

**FACTORS CONTRIBUTING TO THE SUCCESS OF
BIOTECHNOLOGY SMEs IN MALAYSIA**

SARIDAN BIN ABU BAKAR

UNIVERSITI SAINS MALAYSIA

SEPTEMBER 2007

**FACTORS CONTRIBUTING TO THE SUCCESS OF BIOTECHNOLOGY
SMEs IN MALAYSIA**

by

SARIDAN BIN ABU BAKAR

**Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy**

SEPTEMBER 2007

ACKNOWLEDGEMENTS

In the name of Allah, the Most Beneficent, the Most Merciful

This study has been a long and arduous journey, whose winding roads taught many a lesson, and whose end brought great joy to the heart. It was a journey that was shared by many wonderful companions and mentors without whom this study would not see the light of day. Through their guidance, dedication and friendship, they have contributed in a great measure to the exploration and dissertation of this all important subject matter. In this respect, I am especially grateful to my main supervisor and mentor, Professor Mohamed Sulaiman, whose counsel and patience have inspired me in ways that they have equally benefited and equipped a generation of other scholars. My heartfelt gratitude also goes to Associate Professor Intan Osman for her inexhaustible energy in assisting me with the process and the review of my work.

To the dean, Professor Dato' Daing Nasir Ibrahim, and other members and staff of the Management School of USM, I would like to say a big thank you. Even though Dato' Daing once remarked that, "Doing PhD is a lonely journey..." somehow, with people like Professor Mohamed Sulaiman, Associate Professor Intan Osman, Associate Professor Zainal Ariffin Ahmad, Professor Osman Mohamad, Associate Professor Yuserrie Zainuddin, Associate Professor T. Ramayah, Associate Professor Datin Rohani Hj Ali, Associate Professor Ishak Ismail, Dr Mahmod Sabri Haron, Associate Professor Fauziah Md Taib, Associate Professor Aizatt Hj Mohd Nasurdin, Dr Anees Janee Ali @ Hamid, Dr Siti Nabihah Abdul Khalid, Dr Nabsiah Abd Wahid, Dr. Ellisha Nasruddin, Kak Ton, Rusnah and Rizal around, my journey at the Business School was anything but lonely!

Special thanks are due to Professor Asma Ismail (INFORMM), Professor Saringat Ba'i @ Baie (School of Pharmaceutical Science, USM) and Datuk Professor Mohamed Isa Abdul Majid (Pusat Racun Negara) for opening my doors to

biotechnology entrepreneurship and biotechnology R&D commercialization; to the nine biotechnology entrepreneurs for finding time in their hectic schedules to share their thoughts and experiences in the interviews; and to the 209 other biotechnology and non-biotechnology entrepreneur respondents for their professionalism and expertise in completing the quantitative part of this research.

I would also like to thank the following individuals for their direct or indirect support of this research: Associate Professor Mohd Dahlan Ibrahim for data analysis, testing and questionnaire review; Prof Emeritus Dr Abdul Latif Ibrahim (UNISEL), En Ghazali Abdullah (NBD, MOSTI), Encik Yazid Md Jenin (NPC) and Emi Fatmawaty Ariffin (MIGHT) for materials on biotechnology and SMEs; Encik Zailani (UNISEL) and Encik Roslan Mohamad (SMIDEC) for SMEs directories; Dr Zainal Abidin Mohd Yusof (SIRIM), Professor Dr Hasanah M. Ghazali (UPM) and Dr Hassan Mat Daud (MARDI) for information on biotechnology entrepreneurs; Professor Mahfuz, Dr Rehana, Associate Professor Yuserrie and Associate Professor T. Ramayah for their attendance and valuable comments during my mock-up proposal and findings defenses. Associate Professor T. Ramayah has, in addition, been instrumental in guiding me with data analysis. To Associate Professor Zainal Ariffin, I thank him for the invaluable comments on the contents of this thesis and APA formatting. My gratitude also goes to Dr Rosmimah Mohd. Roslin (UiTM) for NVIVO 7 Qualitative Data Analysis software and Dr Mohd Hassan Mohd Osman (UTM) for his thesis on high technology SMEs in Malaysia.

My appreciation would not be complete without mentioning my colleagues at the UiTM, in particular, those from the MEDEC and business faculty; and my PhD colleagues at the USM, for their constant encouragement: Datin Norela Nuruddin, Tuan Haji Basuni Hamim, Tuan Hj Ramli Raya, Ali Bahari, Azimi, Hanafi, Dr Norhana Salamudin, Dr Hayati Dahan, Professor Faridah Hassan, Dr Rokiah Hassan, Puteri Norashikin Mohamad, Rizal, Doblin, Bidin Chee, Bapak Anto, Roaimah, Nik Ramli, Maznah and many others, whose names are not mentioned here.

Finally, I would like to acknowledge the contributions of my own family members: to my late grandmother, Hajjah Aishah Abdullah, for her love in raising me up and my early introduction to education; to my mother, Hajah Zainab Yahaya, whom I get to meet more often when I drop by for curry mee during my regular trips to USM; to my sister-in-law, Toh Puan Zakiah Che Din, for her graciousness in providing me accommodation at her Laketown Villa in Bukit Merah during my stay in USM; to my wife, Nura Che Din and our two boys, Adam and Adeel, for their patience and understanding. To my late father, Allahyarham Hj Abu Bakar Budin, who passed away at the early stage of this study, I hereby dedicate this thesis.

