinery and apparatus, motor vehicles, trailers and semi-trailers, chemicals (excluding pharmaceuticals), machinery and equipment, and railroad and transport equipment. Undeniably, the high and

medium-high technology industries contributed approximately 50% of Malaysia total manufacturing exports (MOSTI, 2010). Foreseeing the threefold growth of the high-technology industry between the periods from 1995 to 2008, it is noteworthy to examine the innovation impact in this industry.

1.2 Research Problems

Commonly, innovation has been described as an invention and creativity from new idea into the product, service or process. Derive from innovation, technological innovation is related to product and process innovation (Damanpour, 2010; García-Muiña, Pelechano-Barahona, & Navas-López, 2009). Innovation undeniably is making significance contribution to an organization performance such as business performance and competitive advantage (Guan, Yam, Mok, & Ma, 2006; Teece, 2006). Extensive research in innovation has been carried out for the past few decades. However, the empirical studies specifically in technological innovation in Malaysia context are still scarce especially in the dimensions of radical and incremental technological innovation adoption in Malaysia high technology industry as most of the research generally studied on the perspective of product and process innovation.

Lot of researches has been conducted in the area of organization resources and capabilities towards firm performance. Resources and capabilities such as intellectual capital and knowledge management infrastructure have been widely discussed on its impact on the organization performance and effectiveness (Phusavat, Comepa, Sitko-Lutek, & Ooi, 2011; Sharabati, et al., 2010; Simsek & Heavey, 2011; Yang, Marlow, & Lu, 2009; Zheng, Yang, & McLean, 2010). There are a number of studies emphasize on the impact of intellectual capital and knowledge management infrastructure towards the firm innovation (Chuang, 2004; Egbu, 2004; H. C. Huang,

Lai, & Lin, 2011). Most of the studies on innovation only focus on the innovation type such as product versus process, radical versus incremental and administrative versus technical (Clercq, Thongpapanl, & Dimov, 2011; Mat & Razak, 2011; Ngah & Ibrahim, 2009; Wu, Chang, & Chen, 2008). Limited attention has been paid in examine the technological innovation scope, which deemed increase interest in today's rapid changing world (Cooper, 1998).

Technological innovation studies have been carried out in various types of industry ranging from pharmaceutical, liquid crystal display (LCD), hospital, logistic, ICT, biotechnology, and manufacturing (Chu & Andreassi, 2011; Hu, 2008; Khemka & Gautam, 2010; Lin & Ho, 2007; Tseng, 2009). Nevertheless, the specific focus of technological innovation in high-tech manufacturing industry is still scarcity in Malaysia scenario. Correspond to the fact that high-tech manufacturing industry contributed to the country total income and competitiveness, thus, it is considerable to understand the technological innovation status.

Most of the studies have been carried out on the direct influence of intellectual capital as well as knowledge management infrastructure towards innovation. Moreover, knowledge management area especially knowledge creation seem to act an important role in enrich the organizational innovation effort (Edvinsson, Dvir, Roth, & Pasher, 2004; Esterhuizen, Schutte, & Toit, 2011; Popadiuk & Choo, 2006). Therefore, knowledge creation capability is identified as a missing link between the relationship of predictors such as intellectual capital and knowledge management infrastructure with technological innovation (Kamhawi, 2010; Shu, Page, Gao, & Jiang, 2012).

Pertaining to the above discussion, this study aims to fill the gap by incorporate knowledge creation capability as a mediator in ascertain the impact of

intellectual capital and knowledge management infrastructure towards firm technological innovation.

1.3 Research Questions

The study aims to answer the following questions:

1. Do intellectual capital influence the technological innovation?
2. Do knowledge management infrastructure influence the technological innovation?
3. Do intellectual capital influence the knowledge creation capability?
4. Do knowledge management infrastructure influence the knowledge creation capability?
5. Does knowledge creation capability influence the firm technological innovation?
6. Does knowledge creation capability will mediate the relationship between intellectual capital and technological innovation?
7. Does knowledge creation capability will mediate the relationship between knowledge management infrastructure and technological innovation?

