Diffusion of Commercialized R&D Funded by Thai Government: Case study of TRF and NSTDA

By

Mr. Napaporn Yuberk

Supmitted in Partial Fulfiliment of the Requirement for the Degree of

Master of Science

in Telecommunication Science
Assumption University

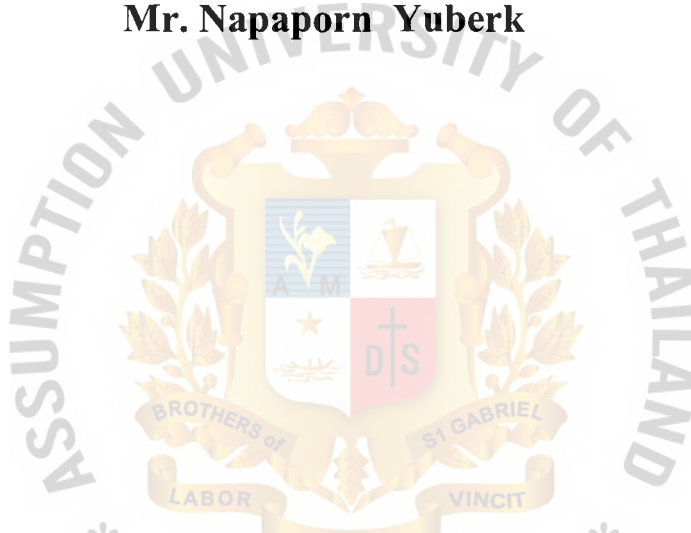
June, 2004

THE ASSUMPTION UNIVERSITY LIBRARY

Diffusion of Commercialized R&D Funded by Thai Government: Case study of TRF and NSTDA

By

Mr. Napaporn Yuberk



Submitted in Partial Fulfillment of the
Requirement for the Degree of
Master of Science
in Telecommunication Science
Assumption University

June , 2004

The Faculty of Science and Technology

Master Thesis Approval

Thesis Title	Diffusion of Commercialized R&D Funded by Thai Government: Case Study of TRF and NSTDA
By	Ms. Napaporn Yuberk
Thesis Advisor	Dr. Jarunee Wonglimpiyarat
Academic Year	1/2004

The Department of Technology Management, Faculty of Science and Technology of Assumption University has approved this final report of the **twelve** credits course. **MT7000 Master Thesis**, submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology Management.

Approval Committee:

(Dr. Jarunee Wonglimpiyarat)
Advisor

(Dr. Kitti Phothikitti)
Committee Member

(Dr. Tibrat Sangroengrob)
Committee Member

(Asst.Prof.Dr. Surapong Auwatanamongkol)
Commission of Higher Education
University Affairs

Faculty Approval:

(Dr. Soonthorn Pibulcharoensit)
Program Director

(Asst. Prof. Dr. Supavadee Nontakao)
Dean

July / 2004

ACKNOWLEDGEMENT

I would like to express my gratitude to many people who contributed to the completion of this thesis.

My greatest gratitude goes to Dr.Jarunee Wonglimpiyarat, my advisor, who constantly motivated me to keep on working and provided the valuable guidance, encouragement, and untiring supervision throughout. Her kindness and devotion to enhance the quality of this thesis has proved to be especially helpful.

I am also grateful for the kindness of Dr. Soonthorn Pibulcharoensit, Director of Technology Management of Assumption University, in supporting official letters for interviewing the participatory companies/organizations in this study.

I wish to acknowledge my sincere thanks to the National Metal and Material Technology Center of the National Science and Technology Development Agency (NSTDA), in allowing Dr. Jarunee Wonglimpiyarat to become my advisor. Regarding to Assumption University, I am very grateful to all faculties that providing me technology management knowledge and business management exercise during my study in Master of Science in Technology Management Program.

Special gratefulness goes to Ms.Elaine Blatt, my boss and Chief of Party of the United States Asia Environment Partnership, and my colleagues (Saengroaj, Mark, and John) who cheered me up during the thesis study.

Great thanks go to Thailand Research Fund (TRF) and the National Science and Technology Development Agency (NSTDA) that granted me the opportunity to interview the senior management of the organization.

In addition, I would like to thank thirty-one companies that granted me the opportunity to for interview the senior management of the company who devoted time to provide valuable data and information.

In editing the draft of this thesis, enormous thanks are contributed to Dr. Jarunee, my advisor who is very careful in all details of this work. Her devotion of time made my thesis more readable. Moreover, my thanks go to my friends in the Ms.TechM . Program for their friendship through the two years of studying.

I would like to give my entire gratitude and appreciation to my parents, brother, sister and my close friend for their love, warmly care and patient understanding throughout my thesis performing.

This study is dedicated to my parents. All deficits in this thesis are all my responsibility.

Assumption University
Bangkok, Thailand

Napaporn Yuberk
June 2004

ABSTRACT

This research has been concerned with laying out the public R&D management system. The researcher aims at finding out a better way to manage R&D projects funded for commercialization. The present study will use the two major research-funding organizations, Thailand Research Fund (TRF) and the National Science and Technology Development Agency (NSTDA) as case study organizations. The diffusion of R&D work funded by the Thai government towards market development stage will be the focus of the study. By using the innovation diffusion theory as a guideline, the innovation process from the development stage towards the diffusion stage (the stage of commercialization) will be analyzed.

This study is a kind of policy research. Methodology employed in this study is qualitative approach; documentary and in-depth interviews are the main instruments in obtaining the reported result and analysis. Thirty-one companies located in Bangkok Metropolitan Region including Bangkok, Samutprakarn, Samutsakorn, Nakhonpathom, Nonthaburi, Pathumthani and Ayuthaya were interviewed about their R&D activities performed with the granted researcher from R&D funding program of TRF and NSTDA.

The result of the analysis will be synthesized based on three of the disciplinary including Innovation Diffusion Theory, Innovation Development Process, and body of knowledge on success/failure in managing R&D for the new product development. The scale measurement was developed for tracking a number of projects funded during 1998-2003. Ten control-variables were set for investigating factors influencing the progress of R&D results toward commercialization. As a result, TRF spent about 44 months whereby NSTDA spent almost 51 months in incubating innovation from R&D funding program. It was found that NSTDA spent the longer period because there were some R&D results awaited for investment by production sector. It was a result of granting R&D without involvement of the private company at R&D stage. In addition, technology packaging from R&D result was far from production's requirement. Meanwhile, TRF performed proactive approach by having "change agents". The change agents are contractors who TRF sub contracted to 12 of skilled coordinators. These coordinators are called "research package coordinators", who bring R&D funding opportunity to the industry sector and

the professional researcher. This operation reflects that TRF can communicate directly with direct users of R&D results (industry) that open the gate to commercialization.

According to variables analysis, the study finds that there are six factors enabling/inhibiting the progress of R&D results to the innovation development stage and the market development stage. It comprise of i) the difficulties of the research task in relation to the capability of researchers ii) the ability to translate R&D results into saleable innovation iii) the design of the product innovations according to the market needs iv) organization capability in pushing the new product innovation to the market v) the market strategy vi) the user of innovation. However, we are aware that the six factors are not the sole factors determining the success or failure of the public R&D management for commercialization. The management of the public R&D system needs further support from industry environment which is uncontrollable variables regarding to a mission of R&D funding organizations. In order to cope with uncontrollable variables, it is argued that they should work as partnership style and be proactive with the related industry development agencies and trade agencies.

The empirical analysis reveals that the Thai industrial firms need linkages that are more effective with the public sector R&D organizations to manage and facilitate the national R&D development system. It is argued that the rate of innovation adoption depends on the interaction with the market and the industry. Effective linkages between the'technology push' and the'market pull' are decisive for the policy agenda of the national R&D system of Thailand.

The results will develop the model of R&D management for speeding up the R&D projects for commercial application. The result will also give policy recommendations in strategic management of innovations to the research-funding organizations.

ABBREVIATIONS

TRF	Thailand Research Fund
NSTDA	The National Science and Technology Development Agency
TDRI	Thailand Development Research Institute
STDB	Science and Technology Development Board
NRCT	the National Research Council of Thailand
TISTR	The Thailand Institute of Scientific and Technological Research
BOI	Board of Investment
IFCT	The Industrial Finance Corporation of Thailand
BMR	Bangkok and the Metropolitan Region
BIOTEC	Genetic Engineering and Biotechnology Center
MTEC	Metal and Materials Technology Center
NECTEC	Electronics and Computer Technology Center
NESDB	The National Economic Social Development Broad
IMD	The International Institute for Management Development
HSRI	Health Systems Research Institute
R&D	Research and Development
NGO	Non-government organization
S&T	Science and Technology
S-Curve	Bell-Shaped Curve

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

THE ASSUMPTION UNIVERSITY LIBRARY

TABLE OF CONTENTS

ACKNOWLEDGMENTS ii

ABSTRACT iii
ABBREVIATIONS iv
TABLE OF CONTENTS v - vii
LIST OF FIGURES viii
LIST OF TABLES ix

CHAPTER 1: INTRODUCTION

1.1 Introduction 1
1.2 Background to the thesis 1
1.3 Research issues
1.3.1 Thesis problems 2
1.3.2 Thesis objectives 5
1.3.3 Thesis questions and hypotheses 6
1.4 Justification for the thesis (Contributions)
1.4.1 Organization 7
1.4.2 Employees 7
1.4.3 Academic interest 7
1.4.4 Society 7
1.4.5 Government 8
1.5 Methodology 8
1.6 Definition of terms 8
1.7 Limitations 9
1.8 Outline of the thesis 10
1.9 Conclusion 11

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction (Background of literature review) 12
2.2 Parent discipline 12

2.3 Immediate discipline 37
2.4 The thesis model (conceptual framework) 47
2.5 Conclusion 49

CHAPTER 3: METHODOLOGY
3.1 Introduction 50
3.2 Problem definition (link the methodology with literature) 50
3.3 Thesis design 50
3.4 Thesis process 50
3.5 Evaluation of measurement scale, tool or technique 63
3.6 Ethical consideration 63
3.6 Conclusion 63

CHAPTER 4: ANALYSIS AND DISCUSSION
4.1 Introduction 65
4.2 Analysis and discussion 65
4.3 Conclusion 140

CHAPTER 5: CONCLUSION
5.1 Introduction
5.2 Conclusions 144
5.2.1 Conclusion - thesis questions 144
5.2.2 Conclusion - thesis problems 147
5.3 Implications for the thesis
5.3.1 Implication for theory

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

5.3.1 Implication for theory 148

5.3.2 Implication for policy 149

5.3.3 Implication for management practice

5.3.3.1 Organizational level 149

5.3.3.2 Individual level 151

5.4 Contributions to the thesis 151

5.5 Limitations of the thesis 151

5.6 Future research or recommendation 152

5.7 Conclusions 152

BIBLIOGRAPHY

APPENDICES

Appendix 1: Background Information of NSTDA and TRF

Appendix 2: Rogers's adopter categories

Appendix 3: Questionnaire

Appendix 4: In-depth interview questions to firms

Appendix 5: Compile list of TRF

Appendix 6: Compile list of NSTDA

Appendix 7: Five attribute ranking

Appendix 8: Company Background

Appendix 9: Rating ability of granted researcher

Appendix 10: R&D Objectives

Appendix 11: Basket Data

Appendix 12: Process Patenting (Thai)

Appendix 13: Executive Summary (Thai)

ASSUMPTION UNIVERSITY OF THAILAND SINCE1969

LIST OF FIGURES

Figure 2-1	Innovation Diffusion Process	14
Figure 2-2	The industry life cycle model	16
Figure 2-3	Variable influencing the rate of adoption of innovation	16
Figure 2-4	Transitional of technology delivery to customer needs	17
Figure 2-5	Link between technology performance and customer satisfaction	18
Figure 2-6	Dynamic model of product and process innovation or " Industry life cycle model"	21
Figure 2-7	Technology progress model	23
Figure 2-8	Innovation development process	24
Figure 2-9	A generic of new product innovation development model	28
Figure 2-10	The science- push model or the linear model of innovation	30
Figure 2-11	Chain- Link Model Showing Flow Paths of Innovation And corporation	31
Figure 2-12	The Innovation process	32
Figure 2-13	Holistic model of best practice for R&D management Within firms	35
Figure 3-1	Scale measurement of Innovation Diffusion Process From R&D stage toward commercialization	56

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR VINCIT
OMNIA
มหาวิทยาลัยอัสสัมชัญ

Figure 4-1	The number of granted project passing through the stage of R&D, innovation development, and market development during 1998-2003	67
Figure 4-2	Diffusion pattern of R&D Funding Program of TRF and NSTDA	70
Figure 4-3	Diffusion of R&D granted project to commercialization	82
Figure 4-4	Share of project funding sources in each stage of Innovation development	84
Figure 4-5	Period of each project carried out in 1998-2003 of TRF	86
Figure 4-6	Innovation Development Period of TRF (1998-2003)	89
Figure 4-7	Diffusion of R&D granted projects and period in commercial achievement: case of TRF	90
Figure 4-8	Diffusion of R&D granted projects to commercialization Of NSTDA	93
Figure 4-9	Share of project funding source from NSTDA and companies	94
Figure 4-10	Time duration (months) of each project carried out in 1998-2003 period	97
Figure 4-11	Show the period of innovation development in each stage	100
Figure 4-12	Diffusion of R&D granted projects and period In commercial achievement: case of NSTDA	101
Figure 4-13	Factors enabling/inhibiting the progress of R&D Along the Innovation Diffusion Process	138
Figure 4-14	Environment influencing the diffusion of R&D Funding toward commercialization in Thailand	139

LIST OF TABLES

Table 1-1	The Technology Status Index in different countries (1999)	3
Table 1-2	The competitiveness ranking in different countries undertaken by IMD	4
Table 3-1	Principals of Innovation Development	54
Table 3-2	Share of sampling frame and sample size	58
Table 3-3	Principals of success/failure in managing R&D	59
Table 3-4	Variables and indicators for the study	60
Table 4-1	Share of companies that participation R&D Granted projects in different type of collaboration	66
Table 4-2	The continuity of the number of projects in each stage	67
Table 4-3	Accumulative number of "adopters" of R&D Funding program in 1998-2003	68
Table 4-4	Ranking of decision to join R&D funding program	72
Table 4-5	R&D objective of participated companies (case study)	73
Table 4-6	Share of interviewees (companies) in respect to firm size.	78
Table 4-7	Share of companies in respect to ownership	78
Table 4-8	Share of R&D granted project progress to each to each stage, as of December 03	81

Table 4-9	Type of innovations from R&D funding program of TRF during 1998-2003	85
Table 4-10	Average duration (month) of innovation development in each stage	88
Table 4-11	Share of R&D granted project progress to each stage –NSTDA, as of December 03	92
Table 4-12	Type of innovations from R&D funding program of NSTDA during 1998-2003	95
Table 4-13	Average duration (months) of innovation Development in each stage	99
Table 4-14	Comparison of spending time for innovation Diffusion process of TRF and NSTDA	102
Table 4-15	Share of companies participated in R&D granted program and finished project in 1998-2003	103
Table 4-16	Profile of champions and followers	104
Table 4-17	Share percentage of sales volume in response To target sale volume	125
Table 4-18	Variable analysis	131
Table 5-1	Factor enabling/inhibiting the progress of R&D Granted project towards commercialization: Case study of TRF and NSTDA (1998-2003)	146

CHAPTER 1: INTRODUCTION

1.1 Introduction

In industries linked with science and technology, the results of the research can increase the company's income and reduce uncertainty of production process. In context of industrialization, R&D's ultimate goal is to achieve new product/process innovations for commercialization. It is generally known that the national R&D management system reflects the national technological capability. Many developed countries, such as the United States, the United Kingdom, Germany, France, Sweden, Japan and Korea, achieve the national wealth from building up technological capabilities. Nevertheless, while the developed countries capture returns from the effective innovation system, Thailand is still in a catching-up process. There have been problems: limited accessibility to technology, limited value-added research and development (R&D), inefficient utilization of ICT infrastructure, no incentives to induce learning new technology (lack of creativity), which inhibits Thailand to get ahead.

As Thailand is going through the knowledge-based economy transformation, the policies of managing innovations are of importance for an effective 'pull' towards commercialization. The present thesis is concerned with the diffusion of research and development (R&D) work funded by the government research-funding organizations in Thailand. The thesis is based on the case studies of the two main public funding organizations: the Thailand Research Fund (TRF) and the National Science and Technology Development Agency (NSTDA).

1.2 Background to the thesis

This thesis has been concerned with laying out the public research and the development (R&D) management system. The rationale for undertaking this thesis comes from the above issue regarding the ineffective R&D innovation system. There is a wealth of literature on innovation management but little attention is paid to the governmental role in managing technological innovations. It is, therefore, useful to investigate this neglected area.

The scope of this thesis will be guided by the theory concerned with the innovation development and diffusion. The related innovation diffusion theory is effective and useful in describing the progress of innovations (Rogers 1995, Twiss 1995, Utterback 1994, Utterback and Abernathy 1975). The thesis will revisit the theories in the innovation life cycle, analyze how Thailand R&D system is shaped, investigate the innovation process and recommend the policy implications to encourage and strengthen Thailand's R&D management system contributing to industrial development.

The present study will use the two main research-funding organizations in Thailand: the Thailand Research Fund (TRF) and National Science and Technology Development Agency (NSTDA) as case study organizations to study the process of innovation. The innovation diffusion process of commercialized R&D projects will be focus of the study. The study will use a case study approach. By using the innovation diffusion theory (Rogers 1995) as a guideline, the innovation process from the development stage towards the diffusion stage (the stage of commercialization) will be analyzed. It is hoped that the conclusions and recommendations drawn from the study can deepen an understanding of the relation between the R&D capability of the Thai industry, the level of innovation diffusion, and the management of public R&D system.

1.3 Research issues

1.3.1 Thesis problems

Technology Policy and Assessment Center, Georgia Institute of Technology highlights the technology status index in different countries (Table 1-1). From the table, it can be seen that Thailand receives low status index rating in technological infrastructure, productive capacity, technological standing, technological emphasis, and rate of technological change.

Table 1-1: The Technology Status Index in different countries (1999)

Country	NO	SE	TI	PC	TS	TE	RTC
USA	78.4	87.0	96.1	88.1	95.4	44.5	16.6
Japan	79.5	63.2	78.3	83.4	82.7	52.3	20.3
UK	72.4	78.0	59.8	53.6	53.8	42.8	30.5
Australia	78.4	83.2	53.0	51.6	19.5	8.2	17.2
Singapore	87.9	71.9	38.9	53.7	51.5	96.3	30.2
South Korea	74.9	73.5	44.6	48.8	32.7	48.1	20
Taiwan	90.7	74.2	43.6	53.7	35.2	54.8	20.9
Malaysia	69.5	58.9	31.9	44.1	30.8	83.8	24.0
China	62.3	52.4	46.4	41.9	44.2	37.2	29.5
Thailand	**50.7**	**46.5**	**20.5**	**30.6**	**16.6**	**42.2**	**15.3**
Indonesia	53.9	43.8	19.2	23.7	14.0	12.3	37.6
Philippine	60.9	63.7	24.4	42.6	15.0	71.4	45.6
India	67.7	48.4	46.8	51.3	20.8	8.4	33.6
Mexico	41.8	40.4	21.8	24.8	19.8	38.8	16.6
Israel	92.0	74.1	58.2	50.6	29.5	44.3	29.8

Source: Technology Policy and Assessment Center, Georgia Institute of Technology (1999)

NO = national orientation	TS = technological standing
SE = socioeconomic infrastructure	TE = technological emphasis
TI = technological infrastructure	RTC = rate of technological change
PC = productive capability	

The competitiveness ranking undertaken by the International Institute for Management Development (IMD) (Table 1-2) has shown that Thailand's technological capability is relatively low. In the year 2000, Thailand was placed at the 47th (out of 47 countries) in science and technology (S&T) capability and the 33rd for overall competitiveness.

Such ranking shows that Thailand encounters a serious problem in building up technological capabilities.

Table 1-2: The competitiveness ranking in different countries undertaken by IMD.

Country	Thailand			Hong Kong			Japan			Taiwan			Malaysia			China		
Year / Factors	98	99	00	98	99	00	98	99	00	98	99	00	98	99	00	98	99	00
Overall	39	34	33	3	7	14	18	16	17	16	18	22	20	27	25	24	29	31
1. Domestic Economy	16	40	36	17	36	32	15	29	6	8	20	21	3	41	26	5	6	17
2. International Performance	37	34	21	3	5	9	34	21	27	32	27	34	24	29	17	20	18	35
3. Government Efficiency	22	17	23	2	2	2	27	23	22	14	11	14	3	3	8	5	16	16
4. Financial Status	44	40	38	9	7	9	23	35	22	19	23	26	28	30	29	42	36	41
5. Infrastucture	41	43	43	19	19	20	21	20	21	26	21	22	24	24	26	40	42	42
6. Management	41	41	39	4	5	21	24	26	24	7	9	18	22	25	26	30	36	38
7. Science&Technology	43	40	42	25	22	27	2	2	2	7	10	12	24	32	31	13	25	28
8. Human Resource	35	38	37	13	14	13	11	13	20	18	15	19	34	36	36	24	27	29

Source: IMD, the World Competitiveness Yearbook (1998-2000)

The above table reflects a problem that urges the Thai government to be concerned with issues in enhancing technological capability of Thailand. In relation with this concern issue, academic studies revealed that local R&D efforts have not contributed much to technological development in industry but it does not mean that R&D is unimportant. Generally known, R&D is a key capability needed to generate technical changes and improvements in industry. However, R&D is never sufficient by itself for generating new products, processes and services as well as various kinds of improvements needed by the Thai industry. A wide range of other technological and managerial resources and capabilities is needed. As suggested by numerous studies in recent years, there is a reason to believe that Thai industrial firms have to build up significant in-house capabilities. However, they still need more effective mechanism to transfer the public sector R&D results to commercialization. By the way, the public sector R&D still limits the effectiveness. A few of the public sector R&D granted projects have resulted in commercial application. In other words, technology users (industrial firms) cannot exert an effective 'pull' on the formal R&D system (Schmookler 1962, Chantramonklasri 1994). This situation clearly urges the Thai government concerns in national R&D development system in particularly R&D funding and facilitating the process in order to drive the innovation commercialization.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969

This relatively low ranking of science and technology competitiveness, again, points to the question why the previous R&D granted projects are not led to commercialization. It is interesting to explore the reasons of these circumstances by applying the Innovation diffusion theory and the innovation development process. In order to increase Thailand's stance in S&T capability and R&D capacity, the Thai government should revise its policy to support the public R&D management system.

1.3.2 Thesis objectives

Objectives

1) Use case study approach to explain the innovation diffusion from the public R&D management system in Thailand (technological innovations) as a management process (the process from the research and development towards diffusion/ commercialization).
2) To explore the characteristics of R&D work's adoption for the innovations managed by NSTDA and TRF (the diffusion level)
3) To find out the factors enabling/inhibiting the progress of these R&D results towards commercialization.

1.3.3 Thesis questions

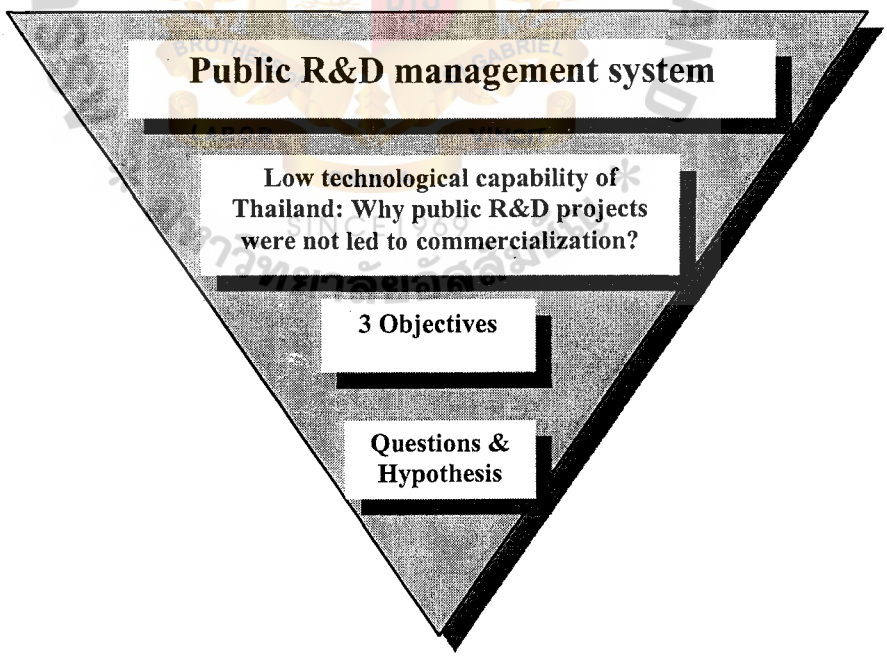
The thesis is designed to address the following questions:

1) How R&D projects funded by NSTDA and TRF are adopted among private companies? What are the characteristics of the diffusion stages (the R&D activities at each stage along the S-curve) of the National Science and Technology Development Agency (NSTDA) and the Thailand Research Fund (TRF) during 1998-2003? [The period of the present study is defined based on the organization development of TRF and NSTDA.]
2) Given the R&D projects carried out at different stages along the innovation diffusion, what factors influence the progress of innovations? (To explore why some innovations can pass through the stages whereas others flop during the way.)
3) What are the policy recommendations to encourage and strengthen Thailand's innovation diffusion?

Hypotheses:

- The innovation process managed by the government organizations is linear, reflecting a science push model (Schumpeterian 1939).
- R&D is a viable strategy needed to generate innovations in industry (Doyle & Bridgewater 1998)
- Effective commercialization needs to be incorporated into the innovation diffusion process (Rogers 1995)
- Failure of management to look far enough ahead inhibits the innovation process (Cooper & Kleinschmidt 1990)

The undertaking of the thesis is aimed to contribute to the body of knowledge in the public R&D management system. It is hoped that the policy recommendations would improve the R&D management system in terms of speeding up the process of R&D projects towards commercialization. In addition, the professionalized Thai researchers would learn the characteristics of diffusion stages in order to develop an aggregate R&D plan for commercial aim.



Policy research with proposed policy recommendations to improve the public R&D management system.

1.4 Contributions for the thesis

1.4.1 Organization

Not only TRF and NSTDA gain benefit from the thesis results, but the techno-entrepreneurs will also gain the body of knowledge in managing R&D granted projects for commercialization. The company management will have better understanding on the interaction between public finding organizations and the company itself in managing the R&D project and exchanging R&D resources (R&D personnel, budget, lab facilities) in an effective way.

1.4.2 Employees

The analysis and discussion of the thesis show that the employee of TRF and NSTDA will learn diffusion process of innovation from the R&D stage towards the market development stage. The R&D manager and the policy maker will have better understanding on managing R&D for commercial application. In addition, R&D personnel of private firms (e.g. technical staff, administration, and marketing) will gain better understanding on the process of innovation diffusion from R&D stage towards commercialization. Besides, the analysis of findings on the factors influencing the progress of R&D project towards commercialization will assist in their design of R&D management system. It is expected that this study will contribute to the government effort in building up the private firm's capabilities in implementing and managing the R&D project towards commercialization.

1.4.3 Academic interest

The importance of the innovation diffusion process and the commercialization concept is even greater for Thai researchers (mostly are university lecturers and professors). Thai researchers can learn from the successful cases of R&D projects (R&D granted projects which are passed towards the commercialization stage) to plan their future R&D design and build up capabilities in innovation management.

1.4.4 Society

The thesis results will be useful to the professional groups of the Thai society, including researchers, techno-entrepreneurs, and particularly the research organizations undertaking the role of managing innovations. The analysis will discuss

the current problem of the public R&D management system and the innovation development process in Thailand. The interested group of the society will gain a better understanding on mechanistic approach towards managing R&D as a business.

1.4.5 Government

The result of the thesis will discuss the policy framework of the public R&D management system in Thailand. TRF and NSTDA, which are two main government funding organizations will gain better understanding in terms of; diffusion process of the R&D funding program; factors influencing the progress of R&D granted project towards commercialization. In order to manage effective linkages with the public sector R&D organizations and Thai industrial firms, the body of knowledge coming out from the thesis contributes directly to the main funding organizations in Thailand regarding their obligation in managing the R&D system for economic growth. In addition, the thesis results will also contribute to the R&D policy-making organization in establishing the clear direction for effectiveness of the national R&D management system.

1.5 Methodology

This thesis was undertaken using a case study approach. Methodology employed in this study was qualitative-oriented. The in-depth interview research and the documentary analysis were the main instruments to obtain the results and analysis. In using TRF and NSTDA as case study organizations, the steps in undertaking the research were designed into three steps as follows: i) identify the scope of the present study ii) establish the scale measurement of the innovation diffusion process toward commercialization for TRF and NSTDA iii) perform analysis of findings.

1.6 Definition of terms

According to Rogers (1995), the study defines the term of "diffusion of the R&D granted projects towards commercialization" based on concept of the "innovation-decision process" and "commercialization". He defines the innovation-decision process as the process through which an individual passes from first knowledge of an innovation to form an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision. In addition, "commercialization" is the product, manufacturing, packaging, marketing,

and distribution of a product or service for sale in the marketplace. Therefore, the study will trace the diffusion of R&D work funded by TRF and NSTDA among private firms.

The study defines the process of R&D diffusion towards commercialization as three stages including:

i) Research & Development (R&D) stage: the period from the undertaking of research to the prototype

ii) Innovation development stage: the period from making the prototype into innovation ready to launch

iii) Market development stage: the period after the launch of innovation into the marketplace

1.7 Limitations

Regarding to the annual result report of TRF and NSTDA 1998-2003, both of TRF and NSTDA have established research fund for social base and science and technology base in a variety of research purposes including i) the national social and economic policy ii) the protection of natural resource and solving environmental, energy, social welfare iii) scientific and technological promotion iv) community development v) development of necessary technologies for small-and medium-size companies (SMEs) vi) academic research vii) the tackle of the serve shortages of highly qualified researchers in the country viii) the solution to local problems and the service the needs of community ix) science and technological development.

TRF fund is a mix of the social and the science & technology research whereas NSTDA fund focuses on the science & technology research. Hence, only the science & technology development research funded by TRF will be taken into this study due to thesis issues.

In addition, a number of projects from venture capital fund and technology licensing outcome will be taken into this study since private firms support its development.

Although the innovation life cycle presents an interesting framework to guide the analysis of this thesis, the study will only focus on innovations funded by NSTDA and TRF due to time constraints and limited budget. Besides, reviewing of TRF and NSTDA organization's development will be a guideline to establish the timeframe of the diffusion study. Therefore, the timeframe for study will be 1998-2003 whereby the innovations under this period will be a focus to the study of the diffusion pattern. This period starts from the beginning of venture capital fund toward recent years based on the availability of information outreach. This period will best reflect the policy outcome of commercialization research funding in the past operation. The research fieldwork will be undertaken within an industrialized area of Thailand: Bangkok and the Metropolitan Region (BMR).

The study designs 10 variables as controllable factors in managing the public R&D system for the case study approach. The case study will help gain an in-depth understanding from the analysis of these 10 variables. However, further study including more case study samples is recommended to gain a firmer understanding of the R&D management system.

Since the research study will focus on the country's main research organizations: NSTDA and TRF, the better understanding (not the generalization) on research management could be achieved. The merits in terms of policy implications can best be applied to other types of research organizations such as the internal projects of NSTDA, the governments' research units and the public R&D centers.

1.8 Outline of the thesis

The thesis is laid out in five chapters. Chapter I describes thesis issues including problems, objectives, thesis questions and hypothesis as well as the desired outcome of the thesis. Chapter II presents the literature review in aspect of the innovation diffusion theory, the innovation development process, and the academic study on factors affecting the success/failure of the R&D management. This chapter also presents the historical development of public research organizations in Thailand. This section points out room to improve the public R&D management system by recognized gurus of R&D organizations such as Thailand Research Fund (TRF),

THE ASSUMPTION UNIVERSITY LIBRARY

Thailand Development Research Institute (TDRI). The end of the chapter presents conceptual framework of the thesis. Chapter III presents the methodology study of the thesis, which is developed from literature review. Chapter IV presents the analysis of findings from reviewing of documentary and fieldwork study. This chapter also presents the answer to thesis questions and the testing of the hypothesis. Chapter V presents policy implication for the lay out of the public R&D management system in Thailand. It also presents the model for evaluating and managing the diffusion of R&D's results towards commercialization.

791 e-4

1.9 Conclusion

The research results would be the Model of R&D management for commercialization with policy guidelines for the research organizations. By studying the two major research-funding organizations, the value-added R&D management model with strategic implications on how to build up Thailand's competitive position will be developed.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

CHAPTER 2: LITERATURE REVIEW

2.1 Background of literature review

The present research concerns the diffusion of research and development (R&D) work funded by the government research-funding organization. The research is based on the case studies of the National Science and Technology Development Agency (NSTDA) and the Thailand Research Fund (TRF). The extent of the research focus is: how R&D granted projects diffuse to commercialization; what factors influence (enable/inhibit) the progress of innovation from development towards commercialization. The three parent disciplines in this research are: (i) the innovation diffusion theory (ii) the innovation development process and (iii) the body of knowledge on success/failure in managing R&D for the new product development.

2.2 Parent disciplines

2.2.1 Innovation diffusion theory

In the innovation studies literature, Rogers (1962) used well-established theories in sociology, psychology, and communications to develop a concise and easily understood approach to the diffusion of innovations. The innovation diffusion principally concerns the definitions of innovation. Schumpeterian (1939) defined innovation as a process encompassing the development of new ideas into marketable products/processes. Freeman (1974) described innovation as a process comprising technical design, manufacturing, management and commercial activities of new (or improved) products. Later, Rogers (1995) gave a comprehensive view by defining the diffusion as a process by which an innovation is communicated through certain channels over time among the members of a social system. In other words, diffusion is a process by which an innovation spreads (Rogers 1995, p.10-11). As the innovation success often depends on ability to manage the product/process innovations, services innovation, organization innovation, people innovation with contention to spin-off innovative ideas from R&D projects, Rogers' work is related to this research study.

According to Rogers' work (1995) on the diffusion of innovation, the main elements in the diffusion process are: (i) characteristics of innovation, (ii) time (iii) communication channel and (iv) social system.

(i) Characteristics of innovations

There are five characteristics in relation to the rate of innovation adoption. First, *relative advantage* - potential adopters need to see an advantage in adopting the innovation. Second, *compatibility* - innovations need to fit in with potential adopters' current practices and values. Third, *complexity* - innovations' ease of use will lead to more rapid adoption. Fourth, *trialibility* - potential adopters want to test the products before adopting them. Fifth, *observability* - potential adopters want to see observable result of an innovation. Rogers argued that the rate of adoption is positively related to perceived relative advantage, compatibility, trialibility, and observability, and is negatively related to perceived complexity of the innovation. (Details of measurable rate of adoption will be described after the concept of s-curve explained in figure 2-1 and 2-2 in the next paragraphs).

(ii) Time

This element refers to the speed with which an innovation is adopted by potential adopters within the diffusion process.

(iii) Communication channels

The diffusion to the potential adopter process involves the spread of new idea from its source. Rogers explained that mass media, such as television, radio, newspapers are effective in generating awareness of the innovation while interpersonal communication is effective in influencing an individual's decision to adopt.

(iv) Social system

This element refers to a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal. Generally, members of a social system are individuals, informal groups, or organizations who work toward a common goal. The culture within the social system and the individuals who make up the social systems can affect the diffusion of new ideas. Given the categorization of innovation adopters, the adopters from the same category share similar socioeconomic status, personality values, and communication behavior.

Rogers also introduced the concept on the role of change agent in an adoption process. The functions of a change agent include the developing need for change on the part of the client, establishing an information-exchange relationship, diagnosing problems, creating intent in the client to change, translating intent to action, stabilizing adoption and preventing discontinuance, and achieving a terminal relationship. In essence, the ultimate goal of a change agent is to positively influence the client's innovation adoption decision. In so far as the process of linking up the potential adopters is concerned, the role of the change agent is normally, but not necessarily, essential in managing technological innovations. Through the work of change agents, the innovation eventually reaches a saturation level, where virtually everyone adopts the innovation.

The spread of innovation can be seen in Figure 2-1, showing a key point of innovation diffusion model or "s-curve". Earlier adopters mark the emergence of S-shaped diffusion to form an envelope of diffusion curves. In the take-off process, a number of early adopters reach a critical mass (between 5 and 15%) where the process would always be irreversible, at the same time, though, change agent work to communicate the innovation to others in the society by whatever means they believe appropriate.

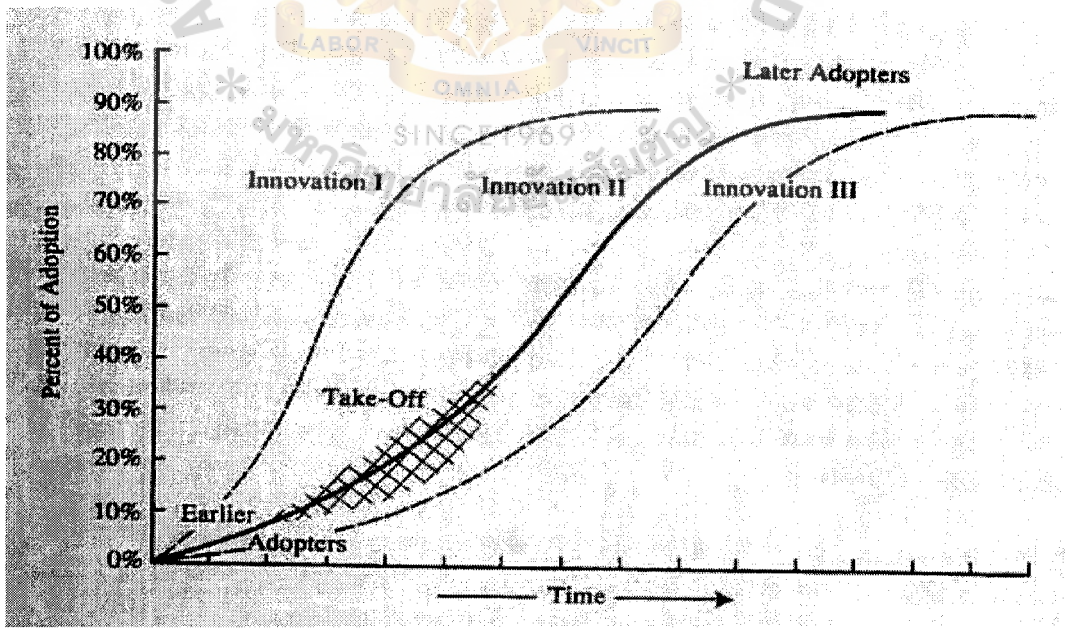


Figure 2-1: Innovation Diffusion Process

Source: Rogers, Diffusion of Innovation 4th Edition (1995)

At the innovation process end, one may expect commercialization and the rate of adoption. Commercialization is the product, manufacturing, packaging, marketing, and distribution of a product or service for sale in the marketplace. Innovations then result from the research activity. In other words, innovations are scientific results packaged in a form ready to be adopted by users. Because private firms usually do such packaging of research results, this stage in the technology-development process is called commercialization.

The rate of adoption is the relative speed with which members of a social system adopt an innovation. It is generally measured as the number of individuals who adopt a new idea in a specified period, such as each year. The rate of innovation adoption can be seen from steepness of the adoption curve (Figure 2-1). The adoption of an innovation usually follows a normal, bell-shaped curve (s-curve) when plotted over time on a frequency basis. This means that the upward shift in the life cycle model straightforwardly shows the technological evolution.

Figure 2-2 shows the category of adopters in the adoption curve. Figure 2-2 changes the Y-axis from the percentage of adoption to the percentage of user/adopter in each unit of time. As diffusion proceeds, the life cycle can be redrawn as a normal, bell-shaped curve. The curve was classified into five categories based on the relative percentage of users who adopt innovation at each stage (Figure 2-2). Early on are the innovators and early adopters (who are concerned with the underlying technology and its performance). Then come in succession the early majority pragmatists, the late majority conservatives and lastly the laggards (all of whom are more interested in solutions and convenience).

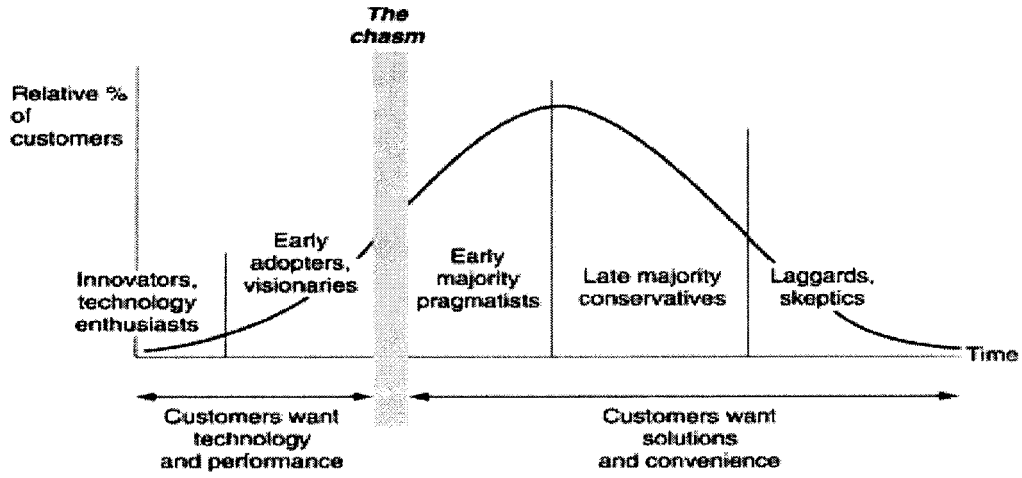


Figure 2-2: Five categories of adopters and innovation diffusion phase

Source: Norman's work: adapt from Rogers and Moore (1998)

Rogers presented 5 groups of variable affecting the rate of adoption of innovations (Figure 2-3). These variables are: (i) the perceived attributes of innovations, (ii) the type of innovation-decision, (iii) communication channels, (iv) the nature of the social system, and (v) the extent of change agents' promotion efforts. The present study will use these variables to frame questions for the analysis section. The detailed description of the variables is shown in appendix 4: Variables determining the rate of adoption.

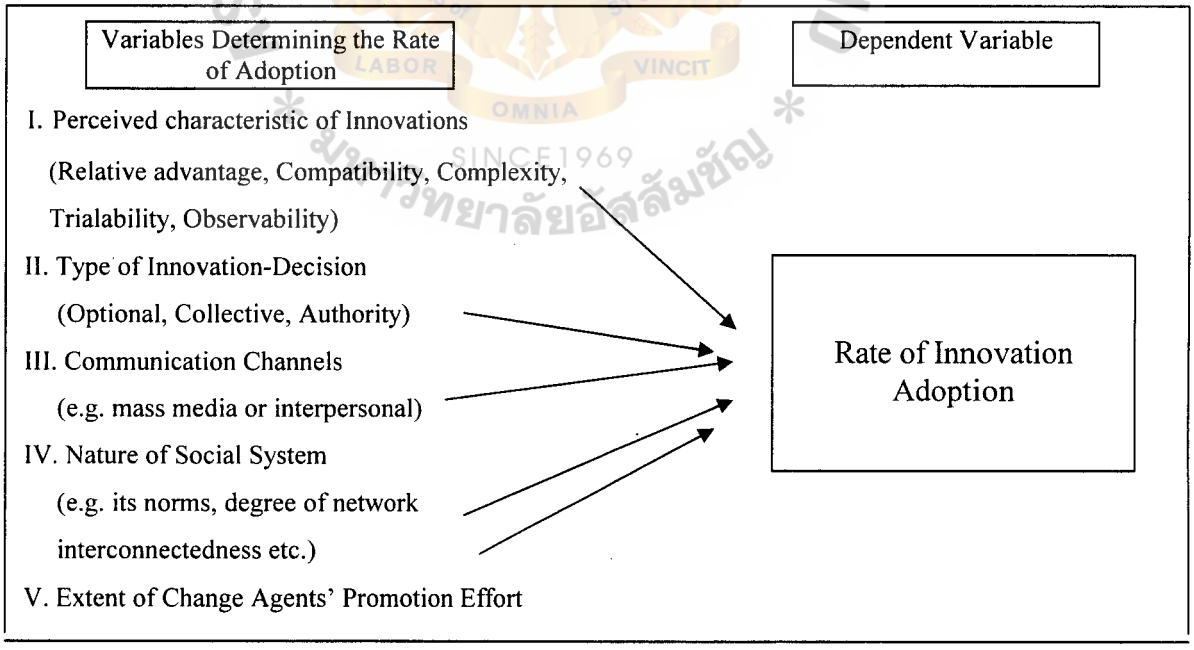


Figure 2-3: Variables influencing the rate of adoption of innovation

Source: Rogers, Diffusion of Innovation 4th Edition (1995)

The recent study on the innovation diffusion by Norman (1998) explains the progress of S-curve in relation to the ability to satisfy customer needs. Norman (1998) and Moore (1991) emphasize the advantages of innovations to customers because of beneficial technologies. Similarly, Christensen (1997) looks at the phenomenon of technology take-up from the perspective of the level of performance required by average users (those in the early and late majority categories in figure 2-2). He argued that once a technology product meets customers' basic needs, they regarded it as "good enough" and no longer care about the underlying technology (see Figure 2-4). Thus, it can be seen that customers are willing to accept the innovations if their needs are understood. Norman further argued that the two curves (Figure 2-2 and Figure 2-4) were in fact telling the same story. When the innovation crossed the chasm (from early adopters to late adopters), this means that the technology became good enough for laggards (Figure 2-5).

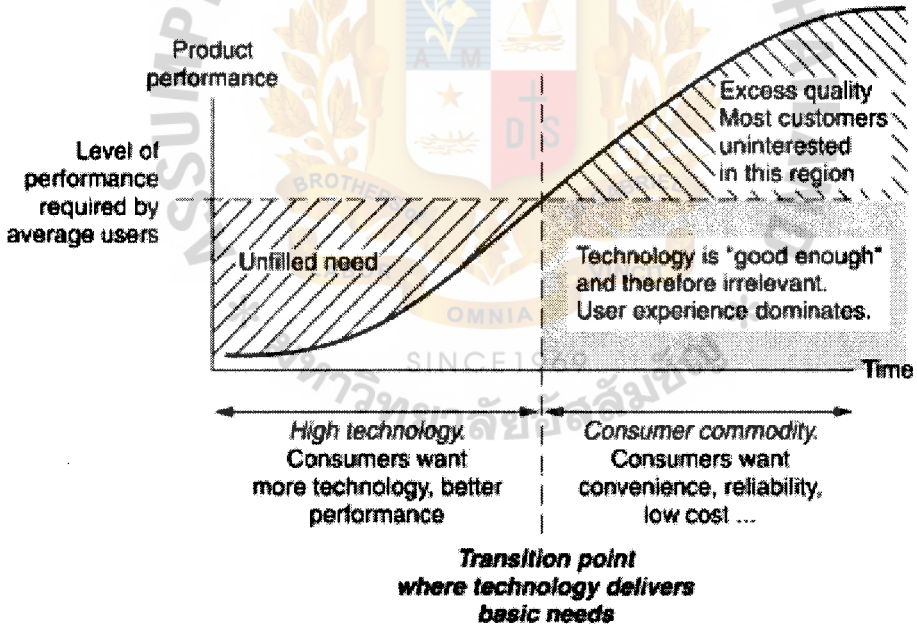


Figure 2-4: Transitional of technology delivery to customer needs

Source: Norman's work: modified from Christensen (1997)

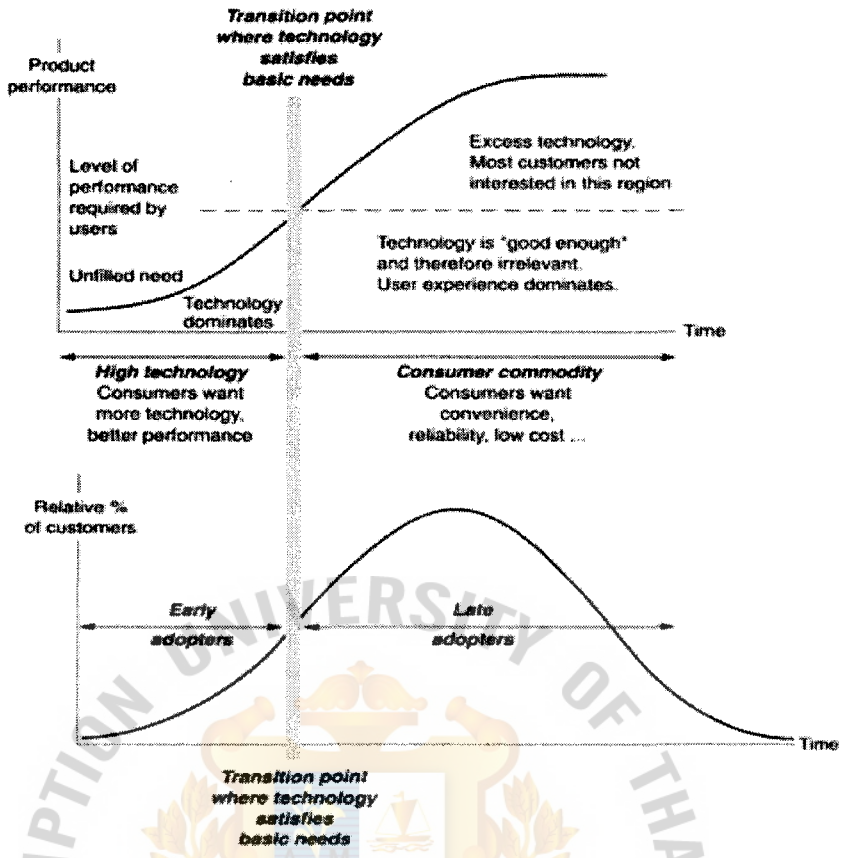


Figure 2-5: Link between technology performance and customer satisfaction

Source: Norman's work: The life cycle of a technology (1998)

The principal measures in relation to the innovation diffusion theory would be based on these models. The innovation diffusion in this study is defined as a diffusion of R&D projects funded by the research-funding organizations (NSTDA and TRF). The rate of innovation adoption is viewed as the number of companies joining R&D projects and having commercial benefits. The thesis issues therefore aim to see how R&D granted projects are managed towards the stage of commercialization. Attention would concentrate on how the projects are adopted among private companies and its progress to commercialization. The findings and results of the analysis can be seen in Chapter 4.

2.2.2 Innovation development process

In relation with the chasm concept (supplementary of innovation diffusion theory), there is some linkage in the thesis finding; factors enabling/inhibiting the progress of R&D projects towards commercialization stage. This study proposes to explanation why the diffusion of R&D granted projects struggle in each stage of adoption curves

e.g. innovator, early adopter, and the chasm. An investigation on 5 groups of variables (Figure 2-3) above is important in studying the factors affecting the rate of innovation adoption. To understand how the R&D granted projects progress along the innovation development process, this section will review various concepts of innovation development process, the characteristics of innovations by different types and models of the innovation life cycle.

In the major work on the process of innovation development, many scholars offered different types of innovations. Knight (1967) offered four types of innovations: (i) product/service innovations, (ii) production process innovations, (iii) people innovations and (iv) organizational innovations. Miller & Merriless (2000) regroup into three types in combination of the production process innovation and organizational innovation into "process innovation". Beside this, they used concept of marketing innovation proposed by Doyle & Bridgewater (1998), so, they extended product/service innovations into broader category of "marketing innovations". Finally, they added "technological innovations" as a separate category. In addition, Edquist (1986) described a definition of product versus process innovation in details, which cover all aspects.

Interestingly, many scholars defined innovations in a different category. However, the scope of this study is limited by the research problem; "why were R&D granted projects not led to commercialization?". Therefore, it is reasonable to study the two types of innovations (product and process innovations) in this study.

Edquist (1996) offers a plausible explanation of product innovation and process innovation as follows:

Definition[1]

1. Product innovation is the new-or-better-products (product varieties) being produce of and sold. Alternatively, the product innovation would relate to the

[1] Edquist, Charles., "Product versus Process Innovation: A Theoretical Framework for Assessing Employment Impacts," at the Conference on Creativity, Innovation and Job Creation, Oslo, Norway, 11-12 January 1996, pp.3-4.

generation, introduction and diffusion of new products (with the production process being unchanged). The product may be brand new for the world, but they may also be new for a firm of a country. Product innovation includes new goods as well as new services. New goods are product innovation in manufacturing and the primary sectors. In contrast to goods, services are immaterial (intangible); they are often consumed, simultaneously to their production and they create values, which satisfy non-physical needs for the user. Examples of the product innovation in goods are the microwave oven, high definition TV in the 1990s, new processor for PC's, a mobile phone. Product innovations in services are such as new financial services, mobile phone calls, and access to Internet, design and maintenance of computer system in firms.

2. *Process innovation* is the new ways of producing goods and service or it would relate to the generation, introduction and diffusion of new production process (with the products remaining unchanged). Process innovation may be technological or organizational. Technological process innovation is the units of real capital (material goods), which have been improved through technical change leading to productivity growth in their use. Organizational process innovation is more productive to organize work.

Some scholars classify the types of innovation into incremental innovation and radical innovation as follows.

1. *Incremental innovation* involves small improvements and extension to existing products, process and services. The target is to increase efficiency-higher quality, reduce times and lower costs. For an incrementally new product the customer is known and the technology does not radically depart from conventional practice.

2. *Radical innovation* involves major changes. Typically there are unknowns concerning both customer and technology.

The definition of innovation reviews above provides a better understanding on characteristic of innovations. This knowledge will facilitate the findings on characteristic of new product/process innovations derived from R&D granted projects during the past 8-10 years. Using interpretation of incremental and radical innovation, this study will be able to reveal technology performance of those R&D outcomes.

Links between innovation types

There are a number of scholars representing the linkage between the type of innovations, including that between product innovations and process innovations, incremental innovations and radical innovations.

Utterback and Abernathy (1975) proposed a dynamic model of product and process innovation. It explained the industry life cycle model comprising the product innovation and process innovation (figure 2-6). This model shows that the rate of major innovation for both products and processes follows a general pattern over time, and that product and process innovation share an important relationship.

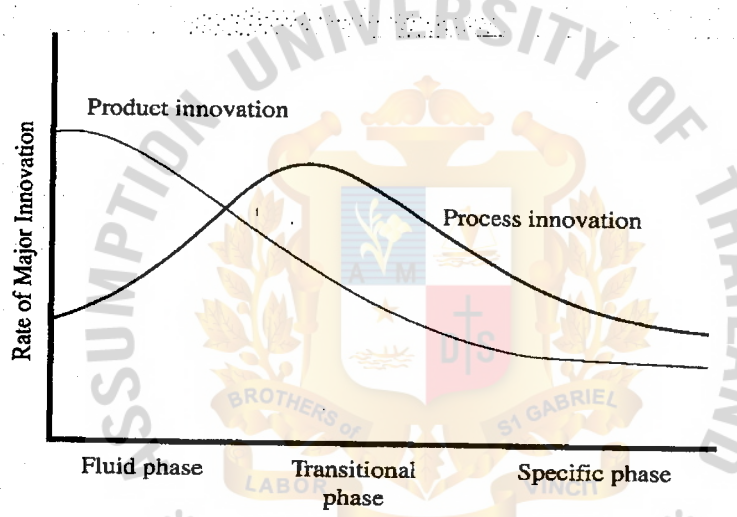


Figure 2-6: Dynamic model of product and process innovation or "Industry Life Cycle Model"

Source: Utterback and Abernathy (1975)

As the figure indicates, the rate of product innovation in an industry or product class is highest when a great deal of experimentation with product designs and operational characteristic take place among competitors. A good example of the 'fluid phase' is found in the early years of the automobile industry, when a bewildering variety of machines including electronic and steam driven cars-emerged from the workshops of dozens of manufacturers. Each hoped to capture the allegiance of the public with a novel new design and driver amenities; the great product variety of this period makes the design innovation in the modern auto age seem sterile by comparison. During this

fluid period of high product innovation, much less attention is given to the process by which products are made, so the rate of process innovation is significantly less rapid.

The period of fluidity, according to the model, typically gives way to a "transitional phase" in which the rate of major product innovation slows down and the rate of major process innovations speeds up. At this point, product variety begins to give way to standard designs that have either proven themselves in the marketplace as the best form for satisfying user needs, or designs that have been dictated by accepted standards, by legal or regulatory constraints. As the form of the product rapidly becomes settled, the pace of innovation in the way it is produced quickens. Again the auto industry provides an example, as the imaginative designs in which the form and features of the automobile achieved a measure of uniformity. By this time auto companies had developed a set of technologies and the driving public had developed a set of expectations that together essentially defined the modern automobile. At the same time, great progress was being made in the ability of firms to manufacture automobiles at the lower cost.

Some industries enter as a "specific phase," in which the rate of major innovation dwindles for both product and process. These industries extremely focus on cost, volume, and capacity; product and process innovation appears in small, incremental steps.

Commonly, not all industries or products pass through these tidy phases, but over the years the model has proven valuable in explaining the pace of innovation as a factor of industrial competition over periods of time.

In generalization, product and process innovations go hand-in-hand. One firm's new product innovation may be another firm's new process innovation. Firms may acquire new technology by purchasing that technology embodied in new capital equipment. Then the capital goods that embody the technology are a product innovation, but the buyer is acquiring a process innovation.

Taking into account the rate of technological change, Foster (1986) argued that radical product/marketing innovations would be followed by incremental process innovations that make the new product in a more efficient way, through a learning process. However, this could create a conflict in priorities because the subsequent attention to process innovations might detract the firm from developing the next (discontinuous) wave of radical product innovations.