Wa billah hi taufiq wal hidayah.

DEDICATION

To my father,
Who taught me
Everything
I ever needed to know
About living
An ethical life.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
TABLE OF CONTENTS	vi
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
ABSTRAK	xviii
ABSTRACT	xix
CHAPTER 1 : INTRODUCTION	
1.1 General	1
1.2 Significance of the Research	5
1.3 Problem Statement	8
1.4 Research Questions	9
1.5 Research Objectives	9
1.6 Organization of the Thesis	10
1.7 Scope	11
1.8 Definition of Key Terms	11
1.9 Biotechnology	18
1.10 Biotechnology in Malaysia	19
1.11 Malaysian Biotechnology Policy	20
1.12 Biotechnology Business	21
1.13 Biotechnology SMEs	21
1.14 Summary	24
CHAPTER 2 : LITERATURE REVIEW	
2.1 Introduction	25
2.2 Differences between Biotechnology and Non-Biotechnology SMEs	25
2.2.1 Knowledge-based Resources	26
2.2.1.1 Education	26
2.2.1.2 Functional Experience	27
2.2.2 Entrepreneurs Age	28
2.2.3 Previous Sector Experience	28
2.2.4 Access to Financial Capital	29
2.2.5 Linkages	31
2.3 Factors Contributing to Biotechnology SMEs success	34

2.3.1	The Importance of Success	35
2.3.2	The Measurement of Success	36
2.3.3	Dependent Variable: Enterprise Success	38
2.3.3.1	Financial Profitability	38
2.3.3.2	Enterprise Growth	47
2.3.3.3	Satisfaction	47
2.3.3.4	Enterprise Success as Dependent Variable in this Research	48
2.3.4	Independent Variables	49
2.3.4.1	Organizational Structure	50
2.3.4.1.1	Organizational Structure and SMEs success	52
2.3.4.1.2	Moderating Role of Environment	54
2.3.4.1.3	Organization Structure as an Independent Variable in this Research	58
2.3.4.2	Enterprise Strategies	59
2.3.4.2.1	Innovation Activities	59
2.3.4.2.1.1	Innovation Activities and SMEs Success	60
2.3.4.2.1.2	Moderating Role of Environment	62
2.3.4.2.1.3	Innovation Activities as an Independent Variable in this Research	63
2.3.4.2.2	Linkages	64
2.3.4.2.2.1	Linkages and SMEs Success	65
2.3.4.2.2.2	Moderating Role of Environment	68
2.3.4.2.2.3	Linkages as an Independent Variable in this Research	68
2.3.5	Moderating Variable	69
2.3.5.1	The External Environment	69
2.3.6	Control Variables	71
2.3.6.1	Entrepreneur Demographic Characteristics	71
2.3.6.1.1	Gender	71
2.3.6.1.2	Entrepreneur Age	72
2.3.6.1.3	Family History	73

2.3.6.1.4	Motivation	74
2.3.6.2	The Enterprise Demographic Characteristics	75
2.3.6.2.1	Enterprise Age	75
2.3.6.2.2	Enterprise Size	78
2.3.6.2.3	Location	80
2.3.6.2.4	Legal Form	81
2.3.6.2.5	Ownership	82
2.3.7	Summary	82

CHAPTER 3 : CONCEPTUAL FRAMEWORK, RESEARCH DESIGN AND METHODOLOGY

3.1	Introduction	84
3.2	Defining Biotechnology SMEs and non-Biotechnology SMEs	84
3.3	Conceptual Framework	86
3.4	Unit of Analysis	86
3.5	Research Approach	87
3.6	Research Design	100
3.6.1	Mixed Methods Research Rationale	100
3.6.2	Qualitative Study	103
3.6.3	Quantitative Study	104
3.7	Summary	104

CHAPTER 4 : METHODOLOGY FOR QUALITATIVE STUDY

4.1	Introduction	106
4.1.1	Methodology	106
4.1.1.1	Grounded Theory, Phenomenology and Ethnography	106
4.2	Qualitative Study Methodology Rationale	109
4.3	Data Collection	111
4.3.1	In-depth Interview	112
4.3.2	Field Notes	115
4.3.3	The Researcher as Instrument	117
4.3.4	Sampling	118
4.3.5	Respondents Selection and Process	119
4.4	Validity and Trustworthiness of the Study	120
4.5	Summary	123

CHAPTER 5 : FINDINGS OF QUALITATIVE STUDY

5.1	Introduction	124
5.2	Results of Cross Case Analysis	124
5.3	Entrepreneur's Demographic Characteristics	125
5.3.1	Age	125
5.3.1.1	Young Age	125
5.3.1.2	Senior Age	127
5.3.2	Family History	128
5.3.3	Motivation	129
5.4	Knowledge-based Resources	129
5.4.1	Education	130
5.4.2	Functional Experience	130
5.4.2.1	Management Experience	131
5.4.3	Training	131
5.4.3.1	Training Received	132
5.4.3.2	Continuous Learning	133
5.4.3.2.1	Continuous Training	133
5.4.3.2.2	Workshops, Short Courses and Seminars	134
5.4.3.2.3	Trade Shows	136
5.5	Organizational Structure	137
5.6	Enterprise Image	138
5.7	Enterprise Strategies	140
5.7.1	Access to Financial Capital	141
5.7.2	Government Assistances	143
5.7.3	Linkages	145
5.7.3.1	Linkages with Other Private Enterprises	146
5.7.3.2	Linkages with Academic Research Institutions	146
5.7.3.3	Linkages with Personal Researchers of the Academic Research Institutions	148
5.7.4	Innovation Activities	151
5.7.4.1	R&D	151
5.7.4.2	Product Newness	155
5.7.4.3	Product Uniqueness	155
5.8	Other Enterprise Strategies	156
5.8.1	Vertical Integration	157
5.8.3	GMP Compliance	160
5.8.4	<i>Halal</i> Certification	165