1.4 Research Objectives

Based on the research questions, the objectives of this study are:

1. To examine whether intellectual capital (human capital, structural capital, social capital) will influence technological innovation.
2. To examine whether knowledge management infrastructure (technological knowledge management infrastructure and structural knowledge management infrastructure) will influence technological innovation.

3. To determine whether intellectual capital (human capital, structural capital, social capital) will influence the knowledge creation capability.
4. To determine knowledge management infrastructure (Technological knowledge management infrastructure and structural knowledge management infrastructure) will influence the knowledge creation capability.
5. To examine whether knowledge creation capability will have an impact on technological innovation.
6. To examine whether knowledge creation capability will mediate the relationship between intellectual capital (human capital, structural capital, social capital) and technological innovation.
7. To examine whether knowledge creation capability will mediate the relationship between knowledge management infrastructure (technological knowledge management infrastructure and structural knowledge management infrastructure) and technological innovation.

1.5 Significance of Study

First and for most, this study is expected to provide noteworthy theoretical and practical foundation and evidence to the research area of intellectual capital, knowledge management infrastructure and technological innovation.

Corresponding to the theoretical perspective, this study is looking forward to provide an in depth understanding of intellectual capital from the resource-based view and knowledge management infrastructure from the knowledge-based theory towards influence the organization performance in term of technological innovation in Malaysia context. Additionally, this study also foresee the important of knowledge management specifically knowledge creation capability as the missing link between

the intellectual capital, knowledge management infrastructure and technological innovation. Organizational knowledge theory will be included for better visionary view of knowledge creation capability as mediator. At whole, the combination of the resources and capabilities will resulted in competitive advantage in support of dynamic capability theory.

In the practical point of view, the findings of this study will assist the organizations in the midst of developing their resource and capability towards achieving competitive advantage. Well-planned and organize the resources of people, network of business partners, organization structure and technology will be able to foster the organization innovation efforts. Furthermore, with the addition of knowledge serve as the base to facilitate the knowledge creation process certainly will boost up the firm innovation.

1.6 Definition of Variables

The variables used for the purpose of this study are defined and presented in the next following section.

Intellectual Capital

Intellectual Capital is defined as sum of all knowledge firms utilize to gain competitive advantage (Subramaniam & Youndt, 2005). There are three scopes of intellectual capital were examined namely human capital, structural capital and social capital.

- Human capital is described as the knowledge, skills and abilities that possessed and utilized by an individual in an organization (Subramaniam & Youndt, 2005).

- Structural capital which also known as organizational capital is termed as the institutionalized knowledge and codified experience that reside within and used through patents, manuals, structures, databases, systems and processes (Subramaniam & Youndt, 2005).
- Social capital is conceptualized as knowledge that resides within and accessible through and utilized by interactions and connections among individuals and their networks of interrelationship (Subramaniam & Youndt, 2005).

Knowledge Management Infrastructure

Knowledge management infrastructure is conceptualized as the firm resources that can be mobilized and deploy for the purpose of gaining competitive advantage (Chuang, 2004). There are two dimensions of knowledge management infrastructure were examined namely technological knowledge management infrastructure and structural knowledge management infrastructure.

- Technological knowledge management infrastructure, also known as technical KM resource is classified as infrastructure comprising of physical information technology (IT) infrastructure components (Chuang, 2004).
- Structural knowledge management infrastructure, namely social KM resource is termed as the facilitation of the knowledge flow through organization's policies, processes, reward and incentive system (Chuang, 2004).

Knowledge Creation Capabilities

Knowledge creation capability is referred to the firm members' ability in combine and exchange information for the purpose of creation of new knowledge (Smith, Collins, & Clark, 2005).

Technological Innovation

Technological innovation is explained as the utilization of new technologies into the products or processes to create new markets or provide new features in order to achieve long term competitiveness (Kim, 2010). There are two dimensions of technological innovation were examined particularly radical technological innovation and incremental technological innovation.

- Radical technological innovation is defined as the introduction of substantially new, novel and different technology from the existing technology into an organization production, service operation and product (Hill & Rothaermel, 2003; Kim, 2010).
- Incremental technological innovation referred to the introduction of established and steadily improves technology from the existing technology into an organization production, service operation and product(Hill & Rothaermel, 2003; Kim, 2010).