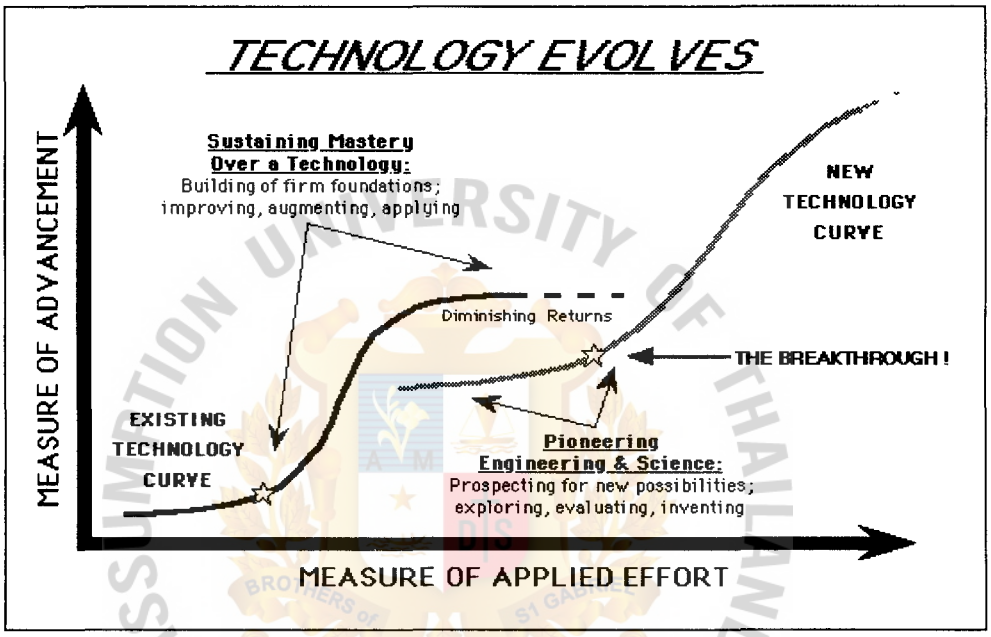


Figure 2-7: Technology Progress Model

Source: Foster (1986)

It is argued that the models proposed by Utterback and Abernathy (1975) and Foster (1986) share reference to Rogers's model on innovation diffusion (1995). According to Utterback and Abernathy (1975), three periods of dynamic product and process innovation are able to interpret with five stages of innovation adoption (see a bell-shaped curve of Rogers, figure 2-2). Fluid phase of innovations is equal to early majority and beginning of late majority. Transitional phase is equal to end of late majority. Specific phase is equal to laggards. In the CD-Rom production case, the technology production of CD-Rom taking place worldwide signifies the progress into the fluid phase (see Figure 2-6). As the CD-ROM technology becomes stable, a large number of users acquire the technology. The important feature in a process of

innovation development is a low cost production. As a CD-ROM technology is submitted to successive incremental improvements, the new technology curve (according to Foster's concept) emerges.

Similar to Foster model (see figure 2-7), generally, breakthrough innovations occur when incremental innovations reach the end of late majority and laggards. Exiting production process will be replaced by new technology. Then, the diffusion of old product/process at the last stage will be replaced by new product/process.

Literature reviews above give a better understanding on characteristics of innovations and the models of life cycles (technology and product/process). Next, to study the progress of R&D granted projects toward commercialization stage, it needs to have better understanding of a process of innovation development.

Innovation development process

Several scholars explained the innovation development process in different views but it is considered, in common as a stage of innovation development. The scholars classified the stage of innovation development in a different stage depending upon background experiences of scholars e.g. business management, technology management, and product engineering management.

Rogers (1995) explained six main phases in the innovation development process including (i) needs/problem (ii) research (basic and applied) (iii) development (iv) commercialization (v) diffusion and adoption and (vi) consequences. See figure 2-8.

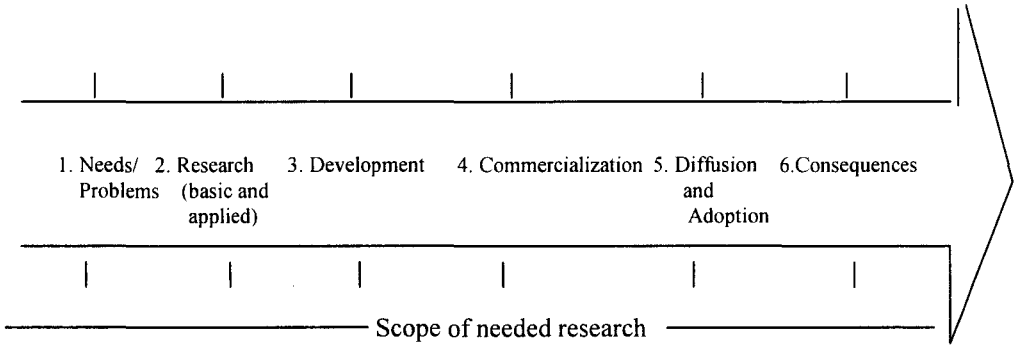


Figure 2-8: Innovation Development Process

Source: Rogers, Diffusion of Innovation 4th Edition (1995)

Rogers explained that innovation usually began with phase (i) the recognizing a problem or need, which stimulates a research and development activities designed to create an innovation to solve the problem/need. In certain cases, scientists may perceive a future problem and launch a research to find a solution. However, it does not mean that a problem/need always occurs from the scientist's or the researcher's doubt. Nevertheless, a problem/need may rise to high priority on a system's agenda of social problems (or national agenda) through a political process. Once needs/problems were out into research launch, research process was executed at phase ii. Phase (ii) is a basic and applied research. The knowledge base for a technology usually derives from basic research, defined as original investigations for the advancement of scientific knowledge that do not have a specific objective of applying this knowledge to practical problems. In contrast, an applied research consists of scientific investigations that are intended to solve practical problems. Scientific knowledge is put into practice in order to design an innovation that will solve a perceived need or problem. Applied researchers are the main users of basic research. Thus, an innovation[2] may result from a sequence of basic research followed by an applied research leading to development.

However, innovation is not always developed from the researcher alone. Indeed, Hipple (1988) found that the "lead user" developed 77 percent of the innovations in the scientific instrument field, and 67 percent of the innovations in semiconductors and printed circuit boards. In addition, much of innovation-development was by manufacturers. Perhaps the general point here is that much innovation occurs when people talk, when information is exchanged about needs and wants versus possible technological solutions.

Next, phase (iii) is development of innovation. It is the process of putting a new idea in a form that is expected to meet the needs of an audience of potential adopters. This phase customarily occurred after a research but before the innovation that stems from a research.

[2] Invention is the process by which a new idea is discovered or created. In contrast, innovation (as defined previously) occurs when a new idea is adopted or rejected. Therefore, invention and innovation are two different processes, although both deal with a new idea.

He also explained the acronym "R&D" corresponded closely to the concept that it represents: "R" always appeared together with "D" and, moreover, always preceded "D" Development was based closely on a research. In fact, it was usually difficult or impossible to separate a research and development, which is why the term "R&D" is so often used. Rogers argued that a research and development can be considered as distinct phases in the innovation-development process.

Phase (iv) is the phase of commercialization. It is the production, manufacturing, packaging, marketing, and distribution of a product that embodied an innovation. It is the conversion of an idea from a research into a product or service for sale in the marketplace

However, not all innovations came from a research and development. They may instead arise from practice as certain practitioners seek new solutions to their needs/problems.

Phase (v) is the diffusion and adoption phase. Rogers called this phase as "Gate keeping". Gate keeping is controlling the flow of messages through a communication channel. One of the most crucial decisions in the entire innovation-development process is the decision to begin diffusing an innovation to potential adopters. On the one hand, there is usually pressure to approve an innovation for diffusion as soon as possible, as the social problem/need that it seeks to solve may have a high priority.

The final phase (vi) in the innovation-development process proposed by Rogers is the consequences of an innovation, defined as the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation.

However, Rogers accepted that these 6 phases do not always occur in exact order, and certain phases may be skipped in the case of certain innovations.

As Roger pointed out that the proposed stages may be skipped in different order for certain innovations, the author would like to add that the innovation process may have lead-time between the research findings to innovation development stage toward

diffusion to marketplace/public stage. The reason is that the R&D investor is always reluctant in technology and market uncertainty. It always occurs that some R&D results hold the translation into commercialization stage. Besides this issue, the safety of the new product may be considered as being questionable to regulatory.

Stage-gate process of innovation management

The discussion above has shown the role of diffusion in the innovation process. As the success of innovations often depends on how firms manage innovations internally, it is useful to review the stage/gate decision process proposed by Cooper and Kleinschmidt (1990). They explained the stages of innovation development process in manufacturing management view. They explained innovation development process as five (5) stages of a generic new product development model. They used concept of game plan to introduce the five stage of the new product development. A new product "game plan" is typically a formal new product process dividing the innovation process into a number of discrete stages or steps. Therefore, they divided the process into preliminary assessment, detail investigation (definition), development, testing and validation, and commercialization (full production). Prior to the first stage, they suggested to screen an initiative idea according to company criteria that deal with issues, such as strategic alignment; feasibility; magnitude of the opportunity versus risk level; and fit with the company policy. Thus, they established a screening process at each stage of the innovation development. Getting into next stages, evaluation result of each stage must pass the criteria. They called this screening process as "gate" (similarly to Rogers) and this gate acts as the "quality control check point" in the innovation process. Gates is pre-defined, and specified a set of "deliverables"; a list of criteria; and an output (for example, a decision and approved path forward). Gates are usually managed by senior managers, who owned the resources required by the project leader and team. A typical or generic new product model is shown in figure 2-9.

THE ASSUMPTION UNIVERSITY LIBRARY

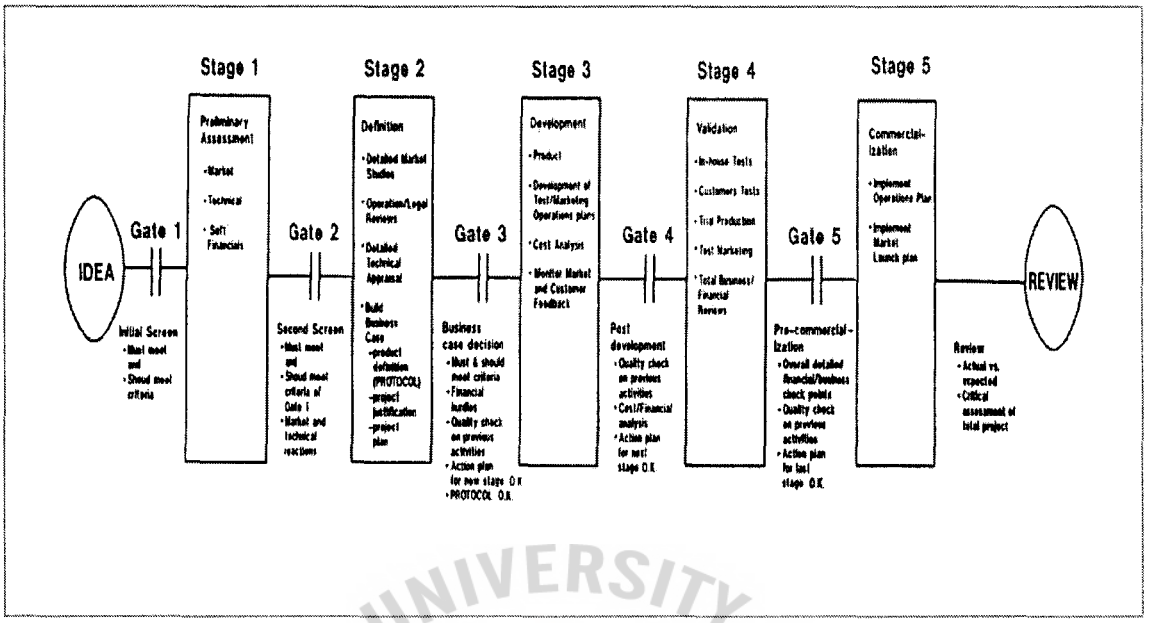


Figure 2-9: A Generic of New Product Innovation Development Model

Source: Cooper and Kleinschmidt (1990)

Figure 2-9 shows a series of stage-gates for innovation development from the idea creation towards the product launch to the market. Cooper and Kleinschmidt explained that the new product innovation is initiated by an idea. From the idea towards the new product launch, it needs to be screened for 5 stages of innovation development including i) preliminary assessment ii) detailed investigation or definition iii) development iv) validation v) commercialization. Before the R&D team has undertaken each stage, it needs the screening process as well. Therefore, it is criteria set for each stage and it is called "gate". This gate will consider feasibility of the project to progress at the next stage. From the figure 2-9, the innovative idea must meet the company criteria and then progress to first the stage in evaluation for feasibility of technical, marketing and financial stages of the projects. If the project is feasible, gate 2 will screen for market attractiveness; synergy; and product advantage. If the project passes through stage 2, gate 3 will screen it for decision for business case. Then, the R&D project will be developed at stage 3. The deliverable at the end of stage 4 is a prototype product. Concurrently, the market analysis and customer feedback work continually, while marketing, production and test plans are developed.

Once, the prototype is derived from stage 3, it will be screened again to ensure that the developed product is indeed consistent with the original definition specified at gate 3. If it meets the definition, it will progress to stage 4 "testing and validation". The final gate (gate 5) opens the door to commercialization – market launch and production start-up. The criteria for passing the gate focus largely on expected financial return and appropriateness of the launch and start-up plans. Finally, the project is on stage 5. It is full production and market launch. This final stage sees the commercialization plans implemented: market launch and production start-up.

In addition, Cooper and Kleinschmidt suggested the R&D team perform post implementation review following the launch. Typically, it would be performed after 6-18 months as launch. At this time, the project is terminated and the product becomes a "regular product" via a final review. However, the innovator team remained responsible for the success of the project up to this termination point.

The linear and chain-link models of innovation

We advance the argument that innovations evolve in the direction of technological change. In the literature of innovation, the progress of innovations has moved away from a linear to more complex model.

The conventional linear model (Schumpeterian 1939), the science-push model is presented to the innovation development field. It is a conventional linear model of the linkage of a research to production (figure 2-10). This model has been a number of attempts to impose the framework of innovation process. At that time, scientists have always presented that technological innovation was driven or pushed by science and a pure scientific research. The innovation process was depicted as a smooth, well behave linear process. This framework was called "the science-push model or the linear model of innovation". This model explained that innovation began with a research then led to development, development to production, and production to marketing.

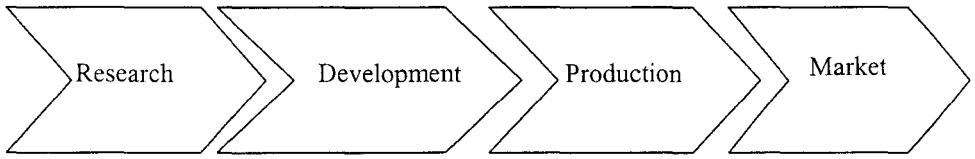


Figure 2-10 The science-push model or the linear model of innovation

Source: Schumpeterian (1939)

Schmookler (1966) is one of the well-known scholars who depicted the deficiencies of the linear, science-push model. He remains important in any discussion of the subject, which incorporates economic influences to the innovation development process. He depicted that the linear, science-push model was to offer the claim that the market demand almost exclusively determines the innovation process. Thus, when economists often preferred the market pull approach to that of science-push, it became clear that, as in all situations analyzed in economics, both demand and supply-side factors needed to be incorporated and linked. The one that explained the whole process of innovation is "the Chain-link model" in Kline and Rosenberg (1986). This model claimed that the innovation process comprises a set of linked activities which may occur in a variety of sequences and sometimes simultaneously (NOT smoothly as linear model any more).

In the model, it was far from single-cause explanations of innovation and unidirectional flows within the process. They emphasize the control role of feedback in innovation (which can be thought of as learning). Kline and Rosenberg defined innovation process into six elements, including a research, the potential market, the invention and/or produce analytic design, the detail design test, the redesign and production, distribution and market. Figure 2-11 shows a dynamic flow of information to each element.

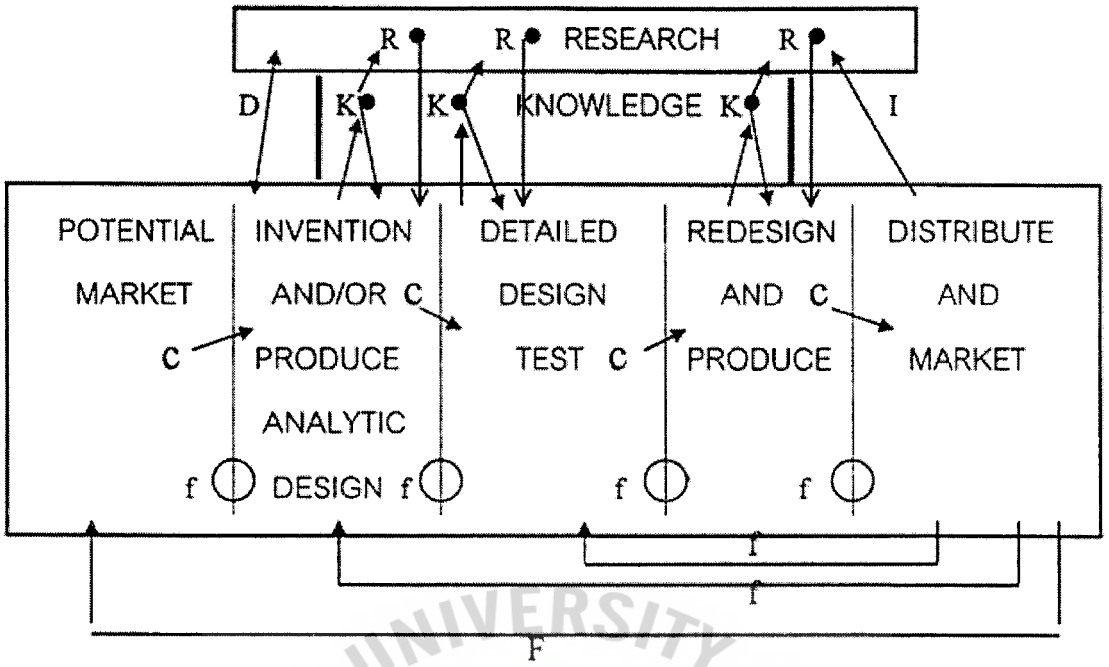


Figure 2-11: Chain-Link Model Showing Flow Paths of Innovation and Corporation
Source: Thesis paper by Methakunavut (1999)

The chain-link model represented the main thoughts about the innovation process that the innovation is neither smooth nor linear. It is complex, variegated and hard to measure. The process or successful innovation needs feedback, especially the interaction with market. Besides this, R&D is not necessary an initiating step in the innovation process. However, it is the core element and employed at all points along the central-chain-of-innovation. It is also the access arm of knowledge accumulation, which most innovation is done with.

In the innovation development process, Hastings and Healy (2002) attempt to develop a framework to assist Australian firms, particularly agribusiness firms, to foster innovation. According to their study, they established an analysis frame from Droege (1999) and Rothwell (1992). Droege depicted the innovation process in a business management view. The process included the three-stage process of culture, strategy (process) and implementation. Besides this, their study incorporated Rothwell's work to develop study variables. Rothwell depicted two styles of organization management, including organic versus mechanistic. Rothwell argued that the organic style of

management, characteristic of flexible and dynamically responsive organizations tends to be featured in innovative companies. The mechanistic style is more likely rigid, formal, hierarchical, and directives flow downwards. The less dynamic (follower) companies, in contrast, attempted to initiate new projects with a more rigid mechanistic framework and suffered accordingly. However, it is not always the case that large companies have to develop flexible management for an innovative purpose whereas the mechanistic style can also inhibit innovation.

Therefore, Hastings and Healy adapted the above concept to develop the analysis framework. They were still adhered with the three stages process of innovation and drew organization management styles that would likely inhibit the innovation process as checklist for the study. Figure 2-12 shows the 3-stages of the innovation process, which are adapted from Rothwell (1992) and Droege (1999).

Figure 2-12: The Innovation Process

Source: Hastings and Healy (2002)

Stark (2000) also viewed the stage of the innovation development in an academic aspect. Typically, it included the 3-stages process of idea creation, development, and commercialization. In Stark's view, innovation has occurred when any aspect (e.g. capability, use) of a product, process or service provides an improved solution to a need.

Base on various scholars, this study has adapted the innovation development process in combination with various aspects above. To reduce complexity in the analysis framework and suit this research questions (see chapter I), this study will define innovation development stages in the aspect of the national R&D management system.

Therefore, the stages of R&D development will fit into the three stages defined by the scope of the thesis research: the research and development stage, the innovation development stage, and the market development stage. This study has also adapted the characteristic of the organic management as one variable for checklist. These 3-stages will always be cover of for checking the characteristic of granters (hereby TRF and NSTDA) and grantees (hereby firms and grants researchers).

2.2.3 Body of knowledge on success and failure in managing R&D for the new product development

Following on a discussion on the innovation development process in Section 2.2.2, this section will be the wider review about the key success/failure in managing R&D towards the new product innovation for commercialization. Then, the reviewed success/failure issues will be adapted for developing all variables for this study.

A number of scholars cited for this section comprise of Cooper (1979, 1980); Maidique and Hayes (1984); Cooper and Kleinschmidt (1990); Myers and Marquis (1996); Townsend (1996);Droege (1999); Sensors-research consulting Inc (2003).

Generally, the success/failure issues are presented in various areas of study. Cooper's work presented in the area of manufacturing for the new product development, which ends up at the new product launch to the marketplace. Myers and Marquis presented in marketing views. Droege presented in the area of the organization management. Townsend, Maidique, Hayes, and Zirge's work are unanimous in the R&D management for the commercial purpose. Besides this, Sensor-research consulting company presented a holistic model of best practice for the R&D management within a firm.

These works shared common methodology for studying the characteristics of "winner" and "loser" firms on the new product development from the in-house R&D process. The winner and the loser were discriminated by successful and unsuccessful new product development projects. Commonly, many scholars recommend having better understanding of customers, the better to success in commercialization. Clearly, one

of the studies shows that "the most successful were market-derived (market pull) projects, and that only 21% of successes were the technology push" (Myers and Marquis, 1996).

In order to understand customer needs, Copper (1979, 1980) suggested that firms must have the well marketing research at the beginning of the innovation development process. Maidique and Hayes (1984) added that firms must have in-depth understanding of the customers and the marketplace. Indeed, several scholars (Townsend 1996, Maidique and Hayes 1984) revealed the close collaboration between the user (customer/adopter) and the innovator is necessary. It still needs a strong internal communication; and highly develops screening and testing procedures. Further similar study indicated that "interfaces with the customer meant a detailed understanding of the customer's problems, and a sound visualization of how the new product will solve the customer's problems" (Maidique 1984, and Zirger and Maidique 1990).

However, understanding the customer needs is not only one factor dominating the success/failure. Copper (1979, 1980) and Maidique and Hayes (1984) revealed in common that technical superiority and product uniqueness were factors to success/failure in commercial of a new product innovation. It needs "technological synergy (development and production), and the understanding of the technological tasks in the project and having a unique superior product in the eyes of the customer, one with a real differential advantage in the marketplace" (Copper 1979, 1980). Maidique and Hayes (1984) added that a good plan and execution of R&D process is necessary and it needs to introduce the product into the market early. Further study of Maidique (1984) and Zirger and Maidique (1990) added that being first in the market and entering a large and growing market lead to success. Then, firms have to ensure that delivering a product provides significant value to the customer.

In addition, firm infrastructure is one of the factors. For example, top management support exists for the project, from development through the product launch is one of a key success factors (Maidique and Hayes 1984). Sensor-research Consultant (2003) has also recommended that successful innovative firms have to be an appropriate

balance in skills and work force in technical task, marketing task, and business task. Combined creative marketing personnel with creative scientists, engineers, and business visionaries can build up an innovation dream team. It means that firms should facilitate employees to work together. Figure 2-13 shows the model.

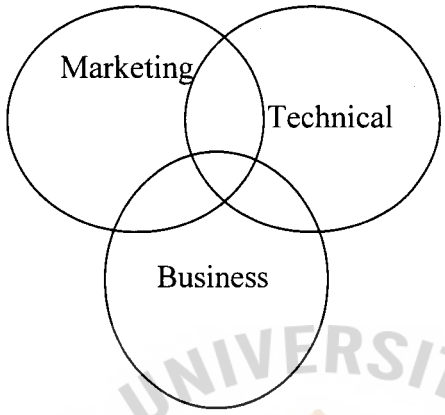


Figure 2-13: Holistic model of best practice for R&D management within firms

Source: Sensor-research consulting Inc. (2003)

Beside this, Sensor-research Consultant (2003) has also pointed out technology transfers facilitates the innovation development process. They have recommended a good idea to ensure an appropriate technology transfer from the research result to saleable development. It was explained that when the research is completed, it is time to turn it into a product. This is an important technology transfer stage and it has the potential for being the most stressful part of the project. It is advised to avoid an abrupt transition between the research and the engineering development phase. The only way to merge these phases is to introduce the engineering development personnel into, or at least near, the research project team, initially as engineering consultants or project observers. The consultant has recommended merging them in the middle of the research project.

Finally, implementation of the innovation process will not only be in an environment of change but will also be influenced by the macro-environment, such as economy, technology, culture, government, social and natural environment, each of which will

assist or hinder the innovation process. For example, government subsidies are a critical factor in the success of innovative firms. Less successful companies, particularly small businesses, make limited use of government programs (Droege 1999).

In summary, the author can categorize a key success/failure into four categories. It comprises of market variables, technology competency variable, collaboration variables (or interface between marketing and technological design and engineering), and organization management variables e.g. top management commitment, the firm's existing technological and organizational competencies, R&D resources.

Knowledge gained from the literature review above is directly the benefit to the R&D manager and the top management in private firms, especially innovative firms who have fruitful R&D resources (financial, R&D personnel, marketing team, and technological base). Nevertheless, those firms cannot be successful in new product development toward saleable development without their well R&D management.

In Thailand, it is generally known that Thai firms lack R&D capability. This is a result of low R&D investment in Thai private firms and a shortage of quality R&D personnel in the country (NIS Report 2003). Thus, the Thai government put a lot of effort to fulfill R&D resources to private firms. Indeed, the Thai government has intervened the private R&D system for about 10 years in the form of R&D funding and bridging the linkage between the academia personnel to private firms. (This is two-way exchange between private firms and the academia personnel. Private firms will access academic knowledge and academia will gain field experiences from the production process.) However, this government process still cannot drive private R&D capability to the next level. To support this argument, the author shows evidence that Thailand has low technological capability and R&D capability is one of the interpretation factors. See chapter I: problem statement of this thesis.

As per the problems, this thesis will investigate factors enabling/inhibiting the progress of R&D project toward the saleable level. The review variable to success/failure of new commercialized product development can be a framework for developing thesis

variables. (See thesis variables in Chapter III: Methodology Study). The variables will be used for checking the activity of R&D projects case study (private R&D granted projects fund by NSTDA and TRF, and public R&D granted projects that transferred result to private engineering and development). The author will consider whether activities follow on thesis variables and interpretation of the result to factors enabling/inhibiting the progress on innovation development of Thai firms (as case study). Findings will be generalized to the policy recommendation to improve the process of the R&D intervention system.

2.3 Immediate discipline

2.3.1 General application of Innovation Diffusion Theory

There is an application of the Innovation Diffusion Theory in various fields and the contributions today are impressive. Rural sociologists to study the diffusion of agricultural technologies in social systems originally used the model of diffusion and innovation proposed by Rogers. The concept of S-Curve has been applied to measure a diffusion level and characteristic of commercial products spread, both from firms and government. For instance, many empirical studies studied the diffusion of safety belt, potato harvesting machine, computers, HIV, birth control medicine etc. Recently, it has been successfully applied in specific information technology products such as Java@ software used in Internet and Internet environments or hypertext environments.

During the past decades the results of the diffusion research have been incorporated in basic textbooks in social psychology, communication, public relations, advertising, marketing, consumer behavior, rural sociology, and other fields. In addition, many US government agencies have a division devoted to diffusing technological innovations to the public or to local governments; examples are the National Institutes of Health, the US Department of Agriculture, and the US Department of Education. These federal agencies also sponsor the research on diffusion, as do the National Science Foundation and a number of private foundations. However, the Federal research and development laboratories in the United States are required by law to transfer their technologies to private companies, who commercialize the technologies into new products that are then sold in the marketplace. Furthermore, most commercial companies have a

marketing department that is responsible for the diffusion of new products and a market research activity that conducts diffusion investigations in order to aid the company's marketing efforts. For instance, the high tech marketer must be able to articulate their vision of how their product fares on each of innovation characteristics. Five characteristics of innovation are the factors affecting customer decisions. The marketer can also forecast the rate of the new product adoption during the time period.

The models of innovations differ to some extent on the application that these theories would be used. By drawing on wide literature, this thesis study will apply the theories to help the policy makers and R&D managers gain better understanding on why research projects were not led to commercialization and how research results could be driven to market.

2.3.2 Background of Science and Technology Development in Thailand

Chantramonklasri (1994) published her research result on TDRI Quarterly Review. According to her study, "Science and Technology Development for Industrial Competitiveness in Thailand: Problems and Lessons", she presented the history of Thailand S&T experiences in relation with national R&D activity. Her work presented that Thailand has been a growing awareness of the need to develop science and technology for more than 30 years (50 years from now). In 1956, the government established the National Research Council of Thailand (NRCT) to fund research activities in wide-ranging areas, from basic science to social science in the public sector, including universities. The Thailand Institute of Scientific and Technological Research (TISTR) was set up in 1963, originally as the Applied Scientific Research Corporation of Thailand. It was established as the main publicly funded institute to carry out a specialized scientific and technological activity, i.e., research and development (R&D) to serve almost all production sectors of the economy. Fifteen years ago, the Ministry of Science, Technology and Energy was established. This clearly indicated the recognition of the role of science and technology in national development. There have also been some research activities in the country's universities, but on a limited scale. Much more research has been carried out in governmental agencies.

Then the Science and Technology Development Board (STDB) has been established in 1985. The STDB aimed to raise the level of Thailand's technological capability through the R&D grant support to public-sector researchers, the R&D grant and loan support to companies, as well as information and consultancy services. STDB's main emphasis, however, in terms of both effort and resources, was on strengthening the R&D capacity in universities and government agencies and on mobilizing this existing public-sector capacity toward a higher level of applicability.

Chantramonklasri interpreted that STDB's establishment reflected dissatisfaction in the under-investment in R&D and, perhaps more importantly, under-utilization of the public-sector capability for the economic development. By the 1980s, it had become evident that not only the existing institutes (especially NRCT and TISTR) had spread their limited resources too thin, but also that the interaction between different scientific and technological components in the country was very weak. In particular, the so-called technology suppliers in public research institutes and universities and the technology users in industry failed to interact with each other; and the latter in many cases was not even aware of the existence of the former.

About the same time that the STDB project was launched, three national centers were established under MOSTE to provide funds to state universities, state enterprises and government agencies for R&D. These specialized in the areas of biotechnology, materials technology, and electronics and computer technology. These four initiatives, i.e., STDB and the three centers, were the predecessors of the National Science and Technology Development Agency (NSTDA), established by a special law, the Science and technology Development Act, in December 1991. NSTDA supports both public and private sector organizations, and has plans to develop its own research laboratories in the three technological fields. Chantramonklasri argued that NSTDA is still new (1991-1994), and it is difficult to assess its current impact on industry. An assessment of its predecessor, however, revealed that few of the public sector R&D projects supported by NSTDA have resulted in commercial application (TDRI, 1992b-g).

At that time, the governmental support to directly stimulate the development of technological capability in industry has been nearly non-existent, apart from the small private sector R&D support of STDB, now under NSTDA, and a similar MOSTE funding program. Besides this, the Thailand Research Fund (TRF) has also been established in the same period of NSTDA establishment (1992, one year after), with a purpose of more flexibility in organizational administrative apart from the Ministry. Nevertheless, TRF mandate is close to that of NRCT rather than aiming specifically at encouraging the industrial technological development.

About incentive issue around 1994, the Industrial Finance Corporation of Thailand (IFCT) used to have a soft-loan program for the private sector R&D, but this no longer exists. In an attempt to stimulate investment in R&D within the industrial sector, the Board of Investment (BOI), the key organization responsible for granting privileges to promote investment projects has offered since 1989 various tax incentives associated with setting up R&D activities. So far, these mechanisms have not been well received by the private sector.

2.3.3 Background of R&D system in Thailand

Beside the review of science and technology development, it is understood that Thai government worked more in the area of R&D institutional arrangement and built up number of researchers and R&D projects. The question came after getting to know the background of institutional arrangement is that how is R&D system in Thailand.

Another reviewed another Thai knowledgeable people in national technological development field is Mr.Chulawattanakul, professor and researcher of Chulalongkorn University.

Chulawattanatol (1994) wrote the book "R&D System in Thailand" (in Thai). This book presented a macro synthesis of the R&D system in Thailand during 1950 - 1994. He aimed to spark an innovative idea to urge the better R&D management system at the national level.

It summarized that R&D system in Thailand comprised of four key players; R&D user, researcher, granting agency, and R&D promotion e.g. database, intellectual property laws, industry standard and testing, and the R&D publication system. For public relation of the research result, he stated that government did not take its role on public relation but government transferred this role to the academic association by granting the journal printing such as Journal of Science Society of Thailand.

The evolution of R&D development system was divided into 4 phases. Firstly, since the National Research Council was established in 1956, the government's researcher performed most research projects. The purpose of the research project is to produce the body of knowledge to the government. Then, the government is being both of the researcher and user. Secondly, since the Ministry of Science Technology and Environment was established in 1979, it was the first launch of the broad policy on R&D as "country development tool". Thirdly, since the establishment of 3 National R&D centers e.g. Genetic Engineering and Biotechnology Center (BIOTEC), Metal and Materials Technology Center (MTEC), and Electronics and Computer Technology Center (NECTEC) -come under the NSTDA umbrella, the Thai R&D direction has more focus on technology base, which plays an important role in the development of industry, agriculture, public health, and environment. Forth, the National Economic Social Development Broad (NESDB) No. 7, 1992. R&D policy has been adjusted due to unsatisfied outcome of R&D projects in the past 35 years. The problem was that R&D projects were not used for commercialization because the government performed most of R&D projects. They expected to translate the R&D result to further development of the private sector. However, in reality, the Thai private sector has more import technology rather than crate technology itself. Therefore, this situation led to the change of R&D policy in NESDB no. 7. The previous policy direction was change from government oriented to private sector oriented. The government changed its role from being a researcher to being a producer of researcher and a private R&D supporter. According to this policy, a program of incentive and privilege on private R&D was being set.

In addition, the Thai Government has set up R&D granting agency e.g. National Research Council of Thailand (NRCT), The National Science Technology

Development Agency (NSTDA), Thailand Research Fund (TRF), and Health Systems Research Institute (HSRI). Government arranges the budget using both of the public and the private R&D support activity. Chulawattanatol also revealed that the budget for public R&D was arranged in larger portion than private R&D.

However, Chulawattanatol stated that Thailand has no unique R&D policy from the past till now. Although Thai Government launched a broad policy to the R&D stakeholder agency, each agency has also established its own policy for implementation. He observed that some national granting agencies e.g. Biotechnology Center, Material Technology Center, and National Electronic Technology Center have also performed in-house research while handling the grant fund at the same time. This fund has been granted to other government units (large portion) and private sectors (small portion).

Chulawattanatol also presented the role of the Thai private sector on the R&D development system in different sizes of business (base on customer oriented). He defined the private sector as a company and business association, and non-government organization (NGO). The private sectors play fewer roles on the Thai R&D system. He disclosed that only large business and export oriented required R&D for business development and gained more competitiveness in the world market whereas medium businesses may have minimum use of the R&D result since they were in relax competitiveness environment of the local market. Small businesses did not have demand on the R&D use because they were not interested in R&D or did not know the beneficial use of R&D.

In generalization, Chulawattanatol gave his own opinion that the Thai R&D system has weakness including no unique R&D policy, non-fascination of professional research career, no linkage system of the R&D user and researcher, high bureaucratic of the Thai government system, and the private sectors were not interested in R&D investment. In the strength, he viewed that it is a good starting point of Thailand in an establishment of the R&D granting agency e.g. NSTDA and TRF. It is a good start of the database, intellectual property law, industry standard, and activity support private R&D investment. Besides these, he viewed that the Thai R&D system has opportunity

to grow along with the Thai economic growth. It may grow in conjunction with various activities e.g. an investment of Mega project that is able to contribute know - how to Thailand, joint venture of Thai-Foreign businesses, intense competitiveness in the world market, and sufficient wisdom. The threat is that changing career of professional researchers, inflexibility of budgeting R&D arrangement, lack of unique policy, and better performance of foreign technology.

Finally, he proposed the recommendations on the R&D development system which focuses on the development of technology cluster, concentrates on the core country economic and technology sector, and concentrates on the beneficial use of the R&D result.

The literature above provides the macro analysis of the R&D system in Thailand. The author and reader will gain better understanding of the R&D system in Thailand. This evidence shows that the Thai government does not neglect to stimulate a better R&D system but it takes time to trial and error. Although a good recommendation on policy implication has been generated by Chulawattanatol for the last 10 years from now (2004). Nevertheless, the author views that all recommendations have been discussed and executed by government R&D stakeholders for a few years ago.

Currently, the government has tried much harder to enhance the national technological capability by using the R&D strategy (e.g. building R&D granting Agency, improving researchers' capability, and supporting private R&D investment). However, a central problem is that many of government R&D projects are still on the shelf. To confirm this argument, Chantramonklasri's work (1994) revealed that tendency of research results so far are isolated and disconnected from the real world. Although of government research centers attempted to launch commercially viable R&D programs, the results have often been unable to have an impact on the industry. A well-known argument often used to explain this ineffectiveness was that industrial firms have a tendency to utilize proven technological capabilities. This argument remains highly questionable because it presumes that those research results have provided the kinds of products, which are relevant to needs of their potential clients. As noted by an empirical study, "industrial firms tend to doubt the ability and effectiveness of

universities and public technical institutes to solve practical industrial problems" (TDRI, 1992a, p.85).

To discuss about research utilization issues, Phanit (1996) wrote a book named "R&D management: Concept and Experience" (in Thai). He had been taken the position of TRF Director. As part of the book, he gave his opinion on the use of the R&D result for commercialization. He explained that it requires many stages to develop the R&D project from the basic research to the commercial development stage. It needs high investment on development and engineering through the prototype. Its technology has required adjusting with user capability. Typically, development and the engineering stage consume higher cost than the basic research and the applied research. This is the reason why the industry sector in the developed country has 2-3 times of R&D investment more than the government.

Phanit (1996) confirmed Chulawattanatol 's opinion (1994) and Chantramonklasri's work (1994) on the R&D activity of the Thai private sector. He added that the Thai private sector does not have behavior of the technology seeker. He emphasized that it is necessary to set up a process to match the user and the researcher with appropriate the R&D projects. This process would drive the usage of R&D result to further commercial development by the user itself. In so doing, he proposed to conduct more often meeting between the user and the researcher, technological mart, set up database for searching a potential R&D project for commercial development.

Based on the views of the three scholars (Phanit 1996, Chulawattanatol 1994, and Chantramonklasri 1994), it is argued that there are gaps between the R&D user (private sector) and the research funding organization (government sector). In fact, the study on driven R&D results to commercial application still has limitation in Thailand. It is interesting to explore the activity during the individual R&D projects execution in the past. It hopes to know problem and obstacles issuing in between the user and the researcher. It is worth learning how some R&D projects succeed in the commercial development stage.

Recently, the author reviewed the Cabinet Resolution on March 9, 2004 and found that R&D strategic planning is subjective. It is mandate on the National Integral R&D Strategic Planning led by The National Research Council of Thailand. This agency plays very significant roles in crosscutting policy formulation process. It is hoped that unique the Thai R&D policy and strategy would be emerging soon. In conjunction with this thesis, it is purposed to study at the micro level of the public R&D management system, focusing on the diffusion of public R&D to commercialization and factors enabling/inhibiting the progress of innovation. Then, the author aims at the contribution of thesis findings to the unique policy implication and designs the implementation plan for commercial use of the R&D result.

2.3.4 Related article and existing research

These are related researches which were conducted on the innovation diffusion theory; 1) the role of the instructional technologist and 2) manufacturing technology evaluation. The author raises the examples of these two because the first topic relates to the factors consideration to the progress of R&D innovation diffusion, by interpreting the instruction technologist as NSTDA, TRF. Details of two the topics are described as follows.

Winnie (2003) wrote an article of Rogers' Diffusion and Adoption Research: What does it have to do with Instructional Technology? The purpose of this paper is to familiarize readers with Rogers' adoption and diffusion research. This research can educate instructional technologists to understand that not only do they need to create well-designed products but also need to ensure the adoption of these products. Rogers (1995) described that the main concern of the innovation diffusion research is how innovations are adopted and why innovations are adopted at different rates. He argues that there are four main elements of diffusion-innovation, time, communication, and the social system. Five characteristics of innovations are identified to explain the differences in adoption rates. Those characteristics are: relative advantage, compatibility, complexity, trialibility, and observability. The process of Innovation diffusion is closely related with adopters. Rogers argues for the classification of

adopters with the similar socioeconomic status, personality values, and communication behavior. The five ideal adopter categories are: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards (Appendix 2). Potential adopters of an innovation must learn about the innovation (knowledge), be persuaded as to the merits of the innovation (persuasion), decide to adopt (decision), put the innovation in place (implementation), and reaffirm the decision to adopt the innovation (confirmation).

Other major scholars in the innovation diffusion field are Surry, Lefebvre & Lefebvre, Schiffmam, and Garland. According to Surry (1995), there are three reasons why the study of diffusion theory is beneficial to the field of instructional technology. First, most instructional technologists lack the knowledge of why their products are or are not adopted. Second, the field of instructional technology is often associated with the concept of innovations. Surry suggested that if instructional technologists understand the adoption and diffusion of the innovation theory, they would be more prepared to work effectively with potential adopters. Third, she concluded that the study of the diffusion theory could result in developing a systematic model of adoption and diffusion for the instructional technology field. Lefebvre & Lefebvre (1996) see that as innovation is introduced into an organizational system, some individuals within the organization are more open to adoption than the others. While Garland (1991) argued that, major barriers in the diffusion stage of innovation concern people issues (including cultural traditions, risk aversion, lack of knowledge, and user acceptance), Winnie argued the role of instructional technologists as change agents to ensure that the innovation meets the adopters' needs. Schiffman (1991) argued that the diffusion process should incorporate four steps: (a) establishing a good relationship with the client and the designer's creditability; (b) diagnosing the problem(s) of the system; (c) acquiring all relevant resources; and (d) sharing innovative views among the members

The initial literature review would provide a basis for the analysis section of this thesis. Particularly, the difference in adoption rate of the Thai innovation created from research funding of NSTDA and TRF will be studied.

Sommenwald, Maglaughlin, and Whitton (2002) studied "Using Innovation Diffusion Theory to Guide Collaboration Technology Evaluation: Work in Progress".

An evaluation method helps predict users' adoption of collaboration technology to facilitate the process of innovation diffusion. Cost effective development of collaboration technology requires evaluation methods for the use in a system's life cycle. To address this challenge, Sommenwald, Maglaughlin, and Whitton developed a multi-scale evaluation instrument based on Rogers' innovation diffusion theory. It is to evaluate collaboration technology. They designed a survey instrument containing scale based on the characteristics of innovation adoption (relative advantage, compatibility, complexity, trialability, and observability).

This paper guides me the research methodology. The type of questions and the use of the scale for ratings learned from this paper will be modified to ensure the appropriateness to the thesis objectives. The use of face-to-face interviews and questionnaire instruments will be integrated in the analysis section.

2.4 Conceptual Framework

This thesis will use three parents disciplinary; the innovation diffusion theory, innovation development process, and the body of knowledge on success & failure in managing R&D for the commercial purpose, as guidelines to develop methodology study and framework for the analysis of findings. Besides, background information, knowledge on S&T development and the R&D system in Thailand will be considered as well as the analysis of findings for interpreting policy recommendations.

Conceptual application of literature review above is depicted as follows:

The concept of S-Curve from Innovation Diffusion Theory (Rogers 1995) is used to establish scale measurement for the diffusion pattern (S-Curve) and the diffusion level of R&D granted projects as case study for the past 6 years.

In addition, based on the theory, the analysis of findings will investigate the variables (5 groups) affecting the innovation diffusion. These variables will trace the diffusion characteristics of those R&D granted projects (these variables are adapted to questionnaire part I. See appendix 3). Findings will reveal the R&D funding operation

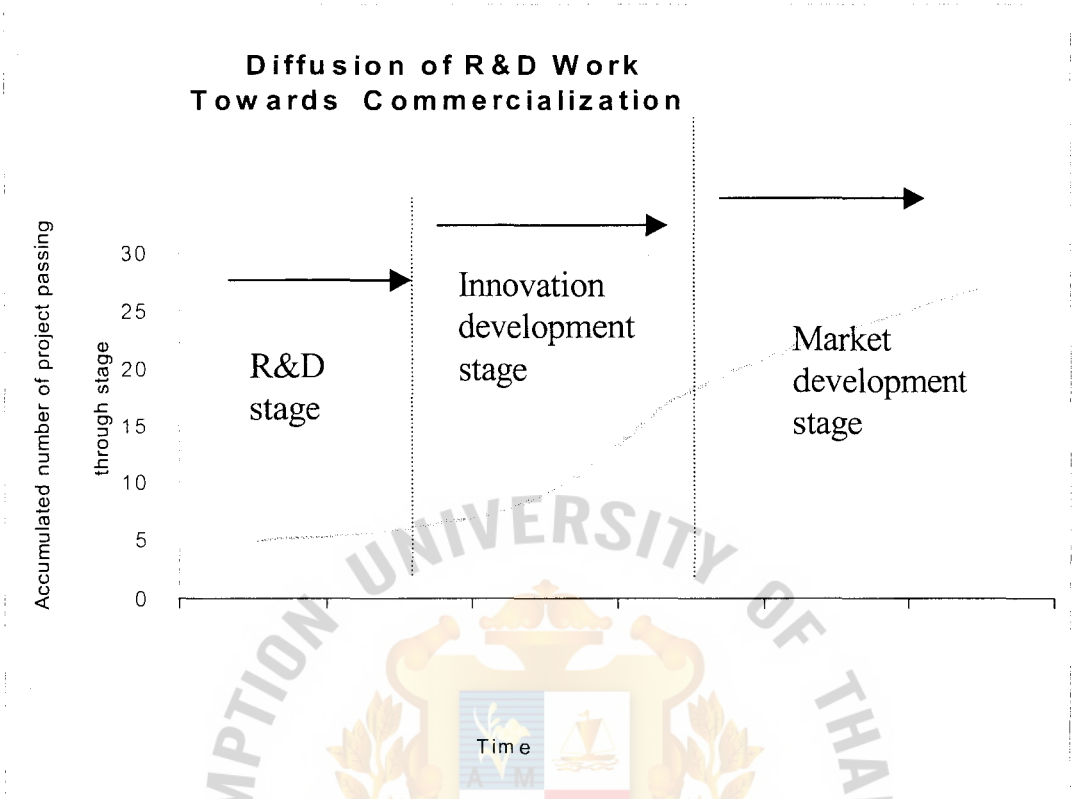
of TRF and NSTDA affects the diffusion of R&D granted projects toward firms, which opens the gate for commercialization.

Adapting the concept of innovation development stages, the study aims to establish the stage of R&D diffusion towards commercialization. Based on literature review, the author synthesized the stage of the innovation development process from various scholars and came up with the new model to apply with the public R&D management system. In aspect of public R&D management, this study classifies the stages of the innovation development process into three stages including the research and development stage, the innovation development stage, and the market development stage. These defined stages will cover general practices of R&D activities along the three stages that were performed by private companies and granted researchers in the past 6 years.

This thesis variables will be adapted from the body of knowledge on success & failure of R&D development for the commercial purpose. The thesis variables will be based on the aspect of public R&D management system. Ten variables (10) will be set in order to find out factors enabling/inhibiting the progress of innovation derived from the R&D granted project toward commercialization (these 10 variables present in chapter 3: Methodology Study). In order to gather information for these variables, this study designs the questionnaire for in-depth interviewing the firms who were beneficiaries of R&D granted projects. Appendix 3 shows the question addressed in the questionnaire, part II.

THE ASSUMPTION UNIVERSITY LIBRARY

2.5 Conclusion (Thesis model)



This figure presents the scale measurement for innovation diffusion from the R&D stage toward commercialization from TRF and NSTDA operation in the past 6 years. This study divides the 3 stages of diffusion including the research development stage, the innovation development stage, and the market development stage. Therefore, a number of R&D granted projects in the past 6 years will be tracked in order to figure out how many of them progress to the innovation development stage and the market development stage. In addition, the author will investigate what are the factors enabling/inhibiting the progress of them. In doing this, the author will conduct the in-depth interview of the companies who get benefit, from the R&D granted project and investigate their innovation development activity along the 3 stages (S-Curve). Variables are set based on the implication of the body of knowledge in success/failure of R&D development for the commercial purpose as presented in chapter 3.

CHAPTER 3: METHODOLOGY STUDY

3.1 Introduction

This thesis was undertaken using a case study approach. Methodology employed in this study was qualitative-oriented. Methodology was designed into three steps as follows: i) identify the scope of the present study ii) establish the scale measurement of the innovation diffusion process toward commercialization for TRF and NSTDA iii) perform the analysis of findings.

3.2 Problem of definition

As mentioned in chapter 1, this chapter will describe the way to come up with new knowledge on effective public R&D management for commercialization. Methodology is designed to track and evaluate R&D outcome of government funding program in the past. Therefore, the in-depth interview of the private sector who had been participated with R&D funding program will help us gain better understanding on problems and the advantage of the existing R&D management system of two case study organizations, TRF and NSTDA, the two main research-funding organizations of Thailand. The thesis finding will contribute to the development of the public R&D management policy that links to the National Innovation System.

3.3 Thesis design

Methodology employed in this study is a qualitative analysis. An in-depth interview, research and documentary analysis were the main instruments to obtain the results. In using TRF and NSTDA as case study organizations, the steps in undertaking the research are described in section 3.2.

3.4 Thesis process

This study aims at revealing two main findings issues; including the explanation of i) an adoption curve (S-Curve) of the R&D funding program (both TRF and NSTDA) to commercialization and ii) factors inhibiting/enabling the progress of

R&D granted projects toward commercialization. The steps undertaken in this research are defined as follows.

Step I. Identify the scope of the present study

This is a purpose of explaining an adoption curve (S-Curve) of the R&D funding program (both TRF and NSTDA) to commercialization the author reviewed R&D activities of TRF and NSTDA since the inception of the organization from 1991 onwards. The source of information comes from interviews, annual report, public and private publications and documentary on organization structure and management of TRF and NSTDA.

Given a preliminary review, the methodology flows as follows:

1. Establish timeframe and define adopters

The comprehensive analysis aims at comparing the different rate of adoption for the R&D funding program between TRF and NSTDA, as well as the reviewing of their innovation development process for commercialization during a certain period of time. In doing this, it is necessary to set the same baseline for analysis framework. Timeframe and a number of adopters are then defined in order to analyze the adoption curve (s-curve).

Rational for scope of timeframe

NSTDA and TRF have been established since 1991 and 1992 respectively. Nevertheless, they had no policy in fostering R&D projects to commercialization during 1991 - 1997. During the stated period, fostering research projects to commercialization was not organization priority whereas building up i) a number of professional researchers and ii) R&D infrastructure were the major priorities. Therefore, this period is not significant to the thesis findings (since it will focus on commercialized R&D projects). Since late 1997, TRF and NSTDA pay more attention in effectiveness of the R&D outcomes. They had more concern in making use of the R&D result. In so doing, both TRF and NSTDA have established R&D commercial policy around 1998. Once the policy was launched, private companies have been engaged to R&D activities and being the users of R&D results.

According to the commercialized R&D policy, TRF has established an industry fund division (Divs. 5, see appendix 1: Background of case study organizations) in 1998. Industry fund aims at supporting the economic growth in the industry sector. The R&D granted program was set up by that time. The purpose of this grant is to build competitiveness of the Thai private company, particularly SMEs, in terms of the R&D strategy. This grant has been set in the form of venture capital between TRF and private companies.

At the same time, NSTDA has also established academic & strategic direction including commercialization strategy around 1997- 1998 and transfer expertise to industry onwards. NSTDA also allocated funding for venture capital about the later time.

As tendency to strengthening R&D in commercialization described above, this study will establish timeframe for the measurement period of granted R&D diffusion to private companies as 1998-2003. This period starts from the beginning of venture capital fund toward recent years based on availability of information outreach. This period will best reflect the policy outcome of commercialization research funding in the past.

Defined adopters

A number of adopters are defined as "companies who join R&D granted program either venture capital or receive technology licensing in 1998-2003". Funding programs are two forms including:

- Venture capital by which the company shares budget to the R&D project
- Technology licensing by which the company acquires technology derived from the R&D granted project for university researchers and other research organizations.

2. Compile list of adopters

A compiled list of the number of adopters is developed in order to obtain the same baseline for analyzing the rate of adoption between TRF and NSTDA. The list is

from selecting all R&D granted projects of two funding forms including venture capital and technology licensing. Data and information is gathered from TRF and NSTDA publication e.g. annual report, commercial project report. This data also had been verified with project database of each organization and confirmed by authority officers. Concerning to business confidential, this report gave a company code shown on the list. See a compiled list in appendix 5 and 6.

In terms of adopter amount[1], in 1998-2003, 54 adopters (47 companies) are from TRF fund whereas 27 adopters (25 companies) are from NSTDA fund.

3. Developed adoption curve for TRF and NSTDA funding program

A number of adopters will be plotted along the time series from 1998-2003. Based on innovation diffusion theory, y-axis is an accumulative number of adopters. X-axis is a time series from 1998-2003. Further details can be seen in Chapter 4 Section 4.2.1.

4. Analysis of the rate of adoption

Five groups of variables (attribute of innovation, type of innovation, communication channel, nature of the social system, extent of change agent) will explain the different rate of adoption for the R&D funding program between TRF and NSTDA. The analysis is based on qualitative information gathered from various sources including i) interview the management person of TRF and NSTDA ii) historical institutional development iii) history of Thailand technological development and R&D policy iv) operation and practices of the R&D funding program of TRF and NSTDA.

[1] Adopters mean amount of companies who joined R&D funded by TRF and NSTDA from 1998-2003. The number of adopters is greater than a number of companies because these companies joined more than one R&D project in different years.

Step II. Establish scale measurement of the innovation diffusion process toward commercialization for TRF and NSTDA

1. Establish the scale measurement

The present study concerns i) the diffusion process of innovation toward commercialization of the R&D projects funded by TRF and NSTDA ii) factors inhibiting/enabling the progress of R&D granted project toward commercialization.

Concept of S-Curve from the Innovation Diffusion Theory (Rogers 1995) will be applied in accordance with principals of the innovation diffusion process, factors influence to the success/failure of R&D management for the commercial goal. Referring to literature review in chapter II, 2.2.2, this study defined innovation diffusion process based on implication from various scholars as described in table 3-1.

Table 3-1: Principals of Innovation Development Process

Principals	Scholars	Year
1. Innovation development contains 6 stages; (i) needs/problem (ii) research (basic and applied) (iii) development (iv) commercialization (v) diffusion and adoption and (vi) consequences.	Rogers	1995
2. Effective innovation development needs to be screened before moving forward to next steps. As manufacturing view, it contains (i) preliminary assessment, (ii) detail investigation (definition), (iii)development, (iv)testing and validation, and (v) commercialization (full production).	Cooper & Kleinschmidt	1990

Cont.

3. The conventional linear, science-push model explained that innovation began with research then lead to development, development to production, and production to marketing.	Schumpeterian Conventional science model	1939 1980s
4. The Chain-link model claimed that the innovation process comprises a set of linked activities which may occur in a variety of sequences and sometimes simultaneously (NOT smoothly as linear model any more).	Kline and Rosenberg	1986
5. Innovation development process is not linear and needs pull model.	Schmookler	1962, 1996
6. Using concept of organization management, innovation development process contains 3 stages including culture, process, and implementation.	Hastings & Healy	2002

Based on the review of the innovation diffusion process (presented above), this study defines the innovation development process in a broad view for national R&D and innovation management toward commercialization. The innovation development process for this study is divided into three stages.

i) Research & Development stage: the period from the undertaking of the research to the prototype

ii) Innovation development stage: the period from making the prototype into the innovation ready to launch

iii) Market development stage: the period after the launch of the innovation into the marketplace

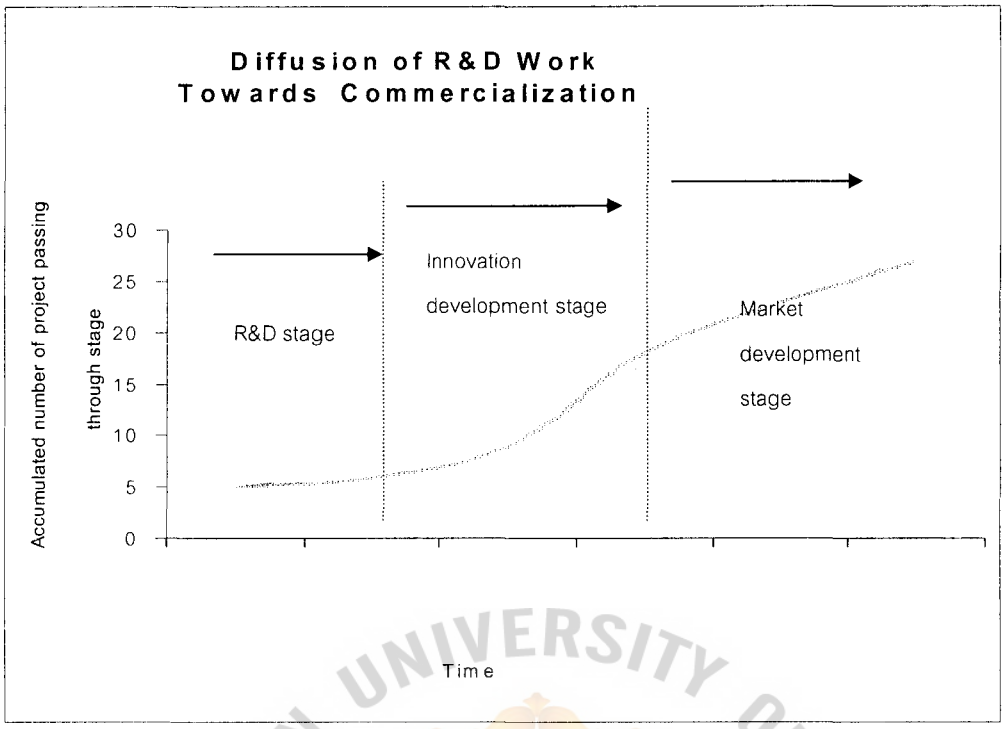


Figure 3-1: Scale measurement of Innovation Diffusion Process from R&D stage toward commercialization

From figure 3-1, this study develops a scale for tracking the progress of innovations along the stages of innovation diffusion and analyzes the evolution of commercial innovation development of TRF and NSTDA during the period of 1998-2003. In doing this, the amount of project progress in each stage will be figured out. Therefore, factors influencing the progress of innovation toward commercialization will be investigated by the in-depth interview. The detail for factors studying is explained in section 2 to 5.