5.9	Enterprise Success	166
5.9.1	Financial Profitability	167
5.9.2	Enterprise Growth	168
5.9.2.1	Growth in Sales	171
5.9.3	Satisfaction	172
5.10	Level of Competition	174
5.11	Analysis	176
5.11.1	Data Analysis	177
5.11.2	Emergent Themes	184
5.11.3	Enterprise Image	187
5.11.3.1	Enterprise Image and SMEs Success	189
5.11.3.2	Moderating Role of Environment	191
5.11.3.3	Enterprise Image as an Independent Variable in this Research	192
5.11.4	Vertical Integration	194
5.11.4.1	Vertical Integration and SMEs Success	195
5.11.4.2	Moderating Role of Environment	197
5.11.4.3	Vertical Integration as an Independent Variables in this Research	199
5.12	Summary	201
CHAPTER 6 : METHODOLOGY FOR QUANTITATIVE STUDY		
6.1	Introduction	202
6.2	Theoretical Framework	202
6.3	Resource-based View of the Firm (RBV)	203
6.4	Hypotheses Development	208
6.4.1	Differences between Biotechnology and Non- Biotechnology SMEs	208
6.4.2	Relationship between Organizational Structure, Innovation Activities, Linkages, Vertical Integration Strategy and Enterprise Image with SMEs Success	211
6.4.3	Intensity of Competition moderates the Relationship between Organizational Structure, Innovation Activities, Linkages, Vertical Integration Strategy and Enterprise Image with SMEs Success	219
6.5	Designing and Validating Survey Instrument	226
6.5.1	Questionnaire Design	226
6.5.1.1	Dependent Variable: Enterprise Success	226
6.5.1.1.1	Financial Profitability	226
6.5.1.1.2	Enterprise Growth	227

6.5.1.1.3	Satisfaction	227
6.5.1.2	Independent Variables	227
6.5.1.2.1	Knowledge-based Resources	227
6.5.1.2.2	Organizational Structure	228
6.5.1.2.3	Access to Financial Capital	228
6.5.1.2.4	Innovation Activities	228
6.5.1.2.5	Enterprise Linkages	229
6.5.1.2.6	Government Assistances	230
6.5.1.2.7	Vertical Integration Strategy	230
6.5.1.2.8	Enterprise Image	231
6.5.1.3	Moderating Variable: External Environment	231
6.5.1.4	Control Variables	232
6.5.1.5	Respondent's Comment	232
6.6	Pilot Test	233
6.6.1	Instrument	233
6.6.2	Data Collection	233
6.7	Method of Analysis	237
6.8	Survey	238
6.8.1	Sampling Frame	238
6.8.1.1	SMIDEC Directory	239
6.8.1.2	NPCB Directory	240
6.8.1.3	PURBATAMA Directory	240
6.8.1.4	NBD Directory	241
6.8.1.5	BiotecCorp Directory	241
6.8.1.6	MOPI	242
6.8.2	Sampling Technique	245
6.8.3	Data Collection	248
6.9	Summary	253

CHAPTER 7 : FINDINGS OF QUANTITATIVE STUDY

7.1	Introduction	254
7.2	Data Collection	254
7.3	Non-Response Bias Analysis	254
7.4	Respondent's Profile	256
7.5	Enterprise Characteristics	265
7.6	Goodness of Measures	271
7.6.1	Factor Analysis	273

7.6.2	Scale Reliability	278
7.6.3	Modified Research Framework for Factors Contributing to the Success of Biotechnology SMEs in Malaysia after Factor Analysis	278
7.6.4	Hypotheses Restatement	279
7.6.5	Analyses of Dependent and Independent Variables	283
	7.6.5.1 Correlation Analysis	283
7.7	Hypotheses Testing	284
	7.7.1 Differences between Biotechnology and non-Biotechnology SMEs	284
	7.7.2 Relationship between Enterprise Factors and Biotechnology SMEs Success	291
	7.7.3 Moderating Effect of Competitive Environment on the Relationship between Organizational Structure, Enterprise Image and Strategies; and Enterprise Success.	297
7.8	Summary	308

CHAPTER 8: DISCUSSION AND CONCLUSION

8.1	Introduction	312
8.2	Recapitulation of Research Findings	312
8.3	Discussion	316
	8.3.1 Differences between Biotechnology and non-Biotechnology SMEs	317
	8.3.2 Differences in Factors Contributing to Enterprise Success between Biotechnology and non-Biotechnology SMEs	320
	8.3.3 The Effect of Competitive Environment in Moderating the Relationship between Organizational Structure, Image and Enterprise Strategies for Biotechnology and non-Biotechnology SMEs	329
8.4	Theoretical Contributions	343
8.5	Practical Contributions	345
8.6	Limitations	349
8.7	Suggestions Future Research Directions	350
8.8	Conclusion	351