1.7 Organization of Thesis

In general, this dissertation is presented into five chapters. First of all, the Chapter 1 highlights the background of the study, research problem, research questions, research objectives, significance of the study, and definition of the variable term. Then, the Chapter 2 illustrates the literature review work done by the previous studies that involve of the independent, dependent and mediating variables. The developed theoretical framework and formulated hypotheses were discussed according to the review of the literature. Next, Chapter 3 demonstrate the research methodology used in this research. The methodology discussed in depth on the population and sample, questionnaire design, measurements, data collection techniques as well as statistical analysis techniques. Chapter 4 elaborates the results and data analysis based on the statistical analysis. Finally, Chapter 5 illustrates the outcomes, implications, limitations, recommendations for the future research, and conclusion.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will illustrate a detailed literature review related to the technological innovation, intellectual capital, knowledge management infrastructure and knowledge creation capability. Previous literatures done in relation with intellectual capital and knowledge management infrastructure leading to knowledge creation capability and technological innovation were discussed as well as the influence of knowledge creation capability on technological innovation. An in depth understanding on the variables used will be gain toward the end of the chapter with support of the proposed theoretical framework and formulated hypotheses.

2.2 Innovation and Types of Innovation

To date, innovation has been broadly used and derived in the academic research, which associates with invention and creativity. Innovation is complex in different forms and magnitude. Each forms and magnitude may contribute to the organization success and failure in the business world. Therefore, there is a need to study the determinants of these forms and magnitudes of innovation.

As accord to the third edition of Oslo Manual (OECD, 2005), innovation is expressed as an implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational business method practices, workplace organization or external business relations. Subsequently, innovation can be further narrow to the implementation of one or more dimensions of innovation, which related with product and process innovation namely technological innovation. Therefore, innovations are clearly distinguished into four

types composing product innovations, process innovations, marketing innovations and organizational innovations (OECD, 2005).

From the academic perspective, innovation is expressed as the adoption of a newness change to an organization and the relevant environment (Knight, 1967). The concept was further explained as a process that occur with an introduction of a new product until the production process completed which is first known to the reference groups of the potential innovator. According to Knight (1967), innovation can be classified in term of categories and radicalness. In the way of categories, innovation is divided into four major types, which are product or service innovations, production-process innovations, organizational-structure innovation and people innovation. While, the innovation radicalness is measured in performance radicalness and structural radicalness. Another common types of innovations is administrative (or organizational) and technical (or technological), which differentiate between the social structure and technology in an organization (Damanpour, 2010). Administrative innovation includes of the organization structure and administrative process that related to the management, on the other hand, technical innovation associates with products, service and production process technology in relation to basic work activities (Damanpour & Evan, 1984; Knight, 1967; Kimberly and Evanisko, 1981). Technical innovation was further explained as any kind of innovation that lies from the organization centralized activities in the design and delivery of products, services, marketing and office operation (Rowley, Baregheh, & Sambrook, 2011). In line with the definition above, in short, innovation can be generalized into three binary categories composed of technical and administrative innovation, product and process innovation, radical and incremental innovation (Wan, Ong, & Lee, 2005). Although these three classifications vary in term of definition, they are presented in the

overlapping dimensions depending to the organization operating condition. As accord to Cooper (1998), a multidimensional model of innovation was suggested by integrating the three types binary innovation mentioned above. An in depth narrow understanding of the attribute combination seeks to present a comprehensive picture of the organization adoption of innovation. In another study, Goktan and Miles (2011) introduced the study focused on the firm level innovation speed by examining the interrelationship between different magnitudes of innovation in term of radical product and process innovation in high-tech industry. In the recent conducted study, Rowley et al. (2011) recommended a paradigm shift in innovation type by mapping innovation type into product innovation, process innovation, paradigm innovation and position innovation.

The first and utmost reason the firm undertakes innovation is because of the firm performance. To beneficial from the market as first mover innovator, the firm will be able to capture higher market share and profitability. This can be done through introduction of new product or product differentiation into the new market in the way of creating and influencing the elasticity of customer demand (OECD, 2005). Furthermore, changes in organization and operation processes will improve the firm's efficiency and quality in developing new products, which in turn will position the firm at higher competitive advantage.