2. Review the activities along the process

Based on the case study methodology using an interview approach, a number of adopters (companies) are requested for the interview. Interview topics are mainly exploration about i) company characteristics that carry out the R&D activity e.g. company size, R&D or the technical personnel, the source of R&D budgeting, the year of joining program, and updated progress of R&D granted projects ii) the information focused around variables inhibiting/enabling the progress of the R&D

granted project toward commercialization. Therefore, core tasks for this step is described as follows.

2.1 Define a sampling frame and sample size

Due to budget limitation, this study employs stratified sampling methodology to conduct the interview of only companies located in Bangkok Metropolitan Region (BMR). BMR included Bangkok, Samutprakan, Samutsakorn, Nakhonpathom, Nonthaburi, Pathumthani, and Ayuthaya. This sampling methodology is developed in order to obtain unbiased estimates of the adopter's population from both funding sources (TRF and NSTDA). The annual report and intra-organization reports of TRF and NSTDA as well as 3 national centers, MTEC, NECTEC, and BIOTEC, with report of a number of granted projects from year by year, are sources of data and information. In addition, the author consults TRF and NSTDA's authority in order to refine data. Table 3-2 presents number of sample size correspondents to sampling frame.

TRF funding program

There are 131 projects carried out by the TRF funding program. These projects derived from 2 forms of funding i) venture capital and ii) technology licensing. Of these, 53 projects are finished at a different stage of innovation development process. For example, project A delivered a product prototype at the end of project funding duration. Project B delivered a body of knowledge at the end of project funding duration. Therefore, further development of R&D project's outcome depended on the decision of the company who joined the funding program. Of these projects, 47 companies located all over the country adopted the R&D funding program. Of these, 36 companies are located in BMR.

NSTDA funding program

There are 27 projects carried out by NSTDA. These projects are under the management of MTEC, NECTEC, and BIOTEC. These projects derived from the program for venture capital and technology licensing. Of these projects, 25 companies are located in the country and abroad. Of these, there are 18 companies located in BMR.

Sampling Frame

The total population of adopters is 72 companies who joined the R&D granted program of TRF and NSTDA in 1998-2003 and completed funding duration recently. These companies are located all over the country and abroad.

Sample Size

Due to budget limitation, this study limits interviewees as companies located in BMR. Therefore, the sample size is 54 companies. Of these, 36 companies are from TRF fund and 18 companies are from NSTDA fund. All companies are requested for the interview.

Table 3-2: Share of sampling frame and sample size

	Sampling frame (company)	Sample size * (company)	% of sample size to sampling frame
TRF	47	36	77.0 %
NSTDA	25	18	72.0 %

* Sample size = Amount of company located in BMR

2.2 Establish variables and characteristics for the study

Along the three stages of the innovation development process, the selected R&D granted projects during 1998-2003 are tracked in order to understand the activities along the S-Curve and the factor enabling/inhibiting the progress of innovation. Variables are set according to the body of knowledge from various scholars described as key success/failure in managing R&D towards the new product innovation for commercialization. Table 3-3 presents a list of scholars and variables in the principals of success/failure in managing R&D.

Table 3-3: Principals of success/failure in managing R&D

Scholars	Description
1. Cooper (1979, 1980); Maidique and Hayes (1984); Maidique (1984) and Zirger and Maidique (1990); Townsend (1996); Myers and Marquis (1996)	Marketing activity, such as having in-depth understanding of the customers and marketplace, close collaboration between the user (customer) and the innovator, need for a strong internal communication, and highly developed screening and testing market
2. Copper (1979, 1980); Maidique and Hayes (1984); Cooper and Kleinschmidt (1990); Myers and Marquis (1996)	Technology competency, such as having technically superior and product uniqueness, having a unique superior product in the eyes of the customer, one with a real differential advantage in the marketplace
3. Maidique and Hayes (1984); Sensors-research consulting Inc (2003)	Organization management e.g. top management commitment, firm's existing technological and organizational competencies, R&D resources.
4. Sensors-research consulting Inc (2003)	Collaboration e.g. appropriate balance in skills and work force in technical task, marketing task, and business task. , ensuring an appropriate technology transfer from research result to saleable development
5. Droege (1999)	Macro-environment, such as economy, technology, culture, government, social and natural environment, For example, government subsidies are a critical factor in the success of innovative firms. Less successful companies, particularly small business, make limited use of government programs.

Therefore, this study established ten (10) variables for investigating the factors enabling/inhibiting the progress of innovation toward commercialization of TRF and NSTDA. Twenty-eight (28) characteristics are set for investigating activities along the stages. These variables, based on the review of the principals presented in Table3-3, are shown below.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 3-4: Variables and characteristics for the study

Stages	Variables	Characteristics
R&D	1.R&D units of organization	• Position of R&D unit in organization chart • Flexibility of organization structure • Corporate culture • Style of management
	2.Management commitment in R&D activity	• Profile of R&D team leader in company • Capability to cope with high degree of uncertainty/difficulties of the research task • Company network of R&D collaboration
	3.Difficulties of the research task in relation to the capability of researchers	• Relationship of TRF/NSTDA researcher with firm's employee • In-house R&D capability • Technical capability of granted researchers
Innovation development stage	4.Ability to translate R&D results into saleable innovation	• Preparation of production line for the derived innovation • Change agent of innovation within organization • Ability of granted researcher in translated R&D result into production activity • Major problems during the prototype running stage • Evaluation of sale volume and market feedback
	5.Design the product innovations according to the market needs	• Understanding of customer need • Purpose of marketing research • Marketing activity launch early

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

		• TRF/NSTDA involvement in marketing activity • Re-invent of innovation
	6.R&D projects progress up to the stage of patenting	• Change agent of patenting and prototype efforts
Market development stage	7.Organization's capability in pushing new product innovation to market	• R&D team's involvement in market evaluation • Participation of marketing team in R&D project • Balance value of marketing activity with R&D and innovation development activities • Collaboration between user & innovation market pull
	8.Marketing strategy	• Marketing strategy in entering the new market
	9. Users of innovations	• Target users and number of innovation adopters
	10. Publications coming out from undertaking R&D activities within companies	• Publications as research outputs

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

2.3 Design the questionnaire for the in-depth interview

In order to understand S-Curve and factors enabling/inhibiting the progress of innovation in each stage, the author developed a semi-structure questionnaire (Appendix 3) to ask stakeholders of three stages. Those stakeholders are the Executive Management or the knowledgeable persons within firms and research organizations.

The questionnaire is divided into two parts. Part I asks about the company's characteristics that carry out the R&D activity e.g. the company size, the R&D or technical personnel, the source of R&D budgeting, the year of joining program,

and the update for the progress of R&D granted projects. Part II designs the interview topics according to the variables.

2.4 Conduct interview

2.4.1 The request for interview letter

The letters were sent by post mail to 54 companies in BMR (36 companies from TRF fund and 18 companies from NSTDA fund). The questionnaire part I was sent along the request for interview letter. This is a purpose of learning the characteristics of the company before getting to interview.

2.4.2 Number of respondents

In the pilot test stage, 20 companies were contacted by post mail and called for the follow- up in December 2003. Five (5) companies allowed for the interview. After the pilot test, the questionnaire and interview protocol, the questionnaire was revised. In addition, the e-mail addresses of the companies were gathered. The rest of companies (34 companies) were contacted in January until March 2004 by post mail, fax and e-mail. An average number of calls for the follow- up to request interview permission were 3-4 time per company. Finally, 23 companies denied the interview, whereas 31 companies granted the interview from December 2003 to April 2004. The interview schedule was made periodically to accommodate the company's time. Of these interviewees, 20 companies were from TRF fund and 11 companies were from NSTDA fund. The information about the companies denying the interviews is indirectly obtained from the funding organizations: TRF and NSTDA.

Step III. Perform analysis of findings

1. Review secondary data surrounding the concept of the R&D management process of the two research organizations (TRF and NSTDA). R&D Director of TRF and NSTDA were interviewed. The interview aims at gaining in-depth understanding of the role of the two organizations in supporting/managing the innovation.
2. Perform analysis of the results. The analysis of this study is to understand the characteristics of projects attaining a stage of commercialization. In addition, the

study is to find out the reasons underlying the failure of innovation commercialization. A group of companies who are able to develop the R&D granted project toward the market development stage is classified as "champion". On the other hand, companies who have not reached the market development yet are classified as "follower". Data and information will be analyzed for two groups in comparison. Existent characteristics of champions which do not exist in followers will be considered as factors enabling/inhibiting the progress of R&D result toward commercialization.

3. Generalize R&D findings in relation to the organizational behavior of the research centers and develop models of R&D management.
4. Propose policy recommendations in the strategic management of innovations to the research organizations.
5. Send the empirical results and the recommended R&D management model to the companies engaging in R&D activities and the R&D funding organizations for the purpose of improving the R&D management system.

3.5 Evaluation of measurement scale, tools or techniques

The thesis will record data and information from fieldwork into Excel spreadsheet. It is called "basket data". (See appendix 11). The spreadsheet is designed to record finding according to answers from interviewees. All interview information will be addressed into basket data in order to be drawn for the analysis. In order to compare the characteristics of champions and followers, data and information from basket data will be managed separately between champions and followers. Appendix 7, 8, 9, and 10 shows the categorized data of champions and followers.

3.6 Ethical considerations

The author is concerned with the sensitive answer coming out from companies who granted the interview. Therefore, there will not be the company's name. The scale rating of the granted researcher's ability is on appendix 9.

3.7 Conclusion

This study is a kind of policy research. Methodology employed in this study is qualitative approach; documentary and in-depth interviews are the main instruments in obtaining the report result and analysis. Thirty-one companies

located in Bangkok Metropolitan Region including Bangkok, Samutprakarn, Samutsakorn, Nakhonpathom, Nonthaburi, Pathumthani and Ayuthaya were interviewed their R&D activities performed with the granted researcher from the R&D funding program of TRF and NSTDA.

Results of the analysis will be synthesized based on three disciplinary frameworks including Innovation Diffusion Theory, Innovation Development Process, and the body of knowledge on success/failure in managing R&D for the new product development. The scale measurement was developed for tracking a number of projects funded during 1998-2003. Ten control-variables were set for investigating factors influencing the progress of R&D results toward commercialization.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

CHAPTER 4: ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents the data analysis on the innovation diffusion process of TRF and NSTDA and factors enabling/inhibiting the progress of R&D projects toward commercialization. This study employs a case study approach to analyze the diffusion process. The case study analysis was based on the details of commercial R&D projects and the in-depth interview of private companies in Bangkok Metropolitan Region (BMR). The aim of this chapter is to test the following hypotheses:

- The innovation process managed by the government organizations is linear, reflecting a science-push model (Schumpeterian 1939).
- R&D is a viable strategy needed to generate innovations in industry (Doyle & Bridgewater 1998)
- Effective commercialization needs to be incorporated into the innovation diffusion process (Rogers 1995)
- Failure of management to look far enough ahead inhibits the innovation process (Cooper & Kleinschmidt 1990)

4.2 Analysis and discussion

4.2.1 Diffusion pattern

The study investigated the diffusion pattern of the R&D funding program of the venture capital and technology licensing to the private company during the period of 1998-2003.

During the period 1998-2003, TRF accomplished R&D granted projects for forty-seven (47) companies. Thirty-eight (38) companies received R&D funding in the form of the venture capital whereby nine (9) companies received technology licensing from public R&D results. See table 4-1. In this period, fifty-three (53) R&D granted projects reached to 47 companies. (See list of projects in appendix 5). The relatively low number of projects passing through the stages of innovation and market development reflects the problem concerning the innovation commercialization.

Regarding the R&D funding by the National Science and Technology Development Agency (NSTDA), NSTDA accomplished R&D granted projects for twenty-five (25) companies during 1998-2003. Ten (10) companies received R&D funding in the form of the venture capital whereby fifteen (15) companies received technology licensing from public R&D results. In this period, twenty-seven (27) R&D granted projects reached to 25 companies, which was opening the gate for commercialization. See list of projects in appendix 6.

Table 4-1: Share of companies that participated in R&D granted projects in different types and different stages of collaboration

Type of Collaboration	Starting stages of the granted projects	TRF Fund		NSTDA Fund	
		No. of Projects	No. of Companies	No. of Projects	No. of Companies
Venture capital (VC)	R&D	44	38	13	10
Technology licensing	Innovation	9	9	14	15
Total		*53*	*47*	*27*	*25*

Source: Annual report of TRF and NSTDA, 1998 – 2003.

According to the number of projects presented in the table 4-1, TRF and NSTDA granted R&D projects at different stage, including R&D, innovation development, and market development. In 1998-2003, TRF granted the forty-four (44) projects at R&D stage and the nine (9) projects at innovation development stage. NSTDA granted the ten (10) projects at R&D stage and the fifteen (15) projects at innovation development stage. It was noted that these projects were continued progressed from the starting stage toward the next stages: e.g. from R&D toward innovation development, from innovation development toward market development. The continuity of the number of projects in each stage is shown in Table 4-2 and Figure 4-1.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969

Table 4-2: The continuity of the number of projects in each stage

	Case of TRF			Case of NSTDA			
	R&D	Innovation Development	Market Development	R&D	Gap	Innovation Development	Market Development
1998	1	0	0	9	0	0	0
1999	7	0	0	1	1	1	0
2000	12	4	0	6	4	1	0
2001	20	4	3	5	1	9	1
2002	9	7	6	6	0	5	3
2003 *	4	2	1	0	0	4	6
Total	53	17	10	27	6	20	10

Remark: *There is no private company joined R&D project in 2003, which finished their project by December 2003 (as period of this study). However, there are 4 companies received R&D results transferred from NSTDA in 2003.

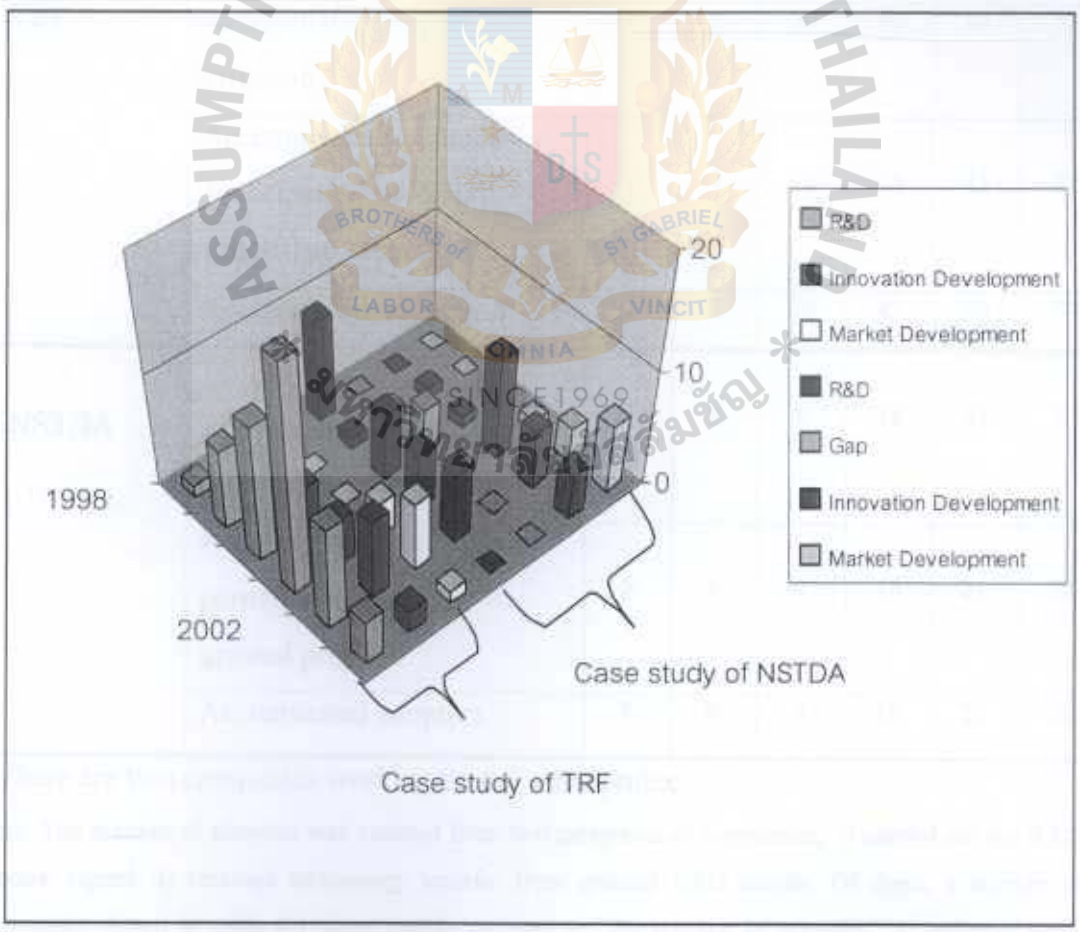


Figure 4-1: The number of granted project passing through the stage of R&D, innovation development, and market development during 1998-2003

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR OMNIA VINCIT
SINCE1969

THE ASSUMPTION UNIVERSITY LIBRARY

By applying the S-Curve concept of Rogers (1995), the study defined R&D adopters as a number of companies who participated in R&D funding programs in *"each year"* from 1998-2003. These companies participating either venture capital or technology licensing from TRF or NSTDA. Therefore, a number of R&D adopters would be slightly different from a number of companies shown in table 4-1 because these companies participated in more than one projects in different years.

Table 4-3 shows a number of adopters for the R&D funding program of TRF and NSTDA in 1998-2003. These adopters were from both types of R&D collaboration (The venture capital and/or received technology licensing from TRF and/or NSTDA).

Table 4-3: Accumulative number of "adopters" of the R&D funding program in 1998-2003

Organizations	Items	1998	1999	2000	2001	2002	2003
TRF	Accumulated project diffusion	1	8	20	40	49	53
	Accumulated companies participating in R&D granted projects	1	8	18	35	43	47
	Accumulated adopters *	1	8	20	41	50	54
NSTDA	Accumulated project diffusion	5	6	9	18	23	27
	Accumulated companies participating in R&D granted projects	5	6	9	16	21	25
	Accumulated adopters	5	6	9	18	23	27

* There are two companies working on the same project.

Note: The number of adopters was counted from two categories of companies; i) carried out the R&D venture capital ii) received technology transfer from granted R&D results. Of these, a number of companies shown in table 4-1 were double counted to "the number of adopters" in different years because they participated in different projects. The number of "adopters", as a result, might exceed the number of companies.

In 2003, the accumulative number of project was plotted on the chart. Figure 4-2 shows the diffusion of R&D funding program to private firms. The y-axis represents an accumulative number of projects reaching to private companies. These companies adopted[1] R&D funding program of government (using TRF and NSTDA as case study organizations). In this study, the number of projects represents the innovation diffusion whereby the adoption curve consists of continuing stages: R&D, innovation development, and market development (the number of projects in each stage is shown in Table 4-2). The x-axis represents the timing of this study from 1998-2003. Rationale time period considers to the historical organization development of two case study organizations as described in chapter 3.

Regarding to plot number of projects against certain period, the derived curve is called "adoption curve" of R&D funding programs. In terms of Innovation Diffusion Theory (Rogers 1995), this curves present diffusion pattern of R&D funding program to private companies. (See figure 4-2).

[1] Type of adoption is including venture capital on R&D projects and/or adopted technology licensing from granted projects.

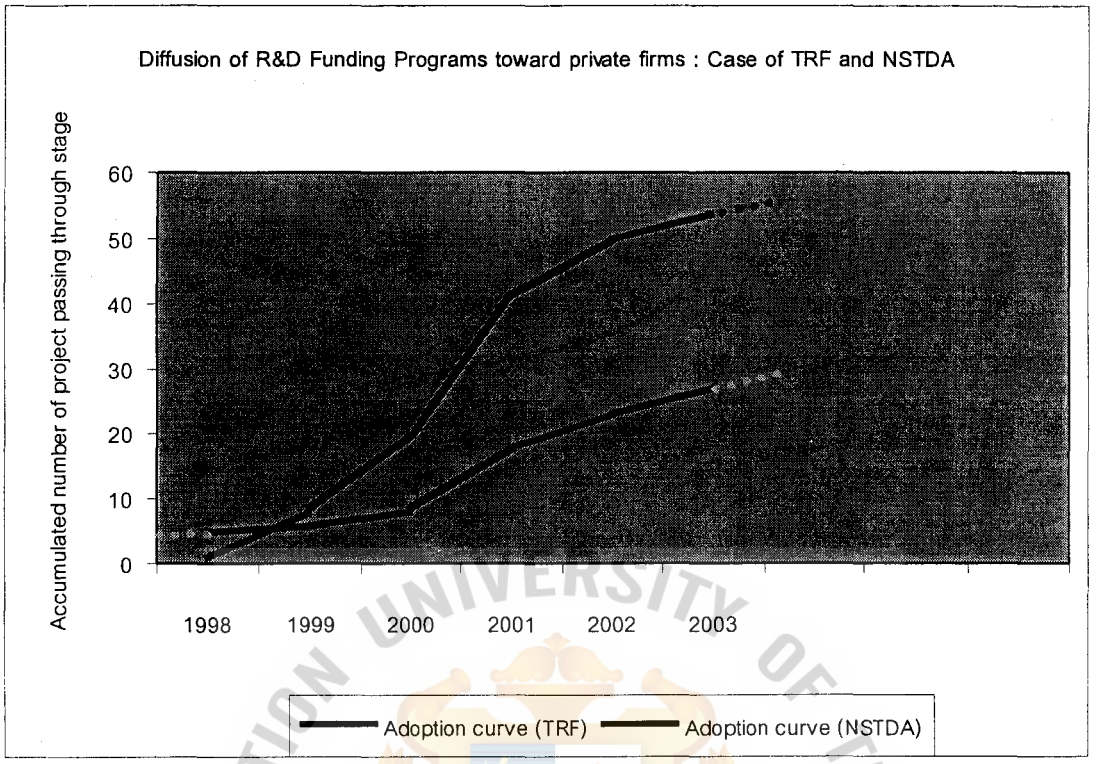


Figure 4-2: Diffusion pattern of R&D Funding Program of TRF and NSTDA

According to the chart, both curves look like S shape as well as the Innovation Diffusion Theory (Rogers 1995). It is interesting to see the different rate of innovation adoption for TRF and NSTDA. The innovation adoption rate of TRF is more progressive than that of NSTDA. In addition, the dot line demonstrates a full S-curve over an estimated period, representing the rapid progress of innovation through stages of the innovation process.

According to adoption curves, the study found that adopted outcome varied based on R&D results. Therefore, the study classified adopters into three categories including:

1. Companies who could develop R&D results to innovation products/process and launched to the marketplace
2. Companies who could apply R&D results with the existing business process
3. Companies who could not develop R&D results to innovations and who canceled the project or hold the project until the coming up of the business opportunity

In terms of speed, it is found that TRF has higher adoption rate of R&D funding than NSTDA. Section 4.2.2 will explain the different rate of adoption by five categories of variables that affect the different rate of adoption (based on the Innovation Diffusion Theory by Rogers (1995).

In generalization, the R&D funding program of TRF and NSTDA spread to private firms as an S-Curve. This curve demonstrated that the R&D funding program of TRF and NSTDA generated commercial innovations at the dismal rate of adoption by private firms (only 54 adopters from the funding program of TRF and 27 adopters from that of NSTDA). Assessing the progressive rate of S-Curve can help public R&D funding managers to evaluate the effectiveness of the commercialized R&D policy in the past 6 year period. In order to open the gate of R&D for commercialization, this S-Curve demonstrated the starting point of managing the public R&D for commercial innovation. By means of starting point, the diffusion of the R&D funding program to private firms started up an innovation idea to the firms. It provided an opportunity to generate innovation among private firms. Therefore, public funding organizations need to speed up the rate of R&D funding adoption among Thai firms and shape up the R&D result for commercialization. The dismal rate of adoption also points out that public funding organizations need to revisit their funding policy and operational policy in the past.

4.2.2 Rate of adoption

According to Rogers (1995), there are five categories of variables affecting the rate of adoption. These variables included i) perceived attributes of innovations, ii) types of the innovation adoption, iii) communication channels, iv) the nature of the social system, and v) the extent of change agents' promotion efforts.

A. Perceived characteristics of Innovations (Relative advantage, Compatibility, Complexity, Trial-ability, Observability)

According to the interview of the 31 companies located in Bangkok Metropolitan Region (BMR), the interviewees are top management including Company Owner & Managing Director, and General Manager. Appendix nine (9) shows the background

TRF and NSTDA fund gave ranking decision to join the R&D funding program in different weights of importance.

From table 4-4, given rank for joining decision of the TRF funding program presents that the most important decision factor is compatibility of the R&D topic and the relative advantage to the company in developing the new product/process and solving the current problem. The second rank is less complexity of the research task. The third rank is trial-ability whereas the least important decision factor is observability. (See individual company rating in appendix 7) By terminology of the relative advantage and compatibility of Innovation Diffusion Theory by Rogers (1995), the relative advantage is that potential adopters need to see an advantage in adopting the innovation. Compatibility is that innovations need to fit in with potential adopters' current practices and values. The study found that the 31 companies (total companies granting for interview) who participated in R&D granted projects saw the relative advantage and compatibility by means of various R&D joining objectives. Table 4-5 shows a variety of R&D project objectives carried out by the 31 companies in BMR. Sharing the great majority R&D objectives, the companies from TRF and NSTDA fund saw the relative advantage by means of expansion for the product range and learning of new technology. They saw compatibility of R&D results to fit in with their current business operation in terms of improving product quality, reducing cost, complying with regulations etc. The analysis clearly indicates that fostering the R&D activity in Thai companies concerns more about relative advantage and compatibility of the R&D topic whether it is the best suit for the company.

Table 4-4: Ranking of decision to join R&D funding program

	Relative advantage	*Compatibility*	*Complexity*	*Trial ability*	*Observ ability*
TRF	*1*	*1*	*2*	*3*	*4*
NSTDA	*1*	*3*	*4*	*2*	*1*

1 =The most important 5 = The least important

Source: Interview by the author, December 2003- April 2004

A slightly difference to the TRF case, the NSTDA funding program presents that the top rank is the relative advantage and observability of the R&D result. While trial-ability, compatibility, and less complexity of the research task are in the lower of the rank respectively. Table 4-5 helped to explain the reason why the companies from NSTDA fund gave aforementioned ranking (See appendix 10). From table 4-5, the NSTDA case alike shared the great majority of R&D objectives in learning about new technology and the expansion of the product range as the TRF case. Nevertheless, they had slightly difference in ranking decision to join the R&D funding program. Reviewing the terminology of observability by Rogers (1995), observability *is that* potential adopters want to see observable result of an innovation. By this meaning, it could be implied that most companies from NSTDA fund were very keen to see the observable result of R&D projects, which were the same line of business. Then, they committed in developing innovation from the R&D stage by learning from granted researchers. From this implication, they could see the relative advantage of the R&D result, which was being upstream of the innovation development process. They were confident in capability of the granted researcher in leading the project and came up with the lab scale or product prototype. Besides, these companies were able to absorb expertise from the R&D result due to having enough in-house R&D personnel. This implication reflects the given first rank of the relative advantage and observability.

Table 4-5: R&D objectives of participated companies (case study)

Objectives*	TRF (companies)	NSTDA (companies)
Improve product quality	4	3
Learn about new technology	8	10
Reduce production cost	6	1
Reduce labor cost	2	2
Extend product range	12	8
Improve cycle time	1	1
Increase market share	2	4
Improve production flexibility	2	3

Cont.

Open up new markets	6	1
Reduce energy consumption	7	1
Fulfill regulations & reduce environmental effects (emission standard)	2	1
Comply with domestic regulation (trade standard)	1	0
Respond to international standards (trade standard)	1	0
Improve work conditions for employees	1	0
Replace products being phased out	0	0

** A company has more than one objective for carrying out one R&D project.*

According to the in-dept interview on joining R&D decision of the 31 companies from the TRF and the NSTDA fund (See appendix 10), the study found that the purpose of the companies from both TRF and NSTDA fund were similar, which shared a wide range of developing new product innovations and process improvement. Nevertheless, joining decision is a different initiative idea. Companies who joined the TRF fund made a decision from compatibility of the R&D result in solving the current problem first. If R&D results were in line with their business development, it would be developed at a later decision. Anyhow, less complexity of project task was a later key consideration for innovation decision in relative with the business development cost. It was also found that these companies had minimum expectation at learning from the granted researcher (generally, they were university professors and professional researchers in government laboratory) and utilized R&D funding in trail and error for the lab scale and prototype development. Therefore, they viewed that the positive result of R&D was a plus of R&D collaboration in order to make a decision for further innovation development for commercialization.

ASSUMPTION UNIVERSITY OF THAILAND
LABOR VINCIT OMNIA SINCE1969
มหาวิทยาลัยอัสสัมชัญ

On the other hand, companies who joined the NSTDA fund made a decision from the relative advantage in further in-house innovation development. Fifty-five per cent (six out of eleven companies) were from high-tech industries such as medical disease diagnoses, electronic, software, and consultant. Due to abundant in-house R&D resources, they can see the relative advantage in utilizing the R&D result as well as trust in the granted researcher and the in-house technical personnel. These companies were looking forward to innovation derived from the R&D result if they joined the funding program. In addition, they can utilize R&D funding in trial and error for developing the lab scale and/prototype, which was led effort by the granted researcher.

B. Type of Innovation-Decision (Optional, Collective, Authority)

According to the interview result of the 31 companies who joined R&D funding of TRF and NSTDA, ninety per cent (eighteen out of twenty) company management from the TRF fund viewed the R&D come out as an optional of their current business. While the rest two (2) companies viewed that R&D activity was part of their business. Although the prior analysis cited that the company from the NSTDA fund was very keen in observability of the R&D result (from joining the R&D funding program), eighty-two per cent (nine out of eleven) company management from the NSTDA fund still viewed the R&D come out as an optional of their current business. While the rest two (2) companies viewed that R&D activity was part of their business, the relatively low percentage of companies undertaking R&D activities shows the problem of lacking the control environment to encourage product/process innovations. This similarity explained why private R&D activities in the Thai industry is still in relaxed atmosphere. Therefore, joining decision for the R&D funding program is optional for the organization. That is to say, joining the R&D funding program is of personal interest of top management.

C. Communication channel

According to documentary review of TRF and NSTDA, there are similar and different communication channels as follows.

Communication practices of NSTDA

- The Formal distribution letter to the University in Thailand
- Interpersonal communication (informal) about funding sources to new researchers
- Participation in formal industry association meeting such as the Federation of Thailand Industry Association (FTI)
- NSTDA and BIOTEC, NECTEC, MTEC Website, www.nstda.or.th
- Special seminar/workshop

Communication practices of TRF

- The formal distribution letter to the University in Thailand
- Contractor (TRF sub contract for R&D coordination work to eligible persons from other organizations. There are 12 contractors (skilled coordinators) from different universities in Thailand and professional association. These contractors take a role of coordinator in funding of R&D packaging. They are called "research package coordinator". These contractors will identify industry needs (users of R&D result) and facilitate their research problem to reach the TRF fund. Next, contractors will facilitate matching between the professional research and the firm in order to develop the R&D project and propose for funding.)
- Special seminar/workshop
- Website of TRF, www.trf.or.th

For communications channel described above, there was a unique difference of communication channels used by TRF and NSTDA. The TRF funding manager revealed that TRF awarded contract to eligible university professors and/or practitioners of professional associations. These are recognized people among the industrial society. TRF expected that communication through these skilled

coordinators would be more effective communication between researchers and private firms. This contract requires directly working in coordinating with industry. Contractors have to work closely with private firms in delivering fund opportunity, identifying research problems, seeking granted researchers etc. NSTDA relied on mass communication via public seminar, website, and circulate letter while TRF does not see interpersonal communication (unofficial practice) of R&D funding by itself sufficient to the spread of the R&D funding program. TRF employed proactive approach in communication about funding opportunity to private firms since it sees that using the independent party (research package coordinators) would be an effective way to speed up the adoption rate of R&D funding.

D. Nature of Social System of the companies who joined R&D funding program

Generally, R&D operation in both TRF and NSTDA offers knowledge to private firms in coping with production or industry problems. Besides, TRF and NSTDA aimed to initiate an idea to develop innovation with company collaboration. Therefore, companies usually join the R&D funding program with a minimum expectation in solving their current problem.

According to personnel communication with the 31 company's management, there were similar characteristics of companies joining TRF and NSTDA fund. These characteristics were size of small- and medium-sized companies (SMEs), having Thai ownership (Table 4-7), no R&D unit, lack of in-house professional R&D personnel, and having domestic market (see appendix 8). It can be seen that SMEs share a large group of participants for both TRF and NSTDA fund (see table 4-6). Appendix 8 shows the company background of the participated companies. Therefore, there is no distinguished characteristic between the companies joining the TRF and NSTDA fund.

In terms of interconnectedness, most SMEs, 60 % of the TRF fund and 64 % of the NSTDA fund (see table 4-6), were isolated from the industry association. Only large businesses have interconnectedness with the industry association such as membership of the Federation of Thailand Industry Association (FTI).

Characteristic of companies

Table 4-6: Share of interviewees (companies) in respect to firm size

	TRF (companies)	NSTDA (companies)
SME*	12 (60%)	7 (64%)
Large Company*	8 (40%)	4 (36%)

*The definition of SMEs in Thailand is companies with less than 200 employees.

In terms of company ownership (see table 4-7), the study reviewed from a compiled list of total companies participating in the R&D granted project from, the TRF and the NSTDA fund during 1998-2003. Forty-seven (47) companies joining the TRF fund were a 100 % Thai own business. Twenty-five (25) companies joining the NSTDA fund were a mix of a 100 % Thai own and foreign business. Of these, two companies from the NSTDA fund are located in Taiwan and England.

Table 4-7: Share of companies in respect to ownership

	TRF (companies)	NSTDA (companies)
Oversea business	0	2 (8 %)
100 % Thai ownership	47 (100 %)	23 (92 %)

E. Extent of Change Agents' Promotion Effort

According to the interview of TRF and NSTDA management in aspects of funding operation, a group of contractors (research package coordinator) awarded by TRF played a role of change agent. The main responsibility of contractor was to facilitate industry needs to R&D funding opportunity. These contractors work proactive in dealing with direct users of R&D results and recruit an appropriate researcher. In doing this, contractors use direct communication with industries in order to hear their needs and facilitate them to funding opportunity and matching with the professional researcher.

According to the National Science and Technology Development Agency (NSTDA), NSTDA used in-house staff called "Business Analyst" to play a role of change agent.

These staff work for the three center including MTEC, NECTEC, and BIOTEC, which were functioned under NSTDA's umbrella. The business analyst plays a role of technology licensing and coordinator between the private firm and the researcher. However, these staff functional has been established in 2003 approximately. The desired outcome is not remarkable in terms of change effort.

In analysis of the five categories of variables affecting to the rate of adoption, it is clear that TRF has faster rate of R&D funding program's adoption than NSTDA. It is clear that TRF and NSTDA differ in respects to communication channels and change agent effort. TRF employed the effective communication channel by using research package contractors. In the meantime, the contractor plays an important role on change agent effort to drive the spread of R&D funding toward private firms. Fostering the innovation diffusion among Thai firms needs to manage the effective communication channel and change agent effort in facilitating R&D funding to potential adopters (private firms).

The results of section 4.2.1 and 4.2.2 point out how many of those adopters (private companies) develop the R&D result and launch it to marketplace or streamline it into the existing manufacturing process. On the other hand, how much do granting agencies (case of TRF and NSTDA) develop innovation towards commercial application and launch it to the marketplace. In addition, what are factors enabling/inhibiting the progress of R&D towards commercialization? The following sections will explain aforementioned questions.

4.2.3 Commercial Innovation Development Process of TRF and NSTDA

This section will explain the development process of commercial innovation derived from TRF and NSTDA in 1998-2003. Finding from this section will explain i) how much of these R&D granted projects progress towards innovation launch to the marketplace ii) how long the innovation development period is towards commercialization.

In order to answer the question ii), this study will use the scale measurement designed in chapter 3 (methodology study) to measure the period of innovation development from the R&D stage toward commercialization for TRF and NSTDA.

Case Study of TRF

It was found that TRF engaged private companies in the innovation development process by allocating R&D funding for the Thai industry. Form of funding is the venture capital by which the granted company shares R&D budget with TRF fund. It is the purpose of using fund for starting up the innovation development process in order to achieve economic benefit of the Thai society. Basically, the venture capital fund requires at least 20% of cost share from private companies and TRF sponsors for the rest of R&D budget. Usually, the university lecturers or professional researchers in government research units are grantees of the TRF fund. Unless leading in technical taskforce, grantees will also manage the financial of the R&D project while joint venture companies share small portion of R&D budget and participate in technical tasks.

Table 4-8 shows the number of companies participating in the innovation development process in each stage. This data helps understand the overall picture for the progress of R&D projects toward commercial application in 1998-2003 derived from the TRF funding program. In 1998-2003, 47 companies participated in the R&D funding program of TRF and finished 53 projects at different stages of the innovation development (some project flopped at R&D stage while others could pass through towards an innovation development stage). All 53 projects passed through the R&D stage and generated various engineering lab scales and engineering prototypes for equipment, post –harvest machine, industrial process, and bio-industry application. (Compiled list of projects is shown in appendix 5). It was found that these 47 companies participate in the funding program in the forms of the venture capital or technology licensing. The venture capital, participated companies conducted R&D projects with the granted researchers. While the participated companies who received technology licensing had only training with granted researchers. After that, the companies further conducted innovation development stage on their own.

Table 4-8: Share of R&D granted project progress to each stage, as of December 03

Stages of Projects	No.of Companies	No.of finished projects	Project Outcomes
R&D	47	53	Lab scale, prototypes
Innovation Development	14	17	Innovations
Market Development	7	10	Commercial innovation (products/processes) launch to the marketplace

According to S-Curve from figure 4-3, in 1998-2003, it can be seen that 53 granted projects diffused to private companies. The empirical analysis shows that, seventeen (17) of fifty-three (53) projects have reached the innovation development stage, by private companies, while, the rest of 36 projects stopped at R&D stage. Ten (10) of seventeen (17) innovation development projects have reached the market development stage, while, the rest of seven (7) projects did not yet reach the market development stage. After innovations launched, nine (9) innovations were sold to current customers, whereas one (1) innovation still had a zero volume of sale. Bar chart in figure 4-3 presents number of project passing through the stage of the R&D, the innovation development, and the market development in each year. Of these, some projects are finished at innovation development stage whereby some projects are in progress. The x-axis is for a period of this study from 1998-2003. This bar chart will be translated into S-curve as chart underneath.

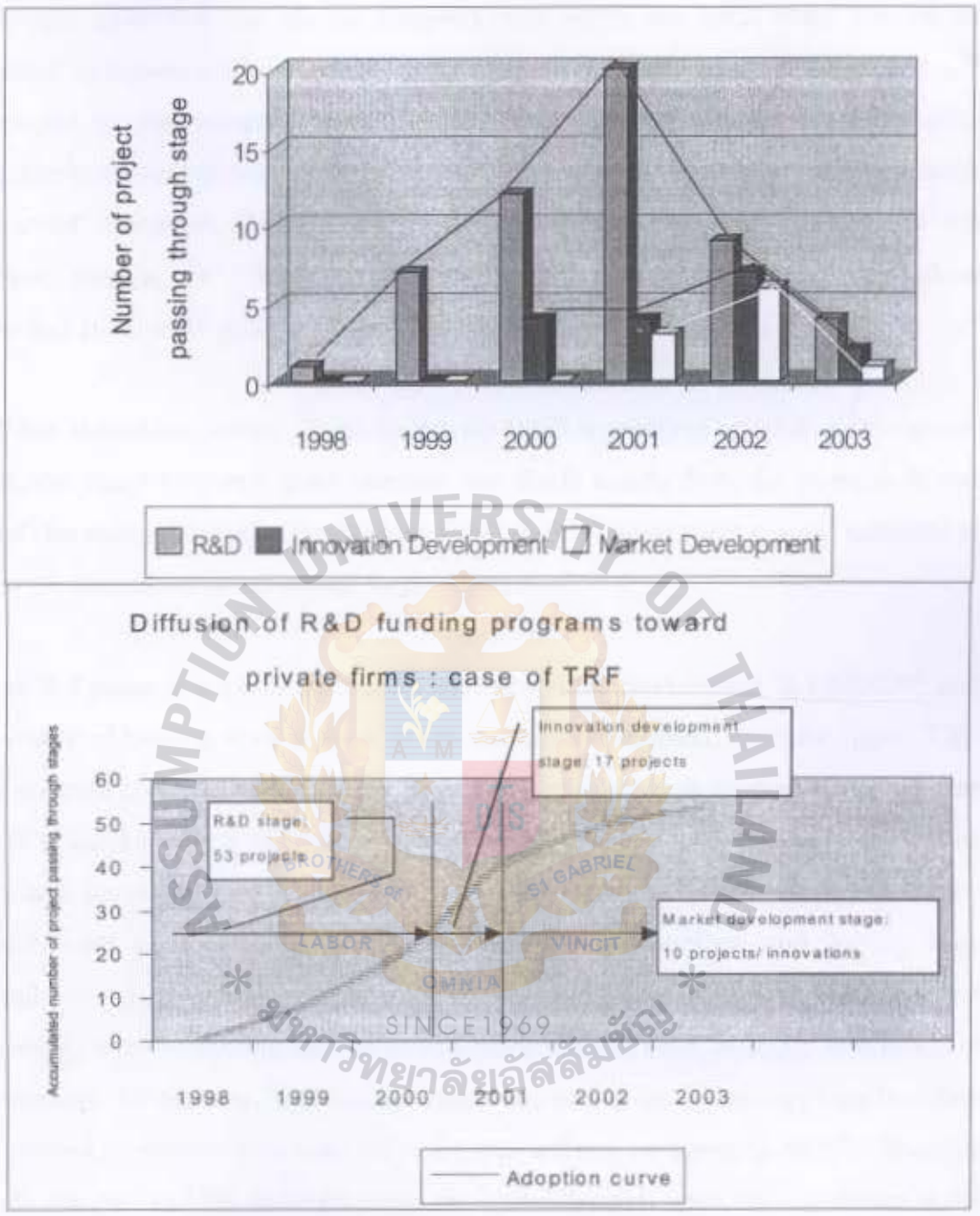


Figure 4-3: Diffusion of R&D granted projects to commercialization: case of TRF fund

From figure 4-3 (S-curve), the integration concept of S-curve and the three (3) stages of innovation development process can measure the progress of R&D result passing through stages of R&D, innovation development, and market development. These 10 project-based innovations progress from the basic research, which was carried out in the period prior 1998 from researchers elsewhere. The granted researcher developed

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

the R&D project base on the basic research in order to come up with the lab scale and prototype. After that, the private company who joined the R&D stage foresaw its potential in business. Therefore, the innovation development project was set up and developed by the company itself. At this stage, all companies evaluated market potential based on business experiences and hoped to push the new product innovation to current customers. Therefore, they had no formal marketing research for the decision process. In 1998-2003, it was found that 10 project-based innovations generated 10 kinds of product/process innovations to the marketplace.

TRF has started the industry fund for private R&D investment in 1998. In November 2003, the study reviewed grant duration and R&D results from 53 projects. It was found that most of the grant covered the R&D stage whereas some grant is extended to cover the innovation development stage (figure 4-4).

Figure 4-4 presents a list of innovation launched to the marketplace in 1998-2003 and the source of funding in each stage of innovation development. From the figure, TRF granted three projects from the R&D stage to the innovation development stage. These are NPK test kits, Deep fryer under zero pressure condition, and Alcohol's distillation for Jilada Royal Project. It was found that TRF expanded funding duration for the project with high potential in development to marketplace and having high commitment from private companies. Once innovation derived, TRF facilitated the technology transfer process toward private companies in order to foster innovation to marketplace. By the way, TRF did not play a big role in the technology transfer while the granted researcher took lead effort for this activity on business benefit. Share of royalty fee paid to TRF and the granted researcher depends upon the negotiation at the technology transfer stage. Only two (2) projects (a shred earthworm for bio-pesticide project and a mango pickling for food safety project) were technology licensing to private companies in developing the innovation and market development stage.

Innovation name	R&D stage	Innovation Development stage	Market development stage
1. Rice Oven (Strabedted)	⟷		⇢
2. Fluidized bed dryer and cyclone	⟷		⇢
3. Mangos teen Sizing Machine	⟷		⇢
4.Cassava Cleansing Machine	⟷		⇢
5. Shred earthworm for bio-pesticide	⟷	⇢	
6. NPK test kit	⟷		⇢
7. Deep fryer under zero pressure condition	⟷		⇢
8. Alcohol's distillation for Jilada Royal Project	⟷		⇢
9. Brown rice frillier by picture detection	⟷		⇢
10. Mango pickling for food safety	⟷	⇢	

⟷ Source of project funding from the TRF fund

⇢ Source of project funding from companies

Figure 4-4: Share of project funding sources in each stage of innovation development

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969

Based on definition cited by Edquist (1996), See chapter 2 p.9, the study classified the type of 10 innovations to product and process innovation. Table 4-9 presents the types of the derived innovations from the R&D funding program during 1998-2003.

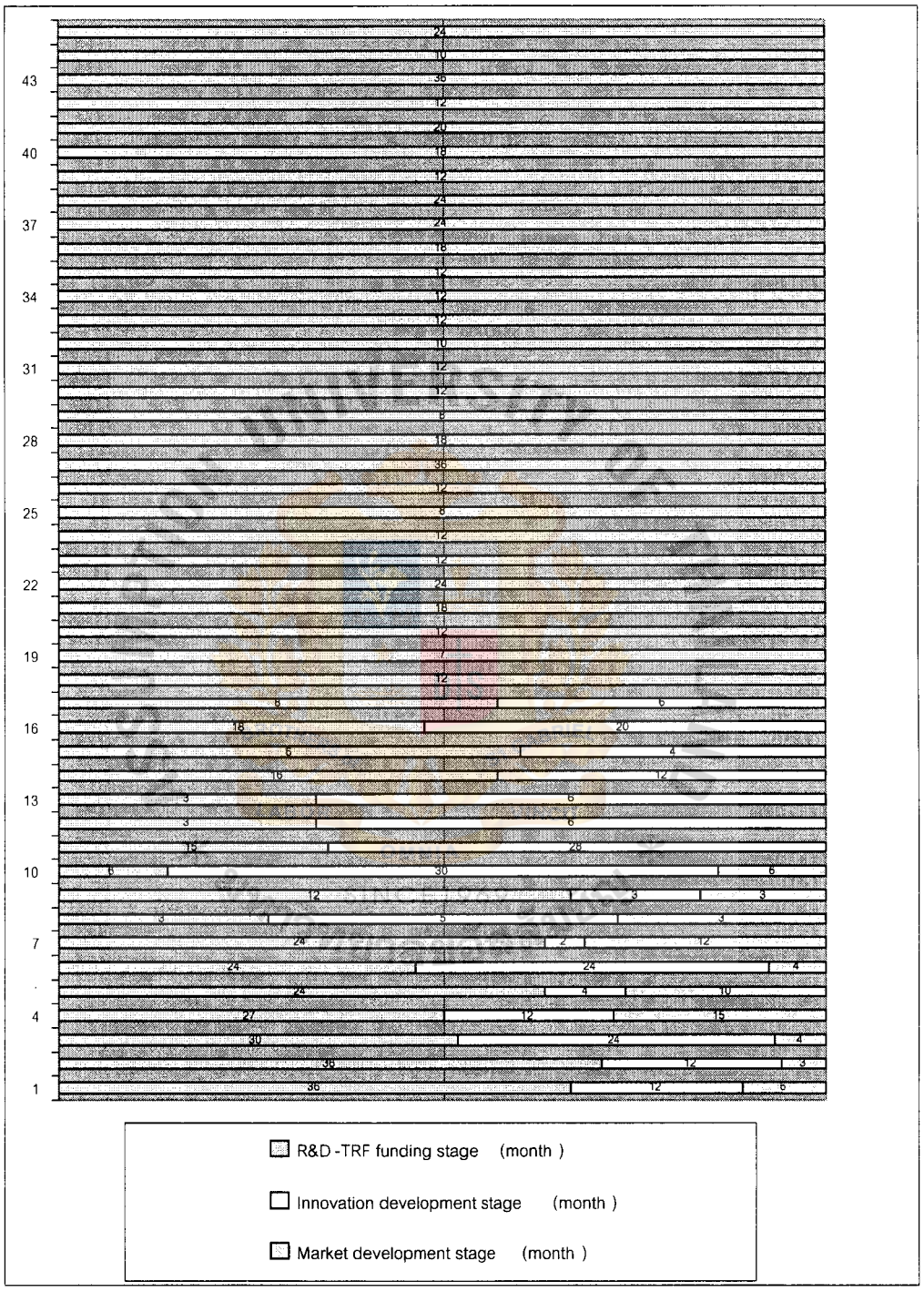
Table 4-9: Type of the innovations from the R&D funding program of TRF during 1998-2003

Types	Name of innovations
Only product innovation	Six (6) innovations • Shred earthworm for bio-pesticide • NPK test kit • Deep fryer under zero pressure condition • Alcohol distillation for Jilada Royal product • Mangosteen sizing machine • Cassava cleansing machine
Only process innovation	One (1) innovation • Mango pickling for food safety
Product & process innovation	Three (3) innovations in rice-mill industry • Fluidized bed dryer Cyclone Burner • Rice Oven (Strabedted) • Brown rice frillier by picture detection

The study found that all innovations initiated from technical problem solving. The granted researcher and the company developed innovation for solving the technical problem in their business or industry. The major topic of R&D funding was for solving problem in industrial production process and agriculture field. Beyond the problem solving, the granted researcher always initiates an idea to develop new product innovation. The purpose was for achieving the superior academic results and the outcome was delivered to create the demand of innovations to the current market. As case study, during 1998-2003, TRF funding program generated ten (10) innovations to

THE ASSUMPTION UNIVERSITY LIBRARY

the industry and agriculture sectors. These innovations were products on post-harvesting, ago-industry, and biotechnology product for cultivating.



* Data available for 45 projects out of 53 projects

Figure 4-5: Period of each project carried out in 1998 – 2003 of TRF

In terms of funding operation in 1998-2003, it was found that TRF granted R&D budget step by step from the basic research, R&D, and innovation development for a particular project. Therefore, these innovations progress step by step along the process. After innovation derived from the process, the company developed market on its own. Therefore, it is concluded that TRF assist in innovation management as linear progressive.

Figure 4-5 presents the duration of each completed R&D project in 1998-2003. It was found that the periods of funding varied from 3 to 36 months depending upon the difficulty of research tasks and complexity of projects. It was found that the body of knowledge; the lab scale and prototype derived at the end of R&D projects.

This study defined R&D stage as the period from the undertaking of research to the prototype. Therefore, the period of the basic research and R&D funding by TRF will be defined as the R&D stage for this study.

From the figure 4-5, the average (median) duration from the basic research funding to the R&D funding stage is 27 months, see table 4-10. It is implied that TRF takes 27 months in the R&D stage of the whole innovation diffusion process of organization during the period of 1998-2003.

After the R&D stage, this study traced the progress of these 53 projects after the end of funding duration. It was found that 14 companies extended its R&D stage toward the innovation development stage (the period from making prototype into innovation ready to launch). At this stage, 17 projects progressed to the innovation development stage. It was found that each project spent 2-30 months for the innovation development stage, which depended upon the complexity of innovation. Average (median) duration of each project is 12 months (Table 4-10). It is implied that TRF takes 12 months for innovation development stage of the whole innovation diffusion process for organization during the period of 1998-2003.

Table 4-10: Average duration (months) of innovation development in each stage

Stage	Average (median) month	Number of projects or N value for calculation
R&D	27	N =53
Innovation development	12	N = 17
Market development	5	N = 10

Of these, 17 projects progress to the innovation development stage. Until December 2003, it was found that 10 projects continue to progress toward the market development stage (see list of project in figure 4-4). Therefore, 10 innovations were launched to the marketplace during 1998-2003. Of these, 10 innovations take 3-15 months to enter the market. Average (median) time duration is 5 months for the market development stage (the period after the launch of innovation into the marketplace). It is noted that this study defines the market development stage in aspect of technology management study, not marketing development study. Therefore, the scope of investigation for this stage is limited when the innovation viable in the marketplace is able to enter the market.

For the review of TRF funding operation and period of innovation development growth, it is implied that TRF manages innovation toward commercialization as linear and presents a science-push approach. Therefore, average (median) duration for each stage can explain estimate duration of innovation diffusion from the R&D stage toward commercialization. It is estimated that TRF takes almost 44 months (Table 4-10) for the innovation diffusion process from the R&D stage toward commercialization. Figure 4-6 presents the duration of each stage of innovation diffusion process for TRF during the period of 1998-2003.

Using concept of S-Curve incorporated with innovation development period will explain the innovation diffusion process of TRF in 1998-2003. Therefore, figure 4-7 explains the diffusion of R&D granted projects and its period for commercialization. It is explaining that fifty-three (53) projects were launched to private companies over 1998-2003 periods. The diffusion of granted projects was increasing from 1,8,20,40,49,53 projects over 1998-2003 (Table 4-3). Of these, 10 innovations were launched to the marketplace.

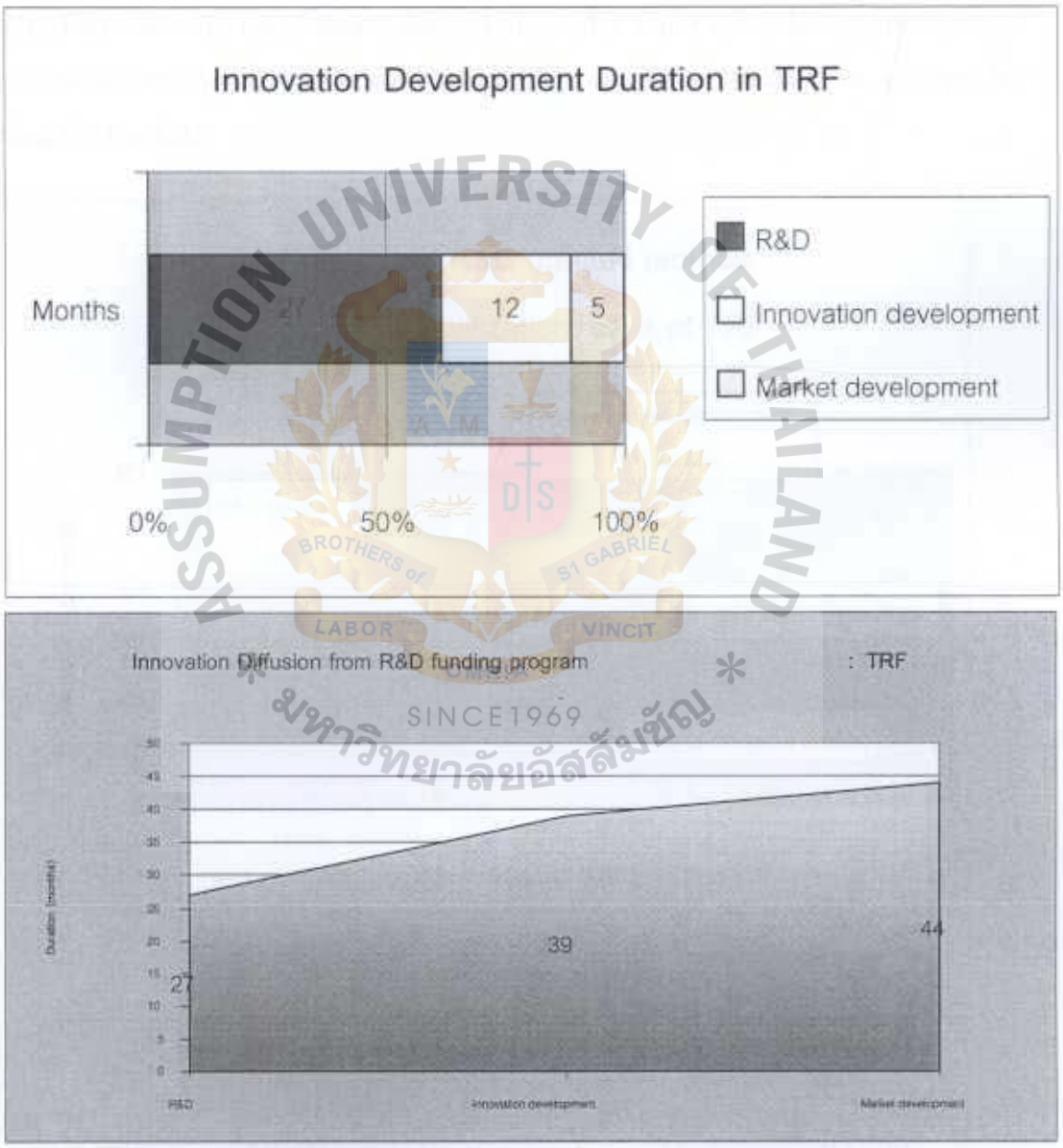


Figure 4-6: Innovation Development Period of TRF (1998-2003)

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Once the R&D granted project diffused to private companies, it has opened the gate to commercialization. Figure 4-6 and 4-7 present the three stages of R&D diffusion towards commercialization; including the R&D development stage, the innovation development stage, and the market development stage. The R&D stage takes 27 months from December 1998 – Mar 2000 (first granted project started in December 1998). The R&D results came up with a various body of knowledge, lab scale, and prototypes. 12 months later, there is a number of R&D results progress to saleable innovation. Therefore, this period is defined as the innovation development stage. Finally, there are 10 innovations derived from the innovation development stage. These innovations were launched to the market and take 5 months in average for entering the market.