REFERENCES

APPENDICES

- Appendix A Definition of Small and Medium Enterprises in Malaysia
- Appendix B Malaysian Biotechnology Policy
- Appendix C Qualitative Interview Guide
- Appendix D Introductory Letter for Qualitative Interview
- Appendix E Confirmation Letter
- Appendix F Interview Descriptions
- Appendix G Questionnaire
- Appendix H Cover Letter for Biotechnology SMEs
- Appendix I Cover Letter for non-Biotechnology SMEs
- Appendix J Chi-Square Analysis on Entrepreneur and Enterprise Demographic Characteristics for Early and Late Responses
- Appendix K T-Test Analysis on Main Variables for Early and Late Responses
- Appendix L Summary of Normality Test
- Appendix M Multicollinearity Analysis
- Appendix N Factor Analysis of Independent Variables
- Appendix O Factor Analysis of Moderating Variable
- Appendix P Factor Analysis of Dependent Variables
- Appendix Q Chi-Square Analysis on Research Variables
- Appendix R Independent Sample *t*-test on Research Variables
- Appendix S Regression Analysis of Factors Contributing to Biotechnology SMEs Success
- Appendix T Regression Analysis of Factors Contributing to non-Biotechnology SMEs Success
- Appendix U Multiple Hierarchical Regression Results of Control Variables, Organizational Structure, Image and Enterprise Strategies; on Success for non-Biotechnology SMEs
- Appendix V Multiple Hierarchical Regression Results of Competitive Environment as a Moderator in the Relationship between Organizational Structure, Enterprise Image and Strategies; on Success for non-Biotechnology SMEs

LIST OF TABLES

	Page
1.1 Development Expenditure and Allocation for Biotechnology under the Ninth Malaysia Plan (2006 to 2010)	3
1.2 Areas of Biotechnology Business	22
2.1 Selected Studies on the Success Measurement of Biotechnology SMEs	39
2.2 Selected Studies on the Success Measurement of Technology-based SMEs	41
2.3 Studies on the Success Measurement of Non-Biotechnology and Non-Technology-based SMEs	43
2.4 Success Measurements of Biotechnology SMEs	49
2.5 Entrepreneur Factors Related To SMEs Success	76
2.6 Enterprise Factors Related To SMEs Success	79
3.1 Selected Studies Utilizing Quantitative Method Approach	89
3.2 Selected Studies Utilizing Qualitative Method Approach	91
3.3 Selected Studies Utilizing Mixed Methods Approach	92
3.4 Characteristics of Quantitative and Qualitative Methods in the Process of Research	94
4.1 Code Names for Respondent in Qualitative Study	116
5.1 Themes from the Interview Transcripts	180
5.2 Integration of Themes	183
5.3 Tree Node for Entrepreneur's Demographic Characteristics	184
5.4 Tree Nodes from Interview Transcripts	185
6.1 Measures Summary	234
6.2 Data Analysis Techniques	237
6.3 Biotechnology SMEs in SMIDEC Directory	239
6.4 Biotechnology SMEs in NPCB Directory	240
6.5 Biotechnology enterprises in NBD Directory	241
6.6 Biotechnology enterprises in BiotechCorp Directory	242
6.7 Biotechnology SMEs in the Sampling Frame	243
6.8 List of Biotechnology SMEs in Malaysia	244
6.9 List of Non-Biotechnology SMEs in SMIDEC Directory	245
6.10 Sample of non-Biotechnology SMEs for the Survey	247
6.11 List of Conferences and Seminar Attended in 2004 and 2005	250
6.12 Reasons for Returned Letters	252
7.1 Data Collection	255

7.2	Non-Responses Bias Analysis on Entrepreneur's and Enterprise Demographic Variables for Early and Late Responses	257
7.3	Non-Responses Bias Analysis on Main Variables for Early and Late Responses	258
7.4	Respondents' Profile	259
7.5	Prior Training Received	260
7.6	Continuous Training Received	261
7.7	Prior Sector Experience	262
7.8	Previous Enterprise Ownership Experience	263
7.9	Years of Functional Experience	263
7.10	Inception of Entrepreneurship	264
7.11	Share Ownership of the Enterprise	265
7.12	Enterprise Characteristics	266
7.13	Respondents by Industry	268
7.14	Size of the Enterprises based on Number of Full-time Employees and Annual Sales	269
7.15	Location of the Enterprises	270
7.16	Summary of Normality Analyses	272
7.17	Results of Factor Analysis for Independent Variables	274
7.18	Results of Factor Analysis for Moderating Variables	277
7.19	Results of Factor Analysis for Dependent Variables	277
7.20	Reliability Coefficients for the Major Variables	279
7.21	Correlation between Variables	285
7.22	Chi-square Test on Differences between biotechnology and non-Biotechnology SMEs	286
7.23	T-test on Differences between biotechnology and non-Biotechnology SMEs	287
7.24	Multiple hierarchical regression results of control variables, organizational structure, image and enterprise strategies; on success of Biotechnology SMEs	293
7.25	Multiple hierarchical regression results of competitive environment as a moderator in the relationships between organizational structure, enterprise image and strategies; and the success of Biotechnology SMEs	299
7.26	Summary Results of Hypotheses Testing	309
8.1	Source of Financing for Biotechnology SMEs	318