Given the rise of competition intensity in current rapid changing world, in order for a company to survive and remain competitive, innovation definitely comes into attention especially in the high-tech industry. In high-tech industry, firms are facing increasing pressure from the competitors, customer demands and requirements, which truncate the product life cycle and lead to fast changing obsolescence of products (Goktan & Miles, 2011). With the shorter product life cycles in

semiconductor, computer, and telecommunication industries, this has urged the firm moving toward to put in efforts in delivering innovative products in fast product development cycles.

2.2.1 Theory Related to Innovation

Dynamic capabilities theory have evolved recently as a source of competitive advantage that comprise of the firm's ability to create, adapt, integrate, reconfigure and release resources and competencies (Goktan & Miles, 2011). Teece, Pisano and Shuen (1997) study advocates that the firm success largely depends on its responsiveness and flexibility on the product innovation coupled with the well manage on internal and external competences. The term dynamic is perceived as the capacity to regenerate competences to accomplish congruence with the volatile business environment, whereas, the term capabilities is termed as blueprint of strategic management in examine the appropriateness of adapting, integrating and reconfiguring internal and external competencies (Teece, Pisano, & Shuen, 1997). Simply puts, dynamic capabilities portrait on the firm's ability to exploit and accomplish new, novel and innovative ideas of competitive advantage providing path dependencies and market positions (Teece, et al., 1997). An organization is heterogeneous and distinctive in term of processes, positions and paths. The organization's dynamic capabilities and competitive advantage underlie on the organizational process developed by the firm's asset positions as well as its evolutionary and co-evolutionary paths (Teece, et al., 1997). Along the line, knowledge certainly viewed as a core skill with respect to the dynamic capabilities context. The combination of know-how within the organization and between organization and external business entity is crucial in promoting the learning and

generation of new ideas towards the innovation effort. Teece (2007) was further elaborated that the core elements of dynamic capabilities comprise of three organizational and managerial processes such as integrating or coordination, learning and reconfiguring that advocates the process of sensing, seizing and managing threats. When the firm able to realize and then seize the opportunities, navigate threats and integrate and reconfiguration assets specifically to meet customer demands, the firm not just merely invents but also to innovate profitably in sustaining long run competitive advantage and value creation (Teece, 2007).

2.3 Technological Innovation

According to Schumpeter (1939) (as cited in Godin, 2008), pioneer in innovation research especially technological innovation, technological innovation is illustrated as a new combination of means of production in term of the way of changes that implement in the production to produce the end products. Following then, technological innovation has evolved as the meaning of initial commercialization of a new or improved product or process (Godin, 2008). In the same vein, concerning to the definition, technological innovation is referred to the products, production process technology and service that directly impact on the organization primary work flows and activities (Damanpour, 2010). The study conducted by Damanpour (2010) aims to address the influence of firm size and market competition towards product and process innovation. Although the findings do not exhibit strong evidence of difference between the determinants of firm size and market competition on the product and process innovation, but, it explicit that product and process innovation are synchronously possess in persuasion of competitive advantage. As such, innovative organizations have to leverage its full potential by combine the innovation type in

consideration on the resource allocation for the achievement of competitiveness. Daft (1978) added that technological innovation refers to the rate of adoption of an idea originate from the technical specialists that will directly impact the basic output processes of the firm. On one hand, technological innovation is perceived as a phenomenon originate from the fulfillment of technological need and/ or from stock of scientific knowledge which is influenced by the interaction among the various society agents and resulted on the country's economy and firm performance (Chu & Andreassi, 2011).

The above discussion summarized that technological innovation as an important element characterized by degree of change or rate of adoption in rapid moving competitive environment in order to achieve competitive advantage (Daft, 1978). The following sections will reviews on the radical innovation versus incremental innovation in detail.