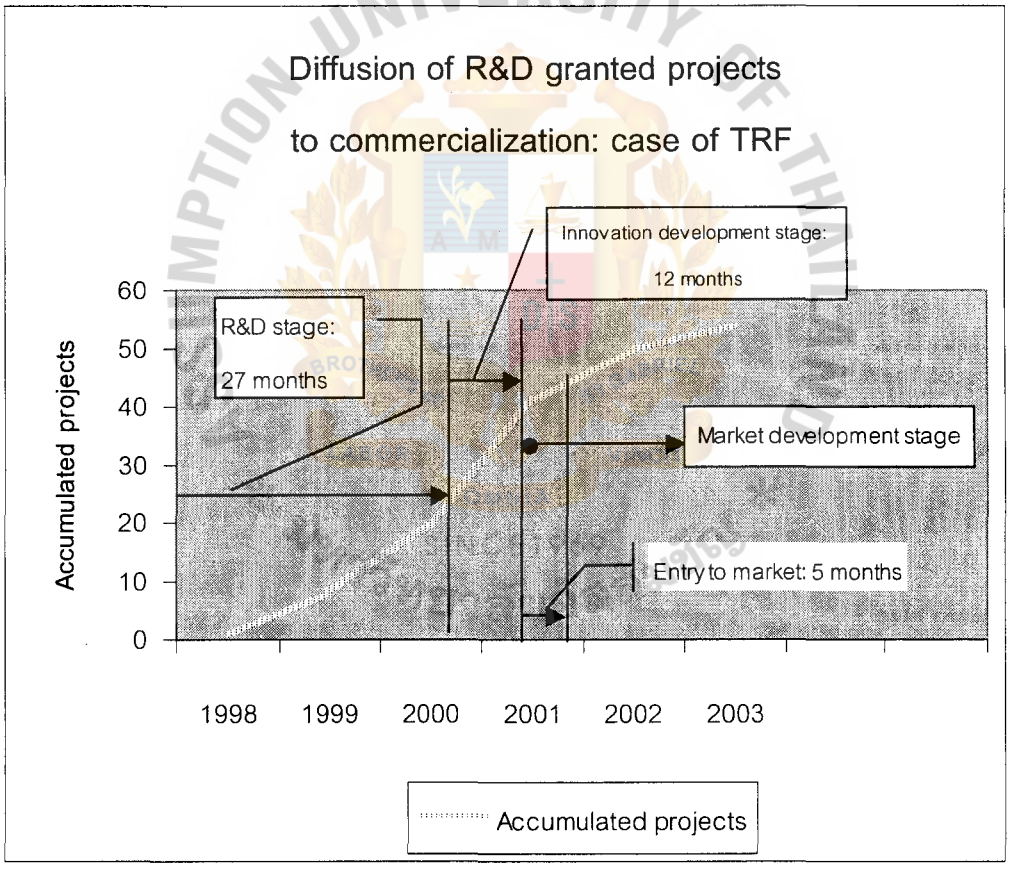


Figure 4-7: Diffusion of R&D granted projects and period in commercial achievement: Case of TRF

Case Study of NSTDA

NSTDA has established R&D for the commercialization policy in around 1998. This policy reflects the R&D activity that has more interactions with the user, which is covered by the industry sector, the agriculture sector, the health sector, and the environmental management sector. Since 1998, NSTDA has worked intensively in fostering the technology transfer from the R&D result, which was derived from the work of the granted researcher. Generally, granted researchers are university lecturers and professional researchers in various research units within the government agency. By the way, NSTDA allocated funding for the private company in the form of the venture capital in the same way as TRF does. It is proposed to engage the direct user of the R&D result in the early phase of innovation development in order to reduce the unrealistic R&D result. In addition, NSTDA has a program of 'NSTDA Investment Center – NIC', which is the venture capital between NSTDA and the public/private organization in generating new business coming out from the R&D result.

Table 4-11 shows the number of companies participating in the innovation diffusion process in each stage. This data helps understand the overall picture for the progress of R&D projects toward commercial application in 1998-2003 derived from NSTDA granting program. In 1998-2003, 25 companies participated in the R&D granted program of NSTDA and finished 27 projects at different stages of innovation development. All 27 projects pass through R&D stage and come up with the lab scale and prototypes in various major sectors e.g. medical and health, agriculture, and industry. See a compiled list in appendix 6. It is found that these 25 companies participating in the granted program in a mixing form of the venture capital and technology licensing.

In terms of output from R&D granted projects, ten project-based (Table 4-11) are able to enter the market. These innovations are in a mix of industry sectors e.g. medical diagnosis test, health, food innovation, functional food product, industry process, and software. These innovations are both of product and process innovation (see figure 4-9 as below). In addition, it is found that three innovations were covered by NSTDA funding program. They are extension from the R&D stage to the innovation

development stage. Of these, one industrial process innovation was covered toward the market development stage (Coji ferment tank).

Table 4-11: Share of R&D granted project progress to each stage - NSTDA, as of December 03

Stages of Projects	No.of Companies	No.of Finished Projects	Project Outcomes
R&D	25	27	Lab scale, prototypes
Innovation Development	18	20	Innovations
Market Development	10	10	Commercial innovation (products/processes) launch to the marketplace

According to S-Curve from figure 4-8, in 1998-2003, it can be seen that 27 granted projects diffuse to private companies. It opened the gate of commercialization. All 27 projects can pass through the R&D stage. Of these, 20 projects have completed the innovation development stage and the ten (10) projects of the rest are on the market development process. As the result of 20 projects, ten (10) projects reached toward the market development stage and entry to the marketplace. Bar chart shows a progress of R&D granted projects along the stage of R&D, innovation development, and market development in each year. This chart will be translated into S-curve as chart underneath.

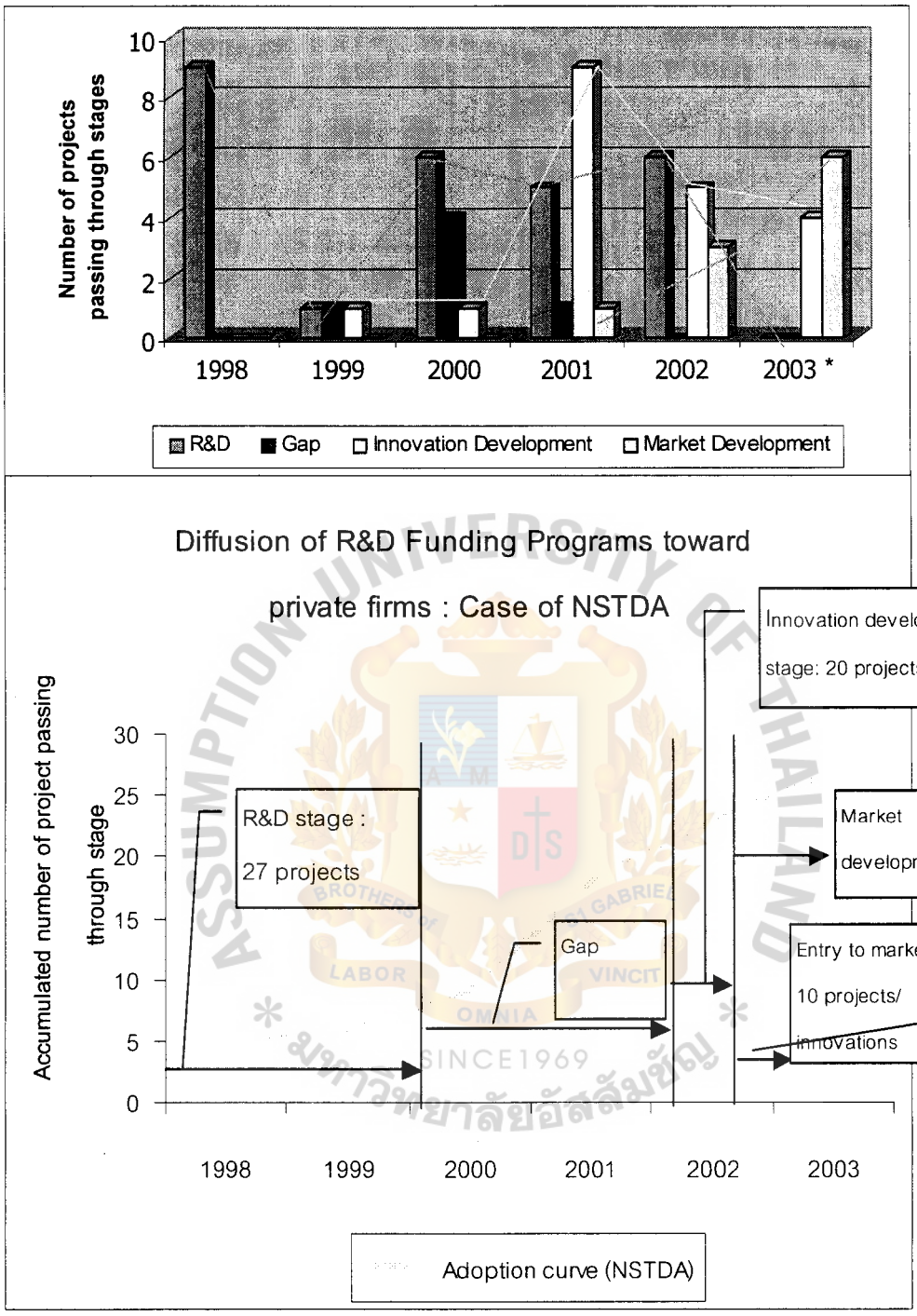


Figure 4-8: Diffusion of R&D granted projects to commercialization of NSTDA

Innovation name	R&D stage	Innovation Development stage	Market Development stage
1.Inspection of infectious virus GAV/YHV in shrimp			
2. Recipe of fermented pork			
3. Fast track of cholera check and antigen check			
4.Test Kit for infectious virus C in human liver			
5. Technology producing of Sprilulina Seaweed			
6.Coji Ferment Tank (Tower) *			
7. Corporate tax and accounting software			
8. Long life of rip mango			
9. Chlorine contamination checking machine			
10. Linux Talay (Software)			

* It is process innovation. It is utilized in the production process of the company. Recently, BIOTEC is announced for licensing technology.

Source of project funding from NSTDA fund

Source of project funding from companies

Figure 4-9: Share of project funding sources from NSTDA and companies

In terms of innovation types, table 4-12 presents the linkage type of innovation launched to the market.

Table 4-12: Type of innovations from R&D funding program of NSTDA during 1998-2003

Types	Name of innovations
Only product innovation	Five (5) innovations • Inspection of infectious virus GAV/YHV in shrimp • Coji Ferment Tank (Tower) • Corporate tax and accounting software • Chlorine contamination checking machine • Linux Talay (Software)
Only process innovation	Three (3) innovations • Recipe of fermented pork • Technology producing of Sprilulina Seaweed • Long life of rip mango
Product & process innovation	Two (2) innovations • Fast track of cholera check and antigen check • Test Kit for infectious virus C in human liver

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

In terms of funding operation in 1998-2003, it is found that NSTDA granted R&D budget step by step from the basic research, R&D, and innovation development for a particular project. This operation is the same as TRF. Therefore, these innovations progress step by step along the process. After innovation derived from the innovation development stage, the company developed market on its own. The way that NSTDA manages innovation for commercialization can be seen as linear.

In terms of the initiative of these innovations, it was found that all innovations are initiated by technical problems (e.g. in applicable of import diagnosis test, virus outbreak in shrimp, industrial wastewater, ineffective food processing, complexity of corporate Tax in Thailand). This is the same as TRF operation. So, the granted

researcher and the company aim at solving the technical problems. Developing the superior product and process from R&D activities was a plus. In addition, the granted researcher initiated an idea to develop a new product to push into the market. In collaboration with the private company, both of them aim at creating the demand of new product innovation to the current market. However, some of them have ambition to open a new market and set up a new product line.

As R&D output, ten innovations are the product range of diagnosis test kit, food innovation, process engineering, and software. From figure 4-10, these ten innovations progress from the basic research which was carried out in the period prior 1998 by the researcher elsewhere. Therefore, the granted researcher developed the R&D project from the basic research in order to come up with the lab scale and prototype. After that, NSTDA works intensively on diffusing R&D result to the private company. As a result, 6 out of 10 innovations progressed by technology transfer from NSTDA to the private company (figure 4-9). Based on documentary review for these six innovations, the technology recipients (companies) have high capability to absorb technology. The indicator of high technology capability included the professional R&D personnel, financial, expertise based technology according to the concept of Enos (1989). However, it is found that the condition of R&D results were far from the manufacturing level. Therefore, technology recipients have to develop their own innovation by using in-house resources. At this stage, it was found that all companies evaluated market potential based on business experiences and hoped to push new product innovation to market. It is interesting that traditional innovation development for these ten cases have not relied on the formal marketing research. Fortunately, all innovations were sold in the current market.

Figure 4-10 presents the funding duration of each finished R&D project in 1998-2003. It is found that some projects progressed from the basic research. For R&D projects, its period of funding varies from 3 to 72 months depending upon the difficulty of research tasks and projects size. It is interesting that some projects took long duration. It is found that these projects are medical diagnosis development, animal cell culture, and microbial culture. These projects are usually complex and require testing with humans and animals. However, it is found that all R&D projects fund can come up with the

body of knowledge, lab scale, and prototype at the end of projects. In addition, NSTDA extended funding for three projects (Technology producing of Sprilulina Seaweed, Coji Ferment Tank (Tower), Software of Linux Talay application) at the innovation development stage (figure 4-9).

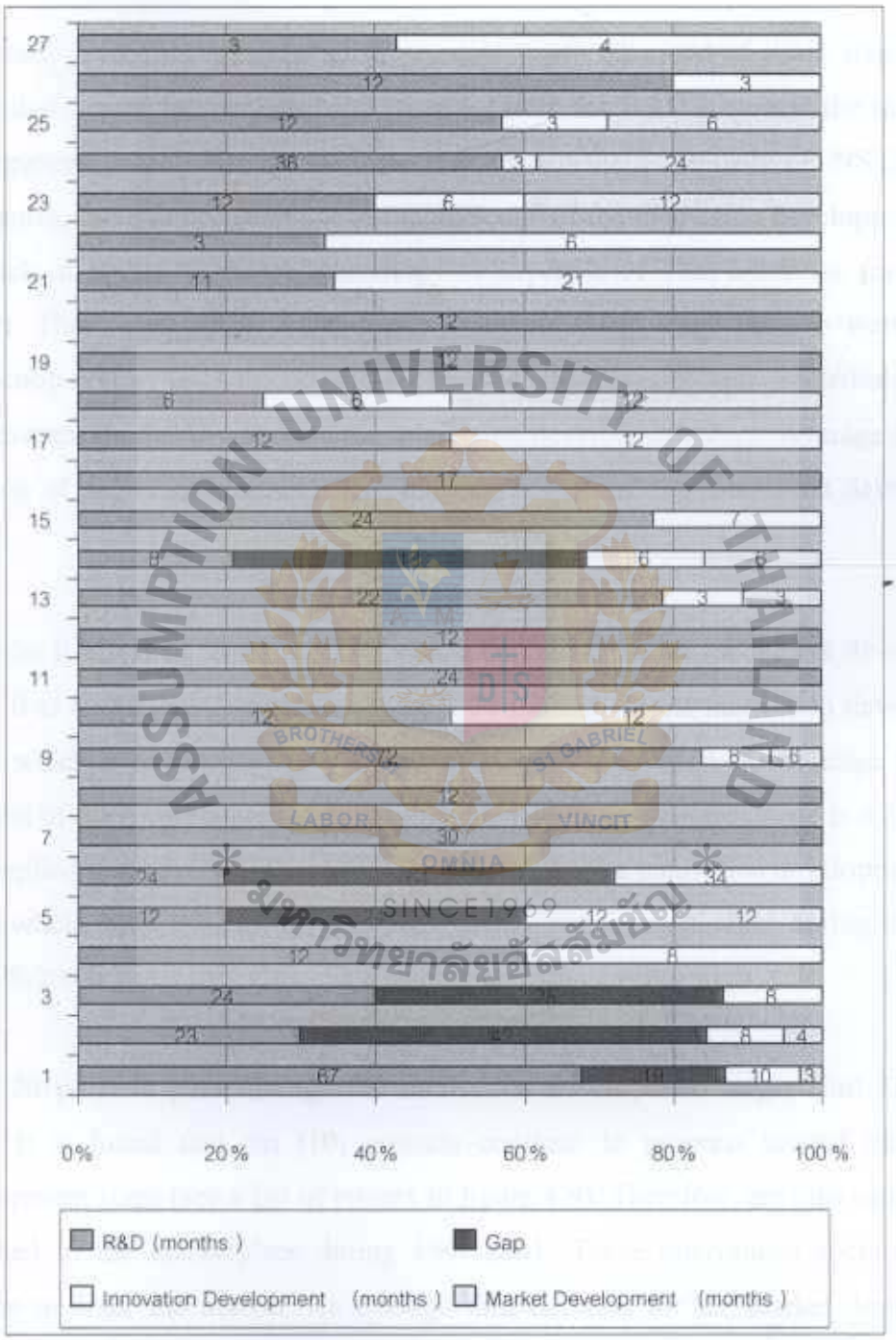


Figure 4-10: Time duration (months) of each project carried out in 1998 – 2003 period: Case of NSTDA

According to its range of project duration, average (median) time duration for R&D stage is 12 months, see table 4-13. It is implied that NSTDA takes 12 months in R&D stage out of the whole innovation diffusion process of entire organization during the period of 1998-2003.

This study traced the progress of these projects after the end of R&D stage. It was found that some innovations have a gap between the R&D stage and the innovation development stage. Based on interview management persons of NSTDA and companies, this gap occurred due to the difficulty of the innovation development stage and lack of ability to absorb technology or expertise of Thai industries (production sector). Then, these fresh technologies from the R&D stage have to wait for the production sector. In terms of gap, six medical diagnosis projects contributed to the gap between the R&D stage and the innovation development stage. Average (median) duration of gap is 26 months before its progress toward the innovation development stage.

After the R&D stage, there are 20 projects completed in the innovation development stage. It is found that each project spent 3-34 months for the innovation development stage, which is depending upon the complexity of innovation. An average (median) duration of the projects carried out at the innovation development stage is 6.5 months. It is implied that NSTDA takes about 6.5 months for the innovation development stage of the whole innovation diffusion process for the entire organization during the period of 1998-2003.

Once 20 projects pass through the innovation development stage, until December 2003, it is found that ten (10) projects continue to progress toward the market development stage (see a list of project in figure 4-9). Therefore, ten innovations were launched to the marketplace during 1998-2003. These innovations spent for 3-12 months to enter the market. An average time-duration for the market development stage is 6 months (the period after the launch of innovation into the marketplace).

Table 4-13: Average duration (months) of innovation development in each stage

Stage	Average (median) month	Number of projects or *N* value for calculation
R&D	12	*N* = 27
Gap	26	*N* = 6
Innovation development	6.5	*N* = 20
Market development	6	*N* = 10

According to NSTDA funding operation and a period of innovation development growth, it is implied that NSTDA manages innovation toward commercialization as linear and science-push approach. Therefore, an average (median) duration for each stage can explain estimate duration of innovation diffusion from the R&D stage toward commercialization. It is rational that NSTDA takes almost 51 months for the innovation diffusion process from the R&D stage toward commercialization. Figure 4-11 presents the duration of each stage of the innovation diffusion process for NSTDA during the period of 1998-2003.

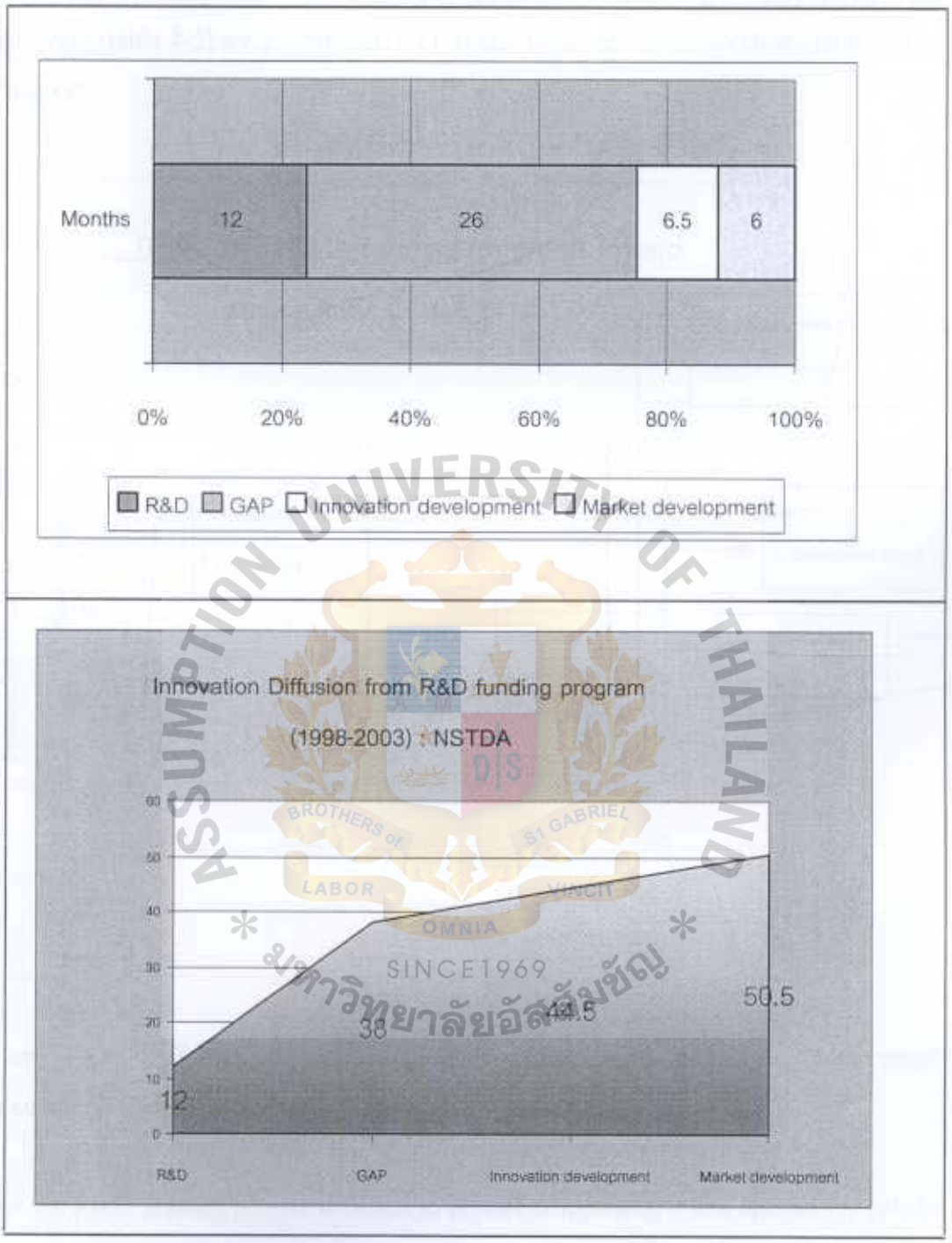


Figure 4-11: The period of innovation development in each stage

Using the incorporated concept of S-Curve with innovation development period can explain the innovation diffusion process of NSTDA in 1998-2003. Therefore, figure 4-12 explains the diffusion of R&D granted projects and its period for commercial

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

achievement. It is explained that there are 27 projects reach to private companies over 1998-2003 periods. The diffusion of granted projects is increasing from 5, 6, 9, 18, 23, 27 projects (table 4-3) over 1998-2003. Of these, there are ten innovations launched to the market.

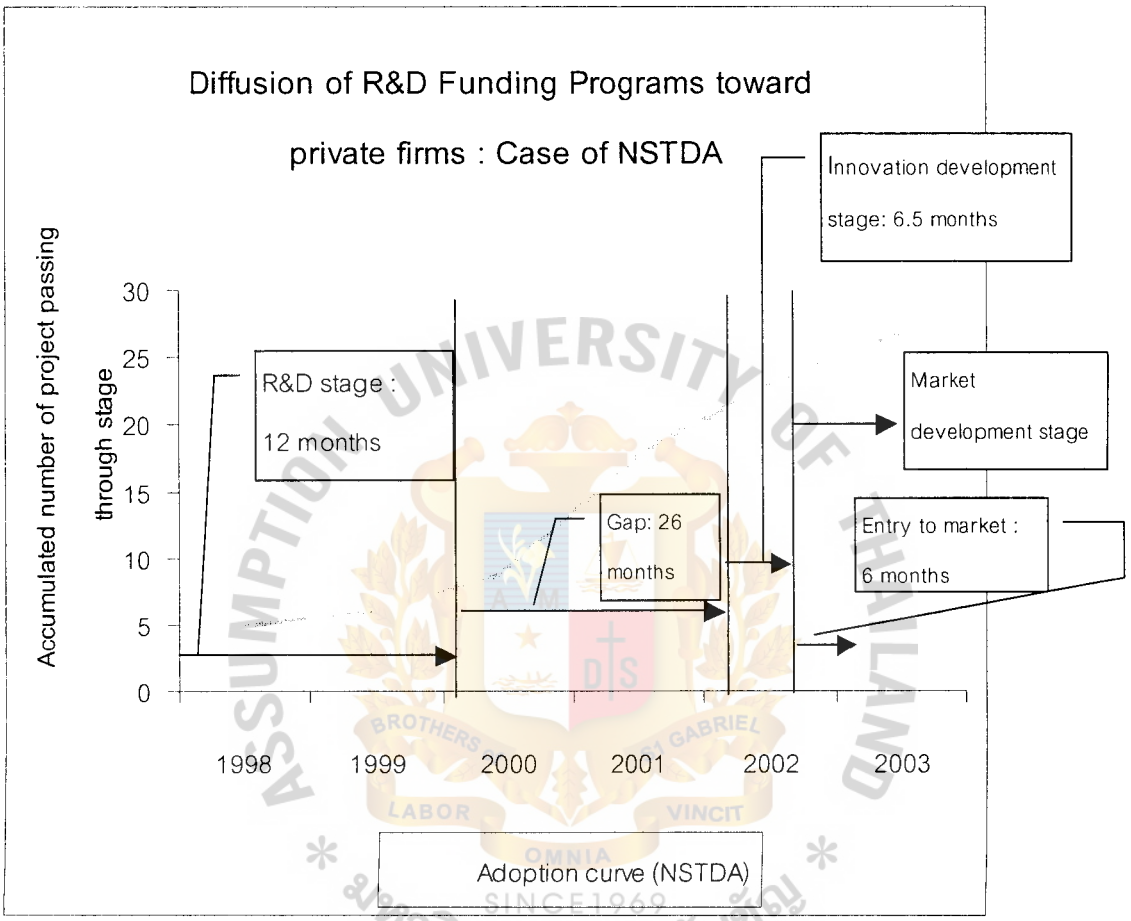


Figure 4-12: Diffusion of R&D granted projects and period in commercial achievement: Case of NSTDA

Once the R&D granted project diffused to private companies, it has opened the gate to commercialization. From the R&D stage toward the market development stage (entry the market), this process takes 50.5 months from December 1998 to December 2003. This process has three stages of development including the R&D development stage, the innovation development stage, and the market development stage. The R&D stage takes 12 months from 1998. Most of these R&D result derived from granted researchers. It is found that R&D results come up with fresh technology. Therefore, it

has an ideal time innovation development. This ideal time is a gap along the innovation diffusion process, which is 26 months. After that, these technologies transferred to private companies in order to develop the innovation for commercialization. This phase spent 6.5 months for the innovation development stage and 6 months for the market development stage (entry to the market).

Conclusion

In comparing the innovation diffusion process between TRF and NSTDA, it is found that TRF has more speed in developing commercial innovation than NSTDA. TRF spent 44 months while NSTDA spent 50.5 months. Table 4-14 presents a comparison about the time taken in each stage of innovation diffusion toward commercialization by TRF and NSTDA organizations. In the meantime, NSTDA has innovation diffusion gap between the R&D stage and innovation development stage. Most of the projects diffused to private companies by TRF fund were from the venture capital, which engaged the private company at the R&D stage, while, NSTDA's projects diffusion were from technology licensing. It is interesting that engaging of the R&D result's user at the beginning process is able to speed up innovation toward commercialization.

Table 4-14: Comparison of spending time for innovation diffusion process of TRF and NSTDA

Stage	Average (median) months	
	TRF	NSTDA
R&D	27	12
Gap	None	26
Innovation development	12	6.5
Market development	5	6
Total duration of commercial innovation development	**44**	**50.5**

However, both of the TRF and the NSTDA case studies are presented once the R&D granted project diffuses to private companies but only some projects progress to the market development stage whereas some are not. It is pointed out the question "what

THE ASSUMPTION UNIVERSITY LIBRARY

are the factors enabling/inhibiting the progress of innovation to commercialization." Section 2.3.4 will explain this.

2.3.4 Factors enabling/inhibiting the progress of innovation to commercialization

Company profile

This section explains the characteristic; of the companies participating in interview information about the companies taking part in the interviews is shown in appendix 11. It includes the 31 companies from various industry sectors. (See table 4-15). It is noted that section 2.3.4 will analyze factor influencing the progress of R&D toward commercialization. Therefore, the total number of the interviewees is from the companies who joined the TRF and the NSTDA funding program.

Table 4-15: Share of companies participating in the R&D granted program and finished the project in 1998-2003

TSIC	Sectors	TRF (companies)	NSTDA (companies)
31	Food, and Beverages and Tobacco	2	4
32	Textiles, wearing apparel leather products	2	0
33	Wood and wood product including furniture	1	0
35	Chemicals and chemical products, petroleum, coal, rubber and plastic products	2	0
36	Non-metallic mineral products	2	3
38	Fabricated metal products, machinery and equipment	4	0
39	Jewelry, diamond, gem and ornaments	2	0
	Electronic Components, Radio, Television and Communication Equipment and Apparatuses	1	2

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Cont.

	Motor Vehicles, Trailers and Semitrailers	3	0
	Others (Software)	0	2

TSIC = Thailand Standard Industry Code

Finding

The study explains the characteristics of champions and followers who participate in interviewing of the 31 companies in Bangkok Metropolitan Region (Bangkok, Nonthaburi, Phathumthani, Nakornpathom, Samutprakarn, Samusakorn and Ayuthaya plus). Champions were defined as companies who have products or process innovations launched to market whereby the followers were defined as companies who stopped at the R&D stage or struggled at the innovation development stage. Table 4-16 presents a profile of champions and followers who comprise small- and medium-sized companies (SMEs) and large business. For this case study, fourteen companies are defined as champions whereby twenty companies are defined as followers. Of the twenty companies from the followers group, three (3) companies are also classified into a group of champions as to these companies join more than one project of R&D funding program. Some projects reached towards the market development stage and some did not. In addition, five (5) champions who received technology licensing have not participated in the innovation diffusion process at the R&D stage. Therefore, innovation activities of these five companies start at the innovation development stage.

Table 4-16: Profiles of champions and followers

Groups	Size of business	Employees	Venture Capital	Technology Licensing	No. of companies	No. of companies having R&D units
1. Champions	1.1 SMEs	9-94	6	4	10	3
	1.2 Large business	210 – 800	3	1	4	3
2. Followers	2.1 SMEs	15-50	8	2	10	5
	2.2 Large business	200-1,500	10	0	10	5

1. SMEs. = Companies with less than 200 employees, Large business = Companies with more than 200 employees

2. Three (3) companies from the group of followers are classified into a group of champions due to these company join R&D funding program more than one project. Some project reached towards market development stage and some does not.

3. Total companies participated in this study is for 31 companies located in BMR.

Stage 1: R&D Stage

This stage of innovation diffusion process concerns the period from the research and development activities and coming up with prototypes. The study established three variables for this stage.

Variable 1: R&D units of organization

Positioning of R&D Units in Organization. Most of the champions (8 out of 14 companies) do not have the R&D department in the organization. (See table 4-16 and see details in appendix 8). It is found that a larger group of companies are small and medium enterprise business as (SMEs.) while the minorities are large businesses.

The observation is that the R&D department in large businesses employs a very small team (1-11 persons) who earn a science and engineering degree. These R&D employees are transferred from the production department. Besides, they still lack high technology equipment/measurement within R&D facility.

Meanwhile, ten out of twenty (10 of 20) followers do not have the R&D department. They are from a mix group of SMEs and large businesses. The observation is that a minority group of the followers (5 of 20 companies) are large business and have the R&D unit. Because some companies who participated in this study carried out many R&D granted projects, they were classified into both champion group and follower group. They were classified into a group of champions if a particular project reached they market development stage. In the same way, they were classified into a group of followers if another project did not reach the market development stage. For this reason, three (3) followers were classified into a group of champions as well. They

were Uniseeds Co., Ltd, Rice Engineering Supply Co., Ltd., and Chen Thailand Co., Ltd. See appendix 8.

Flexibility of organization structure. SMEs from a champion group have more flexibility structure than large businesses. They are easier in transformation of the organization to conduct collaboration R&D with the government funding program. However, most of SMEs do not have the R&D department. They have no clear cut of employee's role and responsibility in a certain job function. Besides, all companies' owners gain a degree of science and engineering. In doing R&D collaboration, the company owner shifts his day-to-day activities to fully participate in the R&D activity. In addition, all SMEs owners (10) from the champion group explained that they drew technicians or production staff to work on the R&D activity in temporary assignment. Most of SMEs owners have not seen the need of setting up the R&D department in the organization, because of it would be over load of business cost.

A group of followers is a mix of SMEs and large businesses. These followers have the same way of flexibility in respect to the characteristics of SMEs and large businesses the of champion group.

Corporate culture. The study found the different characteristics of corporate culture between a company who has and has no R&D department. Six (6) of fourteen (14) champions have the R&D department. A number of SMEs and large businesses share a half of them. They are technology-based firms. Companies who have the R&D department pay a lot more attention in developing innovation through the in-house R&D activity. They employ the science and engineer personnel working on product development. Therefore, these companies'management has openness to encourage their staff to learn new things. In joining the R&D funding program, management views that it is one of the channels for learning. Company management opens for initiating the innovative idea from a senior level of staff. In terms of work environment, these companies have the intensive R&D activity as it is corporate mission.

For a group of eight (8) champions who have no R&D department, most of them are from SMEs. Environment of science and technology development in these companies has a bit more relaxation than the first group. Employees were assigned for routine work according to certain work function. Innovation idea was initiated from the company owner alone.

Ten (10) of twenty (20) followers also have the R&D department (some companies set up the R&D department after they joined the R&D funding program). The characteristic of corporate culture among this group is explained in the same way as these of the champions.

Style of management. Company owners from ten (10) of champions from SMEs handled R&D activities on their own. The decision-making in the R&D and the innovation development project relied on one owner alone. (Family-affiliated corporations allow ownership- and kinship-led rather than skill-based management. This is a kind of "family-ownership-control-type businesses.) This group of champions (SMEs) required a short period in R&D decision-making. Approaching R&D funding opportunity to SMEs might a bit easier than the large company who has skill-based management. In terms of managing the R&D activity, company owners from SMEs group drew their expertise in engineering to work closely with the granted researcher. Besides, they pulled a technician staff from the production department to assist in assembling work or specific technical design task. All company owners from SMEs group revealed that they preferred to formulate the temporary R&D team to setting up the permanent R&D department in the organization. The temporary R&D team would be a mix of staff from production, sale, and administration. The team would be disbanded at the end of a particular R&D project. From interviewing of 10 SMEs from the champion group, all the changes of corporate depend upon one owner alone. One owner dominated all decision-making of the organization. For this style of management, trouble shooting for the R&D activity among champion groups was initiated from the company owners alone. In addition, the study found that all champions from SMEs and large businesses allocated R&D and the innovation development activity by using annual corporate budget.

Large companies, the decision making of four (4) champions rely on more people in the management team such as owners, professional managing director, general manager, and unit's manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for top management's approval. In terms of managing the R&D activity, company staff (R&D staff of 3 companies, and production staff of one company) worked in collaboration with the granted researcher. Some companies set up the R&D working group by using the cross-functional team of marketing and sale, production, and business development. For this style of management, trouble shooting for the R&D activity among large businesses was initiated from the R&D team rather than the company owner alone.

In terms of balance skills and manpower in technical, marketing, and business task in R&D activities, it was found that eight (8) champions utilized multi-disciplinary of technical, market and business development in developing product innovation. These champions were from a group of SMEs. Nevertheless, it was not formal structure. Company owners still took lead effort in developing innovation for commercialization. Company owners also assigned staff to work with the granted researcher.

For a group of followers, twenty (20) companies from both SMEs and large businesses shared the same sense of champion in respect to R&D decision-making, R&D staffing, and R&D management approach. In terms of R&D financing, followers revealed uncertainty in R&D investment. The study found that fifteen (15) of twenty followers allocated annual business profit in R&D and innovation development. Therefore, for the decision to allocate R&D and innovation, a cost is based on the company's annual profit.

While twelve of twenty followers (60%) had a characteristic of balancing skills of technical, marketing, and business task, three of the followers came from the same group of champions. From interviewing, the rest 40% of followers who did not have a characteristic of skill balancing revealed that their companies had a limit number of marketing and business development staff. Besides, they viewed that the R&D activity was not obliged to the marketing staff. Nevertheless, they viewed R&D was obliged to

production and engineering staff only. Besides, 40% of followers had not aligned with the same team of the granted researcher. (The reason will be cited in variable three.)

Variable 2: Management commitment in the R&D activity

Profile of the R&D team leader in the company. The study found that top management e.g. owners and managing director of all fourteen (14) champions took lead effort in R&D and innovation development activities. All top management had high commitment in developing new product innovation. However, the granted researcher from the government funding program took charge of the R&D project manager.

Meanwhile, all top management from the follower group (20 companies) had also high commitment in the R&D activity during the funding period, but less than a half of top management (8 companies) had high commitment in the new product innovation development. The rest of the followers had just expected only to improve an existing production process or product, emission control, and developing cost reduction tools for the industry. For instance, one of the followers expected to develop software for a jewelry design and jewelry cost estimated in collaboration R&D with the granted researcher from the government fund. This company expected to give this software free, not for sale.

Capability to cope with high degree of uncertainty/difficult/ of the research task. With regard to the interview of 14 champions, all top management and R&D staff revealed that taking risk averse was necessary in developing R&D and innovations. Eight (8) companies revealed that they also fail with prototype testing for many times before they reach the saleable level (usually engineering product innovation is sold at about 60 % of efficiency. Medical and biotech products are sold at 100% efficiency.). However, they did not lose enthusiasm in product development. They still invested in the innovation development in order to enter the market.

Meanwhile, three (3) followers reveled that they could not take risks in developing innovation and testing the prototype. Finally, they decided to cancel the project. They

revealed that the proposed innovation was optional to their business. Then, it did not hurt their business status if the company could not produce the new product innovation.

Company network of R&D collaboration. The study found that fourteen (14) champions access Thailand Research Fund (TRF) and The National Science and Technology Development Agency (NSTDA) as a source of technology in developing new products as well as improve the production process. They reveled that they still keep contact with TRF and NSTDA even though the period of funding project is ended. Besides, six of the champions are members of industry associations such as The Federation of Thailand Industry Association (FTI) that provides accessible channels to the peer, industry trend, and source of funding etc. Surprisingly, one of very the small businesses is being a member of Thai Inventor Association. This company received the invention prize award in 2000. In addition, one product innovation produced by one from a group of large businesses that joined R&D with a university professor (Dr.Somchart Soponronnarit) of King Mongkut's University of Technology Thonburi received the Unesco Science Prize. He is the country's first scientist to be awarded the prize. The award was for the professor's research and development of fluidized bed dryer and cyclonic rice husk furnace. By the way, it was found that there is not much networking among a group of champions.

For the group of followers, ten (10) followers are members of FTI as well. The rest of the followers are members of professional associations such as Food Association, Thai Gem and Jewelry Trader Association. After the end of the funding program from TRF and NSTDA, nine (9) of twenty (20) followers did not keep contact with TRF and NSTDA. while, the rest of the followers still keep contact with TRF and NSTDA in order to access a new opportunity. By the way, the study found that there is not networking among the group of followers.

Variable 3: Difficulties of the research task in relation to the capability of researchers

Relationship between granted researchers from the TRF and the NSTDA funding programs and the firm's employees. With regard to interviewing, all of the champions (14 companies) worked closely with the granted researcher. Most of them said complement to the granted researcher in terms of personality, responsibility, and ability in research task. Of these, the study followed up the relationship after the end of funding program period, four (4) of the champions offered a part time job to the granted researcher. During the R&D funding period, these champions participated in various activities including i) progressing project meeting ii) involvement in designing tasks iii) close communication with the granted researcher iv) providing related information for the R&D task v) assigning coordination staff and technical staff.

For a group of the followers, thirteen (13) of twenty followers also worked closely with the granted researcher during the funding period. After the end period, the granted researcher had never contacted the company. In addition, three (3) followers complained about the granted researcher in terms of low responsibility, unreliability, using of low grade of material for the prototype assemble, and high budget on personnel service charge. By the way, the study found that these followers did not assign technical staff to work closely with the granted researcher. It was also found that long distance between the granted researcher's location and the company's location was a hurdle of collaboration. For instance, one company was located in Bangkok but the granted researcher stayed in Khon Kaen.

In house R&D capability. More than half of the champions (8 of 14 companies) do not have the R&D department in the organization. By the way, five (5) company owners of these companies have high capability in engineering and development of machine and mechanic equipment. These owners took action in the R&D task on their own. They pulled technical support staff from the production unit for assembles. For the rest of five (5) champions, company owners have low capability in the technical design and engineering work but they drew science and technology staff from the production and the engineering unit to work closely with the granted research. These companies revealed that they got benefit from the job training in managing R&D and technology development from the granted researcher as well. Besides, six (6) champions have R&D department. There were three large businesses and three (3)

SMEs. The number of R&D personnel varies from 1 to 11 employees. Most of them graduated at least from university level in science and technology (biotechnology, computer, food science, post –harvest science, environmental science, physic, chemical science) and engineering (mechanical, electricity, and electronic).

Meanwhile, ten of twenty (10 out of 20) followers do not have the R&D department whereby ten (10) followers have the R&D department. By the way, a group of non-R&D department employed science & technology and engineering staff in the production unit. An average education level of these staff is in the range of vocational schools to graduate schools. For the 10 followers who have the R&D department, these companies employed the science & technology personnel at least at the graduate level. However, these ten followers insisted that their business did not require permanent R&D staff.

Technical capability of granted researchers. All (14 companies) champions said positively about the granted researcher in terms of his/her technical capability in the research task. From the scale rating of one to five (one is the lowest and five is the highest), all champions gave four to five level to their match-granted researcher, which is the high rate of technical capability. (See appendix 9).

However, all twenty (20) followers gave technological rating to their match-granted researcher in the range of two to three, which is relatively low to the medium rate of technological capability. A number of followers revealed that granted researchers could not present technical options in respect to business oriented. The proposed options were far from the real world, which was not convinced to the company management. Besides, some companies revealed that the development of innovations needed to cope with multi-disciplinary. Granted researchers still lacked multi-disciplinary of science and technology e.g. mechanical, electronic, biotechnical, and information technology.

Stage 2. Innovation development stage

This stage progressed from the R&D stage. Once the prototype or lab scale derived from R&D stage, this stage deals with testing the prototype and enlarging the scale at

saleable innovation. Therefore, the outcome of this stage are products or process innovations that are ready to be launch for the marketplace. Once companies make a decision to move into this stage, these companies have to enlarge the scale or testing the prototype. Some companies undertook this stage from self-fund whereas some companies received fund extension from TRF or NSTDA.

Variable 4: Ability to translated R&D results into saleable innovation

Preparation of production line for the derived innovation. At this stage, fourteen champions took full responsibility for managing the innovation development project. Grant researchers usually phase out their role at the innovation development stage, unless the company hires him/her case by case. From the in-depth interview of 14 champions, both of SMEs and large businesses from the champion group had not prepared the production line of the new product innovation at this stage. They explained that it should be done after the innovation launch and the company received a positive feedback from the market. Therefore, company produced small volume of product innovation at the first stage of market development. Then, the new production line at the manufacturing scale was established later on. In addition, most (10 companies) of the champions also explained that it has no difficulty in laying out the new production line for the new product because it is still in line of business. Sale volume or order is a decision point for setting up mass production. By the way, four (4) of the champions from SMEs engaged some production staff in the first period of the R&D stage. Therefore, it had no difficulty to produce the first lot of new product innovation (small volume of saleable innovation) because their production staff took on the job training at R&D and the innovation development stage. In addition, one (1) of the champions from SMEs who produced Corporate Tax Software had outsourced the production since this company was in business of consultant on accounting and tax.

In case of technology licensing, five (5) champions received the technology transfer from R&D results. They must improve core technology up to the enlarged scale and saleable form. The R&D team always informed the progress of the innovation development project to the production manager or chief of production unit

periodically. By the way, the production manager and the chief of production unit had no full involvement in the innovation development activity. However, these champions explained that the deliverable innovation had no complexity in production. An average transition phase of technology transfer from R&D result to production of innovation was three to six months varied by size of the trainee group, the ability to absorb technology of trainees, the availability of trainers, and the product testing and verification process.

For a group of followers, five (5) of the followers are on process of developing new product innovations. At this moment, they were not concerned much about preparing a production line until they came close to saleable innovation. In addition, they do not involve production staff into new product development at this stage.

In case of innovation failure, three (3) followers could not develop the prototype toward saleable innovation. Two (2) of them flopped at the R&D stage. One (1) of them flopped at the innovation development stage. The first one who flopped at the R&D stage aimed at inventing the ferment machine and using it for the current production process. At present, this company uses a foreign brand of the ferment machine. They aimed to invent the machine for substitution of the foreign brand. Unfortunately, they flopped in developing the first prototype at the R&D stage. Company management revealed that the granted researcher used low grade assembly materials. It affected the stability of the machine. The company viewed that developing this innovation required multi-disciplinary e.g. material science, mechanical engineering, and electronic. But, the granted researcher has only knowledge in mechanical engineering that might be the cause of failure. The second loser at the R&D stage is the machine producer for rice-mill processing. Company management revealed that the granted researcher and the in-house R&D personnel were unable to cope with technology certainty of the proposed machine. Finally, they stopped the R&D project. The third company flopped at the innovation development stage. The company revealed that they were unable to translate R&D results (lab scale) to innovation. The problem was that the proposed technology from the lab scale was unable to cope with condition in the real environment. After the company had trial and error for many times, the company decided to stop the innovation development project.

Interviewees revealed that the R&D result was far from the real world, which reflected the failure of the company.

The rest of twelve (12) followers stopped at the end of the R&D stage. The study found that all followers accomplished the R&D stage by coming up with the improved existing production process, better wastewater treatment, improving solvent dispersion in the production process, energy saving, and software tool of product design and cost estimated. These companies revealed that they were satisfied with R&D results because they could be applied with the company's operation. By the way, these companies did not want to move forward their R&D activity to the new product development level. They explained that the product was still in good position in the market.

Therefore, there was no success in new product development among the followers. The preparation of production line is not the aim of this group.

Change agent of innovation within organization. Top management (The owner and the managing director) of all champions (14 companies) played a change agent role in developing innovation within the organization. In relation with characteristic of management commitment, this top management has high commitment in developing the new product to the market. Therefore, the innovation development team had urged to report the status of development to top management periodically.

For the group of followers, this characteristic related to the R&D objective of each company. As mentioned above, all followers did not produce product innovation during the period of this study. However, all followers revealed that top management paid attention in R&D and the innovation activity but they would be more active in developing new product whenever they could foresee a market opportunity. Therefore, they did not see the demand to develop the new product at the present study.

Ability of the granted researcher in translation of the R&D result into production activity. The study found that after the stage of R&D, SMEs worked a little more for testing and reducing technology uncertainty of the prototype. Six champions from

SMEs revealed that working with the granted researcher at the R&D stage could achieve nearly 60 % of technology certainty of the prototype. Therefore, companies only worked a little more on technology verification and prepared for the final product launch. These products were a kind of mechanical & engineering innovation, software innovation e.g. Mangosteen Sizing Machine, Cassava Cleaning Machine, Corporate tax and accounting software, Coji Ferment Tank, Lenux Talay (Software), and Chlorine Contamination Checking Machine.

While the medical product prototype from the R&D stage was far behind from the stage of saleable innovation, a company who produces medical diagnoses test kit revealed that the R&D result could only reach efficiency at the lab scale or available at control condition. Therefore, this kind of prototype needs a lot of further development in order to have the secured product condition when it is delivered to the user (customer). In developing the medical product in Thailand, the granted researcher can deliver less than 60% of product certainty and condition. While the medical test product requires 100% certainty and secure condition when it is delivered to user. Therefore, this company tested many prototypes (~ 10,000 samples, whereby the industry standard is 200-300 samples) before the launch to the market.

All champions (14) said in the same way that not only the granted researchers could provide excellent research tasks, but they could also provide excellent technical support to the project.

For a group of the followers, twelve (12) of the followers did not aim to produce new product innovation. It had no room for the granted researcher in developing a new piece of innovation with these companies. Three (3) followers flopped during the R&D stage and the innovation development stage. However, the rest five (5) followers are on the innovation development process at the period of present study. Nevertheless, four (4) of them revealed that the granted researcher has never involved with their innovation development activity after the end phase of funding. However, they saw the value of the R&D result and move forward to the innovation development phase on their own.

Major problems during the prototype running stage. All champions (14) confirmed that they had also faced problems during the prototype running stage. The problems included technical failure at the first series of prototype, the financial problem, shortage of testing machine and equipment, and the attack from the competitor in failure of prototype testing. Finally, these companies could overcome their obstacle.

However, one of the followers who failed at the innovation development stage could not overcome technical failure for many times (5 times).

Evaluation of sale volume and market feedback. Thirteen (13 companies) of fourteen champions revealed that top management evaluated sale volume based on the rationale of business experiences such as understand in the technical problem in the industry, low efficiency of a particular manufacturing process, complexity of law and regulation that, is hard to understand, replace import product. It is noticed that they evaluate sale volume and market feedback from the research problem emphasized by the grant researcher too. All interviewees (14 champions) revealed that they had high confidence to push the new product to the market. Of these, one of the companies who produced medical diagnosis test kit, had conduct feasibility study for business development in producing the Test Kit for infectious virus C in human liver in Thailand.

For the follower group, five (5 companies) followers who are on process of developing innovation revealed that they evaluated sale volume and market feedback based on their business experiences and technical problems in the industry.

Variable 5 : Design the product innovations according to the market needs

Understanding of customer need. Most research problems raised an issue of problems in the particular industry and limited performance of the existing product in the market. Therefore, it provided primary information to champions in evaluating market needs in order to make a decision at the R&D stage. At the innovation development stage, champions who launched a product to the market engaged the lead user to the testing of prototype. They employed a team for researching the customer

need in a different approach depending upon product type. A group of champions, who launched the mechanical/engineering product and software product, drew customer need by using the try out of prototype, the observation research, the interview of the user of the existing product. Some champions sent the R&D team to the field and observe limitation of the existing product of other companies. This R&D team went along with marketing staff in order to talk directly with the user about their problems and needs. However, all of them conducted those activities by using the informal way. Champions who launched diagnosis test kit and disease fast track employed the animal test approach. At the final stage of prototype testing, they engaged hospital (lead user) into the design of the saleable product for development of the product's stability. However, some champions who developed the innovation process (e.g. long life of ripe mango, recipe of fermented pork, technology producing of Sprilulina) did not engage the customer at the innovation development stage. They revealed that it was not necessary according to the aim of improving the superior process. It was found that one champion, who launched a machine, had also evaluated market need according to the industry problem at the R&D stage. Nevertheless, they did not engage the lead user at the innovation development stage. They had first introduced a new product at the market development stage. The result was that they could not sell any volume of the product.

About the market response, it was noticed that most of the product innovations from these champions attacked only the current customer or user in the same industry. Only one company had diversified the new product innovation from the current user group to new user group (from the corporate user of vehicle accessory product to the individual user of cultivate machine).

For a group of followers, a group of followers who are on process of the innovation development stage had also evaluated market need according to the industry problem. The result of this activity has not come out yet.

Purpose of marketing research. All champions did not conduct a professional marketing research. In the same way, all followers did not conduct a marketing research, either. All interviewees (31 companies) explained that the target customer

(users) were corporate users, not individual users. They viewed that the marketing research was not necessary for their current business operation. The reason included i) they had good relationship with corporate customers and their customers were interested in the innovation and had high commitment to purchase when innovation would launch a product to market ii) they were production unit, not doing marketing activities. This kind of champions made R&D and innovation decision based on the demand of their traders (counterparts).

Marketing activity launch early. All champions (14 companies) did not have pre-announcement (formal way) on innovation at R&D and the innovation development stage. They revealed that they preferred to announce when it was ready to launch. The reason was that they were aware of uncertainty in developing a new product to achieve saleable innovation. They did not want to lose face if they flopped at the innovation development stage.

TRF and NSTDA involvement in marketing activity. With regard to interviewing 31 companies, all of them revealed that TRF and NSTDA had never support the marketing activity of new product innovation coming out from the R&D funding program. In the meantime, the study interviewed senior management level of TRF and NSTDA. It was found that both of them do not deal with marketing development of product innovation, which derived from companies who had been participating in the funding program. In addition, five of the champions from the SMEs group requested that government, particularly TRF and NSTDA, should play proactive role in market development of their product innovation. The reason was that SMEs had limited financial and marketing technique, which was a hurdle in achieving large sale volume. Therefore, their innovation had less impact on the Thai and customer society. In the meantime, it had high impact on academic area that could not create demand to a larger group of customers.

Re-invent of innovation. All champions (14 companies) revealed that they had to refine the first prototype that derived from the R&D funding stage. By the way, it was on incremental change.

Variable 6: R&D projects progress up to the stage of patenting

Change agent of patenting and prototype efforts. In terms of patenting effort, only three (3) of fourteen champions led effort in patenting. It is found that top management from one large business put high effort in patenting rather than the R&D team (staff). While top management from one of SMEs did not put any effort in patenting, TRF and the granted researcher put high effort on this. In addition, another one champion from SMEs does not want to register patent due to unfairness of sharing benefit and expectation to gain fully benefit from sale value. Based on the funding organization rule, it is found that the company holds less share of patent benefit rate. For example, the funding organization gains 50%, the researcher gains 30% and the company gains 20 % of patent benefit share, whereby the funding organization and the researcher lack capability and are less intensive on the market development activity. In addition, only 20 % is gained, it is not an incentive factor for the company investment on marketing. In addition, five champions from SMEs and large businesses revealed that they encountered with the difficulty on the patent procedure including the long processing time (see the patent registration process in appendix 12) and distrustfulness of patent protection. Most champions revealed that the difficulty in the patenting process was inhibiting the progress of innovation to the marketplace. Then, some software innovators would rather use technical protection to their software than rely on patenting protection. Some of the champions also designed the technical protocol to protect imitation of their engineering product as well. However, funding organizations as a case of TRF and NSTDA provided assistant to the private and the public sectors in processing the patent.

However, 10 innovations (from 14 champions participated in the interview) received patent. The granted researcher led effort in applying the patent. Most of them register to patent whenever it completed the final prototype. However, one of the champions from large businesses had lesson learn that the company should prepare for patenting at an early stage of innovation development. Otherwise, the R&D team member would steal innovation technology during the stage of innovation development. From that lesson learn, the company began the patenting process at an early stage of innovation development of other project. However, this company viewed that they would have

launched the saleable prototype even if patenting did not yet come out. In case of technology licensing, some champions brought royalty fees from TRF and NSTDA. The company aimed at translating R&D results to saleable innovation (final prototype) in the marketplace. In case of the venture capital, champions had to share patent holding with TRF and NSTDA.

In addition, four (4) champions revealed that other companies imitated their innovations even their patenting or copyright. In problem solving, one of them designed technology protocols in protecting the software product. Three of them who produced the machine could not overcome this problem.

In terms of developing the final prototype (saleable innovation), it was top management effort from all the champions (14 companies) and the followers (5 companies) who expected to come up with product innovation. They viewed that developing first series of prototype effort need to be shared responsibility of companies and granted researchers (at R&D stage), while developing final series of prototype was full responsibility of companies.

Stage 3: Market development stage

After champions developed the final prototype (saleable innovation) at the innovation development stage, they would launch a product to the marketplace. This is the stage of innovation diffusion to the society.

Variable 7: Organization's capability in pushing new product innovation to market

R&D team's involvement in market evaluation. From this case study, most of the innovations derived from SMEs, where company owners played an important role in developing innovation and diffuse to the marketplace. In addition, their style of management was directive to the staff and working on every business functions such as business development, marketing and sale, production, and personnel recruitment. For this reason, SMEs group (10 companies) evaluated market need by company owners alone. However, four champions (4 companies) from large businesses arranged regular

meetings for the R&D team in exchanging news and progress of R&D activities as well as sharing customer and market information.

For the followers, this case study found that none of the followers reached to the market development stage at the period of the present study.

Participation of the marketing team in the R&D project. This activity runs in the same way as the characteristics of champions from SMEs and large businesses.

Balance value of marketing activity with R&D and innovation development activity. All champions (14 companies) from SMEs and large businesses revealed that they had high recognition in balancing the marketing activity and R&D & innovation activity. However, three champions from SMEs explained the similar reason that their marketing, R&D & innovation activities were run by company owners alone.

Collaboration between user & innovation market pull. Five (5) champions engaged their target customer into the prototype testing process. This activity is led by the company owner. These champions revealed that they offered free testing prototype e.g. mangosteen sizing machine, rice oven, dryer and cyclone etc. to a merchandiser or corporate customer whom they had good relationship with. It aimed to obtain technical problems and feedback from the user directly. However, technical adjustment was adopted based on the cost and expected of product performance. Beautification of design was always a plus whereby cost limitation and perception level of customers was basic consideration.

Variable 8: Marketing strategy

Marketing strategy in entering the new market. This study asked 14 champions about the marketing strategy of new product innovation. About its norm of marketing channel, twelve (12) champions from SMEs and large businesses conducted their own marketing whereby two (2) champions did not conduct marketing on their own. One of the two champions sold their product through trader companies. Another one of champion was license product technology (in assistance by NSTDA) to other

companies. It was interesting that 1 out of 14 champion ignored in developing the market after the company failed in selling at the first launch of innovation. Company management revealed that they did not see much benefit from innovation sold. The reason was that the company would receive 20 % of share benefit of patent, which was low business advantage.