LIST OF FIGURES

	Page
1.1 Malaysia's Biotechnology Focus Areas	4
3.1 Proposed Research Framework for Factors Contributing to the Success of Biotechnology SMEs in Malaysia	86
3.2 Sequential Exploratory Design	103
6.1 Theoretical Frameworks of Factors Contributing to the Success of Biotechnology SMEs in Malaysia	203
7.1 Modified Research Framework for Factors Contributing to the Success of Biotechnology SMEs in Malaysia after Factor Analysis	280
7.2 Moderating Effects of Competitive Environment on the Relationship between Organizational Structure and biotechnology SMEs success.	303
7.3 Moderating Effects of Competitive Environment on the Relationship between Enterprise Image and Biotechnology SMEs success.	304
7.4 Moderating Effects of Competitive Environment on the Relationship between Enterprise Linkages and Biotechnology SMEs success.	306
7.5 Moderating Effects of Competitive Environment on the Relationship between Internal and External Networking, and Biotechnology SMEs success.	307

FAKTOR-FAKTOR PENYUMBANG KEJAYAAN PKS BIOTEKNOLOGI DI MALAYSIA

ABSTRAK

Bioteknologi merupakan gabungan di antara biologi dan teknologi. Bioteknologi telah dikenalpasti sebagai enjin pemacu pembangunan bagi Malaysia ke arah negara mencapai status negara maju pada tahun 2020. Perusahaan kecil dan sederhana (PKS) bioteknologi merupakan penggerak utama bidang bioteknologi di Malaysia. Jesteru, kejayaan PKS bioteknologi adalah penting bagi menjamin kejayaan sektor bioteknologi di Malaysia. Menyedari pentingnya peranan yang dimainkan oleh PKS bioteknologi kepada kemakmuran ekonomi negara, penyelidikan ini bertujuan untuk mengenalpasti faktor-faktor penyumbang kepada kejayaan PKS bioteknologi di Malaysia. Dalam perkara ini, penyelidikan-penyelidikan terdahulu telah dirujuk bagi mewujudkan kerangka kerja penyelidikan. Penyelidikan ini melibatkan gabungan dua kaedah penyelidikan berturutan iaitu kualitatif dan diikuti dengan kuantitatif. Kajian kualitatif dijalankan mengikut pendekatan teori '*grounded*' untuk mengenalpasti faktor-faktor penyumbang kepada kejayaan PKS bioteknologi di Malaysia. Kajian kualitatif melibatkan pengumpulan maklumat melalui temuduga separa berstruktur secara mendalam dengan sembilan usahawan bioteknologi yang mewakili 10 PKS bioteknologi di Malaysia. Melalui kajian kualitatif, pembolehubah tidak bersandar baru ditambah kepada kerangka penyelidikan yang sebelum ini diwujudkan hanya melalui tinjauan literatur. Kajian kuantitatif berikutnya dibuat dengan kaedah temuduga bersemuka dengan 103 responden bidang bioteknologi dan 106 bukan bioteknologi menggunakan borang soal selidik.

Dapatan utama penyelidikan boleh diklasifikasikan kepada tiga bahagian. Pertama, penyelidikan ini mendapati PKS bioteknologi dan bukan bioteknologi adalah berbeza. Keputusan ujian '*chi-square*' dan '*t-test*' menunjukkan usahawan bioteknologi mempunyai pengalaman yang lebih di dalam sektor yang berkaitan dengan perusahaan yang dijalankan serta aktiviti-aktiviti penyelidikan dan pembangunan,

berbanding dengan usahawan bukan bioteknologi. PKS bioteknologi juga lebih baru ditubuhkan dan lebih kecil berbanding dengan PKS bukan bioteknologi. Namun begitu, PKS bioteknologi lebih banyak terlibat dengan aktiviti integrasi ke hadapan serta mempunyai imej perusahaan yang lebih baik. PKS bioteknologi lebih sulit memperolehi sumber kewangan dari luar, tetapi mereka lebih banyak menerima bantuan-bantuan kerajaan. Dalam aspek inovasi pula, PKS bioteknologi didapati kurang mengendalikan aktiviti inovasi sungguhpun menjalin hubungan yang lebih dengan institusi penyelidikan, penyelidik dan jaringan dengan lain-lain perniagaan persendirian berbanding dengan PKS bukan bioteknologi. PKS bioteknologi secara umumnya berpandangan persekitaran luaran yang dihadapi adalah lebih stabil berbanding dengan suasana persaingan yang lebih sengit dihadapi oleh PKS bukan bioteknologi. Perbezaan yang terakhir ialah dari segi kejayaan di mana kajian ini mendapati PKS bioteknologi lebih berjaya daripada PKS bukan bioteknologi. Kedua, analisis berganda menunjukkan struktur organisasi yang organik, imej, jaringan perniagaan, strategi integrasi ke belakang dan aktiviti-aktiviti inovasi adalah faktor penyumbang yang signifikan kepada kejayaan PKS bioteknologi di Malaysia. Berikutnya yang ketiga, kajian ini juga mendapati dalam persekitaran luaran yang menghadapi persaingan yang sengit, struktur organisasi organik dan imej perusahaan yang tinggi adalah dua faktor utama penyumbang kepada kejayaan PKS bioteknologi. Penyelidikan yang telah dijalankan ini akan dapat menyumbang meningkatkan lagi pengetahuan mengenai perusahaan sektor bioteknologi serta bidang keusahawanan secara keseluruhannya di Malaysia.