2.3.1 Radical Innovation versus Incremental Innovation

Basically, radical innovation and incremental innovation are differentiated as the degree of change in term of new knowledge and continual process improvement. Radical innovation, as outlined by Goktan and Miller (2011), represents the product or process that resulted from advancement in new knowledge for the purpose of transformation or creation of new ones with unprecedented performance. Tushman and Romanelli (1985) (as cited in Koberg, Detienne, & Heppard, 2003) mentioned that incremental is the changes in status quo which is different from radical that characterized as reorganization of the processes wherein the patterns of consistency are fundamentally reordered. Along the same line, radical innovation is known as high order innovation as a consequences of creation of new industries, products or market

with the advancement in technology breakthrough (Koberg, Detienne, & Heppard, 2003). On the other hand, incremental innovation is denoted as lower order innovation consists of three types of continuous, modified and process (Herbig, 1994 as cited in Koberg et al., 2003). According to Dewar and Dutton (1986), radical innovations are varies from incremental from the perspective of knowledge complexity and depth. Radical innovations utilized large extent of new knowledge, higher risk, more time consuming in foster the rate of adoption in targeting new market entry (Dewar & Dutton, 1986). Incremental innovations rely on the exposure through contact and network with the external environment (Dewar & Dutton, 1986). Contrary to radical innovation, it involves of lower degree of new knowledge, lower risk, less time consuming and target for existing market and customer (Dewar & Dutton, 1986). The characteristics of radical and incremental innovation are illustrated in Table 2.1.

Table 2.1

Characteristics of radical and incremental innovation

Characteristics	Radical Innovation	Incremental Innovation
Degree of change	New and revolutionary	Minor and modification
Degree of new knowledge	High	Low
Degree of risk	High	Low
Time consumption	High	Low
Customer/ Market	New	Existing

2.3.2 The Importance of Technological Innovation

A study carried out by Weng, Huang, Kuo, Huang and Huang (2011) deliberate that technological innovation positively influences on the hospital performance in the dimension of ambulatory performance, emergency performance and inpatient performance, which leading to the hospital competitive advantage. Considering the literature review, innovation is certainly enriching the firm performance in several aspects. Different types of innovation will supplement to different dimensions of performance such as innovation performance, production performance, market performance and financial performance (Gunday, Ulusoy, Kilic, & Alpan, 2011). Having a clear perception of the nature of innovations will enable firms to refine appropriate innovation strategies into the firm business execution plan in the midst of achieving desirable market profitability (Gunday, et al., 2011). Likewise, technological innovation is an ongoing activity origin from the insights and ideas which drive to the creation of the new products and services (Tang & Murphy, 2012). Technological innovation is most likely correspond to the generation of breakthrough new ideas, following then, new product and service development conceives as the continuous process of generating and shaping the breakthrough innovations via external elements (Tang & Murphy, 2012).

Building on the above discussion, the evidence of the importance of technological innovation is proven in strengthening the organization competitive advantage and business performance. Hence, technological innovation (radical technological innovation and incremental technological innovation) is visualized as a criterion of competitive advantage. In the following section, the measures of technological innovation specifically radical technological innovation and incremental technological innovation will be discussed in detail.

2.3.3 Measures of Technological Innovation

Commonly, technological innovation is computed in term of research and development (R&D), patents and new products (Tseng, 2009). Owing to Tseng (2009) study, technological innovation is evaluated in the dimension of radical and incremental innovation based on three indicators of patent count, citation and citation ratio. Similarly, Miller, Fern and Cardinal (2007) added that technological innovation is gauged as the extent to which a firm's patents are subsequently cited by other firm patent. In some instance, technological innovation was classified by Weng et al. (2011) into 16 high-tech medical equipment in hospital industry into operational definition by multiplication of the total number of equipment with the weight of equipment's innovativeness. Under García-Muiña, Pelechano-Barahona and Navas-López (2009) study, technological innovation is measured in radical innovation performance as the amount of radically innovative products in the products portfolio and incremental innovation performance using the mean development time of the incremental innovations.

Pertaining to the above discussion, this study intends to measure technological innovation more specific in the extent of radical and incremental technological innovation adoption especially in high technology industry in order to provide an insight on the dynamic scenario of technological innovation.