At this stage, all champions (14 companies) recognized the advantage of the lead user's engagement at the prototype testing process. The lead users were close customers of the company. Once the prototype progressed up to the stage of technology certainty, these companies sold the first series of product innovation to their close customer. It is found that ten (10) of the champions sold product innovation to the corporate customer whereby four (4) champions sold it to the individual customer. All champions explained that characteristics of customers (corporate customer or individual customer) played a significant role in designing the marketing strategy. For corporate customers, all top management of the companies contacted directly with corporate customers. As a result of customer relationship management, they informed the customers about the new product while the company was working on innovation development (innovation development stage). Four (4) champions sold their innovation to the individual customer. In this case, the company employed the sale force strategy which demonstrates their innovation to direct users. Two champions produced innovation to increase productivity of the agriculture field. They sent a sale team to demonstrate the product innovations in the rural village. Another champion produced Lenux Talay software. They gave free download at the first launch and charged low price at the later phase. The last champion transferred technology to the Jilada royal project. It was production of perfume. The product was placed at Jilada Shop.

With regard to sale promotion in corporate customers, ten (10) of the champions offered various approaches including advertisement to the reference user, personnel communication through the sale engineer and promotion through traders. While four champions from large businesses revealed that they had more advantage on public relation e.g. placing it in corporate website, post it in bulletin of industry/ trade association, trade show, being a speaker for TRF and NSTDA in the public meeting. In

addition, all champions (14 companies) viewed that TRF and NSTDA are still far from public relation in aspect of marketing support to the private companies. As it is, they viewed that the purpose of public relation of TRF and NSTDA only focuses on promoting science & technology innovation to give public recognition to the granted researcher alone. TRF and NSTDA should add more value on public relation to foster innovation sale. One of the champions proposed that TRF and NSTDA should play a role in fostering product/process innovations in the same way that government does with OTOP products.

In case of individual customers, one company produces bio insecticide. The company assigned marketing and sale team to the field and getting production problem and users' profile. Sale persons promoted bio insecticide through Agriculture Extension Agent. Once they bought in, sale promotion was processed with the support from recognized change agent among the users in society. Usually, this company engaged community leaders in the promotion activity such as being hosts for demonstration of the product and being the reference and spokesperson for the product.

Fourteen champions revealed that their price was set based on the cost and affordable of customers.

Variable 9: Users of innovations

The study found that a group of thirteen (13) champions could sell product innovations. One (1) of the ten champions from SMEs could not sell any piece of product innovation.

Table 4-17 presents share percentage of sale volume in response to target sale volume. Half of the champions sold 50-80 % of innovation in response to its target. This group was a mix of SMEs and large companies. Champions view that the sales of innovations would be generated in the latter stages of the product life cycle. It has potential of developing intensive marketing. These champions gained drive on intensive marketing and developed other new products.

By the way, the remaining half of the champions sold 0-30 % of innovation in response to its target. It was dismal to this group of champions, which was a SMEs group. They revealed that they lacked ability in developing market in a professional way as well as lacked budget. They adopted the basic marketing approach for sale force such as placing the product at show room, distributing product brochure to a narrow focus group of target customers. They were able to allocate a small budget for marketing promotion. Therefore, they requested TRF and NSTDA to assist in developing market of innovation coming out from R&D activities. Because of low sale outcome, they felt reluctant to develop other pieces of innovation due to unsatisfied market response to their previous innovations.

Table 4-17: Share percentage of volume sold in response to target sale volume

Innovations	% volume sold of target	Innovations	% volume sold of target
Shred earthworm for bio-pesticide	50 %	Mangosteen Sizing Machine	15%
Test Kit for infectious virus C in human liver	80%	Cassava Cleansing Machine	0%
Fluidized bed dryer and cyclone	60 %	Alcohol's distillation for Jilada Royal Project	30 %
Rice Oven (Strabedted)	55%	Corporate tax and accounting software	13 %
Brown rice frillier by picture detection	50%	Machine for cultivate in jasmine rice growing in North East region	5 %
Mango pickling for food safety	60%	Coji Tower	1 %
NPK test kit	75%	Lenux Talay (Software)	10%
Long life of ripe mango	80%	Chlorine contamination checking machine	5%

Source: Interview 31 companies who produce these innovations coming out from R&D funding program of TRF and NSTDA during 1998-2003

A case of cassava cleansing machine development project (0 % volume sold) demonstrated an example of the champion who lost all enthusiasm in market development of their product innovation. The company owner revealed that this project was proposed to solve the international trade barrier for Thailand export of cassava products. Around the year 2000, European Union Commission (EU) announced the regulation of clean and safety food for EU's import items. At that time, the Thai cassava product had the cleanliness problem. Then, the regulation affected Thailand's cassava export market. The granted researcher and the company owner viewed opportunity to develop the cassava cleansing machine and sale to a small business in cassava drying industry. Therefore, the research team developed small scale of machine (low capacity) to serve users in a small business. Surprisingly, after 6 months the machine launched to the market, the sale had zero volume. The company owner revealed that it was a mistake of expectation to market. Before making decision for investment at the R&D stage, the company did not study a real market demand of the cassava cleansing machine. Today, the company owner realize; that dry cassavas were supply to a large cassava processing business. In response to EU regulation, a large cassava processing business decided to protect their supplier by taking responsibility for cleaning of dry cassava (as raw material) instead of forcing their supplier to clean one's self. Therefore, there was no demand on the coming out of the cassava cleansing machine. By the way, the granted researcher and the company owner tried another round for sale force. They proposed the enlarge scale of the machine to the large cassava processing business. However, the large business had also developed their machine. Finally, the company owner gave up pushing the market development of the cassava machine. However, this was not only one reason to give up the sale force. The company owner revealed that the company did not appreciate patent benefit share as well. The company gained only 20% of benefit whereas the granted researcher and the R&D funding agency gained 30% and 50 % respectively.

The example demonstrates that developing commercial innovation from R&D activities is not able to pass over the analysis of demand of innovation before the R&D stage. Failure of innovation's sale volume will affect the lost enthusiasm in developing commercial innovation from R&D activities.

Variable 10: Publications coming out from undertaking R&D activities within companies.

Publications as research outputs. Most of the champions did not submit R&D undertaken to the publication. On the other hand, they viewed that was obligation by the granted researcher in writing the R&D result into publication. However, all innovations have been submitted to both Thai journals and international journals. All champions did not know how many copies of their story were for publication. The priorities of all champions were on the market development activity rather than the publication.

Analysis and Discussion

Stage 1: R&D Stage

At the R&D stage, champions and followers receive government assistant in the R&D financial and personnel (granted researcher). The study reveals clear evidence that achieving the market development stage of the R&D funding program does not necessarily require an establishment of the R&D unit in the private company at present. Meanwhile, having science, technology, and engineering personnel within the organization are must in developing product/process innovations. These S&T personnel should be the company owner or the trainable staff of the company. Therefore, evaluation of S&T capability of organization is necessary in the funding selection process. Having R&D unit is not necessary to succeed in developing product/process innovations.

While R&D staff plays an implementing role in dealing with technical task and coordinate day- to-day work with the granted researcher (from TRF or NSTDA), it is found that all champions work closely with the granted researcher and respect his/her competency in research task.

In terms of management commitment, it is evident that all top management of champions and followers who participate in the interview has high commitment in the

R&D activity. However, the level of expectation in R&D outcome is different between they group of champions and the group of followers.

It is clear that all champions commit in developing new product/process innovation, while, more than half of the followers do not commit in developing new product/process innovation, but only commit in technical problem solving at present. Then, fostering the R&D project toward commercialization needs high commitment in developing product/process innovation from the private company rather than only having high commitment in R&D activities. In aspect of fostering R&D for commercialization, having commitment in initiate product/process innovation is more important than having commitment in the R&D activity. To foster R&D for commercialization, the government funding organization should pay attention in evaluating the demand of private R&D investment for commercial innovation (demand side management) rather than generating the number of R&D granted projects.

In addition, the study reveals that managing R&D project toward the market development stage requires high capability of the granted researcher coping with the difficulties of research task. However, the success needs high capability of the company personnel as well. Therefore, managing R&D for commercialization needs to facilitate partnership on research tasks and to share knowledge of the company and the granted researcher in collaboration on the R&D project.

Stage 2: Innovation Development Stage

It is clear that ability in research task of the company itself reflects the achievement in developing new products of champions whereby some of the followers fail at this stage.

Because this stage requires more financial support, the continuity of top management commitment in this stage is necessary for success in managing the R&D for commercialization. The success needs top management support from R&D stage toward the prototype testing period and final prototype running. In addition, engaging lead users to the prototype testing period helps a better design of product to market need. This activity leads to the success in the market development stage. Therefore, the

design to meet market needs is necessary to developing innovation for commercialization. However, followers who flop at this stage gain a very low degree of top management commitment in developing saleable innovation. This characteristic is necessary in developing innovation among the private companies.

It is noticed that both of the champions and followers evaluate market need according to business experiences as well as personnel communication with corporate customers. In this case study, mass marketing research for innovation development decision is not valid to this kind of target customers. In this case study, most of the champions expect to push new product innovation by offering a better convenient to customers.

In terms of patent, it is clear that sharing of patent benefit and processing of patenting are big concerns of Thai industries and the government. Most of the interview participants reveal that they encounter with unfair was of patent benefit of sharing from government funding organizations. Besides, most of them are reluctant in the patenting process due to not being confident in the patenting process and the long duration of the process. In terms of business, they (champions) cannot wait for patent processing. So, they move forward to acquire market immediately.

Stage 3: Market Development Stage

According to the interaction between the customer and the company, it is found that champions have more interaction with the existing customer during this innovation development stage in order to evaluate demand on the new product and testing the prototype. Therefore, to keep a good customer relationship is advantage for developing the market. It is noticed that most of the champions do not have intensive market study for the product innovation as a whole industry at the prior stage of R&D decision. Then, the final prototype can attack only the current group of customer rather than broader groups of potential users. Therefore, product innovation presented by this case study still has limited impact on the whole society.

It is noticed that, during the period of study, TRF and NSTDA (source of R&D funding) do not assist private companies in developing intensive marketing for

product/process innovation. In fact, this characteristic does not hurt any champions and followers who have high capability in marketing. However, it hurts a small business or SMEs in developing market of product innovation. From interviewing, a number of small businesses or SMEs request the government to assist in market development activities.

In addition, champions from this case study designed the marketing strategy based on the characteristics of their target customers. Most of them target on an existing corporate customer. Then, it has no sophisticated marketing strategy in this case study. Basically, marketing of product innovation for this case study is for business to business (B2B). Keeping a good relationship with customers is an advantage to the champions. To obtain great impact on Thai innovations, it still needs to add marketing research if the champions will develop other product innovation for individual customers. The current practice of champions, reflects that product innovation in Thailand is still far behind the mass production to individual customers.

In terms of innovation price, all champions use the same price of product at a certain period. Thai product innovations from this case study do not rapidly cut the price down as its technology is not much changed. Therefore, this product technology is low speed in compared with world class-product innovation such as VCD, television, computer, digital camera, and mobile phone. However, these product innovations from the case study can represent Thai product innovations but the speed of technology development in these products is still very low. It is implied that Thai innovation development is still far behind the world-class product. In addition, the developing price of product innovation in the Thai company relies on product cost and the affluence of target customers reflect the low profit margin.

Conclusion

This study limited the number of interviewees in BMR. Fifty-eight per cent (58%) of the total population (thirty-one (31) out of fifty-three (53) companies) located in BMR granted the interview. In generalization, this study will give a big picture in managing the R&D funding program towards commercialization among the Thai private company. The analyses based on the information from interview of these innovators.

For the analysis and discussion, ten (10) variables explain a characteristic of champions and followers of the case study. These characteristics reveal that some variable are not factors enabling/inhibiting the progress of R&D toward the market development stage whereas some variables are. (See table 4-18).

Table 4-18: Variables analysis

Stages	Variables	Consensus from analysis and discussion
R&D	1. R&D units of organization	Most of the champions do not have the R&D unit but they can achieve the new product innovation. While some of the followers have the R&D unit but cannot achieve product innovation development. Having the R&D unit is not a factor enabling/inhibiting the progress of the R&D activity towards the first prototype. Therefore,it is not the factor enabling/inhibiting the progress of the R&D result.
	2. Management commitment in R&D activity	Top management of champions and followers has high commitment in the R&D activity. They are willing to pay in-kind and in-cash at the R&D stage. All champions have commitment in developing commercial innovation at the R&D stage and the innovation development stage respectively. On the other hand, most followers stop their innovation diffusion process at the R&D stage. A few followers aim to develop commercial innovation but it flops at the R&D and the innovation development stage. By the way,

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

		most of the followers just want to participate in R&D for process improvement and solving the current problem. The commitment in developing commercial product/process innovation is not the aim of this group.
	3. Difficulties of the research task in relation to the capability of granted researchers	Most of the champions voted for relatively high capability of the granted researcher in respect to the difficulty of the research task, while most of the followers voted at relatively low-medium capacity of the granted researcher. Besides, all champions have high ability of S&T staff (either owner or employee) and work in collaboration with the granted, researcher. while the followers do not have these characteristics. Therefore, it is clear that the ability of the granted researcher is a factor enabling/inhibiting the progress of R&D project towards prototype.
Innovation Development	4. Ability to translate R&D results into saleable innovation	All champions are able to develop the first prototype towards the saleable prototype, because top management have high commitment in developing the new product. Therefore, they always encourage the R&D team (either formal or informal team) to develop a new product within timeframe. Besides, granted researchers who work with champions have high ability to complete the R&D result to almost saleable innovation.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

THE ASSUMPTION UNIVERSITY LIBRARY

		However, the followers do not have the stated characteristics. The reasons are as follows. Firstly, the followers did not aim to develop the new product. Secondly, the followers flopped at the innovation development stage due to unable to cope with innovation fail. Thirdly, a number of followers are working on innovation development. Therefore, the characteristic of champions in translating the R&D result to saleable innovation is a factor enabling/inhibiting the progress of the R&D result towards saleable innovation.
	5. Design the product innovations according to the market needs	Although all champions do not conduct formal intensive marketing research, they evaluate market needs by using business experiences and talking with a current customer. Most of the champions maintain good relationship with customers. They engage a focused group of corporate customers (lead users) to the prototype testing period. They aim at designing the best suit to the user. Finally, they can develop saleable volume of product in the marketplace. Meanwhile, some champions do not engage lead users at the prototype testing period, their product is not sold at its launch. This variable is not valid to the characteristic of followers. The reason is that most of the followers do not aim to launch a new product. Some of them fail in technical development of innovation. Some of them are on going at this stage. For as champions' characteristics, it is clear

ASSUMPTION UNIVERSITY OF THAILAND
* มหาวิทยาลัยอัสสัมชัญ *
SINCE1969

		that success in R&D for commercialization needs to design product innovation according to market needs. This characteristic also leads to success in the market development stage. Therefore, this variable is a factor enabling/inhibiting the progress of R&D result toward the saleable innovation and market development stage.
	6. R&D projects progress up to the stage of patenting	Not all products innovation from champions receive patenting. Nevertheless, non-patenting products could be sold in the market at a certain period after launch. In the same way, most of the derived prototypes from the R&D stage are in the form of unready for sale. It needs to be re-invented for many times until it is ready in saleable form. All champions had gone through this process at the innovation development stage. While the followers fail due to being unable to develop innovation from the R&D result to reach the stage of patenting. From the case of champions, it is not necessary to hold the launch of innovation if it does not yet receive the patent. The company can move forward to the stage of market development independently. As champions' practices, this variable is not a factor enabling/inhibiting the progress of the innovation development stage towards the market development stage.
Market Development	7. Organization's capability in pushing a new product	Characteristics of the followers do not involve at this stage since its progress flops at the innovation development stage. Most of the champions have high

ASSUMPTION UNIVERSITY OF THAILAND
มหาวิทยาลัยอัสสัมชัญ
SINCE1969

	innovation to market	organization's capability in pushing new product innovation to market. Three large businesses from the champion group acquire corporate customers in other countries. Their market grows rapidly. Nevertheless, small businesses or SMEs could not acquire large market share of their product innovations due to low capacity in developing the new market. However, SMEs can attack only a focus group of customers rather than a broader group of potential users. They cannot push a new product innovation to market as a whole (e.g. national level or global market). Therefore, this variable is a factor enabling/inhibiting the progress of innovation to the broader marketplace.
	8. Marketing strategy	The appropriate marketing strategy depends upon the characteristics of customers (corporate or personnel). Almost half of innovations generated from SMEs cannot be competitive in the broader marketplace. They have the relaxed marketing strategy for new product innovation due to the limitation of financial, marketing personnel, and technique. low ability in developing new market of innovator reflects less impact on Thai innovations to the society. Therefore, this variable is a factor enabling/ inhibiting the progress of product innovation to the marketplace.
	9. User of innovations	Half of innovations gain low number of users (estimated by per cent of product sold in response to target sale volume). Therefore, they

ASSUMPTION UNIVERSITY OF THAILAND
มหาวิทยาลัยอัสสัมชัญ
SINCE1969

		are reluctant in developing other innovations afterwards. By the way, half of the champions gained satisfying sale volume and continued to develop other new products. In relation to the user of innovations, most of the sale price of products generated by champions still depends upon the cost and the affluence of existing customers. Then, Thai product innovation sticks on the low price strategy. This reflects low capability in market development of these champions. Therefore, this variable is a factor enabling/inhibiting the progress of innovation to marketplace.
	10.Publications coming out from undertaking within companies	Most of the champions do not submit R&D undertaken to the publication. On the other hand, it is the effort of the granted researcher in doing this. Most researchers wrote the papers for publication based on their research undertakings. Nevertheless, the amount of publication had not been revealed by the interviewees. However, most of the champions ignore writing the publication. They have never seen any value related to market development of innovation. Therefore, this variable is not a factor enabling/inhibiting the progress of innovation to marketplace.

Aforementioned of variables analysis can be summarized that there are six factors enabling/inhibiting the progress of the R&D stage toward the market development stage in the case of Thai industry environment. Six factors are summarized in each stage as follows:

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

R&D stage:

- Difficulties of the research task in relation to the capability of granted researchers

Innovation development stage:

- Ability to translate R&D results into saleable innovation
- Designing product innovation according to the market needs

Market development stage:

- Organization's capability in pushing new product innovation to market
- Marketing strategy
- Users of innovations

From the six factors enabling/inhibiting the progress of the R&D activity towards the market development stage, it is clearly evident that marketing factors still inhibit the progress of innovation among the champions. It is found that many champions are SMEs (10 of 14 companies) and have relatively low capability in developing market of new product innovation which reflects the low number of adopters.

In addition, it can be seen that four variables are not factors enabling/inhibiting the progress of R&D toward the commercialization stage of the Thai industry. The study also reveals that having the in-house science and technology (S&T) personnel is much important than having the R&D unit within the organization (variable 1). In addition, having high commitment of top management in developing a new product is much more important than having commitment in the R&D activity alone (variable 2) because, some companies expect only to improve the current process/or problem solving rather than expect to develop product/process innovation from the R&D activity.

In addition, this case study found that external environment of the private company has relative factor inhibiting the effort in fostering innovation to the market development stage as follows:

✓ Company holds less share of patent benefit rate. For example, the funding organization' gains 50%, the researcher gains 30% and the company gains 20 % of patent benefit share, whereby the funding organization and the researcher lack capability and are less intensive on the market development activity. In addition,

✓ Support of the R&D activity for all project funds ends up with the innovation development stage. There is no more support on the marketing development stage from research funding organization. Thus, it is hard for a very small business to conduct intensive marketing investment. Therefore, many piece of innovation coming out from government funds fail on marketing. In relative with this situation, open channels for imitating product innovation are opened by large companies. (Big fish always eat small fish.).

The empirical study presents that technology and marketing is dynamic. The R&D funding manager needs to adopt the presented concept into managing R&D funding for commercialization. The seven factors present that the R&D result can progress to each stage of R&D diffusion to commercialization (the R&D stage, the innovation development stage, and the market development stage). It is a dependent factor enabling/inhibiting the progress in the stage by stage up to the commercialization.

The study proposes the innovative model in managing innovation diffusion from the R&D stage toward the market development stage as figure 4-13:

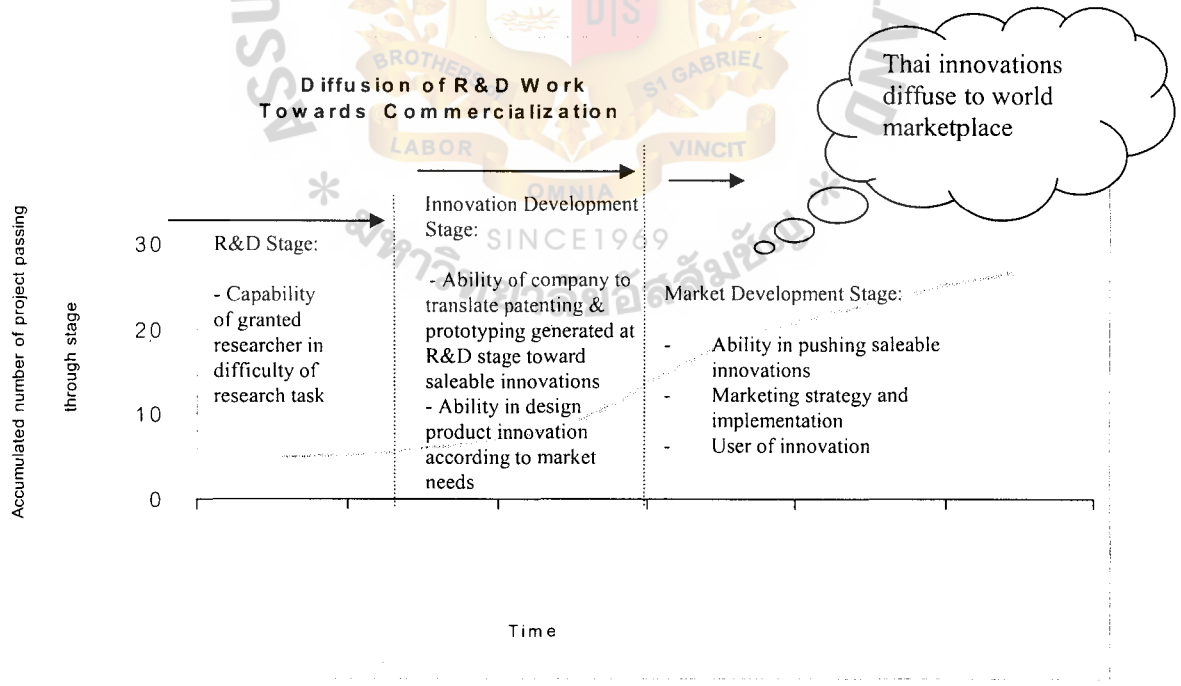


Figure 4-13: Factors enabling/inhibiting the progress of R&D along the Innovation Diffusion Process

The study proposes six factors enabling/inhibiting the progress of R&D activity along the three stages of innovation diffusion process. It is hoped that these six factors can be incorporated into strategic development of public R&D management for commercialization of Thailand. It can be applied with both R&D funding strategy and technology licensing to private companies. Therefore, funding organizations should take more active role at the innovation development stage and the market development stage rather than phase out their role after the end of the R&D stage. In addition, government funding organizations should incorporate external environment and norms of the Thai industry into the strategic planning as well. The result of this study, found that not only six factors enabling/inhibiting the progress of innovation diffusion, but also external environment force to the diffusion as well. These external environments are the characteristics of industry structure and corporate culture in generated innovation of the Thai industry. Therefore, managing of R&D project toward commercialization should consider the relationship between five components as follows.

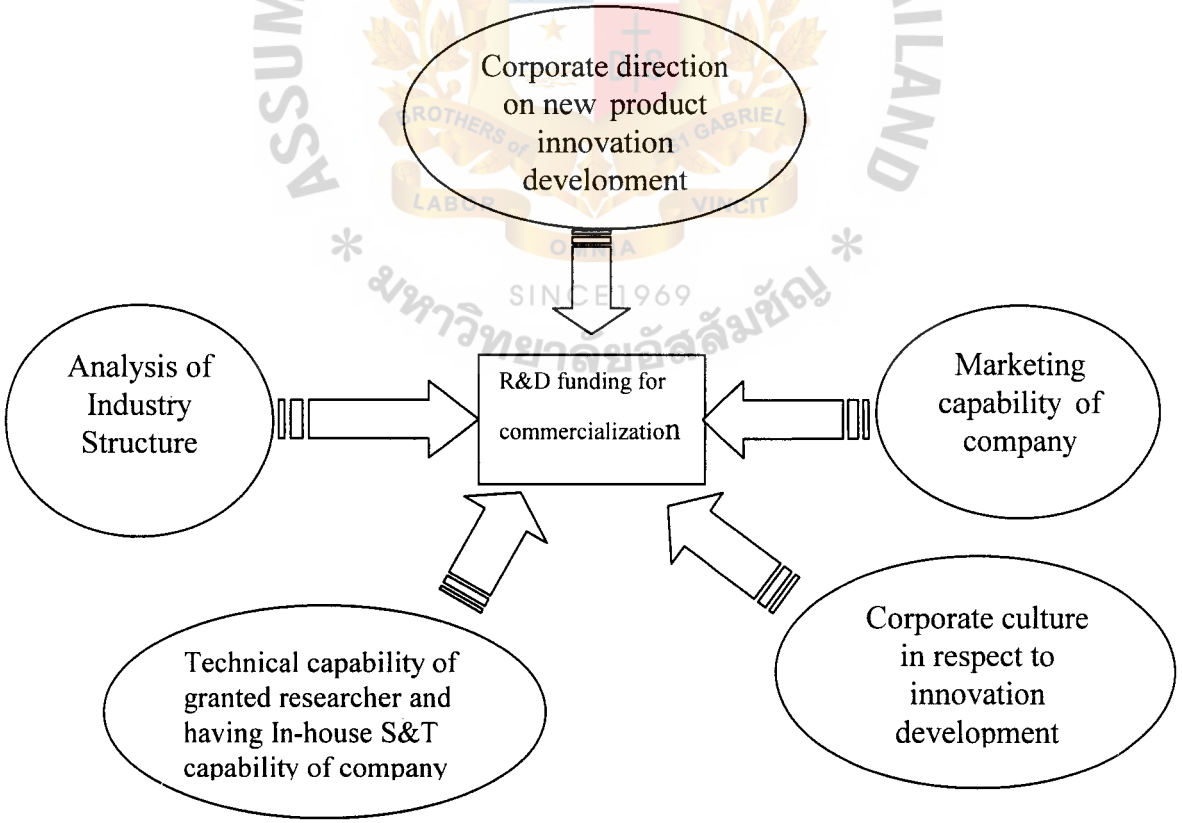


Figure 4-14: Environment influencing the diffusion of R&D funding toward commercialization in Thailand

4.3 Conclusion

This study develops a scale measurement tool, as described in chapter 3, step II, section 1, for the measurement of the innovation diffusion process of two case study organizations including TRF and NSTDA. The scale measurement is developed on basis of Innovation Diffusion Theory (Rogers 1995) incorporated with the principal of the innovation development process. This scale measures the spread of the R&D funding program among private companies. Accumulated number of R&D granted projects are plotted from year by year during 1998-2003. Therefore, the derived S-Curve represents the adoption curve of the R&D funding program among private companies for the case study organizations (TRF and NSTDA). This study would like to propose this measurement tool in managing R&D for commercialization. It is hoped that this scale measurement can be used for the evaluation of R&D funding effectiveness for the commercial purpose

As result, it is found that the diffusion of innovation from the TRF funding program spent 44 months in achieving the market development stage from December 1998 to December 2003. At the same period, innovation diffusion from the NSTDA funding program spent 51 months. These two organizations gained a slightly different rate of innovation diffusion by which TRF gained more rapid rate due to different operations. With regard to five variables affecting the rate of adoption (see section 4.2.2), communication channels of the R&D funding program and the extent of change agent are relative factors enabling a higher rate of adoption for the TRF program than that of NSTDA. Clear different operation is that TRF hires contractors namely "research package coordinator" to coordinate with the industry (production sector) and the professional researchers of universities and government agencies. Contractors take the role of match-markers between users of R&D result and professional researchers. Therefore, this operation of TRF affected the higher rate of R&D funding program than NSTDA. On the other hand, NSTDA did not have full time change agents (contractors), but work on regular basic of public relation through university lecturers, professors, and professional researchers in government agencies. This practice is relatively too far behind the need of the production sector or the direct user of the R&D result.

In terms of the innovation development model, the study found that both TRF and NSTDA employed the linear model with the science-push approach (Schumpeterian 1939). Both organizations performed innovation development work step-by-step. At the beginning, they focused on developing R&D projects as much as possible by using the R&D funding program strategy. There were abundant R&D results at the first period of the innovation diffusion process (R&D stage, see figure 4-13). Both organizations expected that private firms (production sector) would translate the R&D result towards the innovation development stage (figure 4-13). They did a minimum work in facilitating the translation of the R&D result to saleable innovations. There were a few R&D works that TRF or NSTDA funded at this stage. In overall, TRF and NSTDA phased out their role in facilitating the innovation development stage and the market development stage among private firms. From past experiences, TRF and NSTDA took first priority in producing the intensive R&D result. Recently, they had facilitation of some innovation development projects as well as fostering technology licensing of public R&D results. They view facilitation of innovation development and market development are the second and third priority. That was the reason why R&D results funded by TRF and NSTDA were not much led to commercialization. With regard to the linear model, TRF and NSTDA performed the innovation development process step-by-step; from the R&D stage, the innovation development stage, and the market development stage. This study found that most companies undertook these further steps themselves. It was found that both TRF and NSTDA had no mission in fostering intensive market development for product innovations coming out from the R&D funding program. **This finding proves that the innovation process managed by the governmental organizations is linear, reflecting a science-push model (Schumpeterian 1939) (hypothesis 1).**

In terms of innovation derived from the innovation diffusion process, 10 product/process innovations derived from the TRF funding program. NSTDA also derived 10 product/process innovations. These innovations include industry process improvement, agriculture process innovation, post-harvest innovation, medical diagnosis testing, food preservation, by product recycle, and software. Of these, only 13 kinds of product innovations were sold in the marketplace (see detail in appendix 8). Their sale volume varies in relative with the performance of innovation and

marketing & sale capability. It is noticed that Thai innovators can produce new equipment that increases efficiency and effectiveness of the rice-mill production process. It is honored that innovations progress from the R&D activity of the company joining the government funding program. **This finding proves that R&D is a viable strategy needed to generate innovations in industry (Doyle & Bridgewater 1998) (hypothesis 2).**

Finally, the study found six factors enabling/inhibiting progress of innovations from the R&D stage to the innovation development stage and the market development stage. It includes:

R&D stage- In order to achieve the R&D result as the lab scale or first prototype, government funding agency needs to consider difficulties of the research task in relation to the capability of researchers.

Innovation development stage – In order to achieve saleable innovation (final prototype), government funding agency needs to i) evaluate the ability of the company in translating the R&D result into saleable innovation ii) encourage the company to set up the activity in design product innovation according to market needs.

Market development stage – In order to achieve the satisfying marketing result, the government funding agency needs to consider i) the organization's capability of the company in pushing a new product innovation to market ii) the company's marketing capability iii) the user of innovations

This study aims at introducing this factor as basic criterion in recruiting the private company to participate in the R&D funding program in the future. These factors could also be introduced as the commercial policy in managing R&D funding toward commercialization intensively.

Of course, these six factors are not only variables influencing the progress of innovation diffusion from the R&D activity. External environments are hurdles of the progress of innovation towards commercialization including unfair share of patent

benefit rate, no more support on the marketing development stage from the research funding organization, and imitating product innovation by the large company.

This study reveals that Thailand still has hurdles in fostering private R&D activities towards commercialization in terms of ability in saleable innovation. At present, these hurdles reflect from unclear direction of policy on R&D for commercialization during the period of 1998-2003. It is concluded that the R&D funding operation in the past was still far from mechanism in fostering private R&D, particularly SMEs, to reach the marketplace. Therefore, the stem of the problem possibly came from looking ahead of the Thai government in designing and managing R&D funding programs that are applicable to the real marketplace. It is implied that the government should manage the R&D funding program in correspondence to complexity structure of the industry and the society e.g. the Thai industry chain, industry organization culture, perception in Thai technology product of Thai people (as well as foreigners), technology security for imitation, and intellectual property. Finally, the effective commercialization strategy in Thailand needs to be incorporated in the management of the innovation diffusion process.

The analysis confirms the findings of Cooper & Kleinschmidt (1990) arguing that failure of management to look far enough ahead inhibits the innovation process. In addition, the case study analyses of the major two funding organizations argue that an effective commercialization approach needs to be incorporated into the innovation diffusion process (Rogers 1995) (hypothesis 3, 4).

CHAPTER 5: CONCLUSION

5.1 Introduction

Currently, the Thai government attempts to enhance the national technological capability by using the R&D strategy (e.g. building R&D granting agencies, improving researchers' capability, and supporting private R&D investment). The study argues that R&D is undoubtedly a key capability needed to generate technical changes and improvements. However, R&D is never sufficient by itself for generating new products, processes and services needed by the Thai industry. Most of the public R&D projects could not progress towards commercialization. The study will undertake the policy research to understand an effective mechanism in bringing R&D granted projects towards commercialization and the way to manage factors influencing (enabling/inhibiting) the progress from the R&D stage to the innovation development and the market development stage.

5.2 Conclusions

5.2.1 Conclusion - thesis questions

The study raises three thesis questions to the thesis problems. (see chapter I). It is revealed that R&D projects funded by TRF and NSTDA are adopted among private companies regarding the innovation diffusion curve (S-curve) over the period of 1998-2003. It is found that the rate of adoption between TRF and NSTDA is slightly different. From the analysis, TRF employed a proactive funding approach. TRF established the industry fund and requires the matching fund from private companies (venture capital form). In the meantime, TRF communicate with the private company about funding opportunity via a group of skill contractors. This group is called "R&D package coordinator", which deals directly which private companies and professional researchers from universities and government units.

The study found that TRF has shorter process of innovation diffusion than NSTDA. Given R&D projects carried out at different stages along the innovation life cycle, TRF took 44 months approximately in developing the R&D project from 1998 to the innovation development stage and the market development stage in 2003. It was a result that TRF granted R&D budget in the form of venture capital with private

company at R&D stage (as the beginning stage of the diffusion towards commercialization). While, NSTDA took 51 months approximately in developing R&D project from 1998 to innovation development stage and market development stage in 2003. It was also found that NSTDA spent longer period because there were some R&D results awaited investment by the production sector. It was a result of granting R&D without involvement of the private company at the R&D stage. In addition, technology packaging from the R&D result was far from the production's requirement. However, NSTDA licensed core technology to the private company afterward. Therefore, the innovation diffusion process of NSTDA has a gap between R&D stage and the innovation development stage, which is the transition period (early 2000 to early 2002) of R&D results from the lab scale or first prototype to private companies.

In comparison of R&D management outcome of TRF and NSTDA, the study suggests that using the venture capital in managing R&D funding would be an effective approach in fostering innovation development to the private sector. It is emphasized that the private companies should be engaged from the beginning of innovation development to the diffusion process (from the R&D stage to the innovation development and the market development stage). Their involvement is more advantageous than employing the licensing of high technology packaging from the R&D's result to the private company. In the case where licensing of the technology is considered an option in fostering the innovation diffusion, appropriate technology packaging would be necessary to suit the potential licensees' requirements. The analysis, however, shows that using technology licensing strategy will make research-funding organizations (TRF and NSTDA as case study) encounter with the transitional period (gap) of technology absorbing by the Thai industry.

The study explores factors enabling/inhibiting the progress of innovations to understand why some innovations can pass through the market development stages whereas others flop during the way. This study set ten (10) variables. Funding organizations and the private company can control the management of R&D funding regarding ten variables. They are called "controllable variables". Based on the eleven variables set, table 5-1 presents six factors influencing the progress of innovation all together at each stage. The analysis of findings shows that the capability of

researchers in relation to the difficulty of the research task is a determinant factor in achieving the successful lab scale or deriving the first prototype development at the R&D stage. Next, the ability to translate R&D results into saleable innovation is a determinant factor in the success of saleable innovation development (last prototype) at the innovation development stage. In addition, the ability to design product innovation according to market needs is a factor to success at the innovation development stage towards the market development stage.

Finally, the study reveals three determinant factors in the success of the market development stage of the derived innovations. It comprises i) the organization's capability in pushing a new product innovation to market ii) the market strategy of a new product innovation iii) the user of innovations. Therefore, the diffusion of R&D funding program is progressive growth stage by stage from the R&D stage, the innovation development stage, and the market development stage. The study demonstrates that most of the R&D granted projects flop at R&D and the innovation development stage. Only a small portion of granted projects reach the market development stage. All companies who pass through this stage look at market demand of the expected innovation to assist in their decision making for innovation development. The study reveals that the innovation development stage and the market development stage have a linkage between technology pushes and market demand.

Table 5-1 Factors enabling/inhibiting the progress of R&D granted projects towards commercialization: case study of TRF and NSTDA (1998-2003)

Stages	**Factors**
R&D	Difficulties of the research task in relation to the capability of researchers
Innovation development stage	Ability to translate R&D results into saleable innovation
	Design the product innovations according to the market needs
Market development stage	Organization's capability in pushing a new product innovation to market
	Marketing strategy
	Users of innovations

The empirical analyses reveals that the Thai industrial firms need more effective linkages with the public sector R&D organizations to manage and facilitate the national R&D development system. It is argued that the rate of innovation adoption depends on the interaction with the market and the industry. Effective linkages between 'technology push' and 'market pull' are decisive for the policy agenda of the national R&D system of Thailand.

The empirical analysis suggests that managing the effective commercialization approach needs to be incorporated into the innovation diffusion process. Therefore, the model of the innovation diffusion process should be managed to suit the working principal of the R&D funding organization.

5.2.2 Conclusion - thesis problem

According to thesis problems "Thailand has low technological capability and why public R&D projects have not led to commercialization", the study focuses on investigating the controllable variables (10 variables) that influence the progress of the public R&D project through private companies and towards commercialization. The study results present six controllable factors enabling/inhibiting the progress of R&D towards commercialization. However, it is aware that the six factors are not the sole factors determining the success or failure of the public R&D management for commercialization. The management of public R&D system needs further support from industry environment, which is an uncontrollable variable regarding to a mission of R&D funding organizations. In order to cope with uncontrollable variables, it is argued that they should work as partnership style and proactive with the related industry development agencies and trade agencies.

From the present research, the R&D funding organization and the central government will gain better understanding on the diffusion process of the public R&D project toward commercialization and the factors influencing their progress. The result presents that technology push is not enough for the managing public R&D for commercialization, but it also needs to manage the demand of innovation users or absorbers (demand pull). It is hoped that the body of knowledge gained from this thesis can assist in revising the National policy of R&D for commercialization.

Lessons learnt from the past experiences will help improve the public R&D management in a better shape. It is hoped that the thesis result can lead to the development of strategic planning for resolving Thailand's problems on a dismal rate of technology development and ineffectiveness of public R&D outcome for commercialization.

5.3 Implications

5.3.1 Implication for theory

The study demonstrates using the Innovation Diffusion Theory (Roger 1995) to explain the diffusion of R&D granted projects towards commercialization. The implication of theory helps in-depth understanding on the progress of the R&D outcome from the R&D project to the marketplace. The implication of theory shows that the diffusion (S-Curve) of R&D project towards commercialization needs interaction between the potential users (adopters) of the R&D's results (prototype to market) and public R&D funding organizations. In the context of innovation diffusion theory, the potential users of R&D's result are Thai industries and the thesis deals with private companies who adopt the R&D funding program from 1998-2003.

The rate of R&D funding adoption is also explained by the Theory. The thesis reveals that using a proactive approach with private companies in managing the public R&D funding program towards commercialization can stimulate the speed of the rate of R&D funding adoption. The thesis presents the concept of S-Curve is needed to be incorporate with public R&D management. The R&D funding manager can keep track with the adoption rate of funding and how its progress toward commercialization. In terms of foresight, the R&D manager can use an appropriate forecasting technique to see the prospective life cycle of the innovations.

The Innovation Diffusion Theory (Roger 1995) incorporating three stages of innovation progress from R&D, innovation development and market development can be applied with other private R&D organizations as well. The scale measurement of innovation diffusion towards commercialization (see figure 3-1 in chapter 3) developed in this study will help track the progress of innovations from R&D towards commercialization. The measurement's result can show how much they can manage various R&D projects in effective commercialization.

The application of the theory presents the R&D diffusion curve. This curve represents the abstract result of the R&D commercial policy of the public funding organization. It is argued that managing public R&D for commercialization needs to be incorporated with the concept of Innovation Diffusion Theory (Rogers 1995).

5.3.2 Implication for policy

According to a dismal rate of the R&D funding program adoption from two case study organizations (TRF and NSTDA) urges Thai government to revisit the existing policies in managing the R&D system. It is argued that not only R&D funding organizations take proactive role on increasing a number of R&D grantees but also need prudential decision by looking at a commercial result oriented. The Thai government should look far ahead of the R&D stage towards the innovation development stage and the market development stage as a full cycle of public R&D funding and management.

In order to refine the government policy in managing the national innovations system (NIS), the government still needs to stimulate the generating of innovation in a unique industry sector. Because innovations management is dynamic, it is cross of multidisciplinary such as science & technology, society, marketing, production, and economy. Therefore, the government should differentiate R&D for the commercialization policy from the overall innovation policy. Then, the separation of R&D for the commercialization policy needs to be developed for the national agenda. Besides, the government should facilitate a linkage of the dynamic group of multidisciplinary among the government agencies and private sectors. The study proposes that R&D funding agencies should develop a strategic partnership in order to implement more effective results rather than working alone.

5.3.3 Implication for management practice

5.3.3.1 Organizational level

The Innovation Diffusion Theory (Rogers 1995) provides a base to frame the innovation management direction of the R&D funding agency or private company. Reviewing the past period of innovation diffusion urges the management to think forward to the direction of innovation derived from the organization. In the meantime,

THE ASSUMPTION UNIVERSITY LIBRARY

management should review innovation management practices in the organization and provide best practice to the organization in developing innovation by paying attention to the factors enabling the progress of R&D activities from the R&D stage, the innovation development stage, and the market development stage.

However, this study proposes a policy-implementing approach for the management practice of R&D funding organizations as follows:

- Categorize R&D funding for commercialization out of existing type of funding (e.g. funding for knowledge creation, industry, new researcher, post graduate etc.).
- Allocate budget and differentiate R&D funding management for this type of funding. More results oriented in managing R&D funding for commercialization.
- Establish the restricted policy of funding. R&D funding organizations should establish criteria for recruitment of the private company in the process of R&D development. In addition, the funding organization still exists in the loop of the innovation development process until gaining market share for the innovation.
- For recruitment criteria, it should consider factors enabling/inhibiting the progress of R&D towards commercialization. The R&D managers of the public and private companies may use the six factors as a base to plan their innovation management process.
- Prioritize R&D topics in relation with industry profile of Thailand. In the prioritizing process, it must identify the need of the production sector for developing innovation in respect with market opportunity.
- Share of patent benefit. It needs to be fair among the company, the researcher, and the funding agency.
- Marketing support from government agency. It needs marketing activity support to the innovation product, particularly the SMEs producer.
- Imitation of the new product. Technically, the product requires protection mechanism in imitation from other producers.
- Create perception of Thai users in Thai technology. (This deals with culture change.)

5.3.3.2 Individual level

The study demonstrates application of Innovation Diffusion Theory with R&D and innovation management for commercialization. Therefore, the R&D funding manager, the R&D manager in the private company, the professional researcher in the private company and universities, government units throughout top management of the private company can learn and have better understanding in managing R&D towards commercialization.

5.4 Contributions of the thesis

The thesis contributes to the two case study organizations (TRF and NSTDA). The thesis further contributes to private companies in Thailand, particularly SMEs. Private companies can build their innovations capability from learning the innovation diffusion concept and variables influencing the innovation success in the market development. Ultimately, the thesis contributes to the Thai government in assistant to the fostering policy of the National Innovation System (NIS).The body of knowledge derived from this thesis urges Thai government to develop an effective approach in managing the public R&D system . It is expected that effective linkage activities between the industry sector and the research funding organization will drive to the speed of R&D diffusion towards commercialization.

5.5 Limitations of the thesis

The study's results on factors enabling/inhibiting the progress of innovation diffusion are concluded from R&D and innovation development experience of 58 % of the private companies (31 companies out of 53 companies in BMR) who joined the R&D funding program of TRF and NSTDA. These are companies located in seven provinces of BMR (Bangkok, Pathumthani, Samutprakarn, Samutsakorm, Nonthaburi, Nakornpathom, and Ayuthaya). Due to the budget limitation and the short timeframe of the Master thesis study, the analysis and conclusion through the policy recommendations are based on the data and information of the companies in BMR. To develop the action plan of the national innovation system, it may need to revisit this case study and interview more companies all over the country who joined the R&D funding program in order to gain a firmer understanding about the management of the R&D system.

Besides, the conclusion on factors enabling/inhibiting the progress of innovation is limited to the thesis variables (10 variables). It is accepted that there would be more variables in real environment but the study limits them to 10 variables.

However, the model for investigation of Thailand innovation diffusion presented by this thesis is still valid to assist in the development policy and implementation plan for the national innovation system. Validity of the model can be checked against the broader study of the National Innovation System (NIS) initially reported by the National Science and Technology Development Agency (NSTDA) in 2003.

5.6 Recommendations or Future research

According to the R&D diffusion pattern of TRF and NSTDA, this study does not focus on the study of foresight R&D diffusion. Then, this study will not forecast the diffusion toward the next period. However, it is interesting to perform a foresight study of the R&D funding program diffusion. It is expected that the foresight study will reveal a clear direction of public and private R&D funding policies. In terms of making decision for terminating R&D funding to the private sector, the policy maker can use a mathematic model for forecasting the latest cycle of the funding program (S-Curve) in corporate with the concept of the dynamic model of innovation (Utterback and Abernathy 1975) to assist in making a decision for phasing out of R&D funding from the private sector.

In addition, the study also recommends further study on dynamic variables influencing the diffusion of innovation from the R&D activity. More numbers of variables in the area of the marketing activity, technology competency, organization management, collaboration, and macro-environment (e.g. economic, technology, culture, government policy, nature of society) should be set for the study. It is expected that the result of the study will give a broader view of the national innovation management system for Thailand circumstance.

5.7 Conclusion

The study's result reveals that R&D is a viable strategy needed to generate innovations in the industry. It also needs balance management of the "science-push approach" and the "market pull" in developing the national innovation system (NIS). Using the "push

model" in the past five years reflects a dismal rate of innovation diffusion toward Thai private companies that open the gate of commercialization. Therefore, failure of management to look far enough ahead inhibits the innovation process. In addition, effective commercialization approach needs to be incorporated into the innovation diffusion process.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

BIBLIOGRAPHY

_____. 1997,*Technology Foresight 2nd Edition,* NSTDA Publication Department, Bangkok.

_____. 1999, *Science and Technology: Past to Future,* NSTDA Publication Department, Bangkok.

_____. 1999, *Technology for Commerce,* NSTDA Outstanding Report, Bangkok.

_____. 2000, *The IMD World Competitiveness Yearbook 2000,* International Institute for Management Development (IMD), IMD International, Inc., Switzerland.

_____, 1994, Role on R&D: the Challenge of new century, Thailand Research Fund, Bangkok

Anthony Skip Basiel, 2003, "Push &Pull Technology" January, http://www.cogs.susx.ac.uk/lab/hct/hctw99/download/html/skip.html

Baldridge, J, & Burnham, R. 1975, 'Organizational innovation: Individual, organizational and environmental impacts' *Administrative Science Quarterly,* pp. 165-167.

Bernard N. Slade. Comressing the product Development cycle From research to Marketplace. New York: Amacom, 1998.

Chattoe, G. 2002, '*Modeling the Adoption of AEMs as an Innovation Diffusion Process'*, February, http://www.lisc.clermont.cemagref.fr/ImageProject/Results/Models/Diffusion

Chantramonklasi Nit. "Science and Technology Development for Industrial Competitiveness in Thaialnd: Problems and Lessons," TDRI Quarterly Review, 9, Fall 1994, pp.24-30

Chulawattanathon Montri, R&D management system in Thailand, Thailand Research Fund, 1994

Compeau. 2002, *' Extending Innovation Diffusion Theory in Information Systems'*, February, http://www.gsu.edu

Cooper, D. R., & Pamela S. S 2001, *Business Research Methods, 7th Edition.* McGraw-Hill Companies Inc., Singapore.

Csiro, 2003, Country Science Briefs, January, http: //www.csiro.au/international/briefs/thailand.html

Disi, Freeman, Nelson, Silverberg., and Soete. 1988, *Technical Change and Economic Theory* , Pinter Publishers Ltd., London and New York.

Garland, K.P. 1991, 'Diffusion and adoption of instructional technology', *Instructional technology: Past, present, and future* 2nd, eds G. Anglin, Libraries Unlimited, Englewood.

Giovanni Dosi, Christopher Freeman, Richard Nelson, Gerald silverberg., and Luc Soete. Technical Change and Economic Theory. London: Pinter Publishers Ltd, 1998.

Hahn, R, & Schoch, N. 1997, 'Applying diffusion theory to electronic publishing: A conceptual framework for examining issues and outcomes', *The ASIS Annual Meeting* pp. 5-13.

Hastings K. & Healy, Innovating Australia 2000 Study Tour Report. RDRIC, 2000

Jakkrit Kuanpoth. 2003, Major issues in the Thai Patent system; December, http: //www.thailawforum.com/articles/jakpat1.html

John Stark 2000, *Innovation Management;* February, http :// www.johnstark.com/in3.html

Kline and Rosenberg, N. "An Overview of Innovation." In The Positive Sum Strategy: Hamessing Technology for Economic Growth. Edited by R. Landva and N.

Rosenberg Wachington, DC: National Academic Press, 1986.

Lefebvre, E. & Lefebvre, L. 1996, '*Information and telecommunication technologies: The impact of their adoption on small and medium-sized enterprises'*, February, http:// www.idrc.ca/books/focus/807/807.html

Linda M. Pfotenhauer, 2004, "Science and technology Development for Industrial Competitiveness in Thailand" January, http: //info.tdri.or.th/library/quarterly/text/std_comp.htm

Maesincee, Suvit. " Strategic Innovation: Agenda for Enhancing Diffusion and Adoption of Innovation in Thailand," Handout material on IDF Seminar, 30 September 2002.

Malekzadeh, Ali. " Research and Development in Small High-Technology Firms" *Northeastern University Edwin Tiffany Hawks, University of Texas at Arlington* . (2000).

Marvin L. Patterson., and john A. Fenoglio. Leading product Innovation. Accelerating Grownth In A Product-Based Business. New York: John Wiley & Sons, Inc. 1998.

National Metal and Materials Technology Center, 2002. Bulletin

National Science and Technology Development Agency, 2002.Annual Report

NECTEC, 2003, Open Society, Dynamic Economy; January, http: //www.nectec.or.th/users/htk/sciAm/03NSTDA.html

Panit Vichanj, R&D management: Learning from Experiences, Thailand Research Fund, 1996

Robert G Cooper., Elko J. Kleinschmidt., New Products:The key Factors in Success. Chicago: American Marketing Association, 1990.

Rogers, Everett M.,1962, "Diffusion of Innovations" The Free Press. New York.

Rogers, E. 1995, *Diffusion of Innovations, 4 th Edition,* A Division of Simon & Schuster Inc., New York.

Schiffma, S.S. 1991, 'Instructional systems design: Five view of the field', *Instructional technology: Past, present, and future*2nd edition, eds G. Anglin, Libraries Unlimited, Englewood

Sensor Research Company RC. 2000, "Tips & Facts- Organizing R&D for Success" , September,
http ://www.sensors-research.com/tips.htm

Sonnenwald, Maglughlin, and Whitton C. "Using Innovation Diffusion Theory to Guide Collaboration Technology Evaluation: Work in Progress." *IEEE 10th International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises*. (2001).

Sripaipan Chatri, Enhancing Thai private sector capacity for research, development and engineering, Thailand Development Research institute., 1990.

Schmookler, Invention and Economic Growth. Cambridge, MA: Harvard University Press, 1996.

Surry, D. 1997, 'Diffusion theory and instructional technology', February,
http://www.gsu.edu/~wwwitr/diffusion/index.html

Thailand Research Fund Perspective, 2002. Bulletin

Treloar, A. 2002, 'Just another technology? How the dynamics of innovation can help predict the future of the browser' Deakin University, February,
http://www.deakin.edu.au/~aet/

Utterback, J. & Abernathy W. 1975, *A Dynamic Model of Process and Product Innovation,* Omega, Massachusetts.

Utterback, J. 1994, *Mastering the Dynamic of Innovation: how companies can seize opportunities in the face of technological change,* Harvard Business School Press, Massachusetts.

Winnie, K. 2003, '*Rogers' Diffusion and Adoption Research: What does it have to do with Instructional Technology'* February, http://www.gsu.edu/~mstswh/courses

Appendix 1

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 1

Background Information of NSTDA and TRF

1. The National Science and Technology Development Agency

The National Science and Technology Development Agency or NSTDA is an autonomous funding and research organization, established under the "Science and Technology Development Act of B.E. 2534 (1991), outside the normal framework of state-enterprise and civil service. It undertakes a broad-based, systematic approach towards enhancing the entire science and technology system of Thailand in support of national economic and social development.

NSTDA's three main goals are:

1. To support public sector Research, Development, Design and Engineering (RDDE) projects;
2. To strengthen the technological capabilities of firms in the private sectors,
3. To disburse S&T scholarships for studying abroad and locally.

NSTDA' s function comprises four main areas of responsibility:

i) Research, Development, Design and Engineering (RDDE)
The undertaking of RDDE includes the basic research, applied research to call for new scientific knowledge. The knowledge generation is to make effective application to the design of lab equipment and machinery.

ii) Technology Transfer refers to the transfer of knowledge from innovation-oriented research projects to meet societal needs within the context of governmental policies.

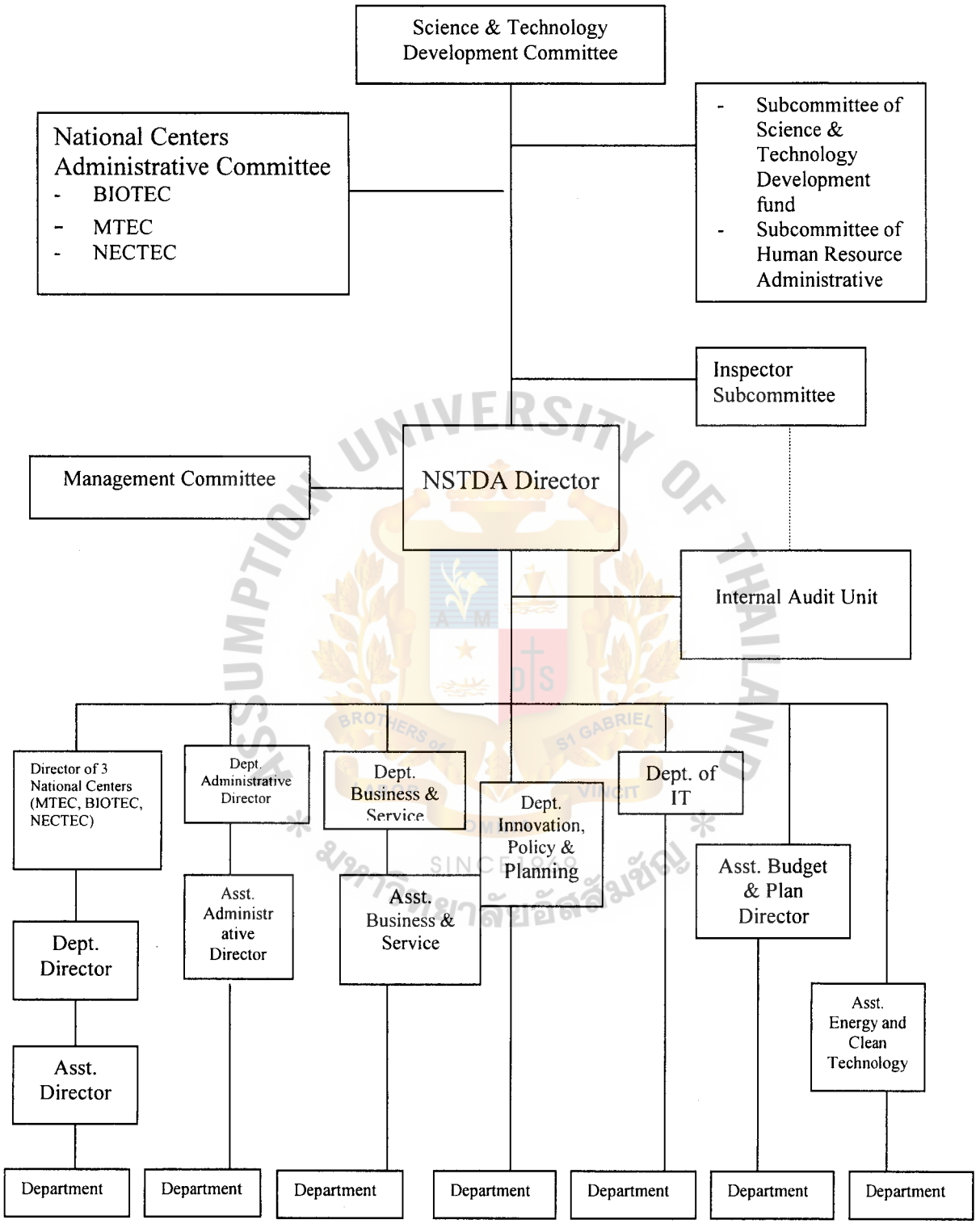
iii) Science and Technology (S&T) Human Resources Development
The development of human capital is carried out by means of providing extensive education through schools, universities, vocational schools, and distance learning approaches.

iv) Enhancement of S&T infrastructure

The principal services entail testing/QC services, certification, consultancy, training/training co-ordination, and intellectual property services to support research and development.

The mission of NSTDA is to improve production and services, as well as back research aimed at commercial application. Three specialized centers- Genetic Engineering and Biotechnology Center (BIOTEC), Metal and Materials Technology Center (MTEC), and Electronics and Computer Technology Center (NECTEC)-come under the NSTDA umbrella.