FACTORS CONTRIBUTING TO THE SUCCESS OF BIOTECHNOLOGY SMEs IN MALAYSIA

ABSTRACT

Biotechnology is the fusion of biology and technology. It is a fascinating field that has been identified as the next engine of growth for Malaysia, one that will accelerate the country's transformation into a highly industrialized nation by the year 2020. In Malaysia, biotechnology based small and medium enterprises (SMEs) are the main players in the emerging biotechnology sector. Their success is crucial to the growth, stability and general well-being of this sector. Realizing their critical role to the country's economy, this research seeks to better understand the underlying factors that contribute to their success. In the course of doing this, prior studies were referred to in the crafting of the initial research framework. This empirical research is an exploratory study that employs a mixed methodology of sequential qualitative and quantitative investigations. For the purpose of the qualitative study, the *grounded theory* approach was used to identify the factors that contribute to the success of biotechnology SMEs in Malaysia. Qualitative data from semi structured face-to-face in-depth interviews involving nine biotechnology entrepreneurs of 10 biotechnology SMEs in Malaysia were then obtained and used to further modify the initial research framework with the inclusion of two new variables. For the quantitative study, a survey instrument was used in face-to-face interviews with 103 biotechnology and 106 non-biotechnology respondents.

The major findings of this research can be classified into three. Firstly, this research found some significant differences between biotechnology and non-biotechnology SMEs. Results of chi-square and independent sample *t*-test, found that biotechnology entrepreneurs are significantly different from their non-biotechnology counterparts in the areas of the owner-manager's related sectoral experience and R&D activities. In these two areas, biotechnology entrepreneurs are found to be relatively more experienced. Other differences encompass the factors of

age, size, external financial capital access, government assistances, image, linkages, networking, integration, innovation and perception of the external environment. In general, biotechnology SMEs are newer and smaller. They are more forward integrated and have stronger image. Though they face a greater challenge to obtain external financial capital, they are at the receiving end of more government assistances. In the area of innovation, they tend to lack behind the non-biotechnology SMEs. Their innovation activities are less extensive by comparison, notwithstanding the array of linkages and networks that they have with academic research institutions, individual researchers and other private enterprises. Perception of their industries is also markedly different between the two SME groups. While the non-biotechnology SMEs tend to characterize their industries as robust and highly competitive, the biotechnology SMEs perceive a more stable competition in their own industry. Finally, biotechnology SMEs are significantly more successful than non-biotechnology SMEs. Secondly, based on two steps multiple hierarchical regression analysis, this research found organizational structure, enterprise image, internal and external networking; backward integration strategy, and innovation activities as being factors that significantly impact the success of Malaysian biotechnology SMEs. Thirdly, results of four steps multiple hierarchical regression analysis finds organic organizational structure and strong image as having particularly strong influences on enterprise success when the intensity of competition is high. Based on these research findings, this researcher puts forward recommendations for future research on biotechnology enterprises in Malaysia. It is the ardent hope of this researcher that these findings also help to elucidate an aspect of biotechnology to the existing body of knowledge, especially in the field of entrepreneurship study in Malaysia.

CHAPTER 1

INTRODUCTION

1.1 General

The Malaysian Government has identified biotechnology as the next engine of growth for the country. It has been identified as one of the five core technologies that will accelerate Malaysia's transformation into a highly industrialized nation by 2020 (Malaysia, 2001). As stated by the Prime Minister of Malaysia, Datuk Seri Abdullah Ahmad Badawi,

Biotechnology has great potential in Malaysia and it could be a catalyst for new growth areas in the country's economy as well as a source of new wealth and income for the people. Biotech is useful in many areas - agriculture, livestock farming, herbal industry and traditional and modern medicine. Its potential in the pharmaceutical industry is also unlimited (Syed Harun, 2004).

Accordingly, Malaysia has wisely invested in biotechnology to achieve a rapid advancement in agriculture, human health and other relevant industrial sectors (BIOTEK, 2001). As a first step, a biotechnology Expert Group was established in 1984 by the National Council for Scientific Research and Development (NCSRD) under the auspices of its Agriculture Science Committee. This Group was asked to study the implications of biotechnology to the country, scope the current status, and make recommendations to the Council (Omar, 1990). Among the recommendations that were put forth and taken up by the NCSRD, was the formation of the National Biotechnology Committee and its five sub-committees representing microbial, plant, industrial and environmental; medical and animal biotechnologies. Later, under the 5th Malaysia Plan (1986-1990), a special funding of RM5.45 million was approved by the government to boost biotechnology based projects (Malaysia, 1986). Omar stated that during the period of 1988 to 1990, 22 biotechnology projects with a worth totalling RM2 million were financed by this fund (Omar, 1990).

In the 6th Malaysia Plan (1991-1995), the government announced long-range plans to substantially expand resources in new and emerging technologies, particularly those that have a potential for optimal pay-offs (Malaysia, 1991). The Plan stated that five key technology areas, including biotechnology had been identified for competence building, innovation enhancement, and expansion of niche area development of the domestic industries. Other than biotechnology, the other areas were automated manufacturing technology (AMT), advanced materials, electronics, and information technology (IT). The 6th Malaysia Plan (1991-1995) further identified biotechnology as having grown in importance as a key technology of the future through advances in molecular biology and genetic engineering. Biotechnology applications in Malaysia were evident in such diverse areas as agriculture, health, food and energy. In these areas, Malaysia had acquired competency and institutional strength. Realizing the great significance of biotechnology, the R&D component of the biotechnology sub-committee had proposed 25 projects at a cost of RM12.5 million under the 6th Malaysia Plan. This amount represented more than a 100 percent increase from the previous 5th Malaysia Plan of RM5.45 million.