2.3.3.1 Radical Technological Innovation

Radical technological innovation refers to the introduction of substantially new, novel and different technology (scientific methods and materials used) from the existing technology into an organization production, service operation and product for achievement of commercial purpose (Hill & Rothaermel, 2003). Specifically, radical

technological innovation embodied novel methods and materials that stem from either entirely different knowledge foundation or from reassemble of the incumbents' existing knowledge foundation with introduction of new knowledge (Hill & Rothaermel, 2003). Radical technological innovation can be envision into radical product and radical process innovation (Kim, 2010). Radical product innovation is denoted as the extent of the newness in product to the firm or industry. The newness embodies of new knowledge and clear departures from the previous practice (Goktan & Miles, 2011). Based on Oslo Manual definition, radical product innovation is a product that produced in the way of significantly differ in technological characteristic (OECD, 2005). Besides, such innovation may incorporate radically new technologies or existing technologies in new operation and knowledge.

To become the first mover in the industry, the firm not only emphasizes on the new product development but also on the process involved through technology utilization and advancement. Goktan and Miller (2011) measured radical process innovation as the extent of radicalness in the process innovation relative to the newness of innovation. A generation of new process may incurs in cost and resource investment over the existing process especially in suffer from inherent deficit factors like undetected virus, erratic norm, and incompatibility with existing operating system. In the same vein, radical process innovation is stated as a process innovation that is new and unfamiliar to the firm as well as the industry (Reichstein & Salter, 2006).

2.3.3.2 Incremental Technological Innovation

Incremental technological innovation refers to the introduction of established and steadily improves technology from the existing technology into an organization

production, service operation and product (Hill & Rothaermel, 2003). Incremental technological innovation solely built upon the firm existing knowledge by steadily improve and modify the methods and materials to suit customer requirement (Hill & Rothaermel, 2003). It can be further sub-categorized into incremental product and incremental process innovation (Kim, 2010). An incremental product innovation is characterized as an enhanced or upgraded performance into existing product (OECD, 2005). A product may be improved through usage of higher quality components or materials in order to achieve better cost differentiation.

Incremental process innovation is referred to the process innovation that is only new to the firm but not new to the industry (Reichstein & Salter, 2006). Such type of innovation may have been introduced by the competitors in the industry. The firm manufacturing process may be radically changed and new to the organization members but not necessary new to the external parties.

From the literature review, several determinants of technological innovation were identified. The determinants are related to the aspects of knowledge management (Abou-Zeid & Cheng, 2004; Edvinsson, et al., 2004; García-Muiña, et al., 2009; Miller, Fern, & Cardinal, 2007; Pérez-Luño, Medina, Lavado, & Rodríguez, 2011), intellectual capital (Alpkan, Bulut, Gunday, Ulusoy, & Kilic, 2010; Edvinsson, et al., 2004; Pérez-Luño, et al., 2011; Subramaniam & Youndt, 2005; Wang, Yen, Tsai, & Lin, 2008), organization variables (Alpkan, et al., 2010; Lin & Ho, 2007; Wan, et al., 2005) and human resources management (Tan & Nasurdin, 2010). From Table 2.2, out of these determinants, knowledge management and intellectual capital are widely studied and viewed as the prominent predictors that influence technological innovation. Therefore, these two variables will be chosen as determinants in this study.

Table 2.2

Determinants of Technological Innovation

Determinants	Scholars												
	Lin and Ho (2007)	Tseng (2009)	Wan et al. (2005)	Miller et al. (2007)	Abou-Zeid and Cheng (2004)	García-Muñia et al. (2009)	Wang et al. (2008)	Alpkan et al. (2010)	Tan and Nasurdin (2010)	Pérez-Luño et al. (2011)	Edvinsson et al. (2004)	Subramaniam and Youndt (2005)	Total
Organization Variables	×		×					×					3
Intellectual Capital							×	×		×	×	×	5
Knowledge management		×		×	×	×				×	×		6
Human resource Management									×				1

2.4 Intellectual Capital

Intellectual Capital has been widely discussed and defined in recent research due to its contribution towards organization performance. Along the literature, intellectual capital always tied closely with the knowledge and information. Stewart (1997) proposed that intellectual capital comprises of information, intellectual property, intellectual material, knowledge and experience that blend together to create an organization wealth. In the same vein, intellectual capital is linked with knowledge