NSTDA ADMINISTRATIVE STRUCTURE



Source: www.NSTDA.or.th (August 25, 2003)

2. Thailand Research Fund

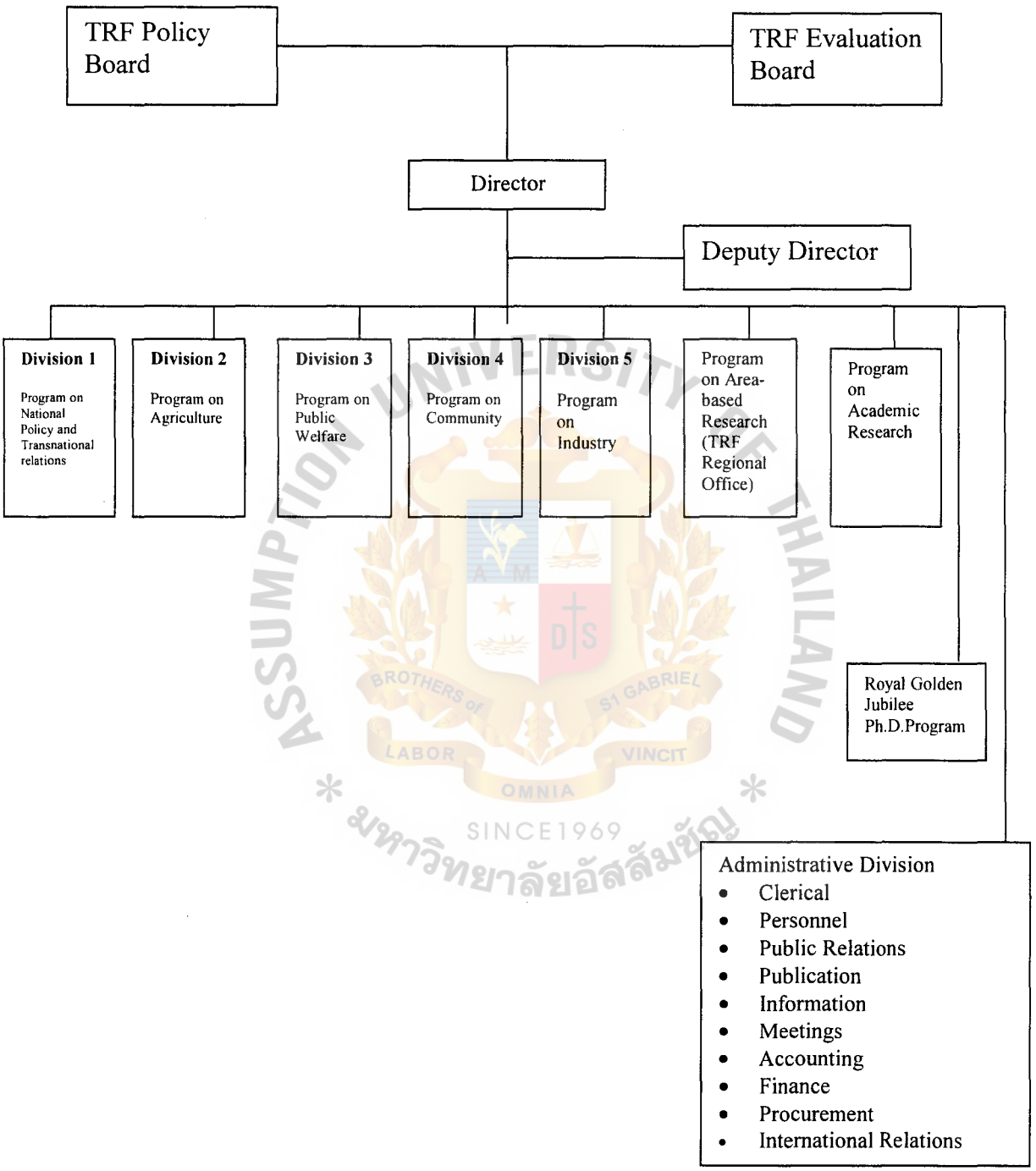
Thailand Research Fund or TRF was established in response to the 1992 Research Endowment Act. It is a juristic body that enjoys being part of the government system but outside the government administrative bureaucracy. This freedom allows great efficiency in research support.

TRF's main missions are:

1. To build up professional researchers and strengthen the research community.
2. To support research that is significant to national development, both for basic research and research where results can be used directly.
3. To promote the dissemination and use of research findings.
4. To raise funds for the national research and development system.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

TRF ADMINISTRATIVE STRUCTURE



Source: TRF Bulletin (2002)

TRF consists of an administrative division, which looks after all office works, and seven divisions. TRF also set up the regional office in Chiang Mai 'TRF Regional Office' to handle research-granting activities to promote research in regional parts of Thailand. The seven divisions and the TRF Regional office are as follows:

1. Program on National Policy and Transnational Relations
2. Program on Agriculture
3. Program on Public Welfare
4. Program on Community
5. Program on Industry
6. Program on Academic Research
7. Royal Golden Jubilee Ph.D. Program
8. TRF Regional Office

TRF's role in managing innovations

Research grants supported by TRF are divided into 2 main categories:

1. Research where results will be used directly.

   This type of research is called " research and development (R&D)" It could be scientific or technological research to develop products or processes, humanities research to be used for institutional adjustment, or national policy research. TRF also provides supplemental funds for research and development support in the areas of project development, pilot project, and state-of-the-art review.

2. Basic research

   This research aims at deriving new knowledge, new theories, new concepts, or new technologies. It does not focus on the practical use of the results. There are two types of basic research: freely initiated research and directed or targeted basic research. The aim of basic research is in the areas which are relatively weak. The expected outputs of both types of the basic research are publications in international journals.

Appendix 2

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 2

Rogers' adopter categories

Table B-1: Rogers' adopter categories and characteristics of adopters

Adopter Categories	Characteristics
Innovators - first 2.5% of individuals in a social system to adopt an innovation	❑ Venturesome and eager to try new ideas ❑ Have more years of formal education ❑ Have higher social status ❑ Have substantial financial resources ❑ Able to cope with high degree of uncertainty ❑ Contacts outside peer group ❑ May or may not be respected by peers
Early Adopters - next 13.5% of individuals in a social system to adopt an innovation	❑ Respected by peers ❑ More integrated part of the local system ❑ Opinion leaders - potential adopters look to them for advice and information ❑ Change agents ❑ Role models for other members of social system
Early Majority - next 34% of individuals in a social system to adopt an innovation	❑ Deliberate before adopting new idea ❑ Adopt new ideas just before the average member of a system ❑ Interact frequently with peers ❑ Rarely hold positions of opinion leadership ❑ Provide interconnectedness in the system's interpersonal networks
Late Majority - next 34% of individuals in a social system to adopt an innovation	❑ Approach innovations with caution and skepticism ❑ Adopt new ideas just after the average member of a system ❑ Adoption may be due to economic necessity or peer pressure ❑ Unwillingness to risk scarce resources ❑ Uncertainty about innovation must be removed before adoption
Laggards - last 16% of individuals in a social system to adopt an innovation	❑ Hold on to traditional values ❑ Resistance to innovations ❑ Last to adopt an innovation ❑ Near isolates in the social networks of local system ❑ Suspicious of innovations and change agents

Appendix 3

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 3

Part I: Questionnaire

The researcher will distribute survey to R&D beneficiary. Beneficiary means organizations and private firms who signed R&D investment contract and/or brought royalty fee of R&D derived by TRF and NSTDA fund. The objective of the questionnaire is to gather data and information on activities along the S-Curve and the factors enabling/inhibiting the progress of innovation.

Background Information

Company Name_____

Contact Person_____Position_____

Address _____Tel. _____

_____Fax. _____

Name of R&D Project_____

R&D Project Manager Name _____

Organization of R&D project manager_____

Signing date of MOU for R&D investment (DD/MM/YY)_____

Date of royalty bought (DD/MM/YY) _____

Organization

Year of establishment R&D unit _____No. of R&D employees _____

No. of employees _____Average level of employees education_____

Education level of R&D employees

☐ Secondary ☐ Vocational ☐ Bachelor degree ☐ Master degree

☐ Doctoral degree ☐ Other_____

Financial source of R&D activity _____ value_____Baht/year

Ownership Thai_____% American_____%

Chinese_____% Others _____%

Type of main products sold _____Amount per annum_____

To who is the company major supplied

☐ Thai customer ☐ Foreigner customer, destination _____

Other activity that company has joined with others organization (Please describe)_____

(Innovative issue: This information will be interpreted to the external characteristic of organization.)

Level of Diffusion

Date of prototype running test (mm/yy)_____

Date of completed prototype (ready to produce first lot) (mm/yy) _____

Date of market launch (mm/yy)_____

Average sale revenue of innovation product (monthly or annual)_____

Average volume of innovation sold (piece, tons /month or year) _____

Characteristic of Innovation

Relative Advantage:

1. Is the innovation better than the status quo? ☐ Yes ☐ No
2. Did the company perceive it as better? ☐ Yes ☐ No

Compatibility:

3. How does the innovation fit with company's past experiences and present needs?

_____

_____

4. Does it require a change in existing values? ☐ Yes ☐ No

Complexity:

5. How difficult is the innovation to understand and apply?

_____

Trialability:

6. Can the company "try out" the innovation before salable production?

☐ Yes ☐ No

Observability:

7. How visible are the results of adopted innovation?

_____

Please rank 1-5 scale (where 1 is the minimum and 5 is the maximum) the five attributes of innovations influence R&D adoption of your organization.

---------Relative Advantage

---------Compatibility

---------Complexity

---------Trialibility

---------Observability

Description of Terms:

1. Relative advantage is the degree to which a new innovation surpasses current practices, or measured, in terms of variables such as usefulness in accomplishing work goals, quality of work outcomes, added convenience and social prestige provide by the innovation.
2. Compatibility is the degree to which an innovation is perceived to be consistent with adopters' existing values, past experiences and needs. It includes individual, group and organizational goals, needs, culture and structure.
3. Complexity refers to the perceived difficulty of learning to use and understand a new system or technology, or measured, in term of ease of use.
4. Trialibility refers to the ease of experimenting with an innovation. It includes the level of effort needed and risk involved in observing and participating in small scale demonstrations of the system, including easily recovering from, or "undoing", operations using the systems and costs involved in reversing the decision to adopt.
5. Observability is the degree to which the results of the innovation are easily seen and understood. Observability has been operationalized as "results demonstrability", i.e., the ease of telling others the consequences or results of using innovation.

Please give score rating 1-5 scale (where 1 is the lowest and 5 is the highest) the ability of granted researcher to cope with research task.....

Demand of R&D activity

Future plan for R&D within organization_____

_____

Government Support

What kind of R&D activities you need the government to support?

_____

Please give recommendations or suggestions for improving R&D management process of TRF or NSTDA

_____

_____

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Part II: In-depth Interview Question to Firms and Research Organizations

The objective of the questionnaire is to gather data and information on activities along the S-Curve and the factors enabling/inhibiting the progress of innovation. The interviewees will be the Executive Management or the knowledgeable persons within firms and research organizations.

Stage I. Research & Development stage

1) What are the characteristics of the R&D units of organization?
   1.1) Positioning of R&D unit in your organization chart
   1.2) Flexibility of organization structure
   1.3) Corporate culture (such as many informal group of employee, individual social system in the work place, organization image in social, cross-functional team etc)
   1.4) Style of management (Problem in managing HR in R&D unit)
   1.5) Relationship of TRF/or NSTDA researcher with firm's employees
2) How is the management commitment in R&D activity?
   2.1) In your organization, who generally carries out the role of R&D team leader? *(Please explain the profile of that person)*
   2.2) How do you see your capability to cope with high degree of uncertainty/ difficulties of the research task?
   2.3) What is your network of collaboration (strategic alliances)?

   Note: question 2.2,2.3 aim at checking the innovators' characteristic in managing innovations
3) What are the difficulties of the research task in relation to the capability of researchers? (To evaluate their science & technological capability, resource need, room to improvements)
   3.1) In your opinion, how do you see the difficulties of this research task in relation to in-house capability?

3.2) How do you see the difficulties of research task in relation to the capability of your partners (e.g. granted researcher of TRF or NSTDA, peer organizations)?

Stage II. Innovation development stage

1) How do you see your ability to translate R&D results into saleable innovation?
   1.1) How does a company prepare a production line for saleable innovation?
   1.2) What is driver to change the innovative of your organization?
   1.3) How well the researcher translated R&D result into production activity?
   1.4) What are the major problems during the prototype running stage?
   1.4) Has your company conducted an evaluation method to help predict user' adoption of new product innovation before the final product development?
2) How could the company and researcher design the product innovations according to the market needs?
   2.1) Does your company conduct a marketing research in line with the design of product innovation activity?
   2.2) What is the purpose of and how does the company conduct an innovation marketing research?
   2.3) When does the marketing activity of innovation begin?
   2.4) Is NSTDA or TRF involved in the marketing activities? In what way?
   2.5) Does the company re-invent innovation derived from the R&D activity of TRF and/or NSTDA? In what way does the company re-invent?
3) How many of your R&D projects progress up to the stage of patenting and prototyping?
   3.1) What are the key drivers that bring about successful patenting and prototyping?
   3.2) How do you see the top management effort to help drive this stage forward?
   3.3) How do you see your employees' effort in driving innovation towards the stage of patenting and prototyping?

Stage III. Market development stage

1) How do you see your organization's capability in pushing new product innovation to market?
   1.1) Is NSTDA or TRF researcher involved in the marketing stage?

1.2) How does your marketing department involve in the market development stage?

1.3) What are channels of market distribution for your product?

1.4) What is the most effective market distribution channel?

1.5) How do you see the importance of a marketing stage in comparison to Research and Development stage and Innovation Development stage?

1.6) Who are your targeted adopters?

2) What is your marketing strategy in entering the new market? (Please describe in terms of product, place, price, promotion, and P+)

3) How much is the number of adopters (users of the innovations)?

3.1) What are the main activities carried out for pushing the R&D results to achieve a level of diffusion?

3.2) How could you define the targeted users?

4) How much is the number of publications coming out from undertaking R&D activities within your organization?

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 4

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

THE ASSUMPTION UNIVERSITY LIBRARY

Appendix 4

Variables Affecting the Rate of Innovation Adoption

I. Perceived attributes of innovations

1. To have a relative advantage: the relative degree to which it is perceive to be better than what it supersedes.
2. Is compatible: whit existing values, past experiences and needs.
3. It is not overly complex: ability to understand and use.
4. Trial-able: the degree to which it can be experimented with on a limited basis.
5. Offers observability: visible results.

II. Type of Innovation-Decision:

1. Optional
2. Collective
3. Authority

Innovations requiring an individual-optional innovation decision are generally adopted more rapidly than when an innovation adopted by an organization. The more persons involved in making an innovation-decision, the slower the rate of adoption.

III. Communication Channels (e.g. mass media or interpersonal). For example, if interpersonal channels (rather than mass media channels) create awareness-knowledge, as frequently happens for later adopters, their rate of adoption is slowed.

IV. Nature of the Social System (e.g. its norms, degree of network interconnectedness, etc.)

V. Extent of Change Agents' Promotion Efforts, however, may not be direct and linear. Greater payoff from a given amount of change agent activity occurs at certain stages in an innovation's diffusion. The greatest response to change agent effort occurs when opinion adopt, which usually occurs some where between 3 and 16 percent adoption in most systems. The innovation will then continue to spread with little promotion by change agent after a critical mass of adopters is reached.

Appendix 5

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 5A: The finished projects funded by TRF which is benificialry company lcated all over the country

	รหัส	โครงการ	หน่วยงาน	ที่อยู่	ตำบล	อำเภอ	จังหวัด	รหัสไปรษณีย์	โทรศัพท์	แฟกซ์	มือถือ	E-mail address	Research stage (month)	R&D stage (month)	Innovtaion development stage (month)	Market development stage (month)	ระยะเวลาทุนดำเนินงาน (เดือน)	ปีที่เริ่มโครงการ	ปีที่ร่วมทุน/รับเทคโนโลยี
1	RDG4450023	การปรับปรุงขบวนการผลิตข้าโพดหมอน	กลุ่มสมุนไพรเพชรบุรี	152 หมู่ 5	ตำบลดอนขุนห้วย	อำเภอบ่อ	จังหวัดเพชรบุรี				01-453-0734		0	12	0	0	12	2544	2544
2	PPG4350005	การพัฒนาชุดเครื่องมือแปรรูปน้ำสมุนไพรสุขภาพขนาดเล็ก	คุณรัตนา										#N/A	#N/A	#N/A	#N/A	#N/A	2543	2543
3	ทุนอุดหนุนการวิจัย ฝ่ายวิชาการ 2544	สิทธิบัตรยาสลายลิ่มเลือด	บ. Boehringer Ingelheim จำกัด										#N/A	24	12	0	24	2544	2546
4	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2542	การศึกษาและวิจัยอุปกรณ์ที่ใช้ในการพรวนดำจัดวัชพืชได้ต้นแบบ	บ. กวินแมชชีน จำกัด	คุณจิโรจน์ ปิฑมโยธิน โทร. 02 996-0485			ปทุมธานี		02 996-0485				#N/A				#N/A	2542	2542
5	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2543	การพัฒนา Antagonist Bacillus subtilis สำหรับการควบคุมโรคข้าว	บ. ทีเอฟไอ. กรีนไบโอเทค จำกัด										#N/A	24	12	0	24	2543	2546
6	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2541	การกำจัดไส้เดือนฝอยรากปม	บริษัท ยูนิบิดส์ จำกัด	1/87-88 ถ. พหลโยธิน ซ. 40	จตุจักร		กรุงเทพฯ	10900	579-1929, 579-9971-2, 579-9976-7	561-1367				12	24	6	12	2541	2543
7	PDG4450002	การพัฒนาเครื่องเพ้อร์เบนเดอร์สำหรับไส้เดือนฝอย Steinernema carpocapsae	บริษัท ยูนิบิดส์ จำกัด	1/87-88 ถ. พหลโยธิน ซ. 40	จตุจักร		กรุงเทพฯ	10900	579-1929, 579-9971-2, 579-9976-7	561-1367			0	3	0	0	3	2544	2544
8	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2544	ชุดตรวจ ปุ๋ย NPK ในดิน	บุญดินไทย										#N/A	#N/A	#N/A	#N/A	#N/A	2544	2544
9	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2543	มธม่วงต่องปลอดสารพิษ	เครือข่ายกรีนคูล										#N/A	24	12	3	24	2543	2546
10	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2543	การหาตัวแปรที่เหมาะสมของเครื่องจักรขึ้นเป็นในงานไถดกรรมจากไม้ยางพารา	บจ. เอส ดี พี อินเตอร์เทรด	169/79 ถ. รัชดาภิเษก	แขวงดินแดง	เขตดินแดง	กรุงเทพ	10320	02-276-9210-21	02-276-9230, 276-9222			#N/A	24	4	0	24	2543	2546
11	RDG4450057	การพัฒนาผลิตภัณฑ์ชิ้นไม้เรียงเส้นจากเศษไม้ยางพารา	บจ.พีพลบอร์ เอ็นจิเนียริ่ง ออฟ กระบี่	65 ถนนกระบี่-เขาทอง หมู่ 4	ตำบลไสไทย	อำเภอเมือง	จังหวัดกระบี่	81000		075 620-990	01-228-4456		0	36	0	0	36	2544	2544
12	RDG4350017	การศึกษาและพัฒนาสารถนอมน้ำยางธรรมชาติชนิดใหม่	บจ.ยูนิเวอร์แซลลาเท็กซ์ โปรดักซ์	99/1-3 ม. 13 กม.ถนนสาย 11 ถ.บางนา-ตราด กม. 7	ต.บางแก้ว	อ.บางพลี	จ. สมุทรปราการ	10540	02-7517171	02-3163938			0	24	0	0	24	2543	2543
13	RDG4450036	การปรับปรุงการกระด้งและความนิ่มของผลิตภัณฑ์วอลเล่ย์บอล	บจ.วิก้าบอลล์แมนูแฟคเจอริ่ง	653 ซ.36 ถ. พัฒนา 1	นิคมอุตสาหกรรมบางปู จ.นนทบุรี	อ. เมือง	จ. สมุทรปราการ	10280	02-3240770	02-3243050-1			#N/A	3	24	0	3	2544	2544
14	RDG4450026	1. เครื่องคัดขนาดข้าวโพดฝักอ่อนด้วยขบวนการภาพถ่าย	บริษัท AGRO-ON จำกัด	26/110 ซอยรัชประชา 2 ถนนรัชดาภิเษก	แขวงลาดยาว	เขตจตุจักร (โรงงานอยู่สุพรรณบุรี)	กรุงเทพฯ	10900	02-911-1477	02-911-1470		pc@agro-on.com	0	24	0	0	24	2541	2541

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

	รหัส	โครงการ	หน่วยงาน	ที่อยู่	ตำบล	อำเภอ	จังหวัด	รหัสไปรษณีย์	โทรศัพท์	แฟกซ์	มือถือ	E-mail address	Research stage (month)	R&D stage (month)	Innovation development stage (month)	Market development stage (month)	ระยะเวลาทำงานต่อเนื่อง (เดือน)	ปีที่เริ่มโครงการ	ปีที่ร่วมทุน/รับเทคโนโลยี
15	RDG4450002	2.การผลิตน้ำส้มสายชูหมักจากน้ำอ้อย	บริษัท AGRO-ON จำกัด	26/110 ซอยวิภาวดี 2 ถนนวิภาวดีรังสิต	แขวงลาดยาว	เขตจตุจักร (โรงงานอยู่สุพรรณบุรี)	กรุงเทพฯ	10900	02-911-1477	02-911-1470		pc@agro-on.com	0	10	6	0	12	2544	2544
16	RDG4550008	การแยกโปรตีนจากเศษหนังฟอกโดยด้วยแอลคาไลน์โปรตีเอสเพื่อใช้เป็นอาหารปลา	บริษัท Kowa International จำกัด (มหาชน)	212/1 หมู่ 17 ถนนอ่อนนุช 66	แขวงประเวศ	เขตประเวศ	กรุงเทพฯ	10250					12	0	0	0	12	2544	2544
17	RDG4350001	การพัฒนาคุณภาพและผลิตผลิตภัณฑ์จากแอลกอฮอล์โครงการส่วนพระองค์ สวนจิตรลดา	บริษัท กรีนสวิลล์ จำกัด	65/3 นิคมอุตสาหกรรมลาดกระบัง ถนนฉลองกรุง	ลาดกระบัง		กรุงเทพฯ	10520	326-0561	326-0801			0	12	3	3	12	2543	2543
18	RDG4450046	การปรับปรุงเครื่องคัดขนาดมังคุดแบบจานหมุน	บริษัท จิตรานล คาร์เปนเตอร์ จำกัด	เลขที่ 52 หมู่ 3 ต. พหลโยธิน กม.51	ตำบลสำโทร	อำเภอวังน้อย	จังหวัดอยุธยา	13170	035-271234-5	035-215049		jakrawal@hotmail.com	0	6	2	4	6	2544	2544
19	RDG4250016	การถ่ายทอดเทคโนโลยีการเพิ่มผลผลิตสีพลอยสู่ภาคอุตสาหกรรม	บริษัท ซันอิเลกทรอนิกส์ จำกัด	81/15 ซอยวิศวเสนานิคม		ตำบลคลองน้ำ	จังหวัดราชบุรี	70000	032-319-309, 319-310	032-319-701	01-851-2477		0	12	0	0	12	2542	2542
20	RDG4550008	การแยกโปรตีนจากเศษหนังฟอกโดยด้วยแอลคาไลน์โปรตีเอสเพื่อใช้เป็นอาหารปลา	บริษัท ซีพี ผลิตภัณฑ์อาหารสัตว์ จำกัด (มหาชน)	82/2 หมู่ 4	ตำบลบางไทรัด	อำเภอเมือง	จังหวัดสมุทรสาคร	74000					12	0	0	0	12	2545	2545
21	RDG4250020	การใช้ประโยชน์มะพร้าวส่วนเหลือทิ้งจากการผลิตน้ำมะพร้าวกระป๋อง	บริษัท ไทยอกริฟู้ดส์ จำกัด (มหาชน)	155/1 ม. 1 ถนนเทพารักษ์		บางเสาธง	สมุทรปราการ	10540	315-4171-6	315-4188, 315-4169			0	15	0	0	15	2542	2542
22	RDG4450044	เครื่องมือทำความสะอาดแบบแห้งและขูดผิวหัวมันสำปะหลังบางส่วน	บริษัท บางกอก คอนสตัคชั่น อัควิเมนท์ จำกัด	100/22	ถนนงามวงศ์วาน	บางเขน	จังหวัดนนทบุรี	11000	02-589-5405-6, 02-951-8040-4	02-589-6897	01-924-3792		0	6	3	12	6	2544	2544
23	RDG4250001	การพัฒนาเครื่องต้นแบบหัวเคาะเก็สัตบัดอัดอากาศออโตเมติกแท็กเก็จต์	บริษัท บุญคนึง วิศวกรรม จำกัด	85 ถนนสนามบิน	ศาลเจ้าเวียง	อำเภอเมือง	ลำปาง	52000	(054)315-380, 218-592	(054) 221-878, (054) 223-152	01-950-9470	bkaco@csloxinfo.com	0	24	0	0	24	2542	2542
24	RDG4450027	การขยายขนาดเครื่องหมอกภายใต้สุญญากาศ	บริษัท บุญชัยหมุ่ยโปรดักส์ จำกัด	เลขที่ 451/ 1	ต.ท่าไหม	อ.ท่าไหม	จ.จันทบุรี	22120	(039)431-049	(039)431-262			0	0	20	3	20	2544	2544
25	RDG4450047	การใช้เถ้าลอยในสารเชื่อมคอนกรีตอัดแรง	บริษัท ปทุมธานี คอนกรีต จำกัด	บริษัท ปทุมธานี คอนกรีต จำกัด	เลขที่ 1339 อาคารอาวรรณ	ถ.ประชาราษ 1 (ข้างสะพานพระราม 7)	เขตบางซื่อ	กทม.	10800				0	3	0	0	3	2544	2544
26	RDG4550001	การออกแบบภาชนะบรรจุของเหลวโดยกรรมวิธีวิศวกรรม	บริษัท ปิยะวัฒนาพลาสติก จำกัด	19 /14 ม. 6 ซ.เอกชัย 63	ถนนเอกชัย	แขวงบางบอน	กรุงเทพฯ	10150	02- 4151894	02-4150951		pjw@bkk.loxinfo.co.th	0	16	0	0	16	2545	2545
27	RDG4250008	ดงไม้รูปโอทีผลิตจากไม้ยางพารา	บริษัท พิสิฐอุตสาหกรรม จำกัด	84/1-2 หมู่ 4 ถนนบ้านกลาง		อำเภอเมือง	ตำพูน	51000	053-552-269, 552-425-7	053-552-269			0	20	4	0	24	2542	2542
28	RDG4450041	การพัฒนาเครื่องนวดเมล็ดข้าวน้ำนม	บริษัท พี เทิน เอิร์น จำกัด	83/116-7 ซ. ชินเขต 2 ถ. งามวงศ์วาน	แขวงทุ่งสองห้องหลักสี่		กรุงเทพฯ	10210	02-5897171	02-5896622			0	6	0	0	6	2544	2544
29	RDG4350002	โปรแกรมเพื่อการออกแบบระบบการจัดการน้ำและน้ำดิ่งสำหรับอุตสาหกรรมฟอกย้อม	บริษัท ยูไนเต็ด เท็กซ์ไทล์มิลล์ จำกัด	18/8 หมู่ 4 ซ. วัดอ้อมใหญ่ ถ.เพชรเกษม	ต.อ้อมใหญ่	อ.สามพราน	นครปฐม	73160	420-0997, 420-5832, 420-0688, 420-0755	420-3408			0	18	0	0	18	2543	2543

ASSUMPTION UNIVERSITY OF THAILAND
LABOR OF LOVE SINCE 1969

	รหัส	โครงการ	หน่วยงาน	ที่อยู่	ตำบล	อำเภอ	จังหวัด	รหัสไปรษณีย์	โทรศัพท์	แฟกซ์	มือถือ	E-mail address	Research stage (month)	RSD stage (month)	Innovation development stage (month)	Market development stage (month)	ระยะเวลาทุนดำเนินงาน (เดือน)	ปีที่เริ่มโครงการ	ปีที่ร่วมทุน/รับเทคโนโลยี
30	RDG4450021	การจัดทำระบบต้นทุนฐานกิจกรรมเพื่อการบริหารในอุตสาหกรรมเครื่องประดับ	บ. ยูทอิม จำกัด (ทำร่วมกับ บ. อาสิเฟค)	เลขที่ 251/4-5 ถนนอิสรภาพ	แขวงวัดอรุณ	เขตบางกอกใหญ่	กรุงเทพฯ	10600	472-4280, 466-3410	472-4255			0	8	0	0	8	2544	2544
31	RDG4250019	การศึกษาและพัฒนาอุปกรณ์ฆ่าเชื้อแบคทีเรียในผลิตภัณฑ์ขนเคี้ยวสำหรับสุนัข	บริษัท เวิลด์เพ็ท อินเตอร์เนชั่นแนล จำกัด	919 หมู่ 4 ซ. บางปู ถ.บางปูใหม่		อ.เมือง	สมุทรปราการ	10280	323-3001-4	323-3005			0	12	0	0	12	2542	2542
32	RDG4350022	1.การออกแบบอุปกรณ์ฉีดอากาศจากไอเสียสำหรับกระบวนการผลิตสปริงแผ่น	บริษัท บางกอกสปริง จำกัด	112 หมู่ 2 ถนนบางนา-ตราด กม.15		บางพลี	สมุทรปราการ	10540	312-5318-28	312-5317			0	7	5	0	12	2543	2543
33	RDG4350021	2.การปรับปรุงการใช้ไฟฟ้าในเตาหลอมไฮเตอร์ที่ใช้กระแสไฟฟ้าเหนี่ยวนำด้วยวิธีควบคุมความร้อน	บริษัท สยามรถ่หล่อเหล็กเหนียว จำกัด	112 หมู่ 2 ถนนบางนา-ตราด กม.15		บางพลี	สมุทรปราการ	10540	312-5318-28	312-5317			#N/A	12	3	0	12	2543	2543
34	RDG4550005	การเพิ่มประสิทธิภาพของกระบวนการไฮดรอกซีโพรพิเลชันของแป้งมันสำปะหลัง	บริษัท สยาม มอลิฟาเมท สตาร์ช จำกัด	38/6 ม. 11 ถ. ปทุมธานี - ลาดหลุมแก้ว	ต.คูบางหลวง	อ.ลาดหลุมแก้ว	ปทุมธานี	12140	02-598-1123-9	02-598-1130			0	18	0	0	18	2545	2545
35	RDG4450062	การพัฒนาระบบดักจับไอระเหยสารอินทรีย์ด้วย	บริษัท สหธาราวัลย์ จำกัด	239 หมู่ 7 ถนนปู่เจ้าสมิงพราย	ตำบลสำโรงกลาง	อ.บางพระ	จ.สมุทรปราการ	10130					0	24	0	0	24	2544	2544
36	RDG4350008	การพัฒนาเครื่องจักรกลเกษตรเพื่อเพิ่มประสิทธิภาพการผลิตข้าวหอมมะลิในภาคตะวันออกเฉียงเหนือ (เดิง ออกคลาดต้นปี 2547 ตามคอนที่สัญญาฯ (ม.อ.47) บริษัทยังไม่ได้ภาพการคอบรับของตลาด)	บริษัท สามมิตร แอกคเซสซอรี่ส์ เจอรี่ จำกัด	39 หมู่ 12 ถนนเทพรัตน	ต.ห้วยมิ่งแน่น	อ.เมืองสมุทรสาคร	สมุทรสาคร	74130	420-0027	431-1482		sammitr@cscomm.com	0	12	12	0	12	2543	2543
37	RDG4450015	1. การบูรณาการโปรแกรมคอมพิวเตอร์กราฟฟิคสำหรับการออกแบบเครื่องประดับและกระบวนการผลิต	บริษัท อาร์ดิเฟค จำกัด	เลขที่ 251/4-5 ถนนอิสรภาพ	แขวงวัดอรุณ	เขตบางกอกใหญ่	กรุงเทพฯ	10600	472-4280, 466-3410	472-4255			0	12	0	0	12	2544	2544
38	RDG4450021	2. การจัดทำระบบต้นทุนฐานกิจกรรมเพื่อการบริหารในอุตสาหกรรมเครื่องประดับ	บริษัท อาร์ดิเฟค จำกัด	เลขที่ 251/4-5 ถนนอิสรภาพ	แขวงวัดอรุณ	เขตบางกอกใหญ่	กรุงเทพฯ	10600	472-4280, 466-3410	472-4255			0	8	0	0	8	2544	2544
39	RDG4350007	การปรับปรุงกรรมวิธีการผลิตแป้งข้าวเจ้า / ข้าวเหนียว	บริษัท อุตสาหกรรมแป้งไทย จำกัด	383 ถนนลาดหญ้า	สมเด็จเจ้าพระยา	คลองสาน	กรุงเทพฯ	10600					0	12	0	0	12	2543	2543
40	RDG4350016	โครงการ การพัฒนาประสิทธิภาพของไฮจากสำหรับใช้กับรถไถ 2 ล้อ	บริษัท เอส-คอน สยาม เอเชีย จำกัด	104/1-2 ถ. สวรรควิถี		อ.เมือง	จ.นครสวรรค์	60000	(056) 213-769/ 212-254	(01) 953-5789			0	24	0	0	24	2543	2543
41	RDG4450057	การพัฒนาเครื่องจักรในระบบการให้อาหาร TMR	บริษัท แอดวานซ์ เอ็นไวรอนเมนทอล เอ็นจิเนียริ่ง จำกัด/ เอดีพีเคร้าท์ราม	บางนา ทราเวลร์ ซี , ชั้น 15 เลขที่ 2/3 หมู่ 14 กม.6.5	ต.บางนา-ตราด	บางเสาธง บางพลี	สมุทรปราการ	10540	(02) 751-9420-5	(02) 751-9419	01-802-4616, 01-642-4764	aeeco@loxfo.co.th	0	36	0	0	36	2544	2544

ASSUMPTION UNIVERSITY OF THAILAND
ESTABLISHED SINCE 1969

	รหัส	โครงการ	หน่วยงาน	ที่อยู่	ตำบล	อำเภอ	จังหวัด	รหัสไปรษณีย์	โทรศัพท์	แฟกซ์	มือถือ	E-mail address	Research stage (month)	R&D stage (month)	Innovtaion development stage (month)	Market development stage (month)	ระยะเวลาทำงานทั้งหมด (เดือน)	ปีที่เริ่มโครงการ	ปีที่รวมทุน/รับเทคโนโลยี
42	RDG4450043	การใช้ประโยชน์น้ำมะพร้าวส่วนเหลือทิ้งจากการผลิตน้ำมะพร้าวกระป๋อง	บริษัท ไทยอกริฟู้ดส์ จำกัด (มหาชน)	155/1 ม. 1 ถนนเทพารักษ์		บางเสาธง	สมุทรปราการ	10540	315-4171-6	315-4188, 315-4189			0	12	0	0	12	2544	2544
43	RDG4350019	การออกแบบบัลลาสต์อิเล็กทรอนิกส์อย่างเป็นระบบ	บริษัทไทยยูนิอิกส์ จำกัด	99/160-162	ถนนเทศบาลสงเคราะห์ แขวงลาดยาว	จตุจักร	กรุงเทพ	10900	954-3306-8, 954-4088	589-4887	01-914-9914	unilux@thaiecommerce.net	0	18	0	0	18	2543	2543
44	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2542	เตาเผาแกลบแบบไซโคลน	บริษัทไร่ เอ็นจิเนียริ่ง อัพพลาย จำกัด	106 หมู่ 7 ซอยสุราบางยี่ขัน 2 ถ. กรุงเทพฯ-ปทุมธานี	ต.บางคูวัด	อ.เมือง	จ.ปทุมธานี	12000	02-5982491-5	02-5982542		yy@riceengineer.com	#N/A	12	30	15	12	2542	2542
45	ทุนอุดหนุนการวิจัย ฝ่ายเกษตร 2543	เตาอบ Strabedted	บริษัทไร่ เอ็นจิเนียริ่ง อัพพลาย จำกัด	106 หมู่ 7 ซอยสุราบางยี่ขัน 2 ถ. กรุงเทพฯ-ปทุมธานี	ต.บางคูวัด	อ.เมือง	จ.ปทุมธานี	12000	02-5982491-5	02-5982542		yy@riceengineer.com	#N/A	12	28	10	12	2543	2543
46	RDG4450052	1. การออกแบบและสร้างเครื่องต้นแบบเครื่องแยกเมล็ดข้าวต่ำโดยการประมวลผลด้วยภาพ	บริษัทไร่ เอ็นจิเนียริ่ง อัพพลาย จำกัด	106 หมู่ 7 ซอยสุราบางยี่ขัน 2 ถ. กรุงเทพฯ-ปทุมธานี	ต.บางคูวัด	อ.เมือง	จ.ปทุมธานี	12000	02-5982491-5	02-5982542		yy@riceengineer.com	#N/A	10	6	4	10	2544	2544
47	RDG4550052	2. การวิจัยและพัฒนากระบวนการผลิตข้าวนึ่งจากข้าวกล้อง	บริษัทไร่ เอ็นจิเนียริ่ง อัพพลาย จำกัด	106 หมู่ 7 ซอยสุราบางยี่ขัน 2 ถ. กรุงเทพฯ-ปทุมธานี	ต.บางคูวัด	อ.เมือง	จ.ปทุมธานี	12000	02-5982491-5	02-5982542		yy@riceengineer.com	#N/A	8	0	0	8	2545	2545
48	RDG4550028	การใช้เส้นใยเคฟลาร์ในอุตสาหกรรมท่าต่ำแบบ	บริษัทอรรถยนต์ จำกัด	667/15 ชั้น 6 อาคารอรรถยนต์	ถ. จรัญสนิทวงศ์	นางกอกน้อย	กรุงเทพฯ	10700	02-8825599	02-8825724		ataboon@ksc.th.com	0	12	6+	0	12	2545	2545
49	RDG4550030	อิทธิพลของมิสต์คอการลอกแป้งด้วยเอนไซม์	บริษัทโออาร์เคมิคอล จำกัด	79/451 ม.2 ถ. เพชรเกษม	แขวงหนองค้างพลู	เขตหนองแขม	กรุงเทพฯ	10160					18	0	0	0	18	2545	2545
50	RDG4450012	เตาอบอินฟราเรดแบบกึ่งสุญญากาศ	ศูนย์พัฒนาวัตถุดิบสมุนไพรชุมชนปฐมอโศก	66 ม. 5	ต. พระประโทน	อ.เมือง	นครปฐม	73000					0	12	0	0	12	2544	2544
51	RDG4550015	การคัดเลือกเชื้อแบคทีเรียกรดแลคติคเพื่อยับยั้งการเจริญของเชื้อราในไซเลจ	สหกรณ์โคนมบ้านบึง		ต.บ้านบึง	อ.บ้านบึง	จ.ชลบุรี	20170					24	0	0	0	24	2545	2545
52	RDG4550027	การปรับปรุงกระบวนการผสมอาหารต่างๆ ด้วยระบบควบคุมแบบกึ่งอัตโนมัติ	สหกรณ์โคนมหนองโพราษฎร์ จำกัด	119 หมู่ 3	ตำบลหนองโพ	อำเภอโพธาราม	จังหวัดราชบุรี	70120	032-389234-5, 389038-9	032-389089			0	18	0	0	18	2545	2545
53	RDG4450037	1. การพัฒนากระสุนยางและเครื่องยิง / 2. การวิจัยและพัฒนาอุปกรณ์เครื่องป่วยลึกทางทหารและตำรวจ	สำนักงานวิจัยและพัฒนาการทหาร กลาโหม/บริษัท พรีซิชาร์ท จำกัด	47/433 หมู่ 3 อาคารสำนักงานปลัดกระทรวงกลาโหม (แจ้งวัฒนะ)	ต.บ้านใหม่	อ.ปากเกร็ด	นนทบุรี	11120	980-5885	980-5891			#N/A	12	12	0	12	2544	2544
54	RDG4550026	การพัฒนาผลิตภัณฑ์เยราบึกน้ำหนักเบา เพื่อใช้ในการตกแต่งและการปลูกด้วยโป่งและไม่ตลกและไม่ประดับ	หจก. ทองประเสริฐศิลป์ชัย ซีราเมิค	6/5 ม. 3 ถ. เศรษฐกิจ 1	ตำบลอ้อมน้อย	อำเภอกระทุ่มแบน	สมุทรสาคร	74110					0	18	0	0	18	2545	2545

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

Appendix 6

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

ที่	ชื่อเทคโนโลยี	ประเภทเทคโนโลยี/ผลงาน	ระยะเวลาดำเนินการ	ปีที่ได้เทคโนโลยี (Year of technology)	R&D work (man/day)	Prototype (unit)	Gap	R&D work (man/day)	Gap	Development (man/day)	Development (man/day)	บริษัทที่นำไปใช้ประโยชน์	ที่อยู่ผู้ใช้	บุคคลที่ติดต่อได้	เบอร์โทรศัพท์	E-mail	ชื่อเทคนิค
1	การตรวจสอบยีน GMO ของข้าวโพด ในรุ่น	การถ่ายทอดเทคโนโลยี	June 94 - Oct 99	2001	48	0	19	19	10	1	Farming Intelligent Technology Corporation., Taiwan	Taiwan					IQ 2000 Kit
2	ชุดทดสอบวิธีการตรวจหาเชื้อแบคทีเรียในอาหารสัตว์	การถ่ายทอดเทคโนโลยี	Apr 93- Mar 96	1998	0	0	22	0	3	3	บ. แอนนาไบโอเทค จำกัด	เชียงใหม่					
3	วิธีการวินิจฉัยเชื้อไวรัสที่ทำให้เกิดอาการตายของกุ้งกุลาดำและกุ้งขาว	การถ่ายทอดเทคโนโลยี	Nov. 97 - Oct 97	2001	0	0	23	42	8	8	บ. Science Development and Management จำกัด	18th Floor., 33 Floor, 97/922 Phaholyothin, Phayathai., Bangkok	Mark Rowelath and 80. วันเพ็ญ พิศดำรง	02 298 0300			เปลี่ยน ส่ง
4	ชุดทดสอบยีนแบคทีเรียที่ผลิตเชื้อไวรัสไข้ตัวแดงจากไวรัสไอซี	ร่วมวิจัยและพัฒนา	Apr 90-Apr 93 Basic research)	1990	36	36	28	28	On going	0	บ. ชูเกอร์ จำกัด	999/9Moo 9 Sukhumvit 105 Soisukum Road., Bangna, Nuegna, Bangkok	คุณสุเทียงศ์ ชนะวัลย์ 80. คุณอ้อ ชนะพัฒนกุล	T. 02 324 0288, 02 709 4139 F. 02 324 0283			
5	ชุดทดสอบยีนแบคทีเรียที่ผลิตเชื้อไวรัสไข้ตัวแดงจากไวรัสไอซี 02.BA	ร่วมวิจัยและพัฒนา	Aug 99 - Jul 99Basic research)	2001	28	13	12	0	On going	0	บ. ชูเกอร์ จำกัด	999/9Moo 9 Sukhumvit 105 Soisukum Road., Bangna, Nuegna, Bangkok	80. ชูเกอร์ เนียงสกุลราช	T. 02 324 0288, 02 709 4139 F. 02 324 0283			
6	การผลิตชุดทดสอบหาเชื้อไวรัสที่ทำให้เกิดอาการจมน้ำตาย	การถ่ายทอดเทคโนโลยี	Oct 94 - Jan 96 and Jan 01-02	2002	24	0	24	65	12	0	บ. Jumbo Biotechnology จำกัด	999/9 ซอยสุขุมวิท 105 ถนนสุขุมวิท แขวงบางนา เขตบางนา กรุงเทพฯ 10260	80. ศิริกุณฑ์ ธรรมวิโรจน์ 80. จันทร์เพ็ญ ชูเกอร์ 80. ศิริกุณฑ์ ธรรมวิโรจน์	T. 02 8844869 F. 02 884 9682			
7	การให้บริการตรวจหาเชื้อไวรัสและแบคทีเรียก่อโรคในกุ้งทะเล	การถ่ายทอดเทคโนโลยี	Oct 94 - Oct 96	2001	0	0	24	64	24	On going	ศูนย์วิจัยและพัฒนาการเกษตร	50 ถนนกสิกรไทย ตำบลคลองหนึ่ง อำเภอคลองหลวง จังหวัดปทุมธานี 12120	50 ถนนกสิกรไทย ตำบลคลองหนึ่ง อำเภอคลองหลวง จังหวัดปทุมธานี 12120				
8	โพลีนโนมาลเวีย	การถ่ายทอดเทคโนโลยี	1998- April 2001	2001	36		Ongoing	0	On going	0	บ. Adpro.ch Limited	England					
9	เทคโนโลยีการเพิ่มสารน้ำและเลือดทดแทน	การถ่ายทอดเทคโนโลยี	Sept 94 - Jan 95	1998	50	0	12	0	0	0	บ. มิโรเมดิคัล จำกัด	ญี่ปุ่น					
10	เทคโนโลยีจำนวนเชื้อก่อโรคและพิษของเชื้อแบคทีเรียสำหรับวิเคราะห์เชื้อในน้ำประปา	การถ่ายทอดเทคโนโลยี	Jul 01 - Jan 03	2001	0	0	12	0	On going	0	บ. ซุปเปอร์เอนเวโรไซ จำกัด	383 อาคารญี่ปุ่น คลองเตย ใน คลองเตย กรุงเทพฯ 10400		02-861-4801			
11	โครงการผลิตไวรัสที่ทำให้เกิดอาการจมน้ำตายในกุ้งทะเล	การถ่ายทอดเทคโนโลยี	1998	2001	0	0	12	0	Increase continuous of	0	บริษัท เอ็กโก้ (ประเทศไทย) จำกัด	3 ชั้น 22 ถนนสาธรใต้ เขตยานนาวา กรุงเทพฯ 10120	คุณประไพพี ชีวประเวช	บางกอก 02 324 0333 (10 line) 02 308 2102			
12	การผลิตเครื่องเติมน้ำมันที่ถังจากจีวา (Base Storage)	การถ่ายทอดเทคโนโลยี	2001-2002	2003	0		12	0	On going	0	บริษัท ซัมมูนาทิพย์ จำกัด	9/17 หมู่ 3 ถนนพระยาสัจจา ตำบลบ้านสวน อำเภอเมือง จังหวัดชลบุรี		0 38 283 833 , 0 38 277 608			
13	การผลิตแบคทีเรียกำจัดศัตรูพืช Bacillus thuringiensis (Bt) ในพืชตระกูลกะหล่ำ	การถ่ายทอดเทคโนโลยี	Sept 1989 -1995, 2000-2001	2003	36	84	24	0	On going	0	บริษัท ราชบุรุษ จำกัด / บริษัท ซีเคฟโก เอ็นไวโรเทค จำกัด	เลขที่ 303 อาคาร เค เอส เค ทาวเวอร์ ชั้น 20 ถนนเจริญกรุง แขวงสุพรรณ เขตราชเทวี กรุงเทพฯ 10400		0 32 253331			
14	เห็ดหอมก้านสั้นพิเศษ	การถ่ายทอดเทคโนโลยี และส่งเสริมการผลิตในไร่	Oct -99 to Jun - 01 , Jan 02-Jun 02	2001	0	0	0	0	0	0	บริษัท ก้านทองเกษตรแปรรูป จำกัด	222 หมู่ 2 ตำบลก้านทองเสน อำเภอก้านทองเสน จังหวัดนครปฐม 73140		0 34 352 556-8 , 0 3 4 333 333			
15	การตรวจสอบหาไวรัสที่ทำให้เกิดโรคระบาดในกุ้งกุลาดำ เช่น โรคหัวเหลือง (Yellow head virus) และไวรัสที่ทำให้เกิดการสูญเสียจากการเพาะเลี้ยงกุ้งในระยะยาว	การถ่ายทอดเทคโนโลยี และส่งเสริมการผลิตในไร่	Feb 01-02	2003	0	0	12	0	On going	0	บริษัท ซูเปอร์ จำกัด	3169 หมู่ 9 ซอยนวโล 102 ถนนศรีนครินทร์ แขวงบางนาเหนือ เขตบางนา กรุงเทพฯ		0 2324 0288 , 0 2709 4139			
16	การศึกษาวิธีการแก้ไขความเค็มของดินเพื่อการปลูกผักกาดขาวปลีในฤดูหนาว	ร่วมวิจัยและพัฒนา	1999-2001	2002	0	0	24	0	1	On going	ศูนย์วิจัยและพัฒนาการปลูกผัก	9/10 ม.4 ตู้ ปณ. 1 ปณ. ธนบุรี กรุงเทพฯ 10162	คุณบุญไทย	0 2 441 0389 , 0 2 441 0687 , 0 2 441			
17	การพัฒนากระบวนการแก้ไขน้ำประปาโดยใช้ถ่านไฮโดร	ร่วมวิจัยและพัฒนา	Oct 2002 -Mar 2004	2002	0	0	17	0	On going	0	บริษัทผู้ผลิตน้ำประปา	กรุงเทพฯ					
18	การพัฒนาเทคโนโลยีการผลิตเชื้อเป็นสำหรับหัวเชื้อไวยาโนต์	การถ่ายโอนเทคโนโลยี	2001-2002	2002	0	0	12	0	12	0	บ. ไฟว์สตั้นโฮล ดุสดาการแพทย์ในและชาชาญ จำกัด						
19	การประโยชน์ในด้านเกษตรกรรม	ร่วมวิจัยและพัฒนา	Mar -Aug 2000	2000	0	0	6	0	6	12	บ. เทค-ประเทศไทย จำกัด	4/1378 ซ.38 ถ.สุขุมวิท แขวง/เขต บางนา กรุงเทพฯ 10260	คุณ สุรางค์ ชุมนวนนท์	02-379-6098			
20	การพัฒนาเทคโนโลยีของผลิตภัณฑ์ในการใช้น้ำมันเมล็ดพืช	ร่วมวิจัยและพัฒนา	Dec 2001 -2003	2001	0	0	12	0	On going	0	บ. เทค-ประเทศไทย จำกัด	4/1378 ซ.38 ถ.สุขุมวิท แขวง/เขต บางนา กรุงเทพฯ 10260	คุณ สุรางค์ ชุมนวนนท์	02-379-6098			
21	เครื่องจักรเย็บกระสอบสำหรับใช้ในเมล็ดพันธุ์	ร่วมวิจัยและพัฒนา	Oct 2000- Sep 2001	2000	0	0	12	0	24	On going	บ. ยอร์ซุงเทค ซิมเมอร์เมนเทค (ประเทศไทย) จำกัด (มหาชน)	สุราษฎร์ ประมิก กรุงเทพฯ	คุณ ประสิทธิ์				
22	การเพิ่มผลผลิตข้าวสาลีด้วยสารสังเคราะห์	ร่วมวิจัยและพัฒนา	Mar 2001 -Jun 2003	2001	0	0	3	0	6	On going	บ. โรงสุกรเกษตรแห่งประเทศไทย จำกัด	99/22 ซอย 6 ซอยสายลมจอยส์ กรุงเทพฯ 10310					

ASSUMPTION UNIVERSITY OF THAILAND
ABAC
SINCE 1969
ABAC RESEARCH INSTITUTE
LABOR PROTECTION
BUSINESS ADMINISTRATION
ST. GABRIEL'S LIBRARY

23	[illegible]	[illegible]	Nov 1999- Nov 20	2000	0	0	12	0	4	12	1. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
24	[illegible]	[illegible]	Jul 1999 - Jul 200	1999	0	0	36	0	3	24	1. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
25	[illegible]	[illegible]	No data reported	2003	0	0	12	0	3	6	1. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
26	[illegible]	[illegible]	Oct 1998- Oct 199	1998	0	0	12	0	3	On going	1. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
27	[illegible]	[illegible]	Nov 1997 - Jan 19	1998	0	0	3	0	4	On going	1. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Source : Designed by Napaporn Vishnik, 2004

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
LABOR OMNIA VINCIT
BROTHERS OF ST GABRIEL
AMDG

Appendix 7

ASSUMPTION UNIVERSITY OF THAILAND
A M
D S
BROTHERS of S1 GABRIEL
LABOR VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 7A: Scale rating for the adoption decision to R&D funding program (case study of TRF)

1 = The most important , 2 = At least important

Project no.	Company name	Project name	Relative advantage	Compatibility	Complexity	Trialibility	Observability
1	Uniseeds Co.,Ltd	Shred earthworm for bio-pesticide	1	2	5	3	4
2	Uniseeds Co.,Ltd	Fermentor for shred earthworm producing machine	2	1	3	5	4
3	Rice Engineering Supply Co.,Ltd.	R&D for boil of half-milled rice processing	2	1	4	3	5
4	SDP Inter Trade Co.,Ltd.	Benchmarking for CNC machine for furniture producer	1	2	3	4	5
5	Green Sweal Co.,Ltd	Alcohol's distillation for Jiada Royal Project	2	1	3	5	4
6	World Pet International Co.,Ltd	Bacteria fertilizer equipment for dog chew processing	1	2	3	5	4
7	Siam Modify Starch Co.,Ltd	Increasing efficiency for hydroxy popilation reaction in starch processing	2	1	3	4	5
8	Sammit Manufacturng Co.,Ltd	Machine for cultivate in justmine rice growng in North East region	2	1	4	3	4
9	Artitect Co.Ltd	Integration of computer graphic in gomological design and processing	2	1	3	4	5
10	Thai Strach Industry Co.,Ltd.	Improve efficiency for rice and sticky rice processing	1	2	3	5	4
11	Thai Uni Lux Co.,Ltd.	Systemetic design for electronic ballast	2	1	4	5	3
12	Atthaboon Co.,Ltd	Development of calfra filament to brake disc	1	2	3	4	5
13	Rice Engineering Supply Co.,Ltd.	Fluidized bed dryer and cyclone	4	1	5	2	3
14	Rice Engineering Supply Co.,Ltd.	Rice Oven (Strabedded)	3	1	2	4	5
15	Rice Engineering Supply Co.,Ltd.	Brown rice fillier by picture detection	2	1	3	4	5
16	U-Lim Co.,LTd	Software development of cost production in gomology business	2	1	4	3	5
17	APP Daily Farm Co.,Ltd	Development of TMR feeder machine	2	1	3	5	4
18	Leng Heng Agrifood Co.,Ltd	Mango picking for food safety	1	3	4	5	2
19	Boon Din Thai Co.,Ltd	NPK test kit	1	4	3	5	2
20	Jakraval Car Center Co.,Ltd.	Mangos teen Sizing Machine	1	3	2	4	5
21	Num Heng Construction Co.,Ltd	Cassava Cleansing Machine	2	3	1	4	5
22	Panja Wattana Plastic Co.,Ltd	Software development for plastic mold design	2	1	3	4	5
23	Somboon Group	Energy saving in blast furnance	1	3	2	4	5
24	Saha Tara Wat Co.,Ltd	Solvent control system in production process	1	2	3	4	5
Total score			41	41	76	96	103
Ranking by recipe of important (1 to 5, 1 = The most important, 5 = At least important)			1	1	2	3	4

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 7B: Scale rating for the adoption decision to R&D funding program (case study of NSTDA)

1 = The most important , 5 = At least important

Project no.	Company name	Project name	Relative advantage	Compatibility	Complexity	Trialibility	Observability
1	Innova Biotechnology Co.,Ltd	Test Kit for infectious virus C in humen liver	2	3	5	4	1
2	Siriraja Hospital Laboratory (Test center)	Fast track record of diagnose the Tuberculosis (T.B.)	2	3	5	4	1
3	Agro (Thailand)Co.,Ltd	Commercial breeding of virus to kill caterpillar in cotton plant.	2	4	5	1	3
4	Bangkok Inter Food Co.,Ltd	Biotechnology for pollution reduction and generating energy in Strach Processing Factory	1	5	4	2	2
5	Kampeng Sean Commercial Co.,Ltd	Long life of ripe mango	2	4	5	3	1
6	Aranyik Muchroom Center	Parasol (Hed Nok Yung) for commercial	1	4	5	3	2
7	Chen Thailand Co.,Ltd	Coji Tower	1	3	5	4	2
8	Chen Thailand Co.,Ltd	Producing of sour sauce from concentrated bacteria	3	5	4	2	1
9	Thai Consultant Service Co.,Ltd	Corporate tax and accounting software	1	2	5	3	4
10	Thai Software (1999) Co.,Ltd	Lenux Talay (Software)	1	4	5	3	2
11	Bangkok Hi Lab Co.,Ltd	Chlorine contamination checking machine	2	5	4	3	1
12	Thai Radio Aviation Co.,Ltd	Noise telecommunication	3	5	4	2	1
Total score			21	47	56	34	21
Ranking by range of important (1 to 5, 1 = The most important, 5 = At least important)			*1*	*3*	*4*	*2*	*1*

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 8

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of S1 GABRIEL
LABOR VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 8A: Company background of The Champions

Project no.	Company Code	Project name	Stage of innovation diffusion	Target customer	Forms of funding	Industry sector	Type of innovation	Market status	Firm size (no. of employee)	R&D personnel	Formal R&D unit	ownership	market customer	Having collaboration between user & innovation maker	Pilot	Patenting
1	CH01	Shred earthworm for bio-pesticide	Market development stage	Personnel	VC	Bioinsectiside product	Product	Sold	45	4	Yes	100 % Thai	Domestic	Yes	Yes	
2	CH02	Alcohol's distillation for Jilada Royal Project	Market development stage	Personnel	VC	Cosmetic	Product	Sold	350	11	Yes	100% Thai	Domestic	No	No	
3	CH03/1	Fluidized bed dryer and cyclone	Market development stage	Corporate	VC	Machanical Equipment for Rice Mill	Product	Sold	400	8	Yes	100% Thai	Domestic/Export	Yes	Yes	
4	CH03/2	Rice Oven (Strabedted)	Market development stage	Corporate	VC	Machanical Equipment for Rice Mill	Product	Sold	400	8	Yes	100% Thai	Domestic/Export	Yes	Yes	
5	CH03/3	Brown rice friller by picture detection	Market development stage	Corporate	VC	Machanical Equipment for Rice Mill	Product	Sold	400	8	Yes	100% Thai	Domestic/Export	Yes	Yes	
6	CH04	Mango pickling for food safety	Market development stage	Corporate	Technology licensing	Food	Process	Sold	70	0	No	100% Thai	Domestic/Export	Not require	Yes	
7	CH05	NPK test kit	Market development stage	Corporate	Technology licensing	Agriculture supply	Product	Sold	50	0	No	100% Thai	Domestic	Not require	Yes	
8	CH06	Machine for cultivate in justmine rice growing in North East region	Market development stage	Personnel	VC	Automobile Part	Product	Launch in early 2004	800	10	Yes	100 % Thai	Domestic/Export	Yes	No	