Moving forward, in the 7th Malaysia Plan (1996-2000), life science was introduced and clustered together with biotechnology as an advanced technology along with five others, namely, information technology and communication; microelectronics, advanced manufacturing technology, advanced materials and environment; and energy-related technologies. These were promoted by the government to create new investment opportunities for the economy as a whole (Malaysia, 1996). A sum of RM 35 million was allocated for a partnership program with the Massachusetts Institute of Technology (MIT), of the USA. Later, under the 8th Malaysia Plan (2001-2005), a larger amount of allocation in the sum of RM100 million was allocated for biotechnology research in the fields of agro-biotechnology, health care, and environmental and energy management (Malaysia, 2001). The Plan

also laid down initiatives taken to identify and formulate research programs in genomics and molecular biology; pharmaceutical and nutraceutical biotechnology; as well as agro-biotechnology.

Recently, the Malaysian government announced that under the Ninth Malaysia Plan (2006-2010), an allocation of over RM2 billion will be set aside for various biotechnology developments in the country (Malaysia, 2006). The breakdown of this allocation is shown in Table 1.1. Almost half of the budget allocation (45.90 percent) will cater for physical infrastructure development, while the remainder (54.10 percent) will be allocated for soft infrastructure development, including R&D, commercialization and business development programmes.

Table 1.1

Development Expenditure and Allocation for Biotechnology under the Ninth Malaysia Plan (2006 to 2010)

Programme	8 th Malaysia Plan Expenditure (RM Million)	9 th Malaysia Plan Allocation (RM Million)
R&D	190.00	463.00
Biotechnology R&D Initiatives	190.00	363.00
Biotechnology Commercialization Fund	-	100.00
Biotechnology Acquisition Programme	-	100.00
Biotechnology Business Development	216.80	529.80
Technology & IP Management	69.90	100.00
Entrepreneurship Development	-	50.00
Agro-biotechnology Projects	46.90	79.80
Institutional Support and Equity	100.00	300.00
Biotechnology Infrastructure	167.60	928.50
Total	574.40	2,021.30

Source: Malaysia (2006, p. 168).

As part of the initiative, the Malaysian Government plans to develop over 400 BioNexus status companies by 2010 (Malaysia, 2006). These companies are harbingers of a new strategic thrust for the modern biotechnology sector in Malaysia. To date, the modern biotechnology sector is relatively young with fewer than 30 enterprises, mostly established within the past decade (Ernst & Young, 2005). These enterprises are involved in the areas of agriculture, healthcare and industrial biotechnologies. In the future, Malaysia's focus areas for biotechnology will be in the 19 areas shown in Figure 1.1.