THE ASSUMPTION UNIVERSITY LIBRARY

Project no.	Company Code	Project name	Stage of innovation diffusion	Target customer	Forms of funding	Industry sector	Type of innovation	Market status	Firm size (no. of employee)	R&D personnel	Formal R&D unit	ownership	market customer	Having collaboration between user & innovation market pull	Patenting
9	CH07	Mangos teen Sizing Machine	development stage	Corporate	VC	Equipment for agriculture field	Product	Sold	22	1	No	100 % Thai	Domestic	Yes	No
10	CH08	Cassava Cleansing Machine	Market development stage	Corporate	VC	Mechanical equipment built and design	Product	Sero sale volume	94	1	No	100 % Thai	Domestic	No	No
11	CH09	Test Kit for infectious virus C in human liver	Market development stage	Corporate	Technology licensing	Medical product	Product	Sold	11	1	Yes	100 % Thai	Domestic	No	Yes
12	CH10	Corporate tax and accounting software	development stage	Corporate	VC	Accounting consultant	Product	Sold	77	5	No	100 % Thai	Domestic	No	No
13	CH11	Long life of ripe mango	development stage	Corporate	Technology licensing	Food	Process	Sold	300	3	No	100 % Thai	Export	Not require	Yes
14	CH12	Coji Tower	development stage	Corporate	VC	Food	Product	Licensing technology	9	1	No	100 % Thai	Domestic/Export	No	Yes
15	CH13	Lenux Talay (Software)	development stage	Personnel	VC	Software	Product	Sold	40	8	Yes	100 % Thai	Domestic	Yes	No
16	CH14	Chlorine contamination checking machine	development stage	Corporate	Technology licensing	Environmental detector trading	Product	Sold	25	3	No	100% Thai	Domestic	No	Yes
Summary			Champions	Corporate the most	VC the most	Varies	Product the most	Sold the most	SMEs and Large	4.50	37.5 % has R&D unit	100 % Thai	29 % export company	5 champions employed this characteristic.	10 innovations patenting

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA VINCIT
SINCE 1969
มหาวิทยาลัยอัสสัมชัญ

Table 8B: Company background of The Followers

Project no.	Company Code	Project name	Stage of innovation diffusion	Target customer	Form of funding	Industry sector	Type of innovation	Reach towards market development stage	Firm size (no. of employee)	R&D personnel	Formal R&D unit	ownership	market customer
1	FO01	Ferment for shred earthworm producing machine	R&D stage (fail)	individual	VC	Bioinsecticide product	process	No	45	4	Yes	100 % Thai	Domestic
2	FO02	R&D for boil of half-milled rice processing	R&D stage (fail)	corporate	VC	Machcanical for rice mill	Product	No	400	8	Yes	100 % Thai	Domestic/ Export
3	FO03	Benchmarking for CNC machine for furniture producer	R&D stage (Stop)	corporate	VC	Furniture	process	No	32	0	No	100% Thai	Domestic
4	FO04	Bacteria fertilizer equipment for dog chew processing	R&D stage (Hold, not aplicable)	corporate	VC	Rawhid dog chew	process	No	200	0	No	100 % Thai	Export
5	FO05/1	integration of computer graphic in gomological design and processing	Innovation development stage (on going)	corporate	VC	Jewelry	process	No	298	5	Yes	100 % Thai	Export
6	FO05/2	Software development of cost production in gomology business	R&D stage (applicable)	corporate	VC	Jewelry	process	No	298	5	Yes	100 % Thai	Export
7	FO06	Cost inventory for management in jewelry business	R&D stage (stop)	corporate	VC	Jewelry	process	No	350	0	no	100 % Thai	Export
8	FO07	Systemetic design for electronic ballast	Innovation development stage (on going)	individual	VC	Energy saving product - Electronic	process	No	20	1	no	100% Thai	Domestic
9	FO08	Development of calfra filament to brake disc	Innovation development stage (on going)	corporate	VC	Automobile Part	product	No	51	3	Yes	100% Thai	Domestic/ Export

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

10	FO09	Software development for plastic mold design	R&D stage (applicable)	personnel/ corporate	VC	Plastic	process	No	300	0	No	100% Thai	Domestic
11	FO10/1	Design for heat trap from exhaust of spring production	R&D stage (applicable)	corporate	VC	Automobile Part	process	No	1500	4	Yes	100 %Thai	Domestic
12	FO10/2	Energy saving in blast furnance	R&D stage (applicable)	corporate	VC	Automobile Part	process	No	1500	4	Yes	100 %Thai	Domestic
13	FO11	Solvent control system in production process	R&D stage (applicable)	corporate	VC	Chemical	process	No	180	0	No	100 %Thai	Domestic
14	FO12	Development of TMR feeder machine	R&D stage (applicable)	corporate	VC	Diary _Food	process	No	15	0	No	100 %Thai	Domestic
15	FO13	Fast track record of diagnose the Tuberculosis (T.B.)	Innovation development stage (on going)	corporate	Technology licensing	Medical product	process	No	25	yes	Yes	100 %Thai	Domestic
16	FO14	Biotechnology for pollution reduction and generating energy in Strach Processing Factory	R&D stage (applicable)	personnel/ corporate	VC	Food	process	No	510	0	No	100 %Thai	Domestic
17	FO15	Commercial breeding of virus to kill caterpillar in cotton plant.	Innovation development stage (fail)	individual	VC	Bioinsecticide	product	No	1200	yes	Yes	100 %Thai	Domestic
18	FO16	Parasol (Hed Nok Yung) for commercial	Innovation development stage (on going)	individual	Technology licensing	Food	product	No	44	0	No	100 %Thai	Domestic
19	FO17	Producing of sour sauce from concentrated bacteria	R&D stage (stop)	individual	VC	Food	product	No	15	0	No	100 %Thai	Domestic
20	FO18	Noise telecommunication	R&D stage (applicable)	corporate	VC	Electronic	process	No	Large	yes	Yes	100 %Thai	Domestic
21	FO19	Increasing efficiency for hydrocy popilation reaction in starch processing.	R&D stage (applicable)	individual/c orporate	VC	Food	process	No	180	5	Yes	100 %Thai	Domestic
22	FO20	Improve efficiency for rice and sticky rice processing	R&D stage (applicable)	individual	VC	Food	process	No	700	11	Yes	100 %Thai	Domestic

Appendix 9

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 9: Scale rating of granted researcher technological capability in research task

Champions (code)	Rating of granted researcher technological capability (1 to 5) 1 = lowest 5 = highest	Followers (code)	Rating of granted researcher technological capability (1 to 5) 1 = lowest 5 = highest
CH01	5	FO01	2
CH02	5	FO02	4
CH03/1	5	FO03	3
CH03/2	5	FO04	2
CH03/3	5	FO05/1	3
CH04	5	FO05/2	2
CH05	5	FO06	2
CH06	3	FO07	3
CH07	4	FO08	3
CH08	4	FO09	2
CH09	5	FO10/1	2
CH10	4	FO10/2	2
CH11	5	FO11	2
CH12	5	FO12	3
CH13	4	FO13	4
CH14	4	FO14	3
Average	* 4.56	FO15	* 2
		FO16	4
		FO17	4
		FO18	2
		FO19	3
		FO20	2
		Average	2.68

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 10

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 10B: Interview data of R&D objective revealed by a group of followers (2003)

Project no.	Company Code	Project name	Improve product quality	Learn about new technology	Reduce production cost	Reduce labor cost	Extend product range	Improve cycle time	Increase market share	Improve production flexibility	Open up new markets	Reduce energy consumption	Fulfill regulations & reduce environmental effects (enterprise standard)	Comply with domestic regulation (trade standard)	Respond to international	Improve work conditions for employees	Replace products being phased out	R&D for routine working	R&D for improvement	R&D for re-engineering/redesign	R&D for learning
1	FO01	Fermentor for shred earthworm producing machine			X														X		
2	FO02	R&D for boil of half-milled rice processing		X			X		X	X								X	X	X	
3	FO03	Benchmarking for CNC machine for furniture producer	X	X	X	X		X													X
4	FO04	Bacteria fertilizer equipment for dog chew processing	X	X							X			X					X		
5	FO05/1	Integration of computer graphic in gomological design and processing							X						X			X			
6	FO05/2	Software development of cost production in gomology business			X													X			
7	FO06	Cost accounting software in jewelry industry			X		*							*				X			
8	FO07	Systemetic design for electronic ballast		X			X					X						X			
9	FO08	Development of calfra filament to brake disc	X				X												X		
10	FO09	Software development for plastic mold design									X							X			
11	FO10/1	Design for heat trap from exhaust of spring production			X							X							X		
12	FO10/2	Energy saving in blast furnance			X							X							X		

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Project no.	Company Code	Project name	Improve product quality	Learn about new technology	Reduce production cost	Reduce labor cost	Extend product range	Improve cycle time	Increase market share	Improve production flexibility	Clean up raw materials	Reduce energy consumption	Fulfill regulations & reduce environmental effects (emission standard)	Comply with domestic regulation (trade standard)	Respond to international	Improve work conditions for employees	Replace products being phased out	R&D for routine working	R&D for improvement	R&D for new product/generation	R&D for savings
13	FO11	Solvent control system in production process										X			X				X		
14	FO12	Development of TMR feeder machine		X		X		*											X		
15	FO13	Fast track record of diagnose the Tuberculosis (T.B.)		X			X											X			X
16	FO14	Biotechnology for pollution reduction and generating energy in Strach Processing Factory		X								X	X					X	X	X	X
17	FO15	Commercial breeding of virus to kill caterpillar in cotton plant.		X			X											X			X
18	FO16	Parasol (Hed Nok Yung) for commercial		X			X											X			X
19	FO17	Producing of sour sauce from concentrated bacteria	X				X		X	X								X	X		X
20	FO18	Noise telecommunication	X	X				*		X									X	X	X
21	FO19	Increasing efficiency for hydrocy popilation reaction in starch processing	X															X	X		X
22	FO20	Improve efficiency for rice and sticky rice processing	X		X													X	X		X
Summary			32%	45%	32%	9%	32%	5%	9%	18%	5%	23%	9%	5%	5%	5%	0%	32%	50%	45%	45%

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

Table 1 A: Interview data of R&D objective revealed by a group of champions (2003)

Project no.	Company Code	Project name	Improve product quality	Learn about new technology	Reduce production cost	Reduce labor cost	Extend product range	Improve cycle time	Increase market share	Improve production flexibility	Launch up new markets	Reduce energy consumption	Fulfill regulations & reduce environmental effects (emission, waste standard)	Generation (create domestic regulatic	Respond to competitors	Improve work conditions for employees	Replace products being phased out	R&D for trouble shooting	R&D for improvement	R&D for reverse engineering	R&D for learning
1	CH01	Shred earthworm for bio-pesticide					X										X				X
2	CH02	Alcohol's distillation for Jilada Royal Project					X				X							X			
3	CH03/1	Fluidized bed dryer and cyclone		X			X				X	X								X	X
4	CH03/2	Rice Oven (Grabedted)		X			X				X	X								X	X
5	CH03/3	Brown rice frillier by picture detection		X			X				X	X								X	X
6	CH04	Mango pickling for food safety	X						X									X			
7	CH05	NPK test kit					X										X				
8	CH06	Machine for cultivate in justmine rice growing in North East region					X				X									X	
9	CH07	Mangos teen Sizing Machine					X													X	
10	CH08	Cassava Cleansing Machine					X													X	
11	CH09	Test Kit for infectious virus C in humen liver		X			X										X				X
12	CH10	Corporate tax and accounting software				X	X		X								X				X
13	CH11	Long life of ripe mango		X					X	X	X						X	X			X
14	CH12	Coji Tower	X	X				X	X		X						X	X	X	X	X
15	CH13	Lenux Talay (Software)		X			X										X				X
16	CH14	Chlorine contamination checking machine		X			X		X											X	X
Summary			14%	57%	0	7%	93%	7%	36%	7%	50%	21%	0	0	0	0	0	50%	29%	57%	71%

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969

Appendix 11

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 11: Gathering data from in-depth interview (Dec 03, Jan - Apr 04)

Variables/Company	1. CH07	2. CH 03	3. CH01/FO01	4. CH02	5. CH04	6. CH05
1.The organization of R&D units						
Positioning of R&D unit in the organization	No formal R&D unit	Formal R&D unit	Formal R&D unit	Formal R&D unit	No formal R&D unit	No formal R&D unit
Flexibility of organization structure	No formal structure. There is one owner in charge to MD and his wife resposible for sale and marketing. The ten (10) employees are technician and labor. MD is machanical engineer and control the production and business development. Therefore, company has high flexibility to formulate R&D team as snap shot event.	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-disciplinary team of R&D project	Even though we have R&D unit. Our organization is very flexible. We can assign staff from each unit to work on special project	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-disciplinary team of R&D project	We don't have much R&D activity at R&D stage. At innovation development stage, we train supervisor with new process. We can also assign any staff from each functiona unit to work on special occasion.	We don't have technical staff to work on R&D stage. However, we can assign supervisor from production unit to work on innovation development.
Corporate culture	Owner is a kind of innovator. He always seek for innovation. Due to this company is very samll and family own business, worker has very limited opportunity to expose to out side organization. Owner has directive style of management.	Learning organization (willingness to joint R&D with university student and professor, and government organization)	Top management has high commitment in developing new product innovation. They are willing to share innovation experiences and more connect to intra-industry and technology resources.	R&D unit is well set. R&D employees takes full responsibility in company's innovation development. More connection to inter and intra- industry	We are innovation seeker. We open opportunity for staff to bring in their innovative idea to management.	We always encourage our staff to think out of the box. We allow opportunity to attend technical workshop as appropriate.
Style of management	Owner takes his role in production and R&D, business management and development, fincial controller, personnel management. His wife, as general manager, take responsible for marketing and sale, and project coordinator. Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	A key role of managers is to maintain high group morale and performance and they are less directive or didactic;rely on more people in the management team such as owners, professional managing director, general manager and units manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for approval from top management. In term of in-house R&D management, these R&D team worked in coordination with marketing and sale unit, production unit, business development unit, and granted researcher from R&D funding program. As this style of management, trouble shooting for R&D activity among large business from champions groups was initiated from the R&D unit rather than company owner alone.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic	A key role of managers is to maintain high group morale and performance and they are less directive or didactic Rely on more people in the management team such as owners, professional managing director, general manager and units manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for approval from top management. In term of in-house R&D management, these R&D team worked in coordination with marketing and sale unit, production unit, business development unit, and granted researcher from R&D funding program. As this style of management, trouble shooting for R&D activity among large business from champions groups was initiated from the R&D unit rather than company owner alone.	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)

Variables/Company	1. CH07	2. CH 03	3. CH01/FO01	4. CH02	5. CH04	6. CH05
2.The management commitment in R&D activity						
Who are R&D team leader? Commitment?	Granted researcher takes role in R&D project management and lead in research task. From company end, Managing Director (MD) take lead in engineering development and invention.	Executive deputy managing director took lead regarding company side. Granted researcher took lead for R&D project management.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.
Ability to cope with high degree of uncertainty	Yes, because MD and genneral manager fully participate in product innovation development. They know problem and limitation and accept to the error. However, we also have technical fail at prototype running. We sale product at 50 % performance. We offer free fixing an dservise to customer if product does not work.	Top management of company is a kind of risk -averse people. He revealed that he accepted in any success and failure of R&D result. Company expected to develop new product to the current market. They launch product at 80 % performance base on offering free service at any problem.	High ability to cope with uncertainty of new product development. The way that technical manager see, it is normal that innovator need to understand failure of prototype.	Company expected to help Jilada Royal project developed new product by which more utilization of by product from Jilada Plant. Company took fully support to any risk of R&D development.	Company paid for technology licensing of TRF. They aimed at developing new product to market. They viewed that R&D risk was normal for business investment.	Company paid for technology licensing of TRF. They aimed at developing new product to market. They viewed that R&D risk is normal for business investment.
Usually contacts outside peer group	Member of Thai Inventor Association. Usually participate to various activity of research center organization	Member of FTI. But they still have less dependent on intra-industry linkage outside the groups. Company expect to play proactive role in outside association.	We are keep contact to NSTDA and TRF. We are seeking fund opportunity for future project.	We are FTI member. We also maintain contact to TRF and NSTDA for funding and technology opportunity.	We keep contact with TRF and NSTDA an other professional association. We always seek for technology or funding opportunity.	We keep contact to TRF in order to capture new business opportunity.
3.The difficulties of the research task in relation to the capability of researchers						
How's difficulty of this research task in relation with in-house capability ? Relationship between granted researchers from TRF and NSTDA funding program and firm's employee. In - house R&D capability.	Not too difficult. Because it is in line of existing business. One of their product namely "Automatic Cultivator" received the first prize of Thai Invention Award 2001 from the Ministry of Science and Technology in associated with Bangkok Bank Foundation. It is effort of company owner. He assigned technical (worker) to work on assemble task.	It's quite difficult! However, we have engineering team (R&D unit) work closely with granted researcher. We got lucky to join th eproject with Dr Somchart, University of King Mongkut Institute of Technology Thonburi, who received the Unesco Science Prize. Today, he is our consultant in R&D activity. Company share holder said.	For Shred Worm project, it is difficult and complicate but our technical team can overcoming the difficulty. The owner give fully support in terms of allocation of staff time and budget.	It is not difficult. We have expertise in distribution process. In addition, we have a good opportunity to learn more with granted researcher from Mahidol university as well. Our top management have a good connection with Jilada project. We have asked for developing this project.	We receive technology transfer from TRF. We think that is a very good process. It is not too difficult in pratice. Company owner said.	We are marketing unit. We do packing and marketing of product. While, researcher of Kasetsart University do the production. We trust in their expertise of this production. We have also hire researcher as part time consultant.
The difficulty of research task in relation to the capability of granted researcher	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)

Variables/Company	1. CH07	2. CH 03	3. CH01/FO01	4. CH02	5. CH04	6. CH05
4.The ability to translate R&D results into saleable innovation						
How is company preparing a production line for saleable innovation?	Not nessecessary to invest any new capital goods. Company is a producer for light machine/tools/equipment serve to agriculture field.	Company choose R&D investment in relation with business line. It is no need to prepare big change o fproduction line in advance. By the way, R&D team inform a chief of production unit about R&D progress at nearly launch.	We have production staff to full fill the gap between R&D result and saleable form of innovation. However, we did not prepare production line as mass production at first phase of innovation launch. We hold it until we have a good market response	This innovation is compatable with exsiting production line.	This innovation is compatable with exsiting production line.	Just prepare for packaing task. We have no need to deal with production activities. We have just buy product from them.
Who is change driver?	Company owner	Company owner	Senior technical manager	R&D manager	Company owner	Company owner
How well the researcher translate R&D result into production activity? (give the rank)	Very well. It is team effort of company technical team and granted researcher to review the research task and design toward detail design and trial the prototype. University student also participated the projects.	Granted researcher, university student, and R&D employees worked on R&D task at the early phase. It is team effort to translate first prototype to saleable product.	Very well	Excellent (5)	Excellent (5)	Excellent (5)
Problem during the prototype running stage	Performance error. It is technical problem,It need to adjust many time before launch to the market.	There was a lot of problem regarding technical constraint. Company tested the prototype with their close customer by offering testing benefit.	No problem	No problem	No problem	No problem
The evaluation method to help predict user's adoption of new product innovation before final product development	Sale and marketing person demonstrate a prototype of mangosteen sorter machine to gardener (direct user). Feed back is good enough to continue develop the machine at commercial stage. By the way, formal marketing research is not nessesary because a limit number of target user.	Product life cycle technique	Product life cycle technique	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner
5.The design of product innovations according to the market need						
Does company conduct marketing research in relation with design of product innovation activity?	No formal marketing research	No formal marketing research	No formal marketing research	No formal marketing research	No formal marketing research	No formal marketing research
How is company conducting innovation marketing research?	NONE	NONE	NONE	NONE	NONE	NONE
When is marketing activity of innovation happen?	Prototype	Testing the prototype	Stage of product launch	Stage of product launch	Stage of product launch	Stage of product launch
Does NSTDA or TRF involve with marketing activity? How?	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.	No, TRF did not require granted researcher involvement in marketing activity. It was personnel interesting of the granted researcher to assist in company marketing activity.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
LABOR OMNIA VINCIT
BROTHERS OF ST GABRIEL

Variables/Company	1. CH07	2. CH 03	3. CH01/FO01	4. CH02	5. CH04	6. CH05
6.The number of patents registered and prototypes derived from the R&D						
Does company re-invent innovation derived from R&D activity of TRF and/or NSTDA? How much did it re-invent?	Yes, it is a minor adjustment of product performance. Company provide after sale service to adjust measurable scale of machine specification to meet the user requirement.	Yes, company re-invent the derived of lab scale from R&D funding program. Company developed the first prototype and conducted testing protocal for many time to ensure its launch to market.	Yes, However, it is minor change. At R&D stage, granted researcher develop prototype at close to saleable form.	Yes, However, it is minor change. At R&D stage, granted researcher develop prototype at close to saleable form.	Yes, However, it is minor change. At R&D stage, granted researcher develop prototype at close to saleable form.	No. Company is marketing unit. We do packing only. We buy product from Kasetsart university.
Did innovation patenting? Who is the key driver of patents and prototype?	No patent register. Company avoid sharing the patent benefit between TRF, granted research, and company which is disadvantage to the company.	Yes, top management and R&D employees share effort to patent	Yes. Granted researcher registered a patent.	No	Yes. Granted researcher registered a patent.	Yes. Granted researcher registered a patent.
How much top management effort to patent?	Low effort	High effort	Not applicable for this innovation. This company received technology transfer from granted researcher.	Ignore to patent. Focus to market first.	Not applicable for this innovation. This company received technology transfer from granted researcher.	Not applicable for this company because they are marketing unit, not production base.
How much of employees effort to drive innovation to patent and prototype?	NONE	High effort	Not applicable for this innovation. This company received technology transfer from granted researcher.	None	Not applicable for this innovation. This company received technology transfer from granted researcher.	Kasetsart university hold the patent.
7.The ability to push product market launch						
Does NSTDA or TRF researcher involve in the developing a marketing plan?	No	It was personnel assistant to the company. Some granted researcher communicated directly with a potential customer. It was the purpose of creditbility of product innovation.	Very limited. It is not their obligation to do this with company. However, company received their assistance in terms of coordinate with Agriculture Extension Agent. Company contacted that agency for developing market.	No.	No	No
How marketing department involve in R&D phase?	Sale and marketing personnel participated all meeting of R&D activity in order to tell user need and comment on machine configuration. On other ward, she communicated new product to potential customer in advance.	Sale engineer explored the customer problem or need during the current sale activity.	Marketing team has fully involved in market development activities.	Marker assist in packaging design of product.	No	No.
What is the communication channels use for marketing of product?	Direct demonstration of new product to potential user (managoateen cultivator and merchadisor)	Direct demonstration of new product to potential user (interpersonnel)	Direct communication with farmer or people in cultivate community. Marketing and sale team demonstrate product performance at rural villedge.	Direct communication	Direct communication	Direct communication

ASSUMPTION UNIVERSITY OF THAILAND
SINCE 1969

Variables/Company	1. CH07	2. CH 03	3. CH01/FO01	4. CH02	5. CH04	6. CH05
What are the most effective communication channel?	Direct demonstration of new product and TV media	Lead user reference to their new product innovation	Direct communication to potential user.	Direct communication to potential user.	Direct communication to potential user.	Direct communication to potential user
How does the company compare the budget for marketing and R&D activity?	Marketing is less than R&D	Balance between marketing and R&D.	Balance between marketing and R&D.	Balance between marketing and R&D.	Marketing is less than R&D.	Marketing budget is more than R&D budget.
What is the first target adopter?	Large mangosteen cultivator and Fruit market in Thailand	A close relationship of customer (rice mill producer in Thailand)	Farmer	Consumer	Consumer	People in cultivate field, farmer
8.The ability to enter the new market						
Marketing strategy	Product performance able to enter a new market but it is small sale volume. It need more advertisement on the product.	High ability to enter new market due to having professional marketing and sale team.	We sent marketing team to the rural villedge. The team demonstrated our product to farmer. They engaged leader of villedge to pursuate farmer.Sale team introduced product to agriculture extension agent. These people helped a lot in pursuating lead user.	Company transferred production technology to Jilada plant. Jilada produce new series of perfume and place their product at Jilada shop. Due to Jilada innnage, customer accepted in quickly. However, we are confident that our product is good for customer. We also announce our product via Jilada website.	Company management has good relationship with export company. These are our customer too. We introduce a better quality of pickle mango. We obtain a good response from them. Before we had investment for mass production, we hold for first lot of order from these customer.	We gained first lot of order from Agriculture extension agency. It was a big oder that make reference to our product to farmer. It was expected that Agricultur Extension Agency would give free product to farmer. We maintanced a good relationship with Agriculure Extension Agency.
9.Users of the innovations						
How long does it take from product launch through obtainning customer?	16 months from design toward prototype. Now a day, product was launch for two year. It took 4 month for obtainning first lot of customer.	15 months for fluidized bed dryer, 12 months for Rice oven (strawberry), 4 months for brawn rice hiller. Our market development is on going activities and extend to international market.	4 months for obtaining first lot of customer.	3 months	3 months	No data reported
What kind of user in general?	Large mangosteen cultivator	Rice mill factory	Individual customer.	Individual customer.	Corporate customer. A superior product benefit to the company for developing new international market.	Corporate customer
Revenues from sales of innovations	390,000	400,000,000	No data reported	No data reported	No data reported	No data reported
% sold volume of target	15%	55%	30%	30%	50%	75%
10.Publications as research outputs						
Publication	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
SINCE 1969

Table 11: Gathering data from in-depth intervi Table K: Gathering data from in-depth interview (Dec 03, Jan - Apr 04)

Variables/Companies	7. CH06	8. CH11	9. CH12	10. CH09	11. CH10	12. CH13
1.The organization of R&D units						
Positioning of R&D unit in the organization	Formal R&D unit. It is part of business development department.	No formal R&D unit. Only base Lab unit.	No formal R&D unit	Formal R&D unit	No formal R&D unit	Formal R&D unit
Flexibility of organization structure	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-disciplinary team of R&D project.	We don't have R&D unit. However, we assign production staff and lab staff to work with granted researcher. Our organization is flexible for R&D activity.	We can pull skill worker to work on special project. We can see any benefit to establish R&D unit because it is cost load to business.	Ou R&D unit is very small (one person). However, we have flexibility to manage staff for R&D activity.	We had formulate R&D team from staff in each unit such as account consultant, marketing, IT. We have high flexibility in managing R&D activity.	Formal structure of department e.g.software unit, computer and IT, R&D, marketing, personnel, administrative, accounting & finance.
Corporate culture	Company management has openness to encourange staff to learn more about new technology. They allow staff to attend technical workshop and seminar.	Company management is innovator. He also open opportunity for staff to participat e R&D activity both on the job and participate workshop.	Company owner are kind of innovator. They always seek innovation opportunity.	Company management opens for invitioning the innovative idea from a senior level of staff. In term of work environment, our company have intensive R&D activity due to it is corporate mission.	Openness of Customers to innovation.	In joining R&D funding program, management views that it is one of the channels for learning.
Style of management	A key role of managers is to maintain high group morale and performance and they are less directive or didactic. Rely on more people in the management team such as owners, professional managing director, general manager and units manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for approval from top management. In term of in-house R&D management, these R&D team worked in coordination with marketing and sale unit, production unit, business development unit, and granted researcher from R&D funding program. As this style of management, trouble shooting for R&D activity among large business from champions groups was initiated from the R&D unit rather than company owner alone.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic. Rely on more people in the management team such as owners, professional managing director, general manager and units manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for approval from top management. In term of in-house R&D management, these R&D team worked in coordination with marketing and sale unit, production unit, business development unit, and granted researcher from R&D funding program. As this style of management, trouble shooting for R&D activity among large business from champions groups was initiated from the R&D unit rather than company owner alone.	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	A key role of managers is to maintain high group morale and performance and they are less directive or didactic. Rely on more people in the management team such as owners, professional managing director, general manager and units manager. Therefore, approaching R&D government funding to this kind of company needs more lead time for approval from top management. In term of in-house R&D management, these R&D team worked in coordination with marketing and sale unit, production unit, business development unit, and granted researcher from R&D funding program. As this style of management, trouble shooting for R&D activity among large business from champions groups was initiated from the R&D unit rather than company owner alone.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.

THE ASSUMPTION UNIVERSITY LIBRARY

Variables/Companies	7. CH06	8. CH11	9. CH12	10. CH09	11. CH10	12. CH13
2.The management commitment in R&D activity						
Who are R&D team leader? Commitment?	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Technology transfer from Granted researcher. MD took lead effort seeking of technology.However, he is team leader in developing new product.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.	Managing Director(MD) is R&D team leader from our end. Granted researcher is R&D project manager.
Ability to cope with high degree of uncertainty	in order to develop new product line (trackter), MD gave fully support in product development from R&D activity. R&D unit received 2-3 million baht for this innovation development project. Failure from investment of 2-3 million baht did not hurt the company financial.	MD presented high confident in technology. He paid for technology licensing with confident in long life of this technology.	Due to its growth of company. R&D activity was inportant driver for the company. Then, risk-averse was need characteristic of MD	It is acceptable to failure of lab scale to saleable form. Innovator need to overcome it.	Failure in developing software is normal. We also fail with runing test of software. Some content is miss. It also require to run with compatable other program. It need friendly user as well. We can overcome that problem in the finally.	The way I see, failure during innovation development is normal. It is just a process to cope with the difficulty.
Usually contacts outside peer group	We are FTI member.	We are FTI member.	We keep contact with TRF and NSTDA. We attend technical workshop in order to improve our knowledge in bidecgnology.	We are FTI member.	We maintain relationship with researcher at NSTDA. We are seeking for funding opportunity and innovation.	We are FTI member.
3.The difficulties of the research task in relation to the capability of researchers						
How's difficulty of this research task in relation with in-house capability ? Relationship between granted researchers from TRF and NSTDA funding program and firm's employes. In -house R&D capability.	It is difficult. However, we have expertise in line of automobile part business. R&D unit have fully support from top management. In addition, we have fully equipment support for assemble the propotype. Our R&D team is work very well with granted researcher. Therefore,we can overcome a research task.	Our company owner interested in developing new line of product. He contacted directly to granted researcher at BIOTEC. We receive technology transfer from BIOTEC. Granted researcher come to train us in our plant. Senior production staff have to be trained and transfer their knowledge to junior satff and labor. In overall, we see that process is not too difficult in practice. Today, she is our consultant in R&D activity.	It is difficult. However, I (son of company owner) view that granted researcher have done an excellent task to come up with Coil Ferment Tank.I work with him on technical task. It can use for our production process as the result of R&D stage. My father assigned technical staff for working on assemble task.	It is quite difficult and complicate! It took almost 10 years in succesful at new knowledge and first lab scale. However, none of industry in Thailand can adopt for producing in manufacturing scale.It took almost 2 years for finding out production base. Finally, we adopted technology and learn a lot with developing for commercialization. I (company share holder) took lead effort in developing this innovation.	It is difficult. We don't have professional programer. However, our owner inmitated the project and ask our team to carry out the project. We have professional accountant and marketing team. We exchange knowledge with NECTEC. We join VC project with granted researcher and work in collaboration on developing program.	It is not too difficult. We have professional programmer. We learn a lot from Microsoft module and adapt it to Lenux Talay. However, we gain technical assistant from granted researcher from NECTEC. We work together in developing software. Company owner gave fully support to the project. Today, we have hire part time professional researcher to help us in R&D activity.
The difficulty of research task in relation to the capability of granted researcher	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)

ASSUMPTION UNIVERSITY
LABOR BROTHERS
THAILAND
SINCE1969

Variables/Companies	7. CH06	8. CH11	9. CH12	10. CH09	11. CH10	12. CH13
4.The ability to translate R&D results into saleable innovation						
How is company preparing a production line for saleable innovation?	Acctualy, it is in line of business. We plan to launch a small volume of product first. New production line for this type of vehicle (tracktor) will be laid out according to market response.	No need to prepare any new production line due to its has compatable with existing process.	Our production capacity is limited. We need only one Coji Tank for this moment. So, we have just assemble this innovation and put into production process. No need to lay out new production line.	We are baby company in this business. We start to prepare production line at the end stage of innovation development. We establish production line in parellel with market developemnt stage.	Production of software is out of our line of business. However, it take easy to pack software into CD rom since technology is available elsewhere.	This innovation is compatable with line of business and production line. No need to prepare any new production line at R&D or innovation developemnt stage.
Who is change driver?	R&D manager and business development manager	Company owner	Company owner	Company owner	Company owner	Company owner and R&D manager
How well the researcher translate R&D result into production activity? (give the rank)	Acceptable	Excellent (5)	Excellent (5)	Excellent (5)	Excellent (5)	Very well
Problem during the prototype running stage	Fail for many time. However, R&D team continue try to overcome technical problem.	There is a few number of failure due to production staff still does not use to with new process.	There is a few number of technical fail. For instance, result of permentation is not satisfaction. Finally, researcher can overcoming the problemby come up with stable performance of coji Tank.	Innovation is not in the saleable form that need a stability of product in hand of customer.	There is a few bug of software. Company and granted resarcher test the software by offer fre software to a close customer. Feedback is incorporate to adjust the program.	There is some program error. A big problem is that program is not compatable with others program like a Microsoft. Company overcome it by developing update version very offen to catch up Microsoft.
The evaluation method to help predict user's adoption of new product innovation before final product development	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner	Make estimate by business experiences of company owner
5.The design of product innovations according to the market need						
Does company conduct marketing research in relation with design of product innovation activity?	No formal marketing research	No formal marketing research	No formal marketing research	No formal marketing research.	No formal marketing research	No formal marketing research
How is company conducting innovation marketing research?	NONE	NONE	NONE	No formal marketing research. However, company received funding from BIOTEC in performing industry analysis research. It is opportunity to evaluate business feasibility of this industry.	NONE	NONE
When is marketing activity of innovation happen?	At innovation development stage	Stage of product launch	BIOTEC perform technology licensing activity for this technology.	At innovation development stage	At innovation development stage	At innovation development stage
Does NSTDA or TRF involve with marketing activity? How?	No	No	No	No	No	No

ASSUMPTION UNIVERSITY THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA VINCIT
SINCE 1969

Variables/Companies	7. CH06	8. CH11	9. CH12	10. CH09	11. CH10	12. CH13
6.The number of patents registered and prototypes derived from the R&D						
Does company re-invent innovation derived from R&D activity of TRF and/or NSTDA? How much did it re-invent?	Yes, of course. Our R&D unit put a lot of effort to re-invent of cultiveling machine.	No	No	Yes. We do need to develop R&D result to saleable form. We have to perform the testing process, which we have to re-invent base on the testing result.	Yes, we make update version of software from version 1 to 3.	Yes, we always update version of software.
Did innovation patenting? Who is the key driver of patents and prototype?	Yes, R&D personnel procede to the patent.	Yes. Granted researcher registered a patent.	Yes. Granted researcher registered a patent.	Yes. Granted researcher registered a patent.	No. However, company try to register the copy right. The process is too long and not effectiveness.	No. Company register to copy right.
How much top management effort to patent?	High effort	Not applicable for this innovation. This company received technology transfer from granted researcher.	Granted researcher. Company don't know about this patent.	Not applicable for this innovation. This company received technology transfer from granted researcher.	Marketing staff (general manager)	R&D staff
How much of employees effort to drive innovation to patent and prototype?	High effort	Not applicable for this innovation. This company received technology transfer from granted researcher.	Granted researcher	Not applicable for this innovation. This company received technology transfer from granted researcher.	Marketing staff (general manager)	R&D staff
7.The ability to push product market launch						
Does NSTDA or TRF researcher involve in the developing a marketing plan?	No	No	No	No	No	No
How marketing department involve in R&D phase?	Yes, marketing staff inform information of existing product to R&D staff.	Marketing personel and company management are always inform customer needs and demand to production personnel. Production personel work on R&D activity at oppourtunistis.	Company management is the same person of marketer. Besides, he is the same person of R&D personnel who work with granted researcher. Therefore, he input his business experiences to R&D design task.	No	Marketing staff ask customer need and limation. Therefore, R&D team has customer information at the design stage. Marketing staff is one of the team.	Marketing staff ask customer need and limation. Therefore, R&D team has customer information at the design stage. Marketing staff is one of the team.
What is the communication channels use for marketing of product?	Direct communication	Direct communication	Direct communication	Direct communication	Direct communication	Mass communication
What are the most effective communication channel?	Direct communication to potential user	Direct communication via management to management	No answer	Via trading agency	Direct communication via consultant staff	Mass communication via TV, Website, publication
How does the company compare the budget for marketing and R&D activity?	Balance between marketing and R&D.	Balance between marketing and R&D.	Less marketing. Less R&D	R&D budget is more than marketing.	Less marketing. Less R&D	Balance between marketing and R&D.
What is the first target adopter?	People in cultivate field, farmer	Cunsumer	Department store	Hospital	General company who has accountant activity	Cusumer

ASSUMPTION UNIVERSITY OF THAILAND
ABAC POLL RESEARCH CENTRE
SINCE 1969

Variables/Companies	7. CH06	8. CH11	9. CH12	10. CH09	11. CH10	12. CH13
8.The ability to enter this new market						
Marketing strategy	We sent our marketing and sale team to the rural villedge. Our strategy is that to sale machine to loaner. Base on observation and study characteristic of potential user, our marketing team reported that small farmer is not target. They cannot effort our product prices (1 million baht) for personnal use. So, we target to landlord or cultivate contractor. This contractor will buy a machine for providing cultivate service to each farm or pady field. We have just introduce product to a few contractor in February 2004.	Our management form a good relationship with our customer (company). He introduced new process at innovation development stage. We obtained a good signal from our customer to develop mass production. Our management conduct a road show to corporate customer in many countries. He gained a very good marketing result.	We don't expect to have a new Coji Tank. The botter line is to use it in our production process. However, BIOTEC aims at licensing technology to others.	We had study feasibility to business development. Due to we have competency in technology development rather than marketing. We choose to sale our product to trading agent. We have a good relationship with the agent. They take lead in developing market and doing well. We are production and technology base.	We introduce new software to our existing customer. Usually, our customer calls for ask accounting question frequently. We take this chance to recommend them to look at software. We give free software for some customer. By the way, we place our software at See-Ed Book Store, Julalongkorn university. We also advertise in accounting association beltin. Due to budget limitation, it is not sufficience in terms of marketing effort.	We had joint venture R&D with NECTEC. We designed market strategy with NECTEC. We know that we encounter with Microsoft, but we try to gain market share. We place product as Thai royaltee. We give free down load at first version of product. People can download from NECTEC website. We are expected that Lenux Talay can serve individual need due to its price is cheapter than Microsoft. For new version, we sale it at our company office.
Marketing strategy						
9.Users of the innovations						
How long does it take from product launch through obtainning customer?	Just lauch for 1 months. We cannot judement. (as interview in April 04)	6 months. Company developed international market. However, they are encountering with trade barrier in Japan. Due to its new process technology, Japan trade considered this is not applicable with their existing food safety regulation. Company are trying to negotiate with Japan trade about this new process.	Company used it. This technology was licensed by BIOTEC in 12 months later its announcement.	Meet break even point within 12 months.	12 months for introducing software to current customer. Marketer always introdue software to their customer. They tried to convince customer to use software rather than calling for ask company staff about accounting question.	24 months for obtaining first lot of customer. At first phase of product launch, company offered free using of Lenux Talay. People can download from NECTEC website.
What kind of user in general?	Individual customer	Corporate customer	Corporate customer	Corporate customer	Corporate customer	Individual customer
Revenues from sales of innovations	No data reported	No data reported	No data reported	No data reported	1,040,000	No data reported
% sold volume of target	5%	80%	1%	80%	13%	10%
10.Publications as research outputs						
Publication	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.

Table 11: Gathering data from in-depth intervi Table K: Gathering data from in-depth interview (Dec 03, Jan - Apr 04)

Variables/Companies	15.FO05	16. FO06	17.FO08	18.FO09
1.The organization of R&D units				
Positionong of R&D unit in the organization	Formal R&D unit	Formal R&D unit	Formal R&D unit	No formal R&D unit
Flexibility of organization structure	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-discipinary team of R&D project.	Formal structure of department e.g production engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-discipinary team of R&D project.	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-discipinary team of R&D project.	Have flexibility of organization to work on special project.
Corporate culture	High openness of Government Departments & Regulatory Authorities to Innovation. High openness of customers to innovation	Company management is not pay too much attention to R&D activity.	Openness of Customers to innovation	Only company management participate R&D activity. Staff has a very limited opportunity in outside activity.
Style of management	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	The decision-making in R&D and innovation development project is relying on one owner alone. (It is family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management. This is a kind of "family-ownership-control-type businesses".	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business).
2.The management commitment in R&D activity				
Who are R&D team leader? Commitment?	MD approve in developing this software. However, he does not aim at selling the software. He aims to inprove cost system.	Company management approve to join the project with Artifec and TRF. We does not aim to develop for sale.	Our MD is team leader. We aims to develop new type of product and launch at high end market.	General Manager (Son of founder) is team leader. However, we does not aim at developing this project to commercialization.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Variables/Companies	15.FO05	16. FO06	17.FO08	18.FO09
Ability to cope with high degree of uncertainty	Company expected to develop innovation for utilizing in current production process. It was not a purpose of new product development. Therefore, software innovation launched for free copy. Interviewee revealed that company was not ready to cope any failure with new product development.	This company was co-R&D with Artifect Co. but they phased out from the project at the midle way. Company expected to develop innovation for utilizing in current production process. It was not a purpose of new product development. Therefore, software innovation launched for free copy. Interviewee revealed that company was not ready to cope any failure with new product development.	Innovation development is on going. Company expect to launch in 2005. Interviewee (R&D manager) explained that company paid fully attendtion to cope with R&D risk.	This company was not aim to develop new product. They developed the design software for utilizing current production process. Company are not ready to cope with R&D risk for new product development.
Usually contacts outside peer group	We have never keep contact with granted researcher after the end of project.	We have never keep contact with granted researcher after the end of project.	We have not heard any innovation news from granted researcher. However, we search information from FTI.	We are FTI member. However, we have never contact to granted researcher after the end of project.
3.The difficulties of the research task in relation to the capability of researchers				
How's difficulty of this research task in relation with in-house capability ? Relationship between granted researchers from TRF and NSTDA funding program and firm's employee. In -house R&D capability	Our R&D staff work closely with granted researcher. We help them collecting data and information for developing program.	We sent our marketing staff work with Artifec Team and granted researcher.	At that period of joint project, we did not assign full time staff work with granted research. We let granted researcher lead the management of R&D project. Our technical satff followede instruction and supply technical data.	We lack of technical staff. It is opportunity to join the project. I (son of company owner) work closely with granted researcher.
The difficulty of research task in relation to the capability of granted researcher	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)	(see rating in appendix 9)
4.The ability to translate R&D results into saleable innovation				
How is company preparing a production line for saleable innovation?				
Who is change driver?	General manager	R&D manager	General manager and R&D manager	General Manager (Son of founder)
How well the researcher translate R&D result into production activity? (give the rank)				
Problem during the prototype running stage			R&D team are working intensively to produce first saleable form of break disc. At this satge, we receive know how from	

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Variables/Companies	15.FO05	16. FO06	17.FO08	18.FO09
The evaluation method to help predict user's adoption of new product innovation before final product development	Company staff have to test the program that coming out from R&D stage. It was debuged many time. However, company staff developed the program furture. Today, this program was use cor business operation.	Company joined the project with Artifect Co. But, company leave the project at the middle way of project progress	our partner in Canada We also inform our corporate customer such as TOYOTA, Demlor Csylor etc about our new product innovation (calfra filament to brake disc) at this phase. We perform marketing of new product at this stage. We place product positioning at high end product.	We are mot aim to developed this innovation for sale. We can use the software coming out at R&D stage.
5.The design of product innovations according to the market need				
Does company conduct marketing research in relation with design of product innovation activity?				
How is company conducting innovation marketing research?	NONE	NONE	NONE	NONE
When is marketing activity of innovation happen?				
Does NSTDA or TRF involve with marketing activity? How?	No	No	No	No
6.The number of patents registered and prototypes derived from the R&D				
Does company re-invent innovation derived from R&D activity of TRF and/or NSTDA?	Company have not reached market yet.	Company have not reached market yet.	Company have not reached market yet.	Company have not reached market yet.
How much did it re-invent?				
Did innovation patenting? Who is the key driver of patents and prototype?				
How much top management effort to patent?				
How much of employees effort to drive innovation to patent and prototype?				
7.The ability to push product market launch				
Does NSTDA or TRF researcher involve in the developing a marketing plan?	Internal use of siftware for by company However, company are willing to share with others.	Company joined the project with Artifect Co. But, company leave the project at the middle.	On innovation development process. It is expected to launch new product in mid-2005.	Application in company only
How marketing department involve in R&D phase?				
What is the communication channels use for marketing of product?				
What are the most effective communication channel?				
How does the company compare the budget for marketing and R&D activity?				
What is the first target adopter?				
8.The ability to enter the new market				
Marketing strategy	Non product existent	Non product existent	Non product existent	Non product existent

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of LABOR ST GABRIEL VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Variables/Companies	15.FO05	16. FO06	17.FO08	18.FO09
9.Users of the innovations				
How long does it take from product launch through obtainning customer?	Non product existent	Non product existent	Non product existent	Non product existent
What kind of user in general?	Corporate customer	Corporate customer	Corporate customer	Corporate customer
Revenues from sales of innovations	No product launch	No product launch	No product launch	No product launch
% sold volume of target	-	-	-	-
10.Publications as research outputs				
Publication	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Table 11: Gathering data from in-depth interview (Dec 03, Jan - Apr 04)

Variables/Companies	19. FO10/1/2	20. FO11	21. FO12	22. FO04	23. FO03	24. FO20
1.The organization of R&D units						
Positionong of R&D unit in the organization	Formal R&D unit	No formal R&D unit	No formal R&D unit	No formal R&D unit	No formal R&D unit	No formal R&D unit
Flexibility of organization structure	Formal structure of department e.g.production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-discipinary team of R&D project.	If R&D opportunity comes, we can assign staff as appropriate.	If R&D opportunity comes, I can manage my time to work with granted researcher. We can also assign staff as appropriate.	If R&D opportunity comes, we can assign staff as appropriate.	We can assign staff to work on R&D activity when opportunity comes.	Our management can allocate staff from diferent unit to work on R&D activity. If R&D opportunity comes, we can assign staff as appropriate.
Corporate culture	R&D unit has just be set for a year. Small team and yong staff. Top management commitment in innovation devlopment from R&D activity. R&D activity has been promoted to entire organization.	We always encourage our staff to think out of the box. We allow opportunity to attend technical workshop as appropriate.	We are small farm. Most of technical staff is animal husbandry. We open for innovation idea.	Openness of Customers to innovation	We always open for innovative idea from staff.	We always encourage our staff to think out of the box. We allow opportunity to attend technical workshop as appropriate.
Style of management	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	Family-affiliated corporations that allow ownership- and kinship-led rather than skill-based management (Family own business)	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.
2.The management commitment in R&D activity						
Who are R&D team leader? Commitment?	Top management committee approve the project. Plant manager is team leader from company end. However, we does not aim to commercialzation. We just expect to inprove energy efficiency to production process.	Plant manager is team leader. We aim to solve solvent problem in production process. We join R&D granted program of TRF. It is not expected to sale this technology to others.	Managing Dierctor is team leader. We aim to develop food feeder machine. It is expected to use for our operation activities.	MD is team leader. We does not aim to develop innovation for commercialization. We are in the beginning of R&D learning. We aim to learn technocal task from granted researcher.	MD is team leader. We want to learn furniture industry in Thailand. We don't have ambitious to develop innovation for commercialization at this moment.	Production manager is tean leader. We aim to improve product quality to meet food safty law.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Variables/Companies	19. FO10/1/2	20. FO11	21. FO12	22. FO04	23. FO03	24. FO20
Ability to cope with high degree of uncertainty	This company expected only to solve the current problem (energy loss). At the time joinning wwith TRF fund, they still have low risk averse with new product development. Now a day, they have more confident in R&D for porduct development. Then, company set up new R&D unit.	We can overcome with failure of system. By the way, our granted researcher can overcome that problem.	It is normal that we need to have patient in developing new machine. We also face with technical failure of machine. But, granted researcher can overcome the problem.	It is normal issue. Innovator need to have face with testing process. Nothing completed 100 % at first try.By the way, our project end at lab scale. We have never test it with the real production.	We have to deal with uncertainty of R&D result. By the way, our reasercaher can overcome the problem untill it usable to existing operation.	R&D outcome is not satisfy at the first an dsecond time of testing the production. However, we try it many time. Finally, we can improve and use it for the production process.
Usually contacts outside peer group	Granted researcher have never follow up the project with us. We have never keep contact to each other. However, we are FTI membership. We have heard R&D opportunity from FTI meeting.	We are FTI member. We separate from granted researcher once the project end.	We are quite isolate. We have never keep contact with granted researcaher after the end of project.	FTI member	FTI member	FTI member
3.The difficulties of the research task in reason to the capability of researchers						
How's difficulty of this research task in relation with in-house capability ? Relationship between granted researchers from TRF and NSTDA funding program and firm's employee. In -house R&D capability.	The research task is complicate. We let granted researcher lead the technical and management task. Our engineer support them a data amd information of production.	We don't have formal technical team work with granted researcher. One or two engineer followed R&D task by researcher instruction. Researcher look fully R&D management task. However, we veiwed that researcher use a very low grade of assemble part.	We don't have technical staff who can work with granted researcher. I (general manager) am only one who work follow instruction of researcher in support the data of R&D task.	We don't have technicla staff who can work with granted researcher at that period of project. Today, we hire two staff for cary out R&D activity for other projects. At that period of R&D projecvt with TRF, I viewed that researcher did not have well management.	At project period, I (company owner) work closely with granted researcher. Researcher lead all the work and report to me periodically. The way I see, research task is not too difficult. However, it still need research who has multi-disciplinary to work for R&D task such as machanical, electronic, material, management, business and marketing.	It is not too difficull. It need experiment and lab facility. Granted researcher lead the project task. I followed their instruction for gathering data and information for R&D design. After project end, we have never contact to granted researcher.
The difficulty of research task in relation to the capability of granted researcher	(see rating in appendix I)	(see rating in appendix I)	(see rating in appendix I)	(see rating in appendix I)	(see rating in appendix I)	(see rating in appendix I)
4.The ability to translate R&D results into saleable innovation						
How is company preparing a production line for saleable innovation?	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only
How well the researcher translate R&D result into production activity? (give the rank)	See app. 9	See app. 9	See app. 9	See app. 9	See app. 9	See app. 9

ASSUMPTION UNIVERSITY THAILAND BROTHERS OF ST GABRIEL LABOR VINCIT OMNIA DIS

Variables/Companies	19. FO10/1/2	20. FO11	21. FO12	22. FO04	23. FO03	24. FO20
Problem during the prototype running stage	test. For instance,company have a lot of oder. We cannot stop the production for testing the prototype. We have to hold the	making use of solvent control system. We have to meet safty law by dead line. Finally, we can develop an dassemble the	coming out from R&D stage. We have just assemble base on granted researcher recommendation at R&D stage.	currently. Granted researcher design another option of produution process to us. As is, we use batch processing process. Our product is customize.	furniture production problem at R&D stage. We found that we need to recruite strategic alliance to formulate innovation	sale. We expected to solve our production process to meet with food safty law and international trade regulation. We utilized R&D
5.The design of product innovations according to the market need						
Does company conduct marketing research in relation with design of product innovation activity?	No	No	No	No	No	No
How is company conducting innovation marketing research?	NONE	NONE	NONE	NONE	NONE	NONE
When is marketing activity of innovation happen?	NONE	NONE	NONE	NONE	NONE	NONE
Does NSTDA or TRF involve with marketing activity? How?	No	No	No	No	No	No
6.The number of patents registered and prototypes derived from the R&D						
Does company re-invent innovation derived from R&D activity of TRF and/or NSTDA? How much did it re-invent?						
Did innovation patenting? Who is the key driver of patents and prototype?	Not interested to partent	Not interested to partent	Not interested to partent	Not interested to partent	Not interested to partent	Not interested to partent
How much top management effort to patent?						
How much of employees effort to drive innovation to patent and prototype?						
7.The ability to push product market launch						
Does NSTDA or TRF researcher involve in the developing a marketing plan?						
How marketing department involve in R&D phase?						
What is the communication channels use for marketing of product?	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only	Hold innovation use untill coming of market oppturunity	Internal use of innovation only	Internal use of innovation only
What are the most effective communication channel?						
How does the company compare the budget for marketing and R&D activity?						
What is the first target adopter?						
8.The ability to enter the new market						
Marketing strategy	Internal use of innovation only	Internal use of innovation only	Internal use of innovation only	market oppurtunity	Internal use of innovation only	Internal use of innovation only
9.Users of the innovations						
How long does it take from product launch through obtainning customer?	Non product existent	Non product existent	Non product existent	Non product existent	Non product existent	Non product existent
What kind of user in general?	Corporate customer	Corporate customer	Corporate customer	Corporate customer	Corporate customer	Individual customer
Revenues from sales of innovations	No product launch	No product launch	No product launch	No product launch	No product launch	No product launch
% sold volume of target	-	-	-	-	-	-

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABOR OMNIA VINCIT
มหาวิทยาลัยอัสสัมชัญ

Variables/Companies	19. FO10/1/2	20. FO11	21. FO12	22. FO04	23. FO03	24. FO20
10 Publications as research outputs						
Publication	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969
LABOR OMNIA VINCIT
BROTHERS OF ST GABRIEL
AMDG
THE ASSUMPTION UNIVERSITY LIBRARY

Table 11: Gathering data from in-dep Table 11: Gathering data from in-depth interview (Dec 03, Jan - Apr 04)

Variables/Companies	25. FO19	26. FO07	27. FO13	28. FO14	29. FO15	30. FO18	31. FO16
1.The organization of R&D units							
Positionong of R&D unit in the organization	No formal R&D unit	No formal R&D unit	Formal R&D unit	No formal R&D unit	No formal R&D unit. Only have Lab unit	Formal R&D unit	No formal R&D unit
Flexibility of organization structure	If R&D opportunity comes, we can assign staff as appropriate	We can assign staff as appropriate.	Formal organization under umbrella of The hospital	If R&D opportunity comes, we can assign staff as appropriate	We can assign our production and lab staff to work on R&D activity. If R&D opportunity comes, we can assign staff as appropriate	Formal structure of department e.g production, engineering, R&D,marketing & sale, personnel, administrative, accounting & finance. It is clear cut functional of employees in different units. Low flexibility in to develop multi-discipinary team of R&D project	If R&D opportunity comes, we can assign staff as appropriate
Corporate culture	We always encourage our staff to think out of the box. We allow opportunity to attend technical workshop as appropriate	We are very small business. Company owner has special attention in R&D activity. However, our staff has low opportunity in R&D activity	Our officer has opportunity to propose an innovative idea base on their job function.	We are innovation seeker. We open opportunity for staff to bring in their innovative idea to management.	We always encourage our staff to think out of the box. We allow opportunity to attend technical workshop as appropriate.	We are high technology business. Our staff has fully opportunity in initiating innovative idea to organization	Company owner are kind of innovator. They always seek innovation opportunity.
Style of management	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	Family-affiliated corporations that allow ownership and kinship-led rather than skill based management (Family own business)	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	A key role of managers is to maintain high group morale and performance and they are less directive or didactic.	
2.The management commitment in R&D activity							
Who are R&D team leader? Commitment?	Plant manager is team leader. We aim to improve product quality.	MD is team leader. We aim to study opportunity in deloping product to substitute import. By the way, it is quite difficult to us.	Director is team leader.	MD is team leader. We aim to solve wastewater problem.	MD is team leader. We aim to develop new product in the area of bio-insecticide, which is challenge to us.	R&D manager is team leader. We aim to develop new device use for our existing system.	MD is team leader. In fact, he is only one who work closely with granted researcher. He aim to develop new kind of muchroom.
Ability to cope with high degree of uncertainty	We have patient enough with R&D project. Finally, we can adjust technical problem until it usable with operation process.	High degree to cope with uncertainty	It is mission to cope with high degree with uncertainty of R&D activity.	High degree to cope with uncertainty	We performed experiment for 5 times but we fail. Then, we terminated the project.	High degree to cope with uncertainty	High degree to cope with uncertainty of new mushroom plantation.
Usually contacts outside peer group	FTI member	We have never keep contact with granted researcher.	We are keep contact with grant researcher in order to develop innovation for commercialization. Today, we are still far from goal.	FTI member	FTI member	Granted researcher have never contact to use after the end of project.	We are still keep contact to granted researcher for developing innovation.

ASSUMPTION UNIVERSITY OF THAILAND

Variables/Companies	25. FO19	26. FO07	27. FO13	28. FO14	29. FO15	30. FO18	31. FO16
3.The difficulties of the research task in relation to the capability of researchers							
How's difficulty of this research task in relation with in-house capability ? Relationship between granted researchers from TRF and NSTDA funding program and firm's employee. In -house R&D capability.	It is difficult. We cannot solve our problem due to lack of expertise on R&D. We assign some production satff work with granted researcher in gathering data and information to him.	I (company owner) work closely with granted researcher. However, I don't have staff who chan work with researcher team. The way I see, we cannot perform our own R&D project without government assistant.	This research topic is very difficult by natute due to its deal with life. Even though, we have not involve with this project at the beginning but we see our potential to overcome it. We believe that we can work closely with granted researcher in developing innovation	We don't have R&D department. We assign technical staff to work closely with granted researcher at that period	It is difficult. We received technology transfer. We need to overcome with technology cerainty. It is quite difficult to our staff. Finally,we fail at developing innovation stage. After that we have never contact with granted researcher.	It is difficult task. That 's the reason why we join R&D project with NECTEC. We gain knowledge from granted researcher at R&D stage.	It is difficult task. We don't have expertise in biotechnology but we have local wisdom. I work closely with granted researcher to gain technical know how in biotechnology.
The difficulty of research task in relation to the capability of granted researcher	(see rating in appendix9)	(see rating in appendix9)	(see rating in appendix9)	(see rating in appendix9)	(see rating in appendix9)	(see rating in appendix9)	(see rating in appendix9)
4.The ability to translate R&D results into saleable innovation							
How is company preparing a production line for saleable innovation?					Company personnel cannot control condition as provide by R&D result. Innovation failed at innovation development stage		Top management (company owner) wok closly with granted researcher in developing a good condition of mushroom.
Who is change driver?	Company Owner	Company Owner	Director of department	Company Owner	Company Owner	Company Owner	Company owner
How well the researcher translate R&D result into production activity? (give the rank)	See app. 9	See app. 9	See app. 9	See app. 9	See app. 9	See app. 9	See app. 9
Problem during the prototype running stage	None	None	None	None	Many problems	None	None
5.The design of product innovation according to the market need							
Does company conduct marketing research in relation with design of product innovation activity?	We utilized R&D result with production process at the end of R&D stage. Nothing to do with innovation development. We satisfy with R&D result.	We are trying to develop furture innovation development activity. At R&D phase, we have study SWOT analysis of existing product in market. We see opportunity to form project. Today, we are not ready to do that due to cost limitation.	We joint venture with BIOTEC in order todevelop business unit for testing dianoses. We aim at providing service to other hospital (private and government). We expect to finish inovation development to 100% certainty by 2007.	R&D result can utilize to our wastewater trestmennt system very well. We have just maintain the system. However, we open for factory visit by other organizations as well.	Our technical team tried many time for developing condition for incubating the worm. However, we failed for 5 times. Company owner stop the project. Today, we re-assign these techeical staff to work in production unit, lab unit, and engineering unit.	At R&D stage, we can have fist prototype. After that, our engineering team develop it for compatable with existing opration.	We are working on stability of mushroom in difficulty condition. BIOTEC still sopport technical and budget to us. We don't have technical staff in doing this project. I (company owner) work closely with granted researcher in dveloping the certainty process in incubating the mushroom. Company plan to ensure product adoption via TV media.
How is company conducting innovation marketing research?	NONE	NONE	NONE	NONE	NONE	NONE	NONE
When is marketing activity of innovation happen?							
Does NSTDA or TRF involve with marketing activity? How?	No	No	No	No	No	No	

ASSUMPTION UNIVERSITY OF THAILAND
SINCE1969

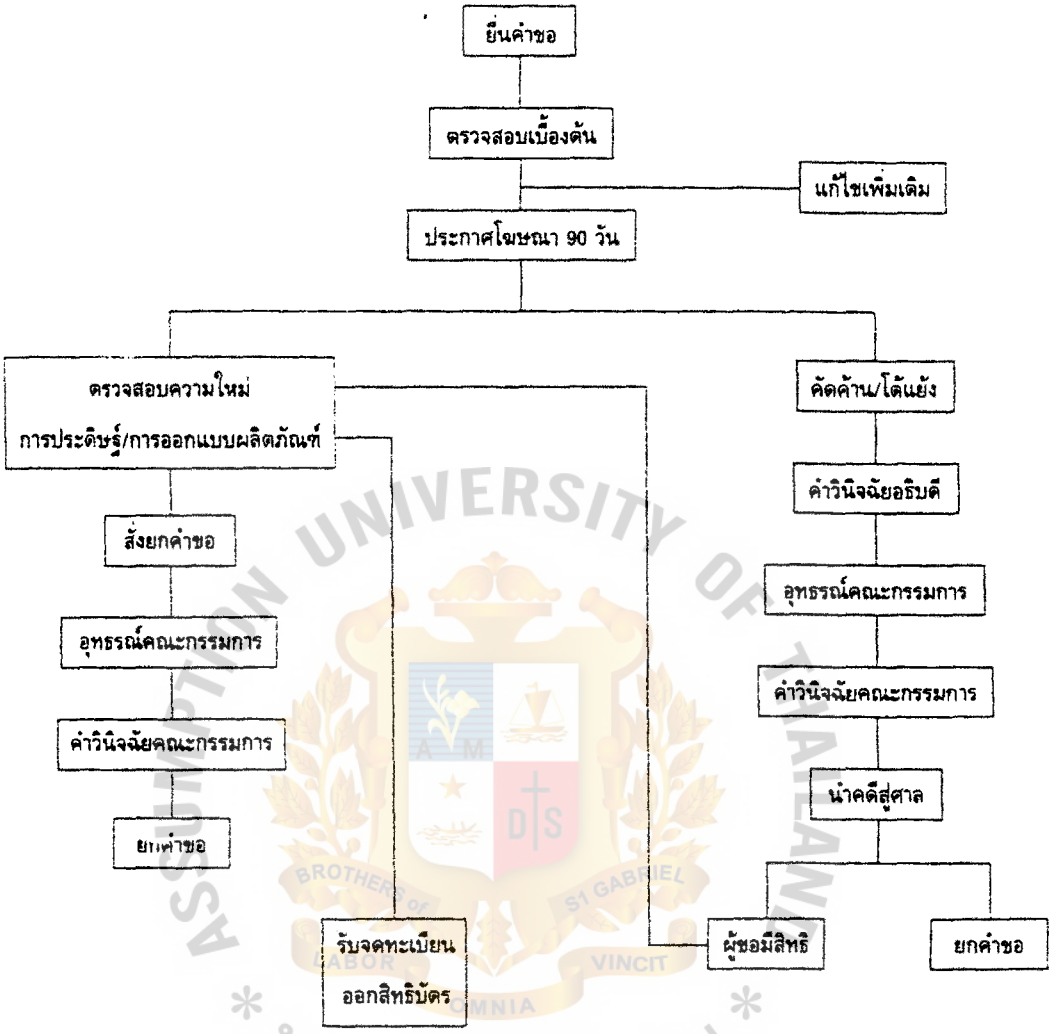
Variables/Companies	25. FO19	26. FO07	27. FO13	28. FO14	29. FO15	30. FO18	31. FO16
6.The number of patents registered and prototypes derived from the R&D							
Does company re-invent innovation derived from R&D activity of TRF and/or NSTDA? How much did it re-invent?							
Did innovation patenting? Who is the key driver of patents and prototype? How much top management effort to patent?			On innovation development process	Application in company only	Fail with innovation development process	Application in company only	On innovation development process
How much of employees effort to drive innovation to patent and prototype?	Internal use of innovation only	R&D result is body of knowledge, not product/process innovation					
7.The ability to push product market launch							
Does NSTDA or TRF researcher involve in the developing a marketing plan?							
How marketing department involve in R&D phase?							
What is the communication channels use for marketing of product?	Not application	Not application	Not application	Not application	Not application	Not application	Not application
What are the most effective communication channel?							
How does the company compare the budget for marketing and R&D activity?							
What is the first target adopter?							
8.The ability to enter the new market							
Marketing strategy	Not application	Not application	Not application	Not application	Not application	Not application	Not application
9.Users of the innovations							
How long does it take from product launch through obtainning customer?	Non product existent	Non product existent	Non product existent	Non product existent	Non product existent	Non product existent	Non product existent
What kind of user in general?	Corporate customer	Individual customer	Corporate customer	Corporate customer	Individual customer	Corporate customer	Individual customer
Revenues from sales of innovations	No product launch	No product launch	No product launch	No product launch	No product launch	No product launch	No product launch
% sold volume of target	-	-	-	-	-	-	-
10.Publications as research outputs							
Publication	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.	Don't know how many publication. Researcher might write on his own. The way I see, it can not help us interms of market development of innovation.

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST. GABRIEL
LABOR OMNIA VINCIT
SINCE 1969

Appendix 12

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR VINCIT OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

ขั้นตอนการขอรับสิทธิบัตร



ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS OF ST GABRIEL
LABORE ET SCIENTIA OMNIA VINCIT
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

Appendix 13

ASSUMPTION UNIVERSITY OF THAILAND
BROTHERS of ST GABRIEL
LABOR
VINCIT
OMNIA
SINCE1969
มหาวิทยาลัยอัสสัมชัญ

การแพร่กระจายของนวัตกรรมงานวิจัยและพัฒนาจากการบริหารงานของภาครัฐสู่เชิงพาณิชย์ กรณีศึกษาของสำนักงานกองทุนสนับสนุนการวิจัย (สกว.) และสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ (สวทช.)

Diffusion of commercialized R&D funded by Thai government: Case studies of the Thailand Research Fund (TRF) and the National Science and Technology Development Agency (NSTDA)

บทสรุปสำหรับผู้บริหาร

ปัญหาสำหรับงานวิจัย

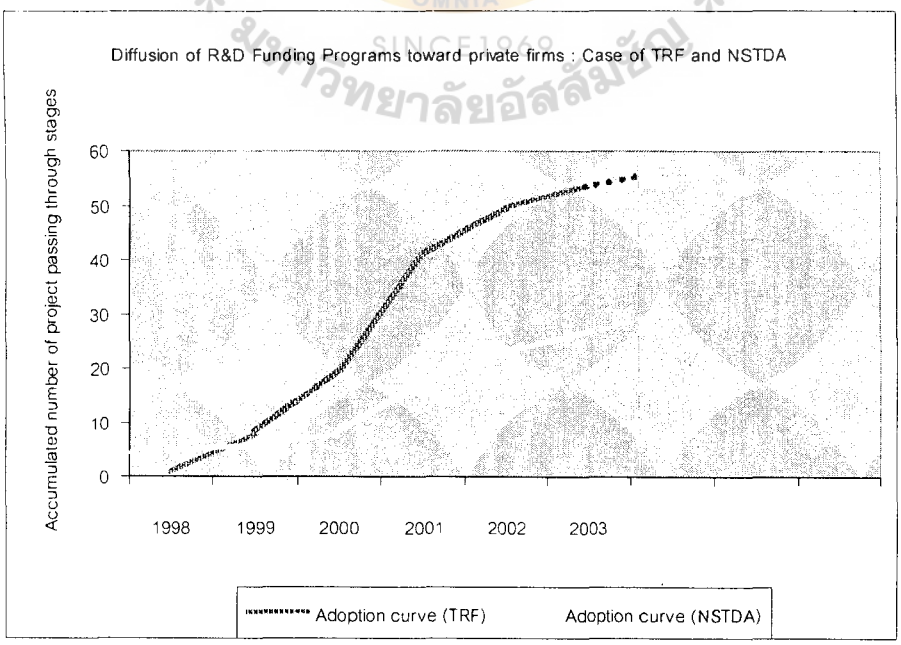
ประเทศไทยถูกจัดให้อยู่ในกลุ่มประเทศที่มีความสามารถทางเทคโนโลยีค่อนข้างต่ำ เมื่อเทียบกับประเทศกำลังพัฒนาในภูมิภาคเอเชีย นอกจากนี้ ประเทศไทยยังมีความสามารถในการแข่งขันด้านวิทยาศาสตร์และเทคโนโลยีอยู่ในลำดับท้ายๆ ทั้งนี้มีตัวแปรด้านขีดความสามารถในการบริหาร R&D ของประเทศ (R&D capability) เป็นหนึ่งในตัวแปรที่ทำให้ประเทศไทยถูกจัดอยู่ในลำดับท้ายๆ และเป็นที่ยอมรับโดยหน่วยงานบริหารงานวิจัยในประเทศว่า ยังมีผลงานวิจัยที่ดำเนินงานไปแล้วจำนวนมากที่ไม่สามารถพัฒนาให้เกิดประโยชน์เชิงพาณิชย์ ได้ ดังนั้นงานวิทยานิพนธ์ชิ้นนี้จึงมุ่งเน้นการวิเคราะห์ระบบการบริหารงานวิจัยภาครัฐในอดีตที่ผ่านมา โดยเจาะลึกรูปแบบการให้ทุนสนับสนุนการทำ R&D ในภาคเอกชน ของ 2 หน่วยงานสนับสนุนทุนวิจัยหลักของประเทศ ได้แก่ สำนักงานกองทุนสนับสนุนการวิจัย (สกว.) และสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ (สวทช.)

สรุปผลการวิเคราะห์

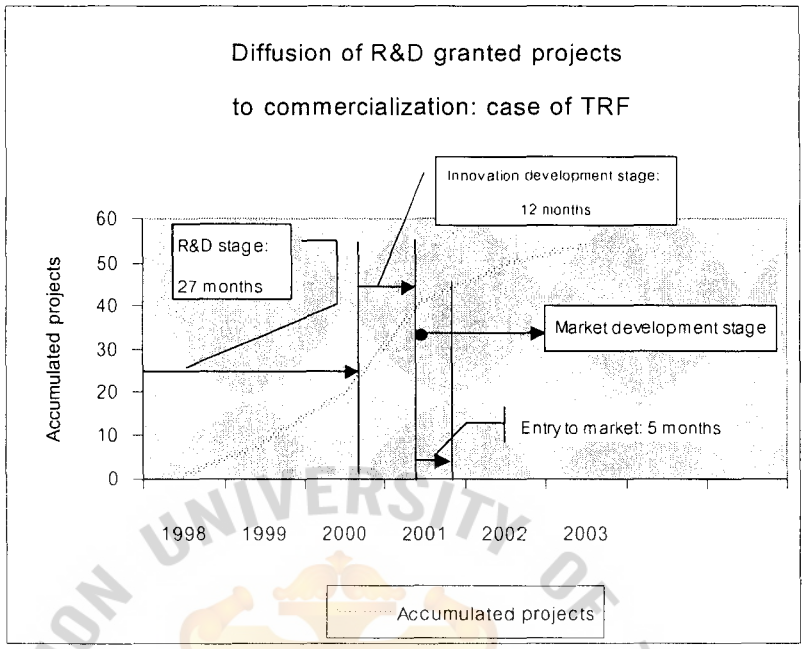
1. สกว. (TRF) และสวทช. (NSTDA) ใช้รูปแบบการบริหารงานวิจัยเพื่อประโยชน์เชิงพาณิชย์ ในลักษณะระนาบเชิงเส้น (Linear Model) กล่าวคือ มีความมุ่งเน้นการให้ทุนวิจัยในขั้น R&D เป็นลำดับแรก เพื่อกระตุ้นให้เกิดการทำวิจัยในบริษัทเอกชน (ภาคการผลิต และบริการ) ซึ่งถือเป็นประตูด่านแรกสู่การพัฒนาขีดความสามารถในการพัฒนางานวิจัยของประเทศให้เกิดประโยชน์เชิงพาณิชย์ ดังนั้น ในช่วง ปี 2540 – 2546 ที่ผ่านมา ทั้ง 2 หน่วยงานจึงเร่งให้ทุนวิจัยแก่นักวิจัยอิสระและบริษัทเอกชน ที่ประสงค์ทำวิจัยร่วมกัน โดย สกว. และ สวทช. มีเป้าหมายเพื่อพัฒนาฐานเทคโนโลยี (Core Technology) ส่วนใหญ่อยู่ในรูปแบบระดับปฏิบัติการ (Lab Scale) และ ระดับต้นแบบ (Pilot Scale) ที่ยังไม่สามารถผลิตเพื่อขายเชิงพาณิชย์ได้ ยุคถัดมา ประมาณปี 2542 เป็นต้นมา ผู้ให้ทุนเริ่มพิจารณาให้ทุนขยายโครงการสำหรับโครงการที่เห็นว่ามีศักยภาพในการพัฒนาในระดับอุตสาหกรรมเป็นเฉพาะรายไป อย่างไรก็ตามทั้ง สกว. และ สวทช. ไม่ได้แสดงบทบาทในการส่งเสริมการพัฒนาตลาดสินค้านวัตกรรมที่เกิดจากงานวิจัยดังกล่าว ทำให้มีงานวิจัยหลายชิ้นไม่สามารถทำตลาดได้ และ/หรือ มีตลาดในวงแคบ ซึ่งชี้ให้เห็นว่า หน่วยงานให้ทุนวิจัยของรัฐยังมองการพัฒนานวัตกรรมแบบแนว

ระนาบเชิงเส้น โดยมุ่งเน้นให้เกิดการทำวิจัยในขั้น R&D เป็นลำดับแรก จากนั้นจึงเริ่มขยายขอบข่ายการสนับสนุนไปยังขั้นพัฒนานวัตกรรมระดับอุตสาหกรรมเป็นลำดับรองลงมาและมองการสบับสนุนด้านพัฒนาตลาดเป็นเรื่องของอนาคต ดังนั้นการใช้รูปแบบการพัฒนานวัตกรรมแนวระนาบเชิงเส้นนี้ เป็นสิ่งสะท้อนถึงว่ายังมีงานวิจัยอีกจำนวนมากที่ยังไม่สามารถนำไปใช้ประโยชน์เชิงพาณิชย์ โดยภาคการผลิตและบริการของประเทศไทย

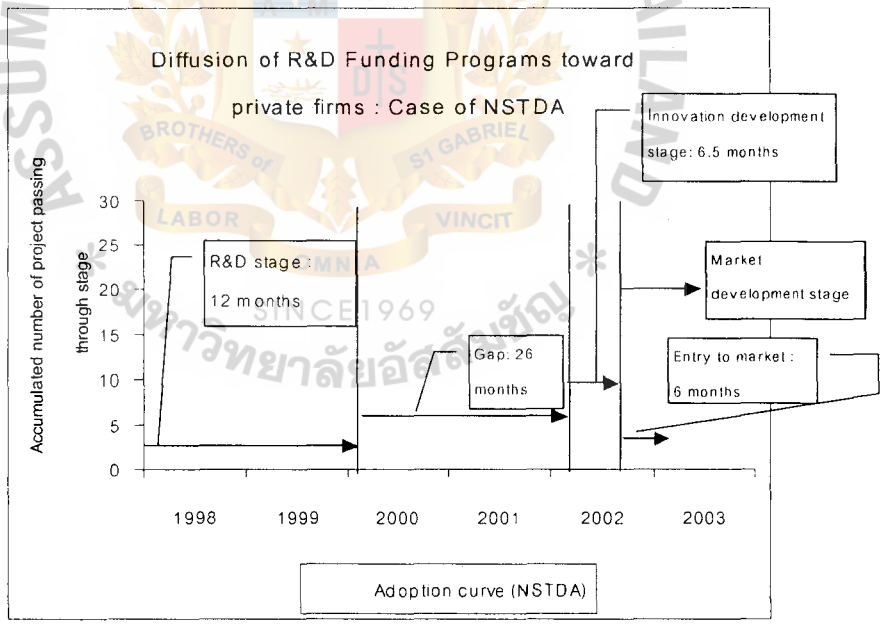
2. จากการวิเคราะห์พัฒนาการในการบริหารงานวิจัยของ สกว. และสวทช. (รูปที่ 1-1) ในอดีต 6 ปีที่ผ่านมา พบว่า สกว. มีนวัตกรรมเกิดขึ้นจากผลงานวิจัยที่ได้รับทุนวิจัยจาก สกว. และ สวทช. และไปสู่เชิงพาณิชย์หน่วยงานละ 10 นวัตกรรม รวม 20 นวัตกรรม ดังแสดงในรูปที่ 1-2 และ 1-3 โดย นวัตกรรมที่เกิดจากทุน สกว. ใช้เวลาประมาณ 44 เดือน ในการพัฒนาจากขั้นวิจัยและพัฒนา (R&D stage) ขั้นพัฒนานวัตกรรม (Innovation development) และขั้นพัฒนาตลาดของผลิตภัณฑ์นวัตกรรม (Market development) ส่วน สวทช. ใช้เวลากว่า 51 เดือน ในการพัฒนานวัตกรรม จากทั้ง 3 ขั้นดังกล่าว ซึ่งการที่นวัตกรรมจากทุน สกว. แพร่กระจายสู่เชิงพาณิชย์ได้เร็วกว่า สวทช. เนื่องจากสกว. มีการจ้างผู้ประสานงานมืออาชีพมาเป็นผู้ประสานงานชุดโครงการทำหน้าที่แสวงหาโจทย์วิจัย จากภาคการผลิตและบริการ (โรงงานอุตสาหกรรม และบริษัทเอกชน) และแสวงหานักวิจัยวิชาชีพที่มีความรู้ความสามารถเหมาะสมกับโจทย์วิจัย ดังนั้นผู้ประสานงานชุดโครงการจึงมีบทบาทเป็นผู้จับคู่(Change Agent) ระหว่างผู้ต้องการใช้ผลงานวิจัย ได้แก่ ภาคผลิตที่สามารถพัฒนานวัตกรรม กับนักวิจัยวิชาชีพที่มีความประสงค์ตรงกันในการร่วมวิจัยและพัฒนาในหัวข้อวิจัยที่นั้นๆ การดำเนินงานดังกล่าวจึงทำให้ สกว. สามารถสื่อสารเกี่ยวกับแหล่งทุนวิจัย (Direct communication on R&D funding program) ได้อย่างเข้าถึงโดยตรงต่อตัวผู้ใช้ผลงานวิจัยเพื่อพัฒนาต่อยอดสู่เชิงพาณิชย์ ในขณะที่ สวทช. มิได้มีตัวแทนทำหน้าที่ดังกล่าว อย่างไรก็ตาม ช่วงปี 2545 สวทช. เริ่มตระหนักถึงบทบาทของตัวแทนที่จะช่วยขับเคลื่อนผลงานวิจัยสู่เชิงพาณิชย์ได้เร็วขึ้น จึงได้ตั้งตำแหน่งงานด้านนักวิเคราะห์เชิงธุรกิจมาช่วยผลักดันผลงานวิจัยที่รอให้ภาคผลิตนำไปพัฒนาต่อ จึงเป็นสิ่งที่น่าติดตามต่อไปเกี่ยวกับผลการดำเนินงานนี้



รูปที่ 1-1 การแพร่กระจายของผลงาน R&D สู่เชิงพาณิชย์ จากทุนวิจัยของสกว. (TRF) และ สวทช (NSTDA)



รูปที่ 1-2 การแพร่กระจายของผลงาน R&D สู่เชิงพาณิชย์ จากทุนวิจัยของ สกว. (TRF)



รูปที่ 1-3 การแพร่กระจายของผลงาน R&D สู่เชิงพาณิชย์ จากทุนวิจัยของ สวทช (NSTDA)

3. จากรูปแบบและผลจากการพัฒนานวัตกรรมดังสรุปในหัวข้อ 1 และ2 งานวิทยานิพนธ์นี้จึงทำการศึกษาตัวแปรที่ทำให้ผลงานวิจัยจากขั้น R&D ก้าวหน้าไปยังขั้น Innovation development และขั้น Market development เป็นลำดับ การศึกษานี้ได้กำหนดตัวแปรจำนวน 10 ตัว ที่คาดว่าจะส่งเสริมหรือเป็นอุปสรรคต่อความก้าวหน้าของการบริหารงานวิจัยในแต่ละขั้นดังต่อไปนี้

ขั้น R&D	ขั้น Innovation development	ขั้น Market development
1. Organisation of R&D units 2. Management commitment in R&D activities 3. Difficulties of the research task in relation to the researchers' capability	4. Ability to translate R&D results into saleable innovation 5. Design the product innovations according to the market needs 6. The progress of R&D projects in the stage of patenting and prototyping	7. Organisation's capability in pushing new innovation to market 8. Marketing strategy 9. Target users and number of innovation adopters 10. Publications from R&D undertakings

จากการสัมภาษณ์เจาะลึกผู้ประกอบการระดับบริหาร จำนวน 31 บริษัท ที่ตั้งอยู่ในเขต กรุงเทพและปริมณฑล รวมถึงจังหวัดอยุธยา ซึ่งเป็นบริษัทที่ได้รับทุนสนับสนุนงานวิจัยและพัฒนาจากสกว. หรือ สวทช. หรือ เป็นบริษัทที่รับถ่ายทอดเทคโนโลยีจากผลงานวิจัยที่ได้รับทุนจาก สกว. หรือ สวทช. มีผลการวิเคราะห์ดังนี้

ผู้วิจัยแยกลักษณะของบริษัททั้ง 31 แห่ง เป็น 2 กลุ่ม คือ

กลุ่ม1 สามารถพัฒนางานวิจัยเป็นผลิตภัณฑ์ออกสู่ตลาด หรือกระบวนการผลิตใหม่ที่ขายสิทธิให้กับบริษัทอื่นได้ เรียกว่า "Champion"

กลุ่ม 2 กลุ่มบริษัทที่ยังไม่สามารถพัฒนางานวิจัยออกสู่ตลาด หรือเพียงแค่ใช้ผลงานวิจัยเพื่อปรับปรุงกระบวนการผลิตในปัจจุบัน เรียกว่า "Follower"

การวิเคราะห์กิจกรรมที่เกิดขึ้นกับสองกลุ่ม พิจารณาตามตัวแปร 10 ตัวที่ตั้งไว้ เพื่อพิจารณาลักษณะที่แตกต่างกันอย่างเห็นได้ชัดระหว่างกลุ่ม "Champion" กับ "Follower" พบว่ามี 6 ปัจจัย ที่มีผลส่งเสริมหรือเป็นอุปสรรคต่อความก้าวหน้าของผลงานวิจัย ในแต่ละขั้นดังนี้

ขั้น R&D ได้แก่

- ความสามารถของนักวิจัยในการดำเนินงานวิจัย (Capabilities of researchers relative to the complexities/ difficulties of the research task)

ขั้น Innovation development ได้แก่

- ศักยภาพในการแปลงผลงานวิจัยจากขนาดทดลองหรือต้นแบบ ให้สามารถผลิตจนออกขายได้ (Ability to translate R&D results into saleable innovation)
- ความสามารถของทีมวิจัยในการออกแบบนวัตกรรมให้ตรงความต้องการของตลาดผู้ใช้ (Design the product innovations according to the market needs)

ขั้น Market development ได้แก่

- ความสามารถในการผลักดันสินค้านวัตกรรมออกสู่ตลาด (Organisation's capability in pushing new innovation to market)
- ความสามารถในการวางกลยุทธ์ทางการตลาดที่ดี (Marketing strategy)
- จำนวนผู้ใช้นวัตกรรมที่น่าพอใจ (Target users and number of innovation adopters)

อย่างไรก็ตาม เป็นที่น่าสนใจว่า การประสบความสำเร็จ ในการพัฒนานวัตกรรมเชิงพาณิชย์ ของบริษัทที่เข้าร่วมในการศึกษานี้ ไม่จำเป็นต้องมีแผนก R&D อยู่ในองค์กรก็ได้ ขอเพียงแต่เป็นบริษัทที่มีบุคลากรด้านวิทยาศาสตร์ เทคโนโลยี การตลาด การบริหาร และผู้ทำหน้าที่ประสานงานติดตามความก้าวหน้าโครงการร่วมกับนักวิจัยที่ได้รับทุนอย่างใกล้ชิด ก็สามารถนำไปสู่ความสำเร็จในขั้น R&D ได้ นอกจากนี้การมีความมุ่งมั่นในการพัฒนาผลิตภัณฑ์ใหม่ หรือกระบวนการผลิตใหม่ของบริษัทเป็นกุญแจดอกสำคัญในการผลักดันผลงานวิจัยสู่เชิงพาณิชย์มากกว่าเพียงแค่มีความมุ่งมั่นในการดำเนินงานด้าน R&D เพื่อเพิ่มประสิทธิภาพการผลิต หรือแก้ปัญหาการผลิตในปัจจุบัน

ผลการศึกษาแสดงให้เห็นว่าบริษัทกลุ่ม Champion มีความมุ่งมั่นในการพัฒนาผลิตภัณฑ์ใหม่เพื่อออกสู่ตลาดให้ทันกับกรอบเวลาที่ตั้งไว้ให้เร็วที่สุด จึงไม่สามารถรอจนกว่าจะสามารถขึ้นทะเบียนสิทธิบัตรแล้วเสร็จจึงนำผลิตภัณฑ์ออกตลาด ประกอบกับความไม่ไว้ใจในระบบการปกป้องสิทธิบัตรในประเทศไทย บริษัทเหล่านี้จึงไม่เห็นความจำเป็นใดๆ ในการรอให้ได้สิทธิบัตรแล้วจึงนำผลิตภัณฑ์ออกสู่ตลาด จึงดำเนินการคู่ขนานในการนำผลิตภัณฑ์ออกตลาดกับการจดสิทธิบัตร ทั้งนี้มีบางบริษัทไม่ประสงค์จดสิทธิบัตรเนื่องจากอัตราส่วนแบ่งผลประโยชน์จากการขายสินค้าที่จดสิทธิบัตรไม่น่าพึงพอใจ เนื่องจากเป็นเงื่อนไขในการให้ทุนสนับสนุนงานวิจัยของทั้ง สกว. และ สวทช. ได้จำกัดส่วนแบ่งผลประโยชน์แก่บริษัทในสัดส่วนที่ไม่จูงใจในการทำธุรกิจ ดังนั้นบริษัทกลุ่ม Champion จึงผลักดันการพัฒนานวัตกรรมสู่ตลาดโดยไม่มีความจำเป็นต้องรอการจดสิทธิบัตรแล้วเสร็จ

อย่างไรก็ตามพบว่าการไม่จดสิทธิบัตรหรือแม้แต่จดแล้วก็ยังมีการเลียนแบบสินค้าโดยบริษัทอื่นซึ่งมีศักยภาพในการพัฒนาผลิตภัณฑ์และการตลาดเหนือกว่าบริษัทกลุ่ม Champion ที่ส่วนใหญ่เป็นบริษัทขนาดกลาง และเล็กที่ผู้ประกอบการยังขาดประสบการณ์บริหารธุรกิจเชิงการจัดการเทคโนโลยี

แม้ว่ากลุ่ม Champion จะสามารถนำผลิตภัณฑ์ออกสู่ตลาดได้แต่พบว่าบริษัทขนาดกลางและย่อม ได้รับผลตอบรับทางการตลาดอย่างกำจัด ซึ่งส่งผลต่อการเดินหน้าอย่างต่อเนื่องในการลงทุนพัฒนางาน R&D โครงการอื่นๆต่อไป สำหรับตัวแปรด้านนำผลงานวิจัยสู่เอกสารประชาสัมพันธ์ หรือทางวิชาการ จากการศึกษาไม่พบว่ากลุ่ม Champion มองเห็นว่าตัวแปรนี้เป็นปัจจัยในการส่งเสริมหรือเป็นอุปสรรคต่อการพัฒนางานวิจัยสู่เชิงพาณิชย์ของตนแต่อย่างใด โดยมองว่าเป็นหน้าที่และความสนใจของนักวิจัยที่ได้รับทุน เป็นผู้เขียนเอกสารเหล่านี้เพื่อประโยชน์เชิงวิชาการ

จากผลการวิเคราะห์ข้างต้น ผู้วิจัยได้พัฒนารูปแบบ (Model) การบริหารงานวิจัยภาครัฐจากขั้น R&D สู่เชิงพาณิชย์ โดยอาศัยหลักการวัดผลเชิงปริมาณและคุณภาพของผลงานวิจัยที่พัฒนาขึ้นในช่วงระยะเวลาหนึ่งๆ เพื่อดูลักษณะการกระจายตัวของผลงานวิจัยสู่ภาคการผลิตและบริการ และนำเสนอเกณฑ์ในการออกแบบโครงสร้างการบริหารและการจัดหาปัจจัยพื้นฐานที่สนับสนุนความก้าวหน้าของผลงานวิจัยในแต่ละระยะ ดังรูปที่ 1-4 อธิบายการนำเสนอรูปแบบดังกล่าวต่อหน่วยงานบริหารงานวิจัยของรัฐ หรือหน่วยงานสนับสนุนทุนวิจัย ที่มีภาระหน้าที่ต้องติดตามผลการดำเนินงานของงานวิจัยที่ให้การสนับสนุนเป็นจำนวนหลายๆโครงการในแต่ละปี เพื่อนำไปประยุกต์ใช้ในการบริหารงานวิจัยในระดับมหภาค

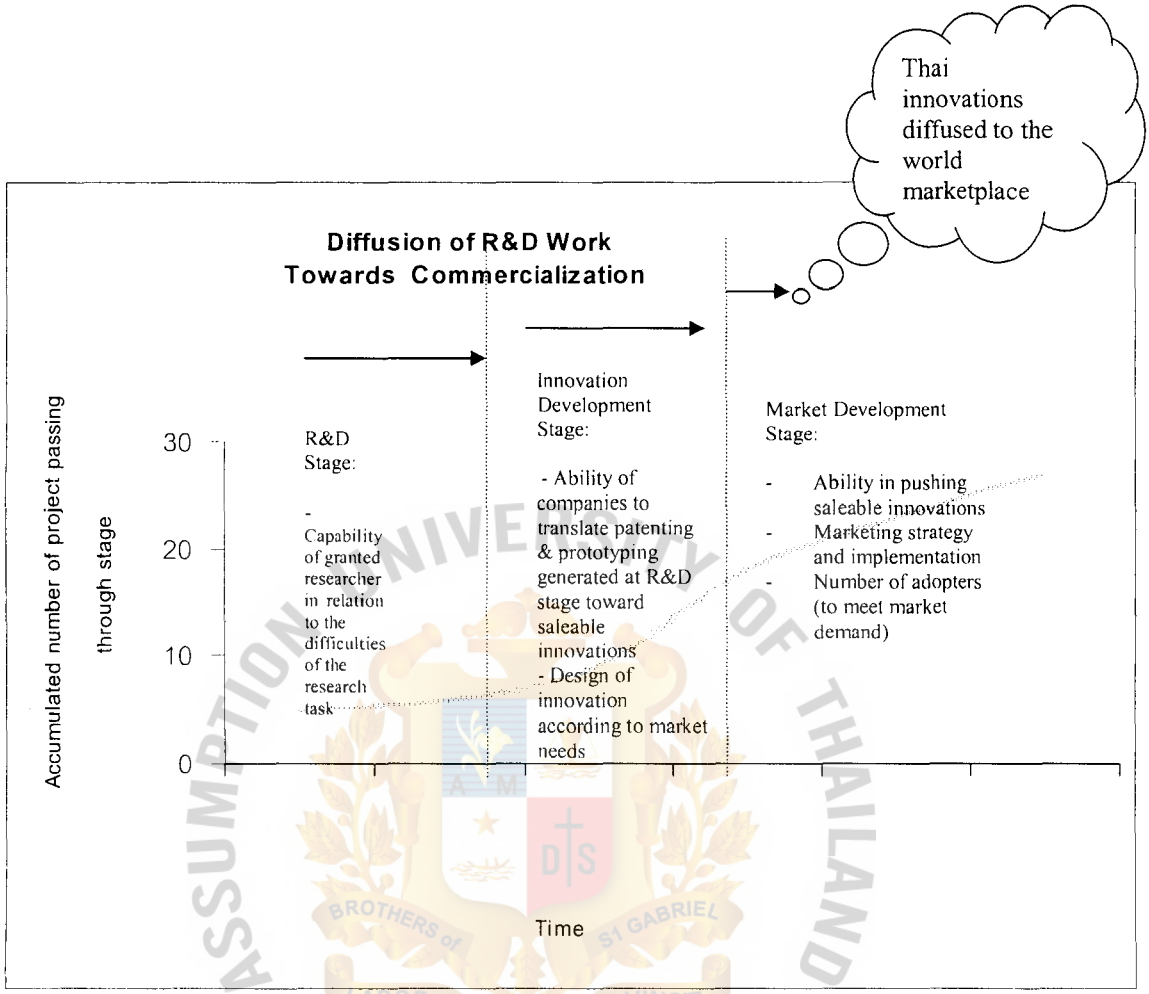
การนำ Model ไปใช้ในทางปฏิบัติ

ผู้จัดการกองทุนวิจัยและพัฒนาของหน่วยงานรัฐ ตลอดจนผู้บริหารงานวิจัยและพัฒนาในหน่วยงานเอกชนที่มีการพัฒนางานวิจัยหลายๆโครงการ สามารถนำ Model ไปใช้ตามขั้นตอนนี้

1. วิเคราะห์และติดตามจำนวนโครงการที่แล้วเสร็จในช่วงระยะเวลาหนึ่งๆ เช่น 2540 – 2546 และนำมาจัดทำกราฟแสดงจำนวนโครงการที่ดำเนินงานเพิ่มขึ้นในแต่ละปี (หรือแต่ละไตรมาส)
2. ทบทวนระยะเวลาดำเนินงานแต่ละโครงการ และหาค่าเฉลี่ยของระยะเวลาดำเนินโครงการในแต่ละขั้นของกระบวนการแพร่กระจายนวัตกรรมสู่เชิงพาณิชย์ ได้แก่ R&D development stage, Innovation development stage, Market development stage
3. ประเมินผลลัพธ์ของแต่ละโครงการว่าอยู่ในรูปแบบใด
    - ขั้น R&D development มีผลลัพธ์เป็น Lab scale หรือ Prototype
    - ขั้น Innovation development มีผลลัพธ์เป็น ผลิตภัณฑ์ หรือกระบวนการที่นำออกสู่ตลาดได้
    - ขั้น Market development stage มีผลลัพธ์เป็นปริมาณ (Volume) การขายผลิตภัณฑ์นวัตกรรม หรือรายได้จากการขายสิทธิการใช้เทคโนโลยี (Licensing)

ผลที่ได้จากการวัดผลเชิงปริมาณและคุณภาพของการดำเนินงานวิจัยในภาพกว้างนี้ สามารถช่วยผู้บริหารงานวิจัยให้มีความเข้าใจจุดบกพร่อง หรือข้อได้เปรียบ ในการดำเนินงานที่ผ่านมา เพื่อปรับปรุงการดำเนินงานต่อไป

ทั้งนี้ผู้วิจัยได้นำเสนอปัจจัยที่สนับสนุน หรือขัดขวาง ความก้าวหน้าในการพัฒนางานวิจัยในแต่ละระยะเพื่อพัฒนาไปสู่เชิงพาณิชย์ (Factors enabling or inhibiting the innovation process) ดัง ปัจจัย 6 ด้าน ที่นำเสนอมาข้างต้น ซึ่งชี้ให้เห็นว่า ผู้บริหารงานวิจัยและพัฒนาของหน่วยงานรัฐ ที่มีบทบาทเกี่ยวข้องกับการพัฒนาเทคโนโลยีและนวัตกรรมของประเทศ สามารถนำปัจจัยทั้ง 6 มาช่วยในการกำหนดเกณฑ์การคัดสรรบริษัทเอกชน และนักวิจัยวิชาชีพ (ส่วนใหญ่มาจากมหาวิทยาลัย และหน่วยงานวิจัยและพัฒนาของรัฐ) เพื่อเข้ารับทุนสนับสนุนงานวิจัยและพัฒนา ได้อย่างเต็มรูปแบบและมีประสิทธิผลในการพัฒนานวัตกรรมสู่เชิงพาณิชย์



รูปที่ 1-4 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-4 ผู้วิจัยตั้งข้อสังเกตว่า ผู้บริหารงานวิจัยของรัฐ ควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะโครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 6 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

นางสาวนภาพร อยู่เบิก
นักศึกษาปริญญาโท ภาควิชาการจัดการเทคโนโลยี
คณะวิทยาศาสตร์และเทคโนโลยี มหาวิทยาลัยอัสสัมชัญ

From : เจษฎา ลวเพชร เลิศเดชา

Attn : คุณอนงภาพร อยู่เย็น

นักศึกษาปริญญาโท สาขาวิชาการจัดการเทคโนโลยี

รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะโครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมขององค์กรของนอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 7 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบกลยุทธ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

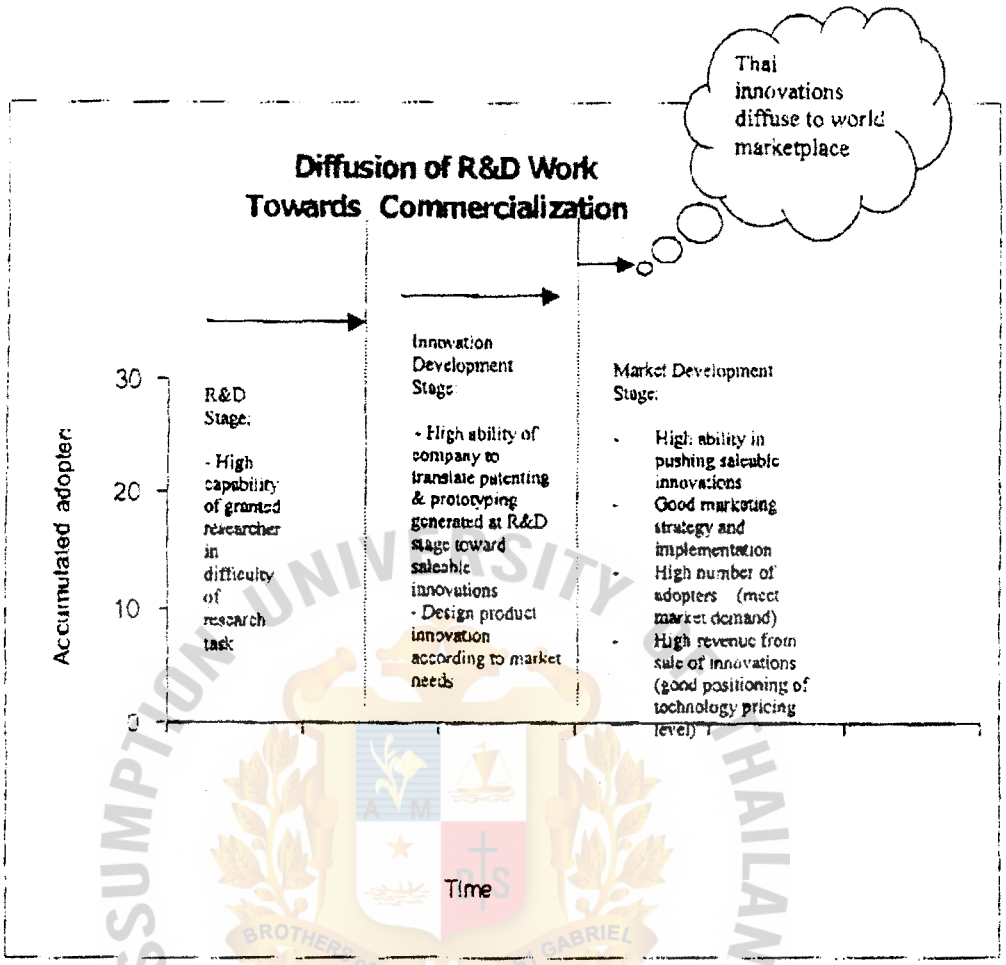
ข้าพเจ้า เห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

ลายเซ็นต์ .....

ลงชื่อ (นาย เจษฎา ลวเพชร เลิศเดชา)

ตำแหน่ง ผู้จัดการโรงงาน

หน่วยงาน บริษัท เชน (ประเทศไทย) จำกัด



รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่น่าเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะโครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 7 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

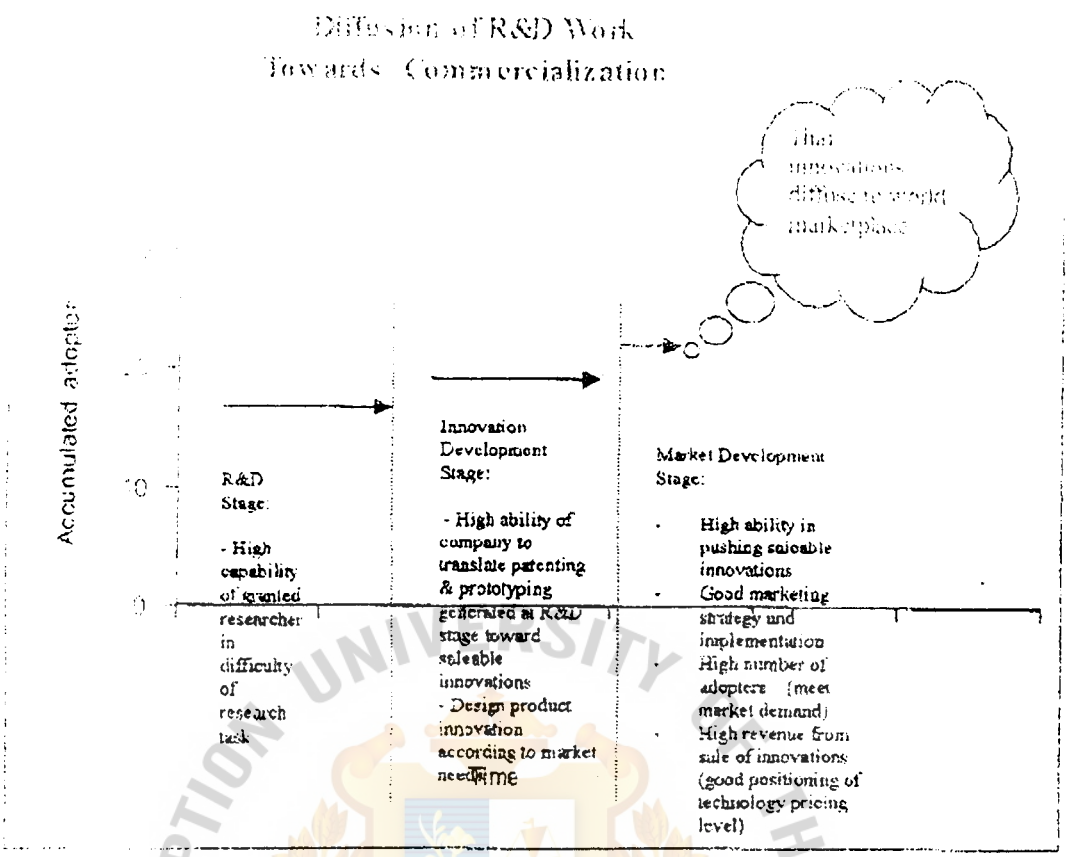
ข้าพเจ้าเห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

ลายเซนต์ .....

ลงชื่อ (.....)

ตำแหน่ง .....

หน่วยงาน .....



รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะ โครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 7 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

ข้าพเจ้า เห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

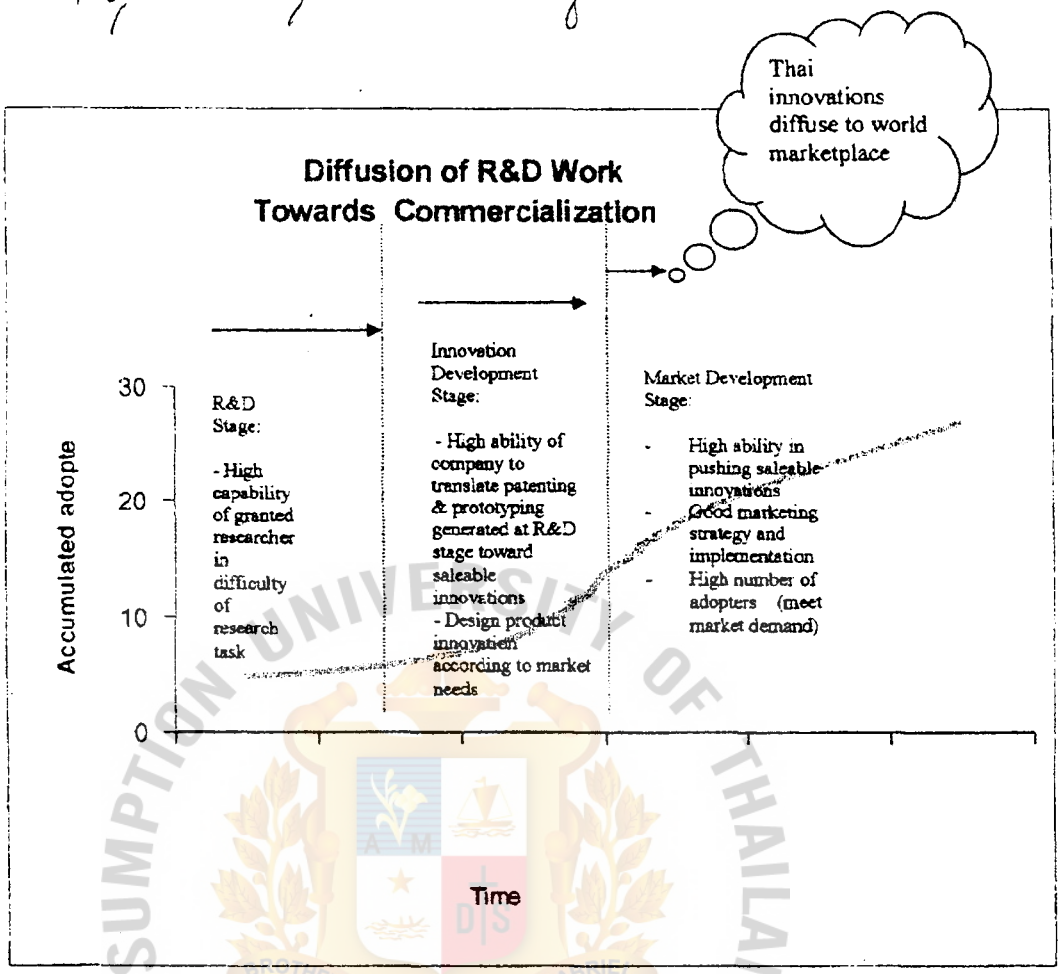
ลายเซ็นต์ .....

ลงชื่อ (นาย สุภชัย อัศวภาพ)

ตำแหน่ง General manager

หน่วยงาน .....

บุคคลากร ดูแลภาพ อยู่ไกล



รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะ โครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตรกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 6 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

ข้าพเจ้า เห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

ลายเซนต์ .....

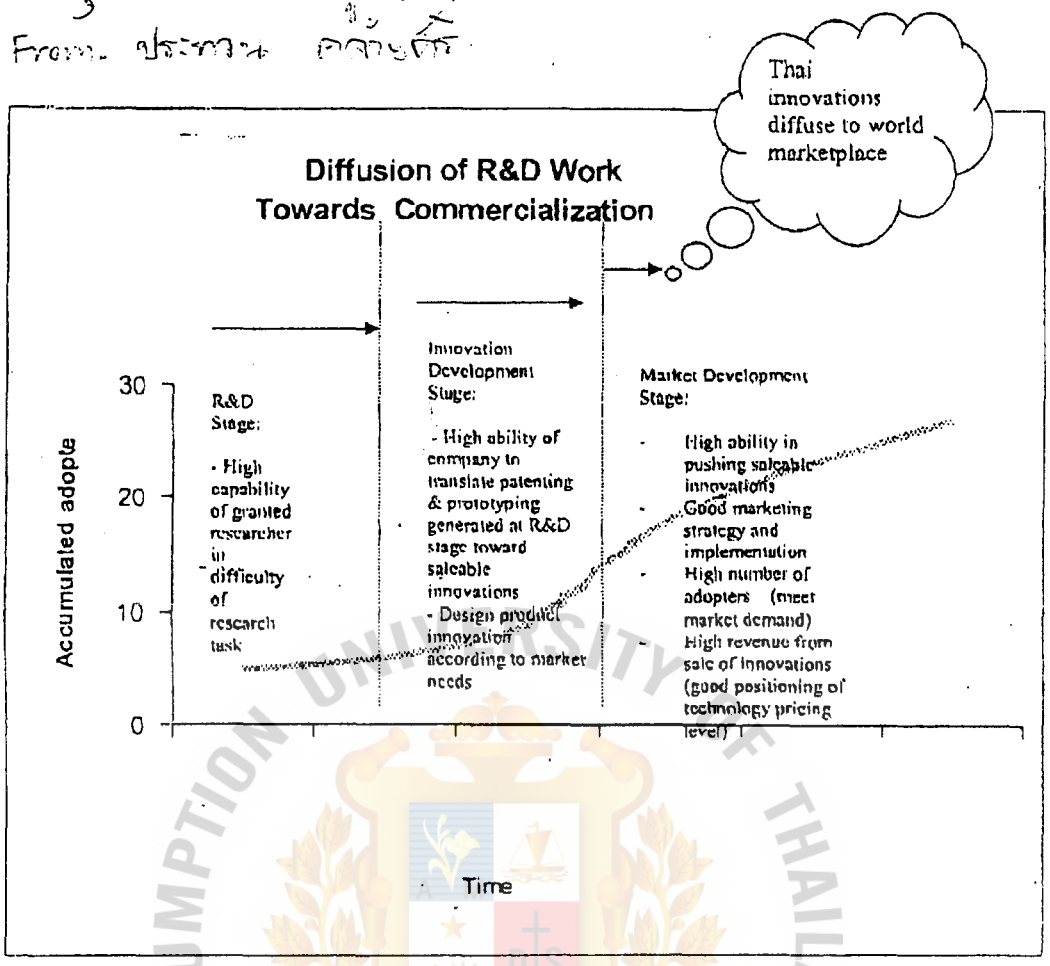
ลงชื่อ (นายวิโรจ ตันวศิษฎ์กุล)

ตำแหน่ง ผ.จ.ผจก

หน่วยงาน World Net International Co,Ltd.

26-6-47

To. กุณนรภาพร จยเจิก
From. ประภาส คล้ายศรี



รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะโครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 5 ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

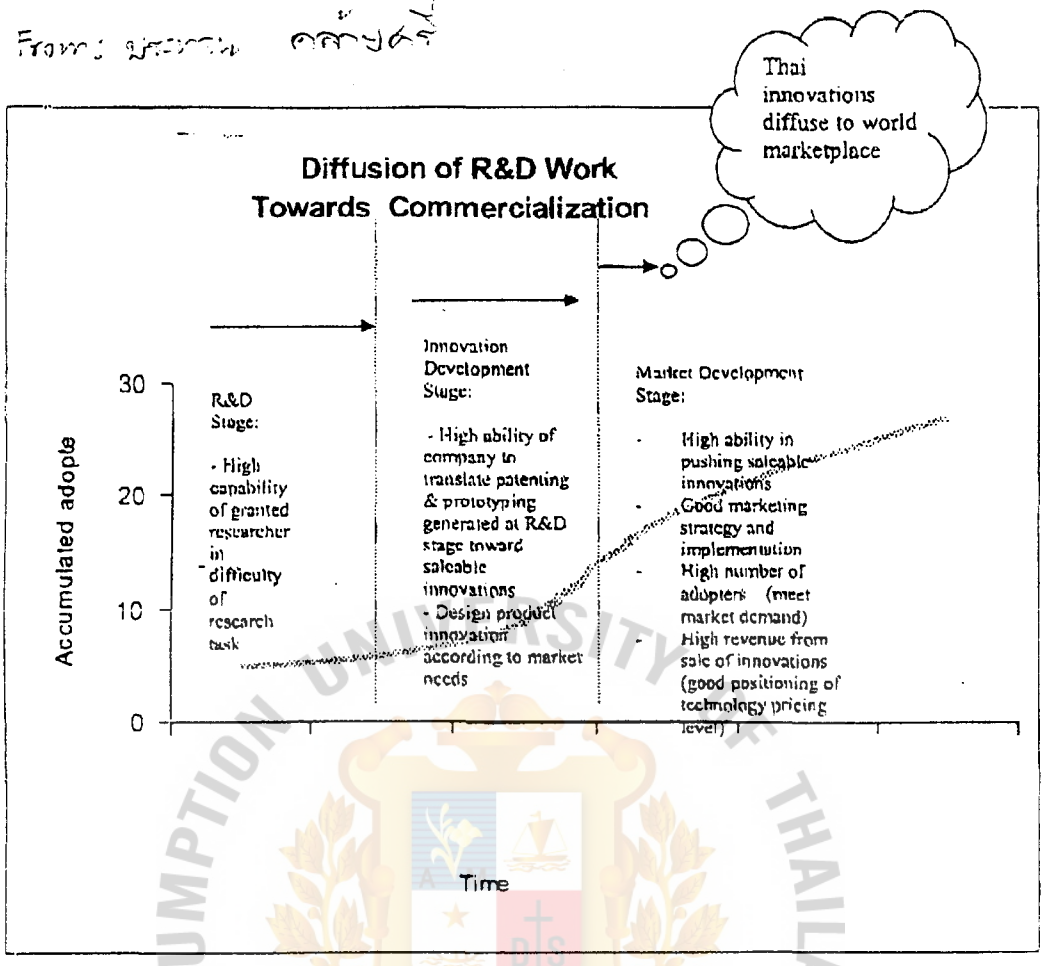
ข้าพเจ้า เห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

ลายเซนต์ .....
ลงชื่อ (นายประภาส คล้ายศรี)
ตำแหน่ง ผู้จัดการฝ่าย พลังงาน และสิ่งแวดล้อม
หน่วยงาน บริษัทสยามยุทธพลอเทคโนโลยี จำกัด

To. คุณนงลักษณ์ ชูชื่นกิจ

From: ประภาส คล้ายศรี

สิ่งที่แนบมาด้วย 1



รูปที่ 1-5 รูปแบบการบริหารงานวิจัยภาครัฐในระดับมหภาค เพื่อพัฒนางานวิจัยสู่เชิงพาณิชย์

จาก Model การบริหารจัดการงานวิจัยและพัฒนา สู่เชิงพาณิชย์ ดังรูปที่ 1-5 ผู้วิจัยตั้งข้อสังเกตุว่า ผู้บริหารงานวิจัยของรัฐควรพิจารณารูปแบบที่นำเสนอนี้ควบคู่กับตัวแปรภายนอกที่มีอิทธิพลต่อการผลักดันงานวิจัยสู่เชิงพาณิชย์เช่นกัน กล่าวคือควรมีการวิเคราะห์ลักษณะโครงสร้างอุตสาหกรรมประเภทต่างๆตลอดจนวัฒนธรรมองค์กรของเอกชนที่เหมาะสมต่อการพัฒนานวัตกรรมเชิงพาณิชย์ นอกจากนี้ยังเห็นว่า ไม่เพียงแต่ปัจจัย 6ประการ ที่สนับสนุนการพัฒนางานวิจัยเชิงพาณิชย์ดังที่เสนอนั้นเป็นเพียงปัจจัยที่ควบคุมเพื่อกำหนดในการศึกษานี้เท่านั้น จึงอาจมีปัจจัยอื่นๆที่ผู้บริหารงานวิจัยของรัฐหรือเอกชนควรศึกษาเพิ่มเติมเพื่อเป็นประโยชน์ในการออกแบบเกณฑ์ในการบริหารงานวิจัยได้อย่างเต็มประสิทธิภาพยิ่งขึ้น

ข้าพเจ้า เห็นด้วยในหลักการที่ได้จากผลการวิเคราะห์และรูปแบบการบริหารที่นำเสนอข้างต้น

ลายเซนต์ .....

ลงชื่อ (นายประภาส คล้ายศรี)

ตำแหน่ง พนักงานสำนักงาน เลขานุการ

หน่วยงาน มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

THE ASSUMPTION UNIVERSITY LIBRARY