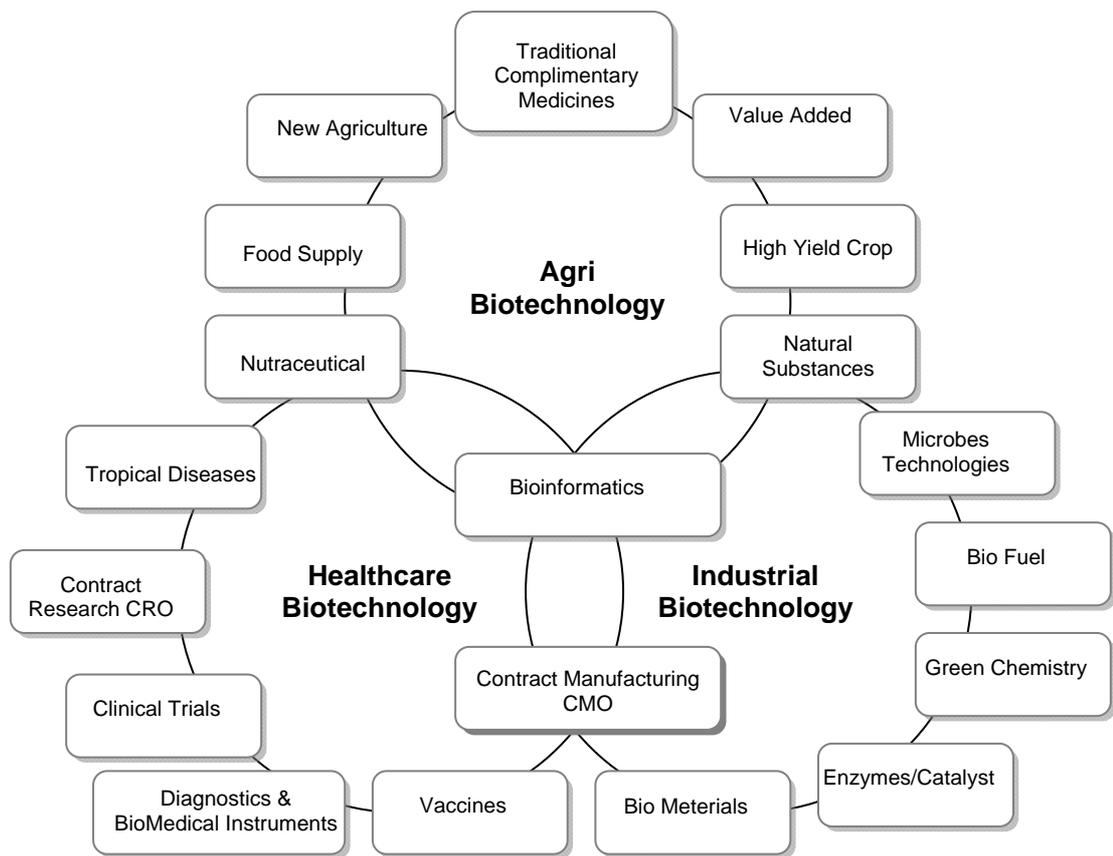


Figure 1.1. Malaysia's biotechnology focus areas.

Source: Malaysian Biotechnology Corporation [BiotechCorp], 2006).

Biotechnology is an extremely competitive field and has evolved predominantly in response to a market need for technologies and approaches that can speed up product development and reduce development costs. The promise of biotechnology seems to have caught the imagination of many scientists, government authorities and investors around the world today. Countries in Asia such as Singapore, India and Malaysia are now intensely into developing their biotechnology centres (Heong, 2004). However, the report commented that these countries might have been taken overboard by the sales pitch of biotechnology proponents, who often exaggerated the benefits of the technology and the wonders that techniques, such as genetic engineering, bring to people's lives.

Aside from environmental and health risks and questions over the financial viability of investing in biotechnology, there is growing evidence that the technology is not benefiting people whose lives depend on it (Li, 2004). The Star report highlighted the experiences of cotton farmers in Indonesia and India who have not gained any benefits of higher yields, and hence better incomes, from genetically modified cotton.

However, these evidences have not hampered countries around the world to set up their own biotechnology initiatives. According to Datuk Jamaluddin Jarjis, the Malaysian minister of Science, Technology and Innovation (MOSTI), Malaysia is committed to provide attractive incentive packages to biotechnology companies investing in the country (Syed Harun, 2004). The New Straits Times (NST) report further stated that the package would include a wide spectrum of financing structures; including business-angle financing, venture-capital financing, debt ventures and technology banking. Datuk Jamaluddin Jarjis has also offered biotechnology companies to conduct their clinical tests in the country (Jalil, 2004).

1.2 Significance of the Research

The Malaysian biotechnology sector is dominated by specialized biotechnology, agricultural, biopharmaceutical and bioinformatics SMEs, as well as

suppliers to the biotech industry (Biotechnology Information Centre Malaysia [BIC], 2001). The importance of SMEs in the development of the biotechnology sector in Malaysia suggests that an understanding of the success factors of these SMEs is crucial to the stability and health of the technology, and eventually the nation's economy. However, currently there are limited studies in Malaysia that determine the factors that contribute to the success of biotechnology SMEs. In fact, despite their important role in the national economy, research on general SMEs too appears limited and neglected (Sulaiman & Hashim, 2000). The extant literature indicates that SMEs have received minimal theoretical and empirical research attention as a serious field of study. Moreover, according to Sulaiman and Hashim (2000), even though SMEs in Malaysia have, of late, attracted some degree of research attention, investigations on them are still relatively limited in scope and not integrated in nature. The focus has been mainly on observing, describing, and reporting their general profile; the personal characteristics of the owners; problems and constraints faced by them; and the assistance programmes provided by the government. The above authors found that research emphasis on SMEs' management styles, their organisational structures, culture, stage of development, and their external environment has been rather limited.

Fewer studies have been made to investigate the relevant theories of entrepreneurial achievements such as the personality traits of successful entrepreneurs and the competencies required for becoming successful entrepreneurs. The study of demographic characteristics and their relationships to SMEs performance appears to be likewise limited (Chee, 1986).

Much interest has been shown on the factors contributing to the success of SMEs in general. A number of studies in this area examined the entrepreneurial characteristics in order to explain the success or failure of firms (e.g., Hisrich & Brush, 1986). Other studies (e.g., Hashim, 2002a) chose to delve into the enterprise factors for pointers of SMEs success. In this regard, Hashim singled the adaptation

of strategy, distinctive capabilities, organizational structure, technology, organizational culture and firm characteristics as six factors related to the enterprise.

Another important success factor relates to the external environment. Here, the external environment of the enterprise can be classified into two, namely, general and competitive environments (Miller & Dess, 1996). The general environment consists of the political-legal, macroeconomic, socio-cultural, technological, demographic and global factors that might affect the organization's activities. On the other hand, the competitive environment consists of other specific organizations that are likely to influence the profitability of the enterprise, such as customers, suppliers and competitors. It would seem from the above studies that the success of SMEs is highly dependent on the interrelationship of the three strategic factors; entrepreneur characteristics, enterprise factors and the external environment (Hashim, 2002a).

The foregoing studies relate to SMEs in general. Despite their importance to the country's economy, as evidenced by the huge budget allocation mentioned earlier, little empirical work has been done specifically on the biotechnology sector in Malaysia. To the best of this researcher's knowledge, only one study by Mohd Osman (2002) has been conducted thus far on high technology-based SMEs. In his mixed methods study of growth determinants and constraints faced by high technology SMEs in Malaysia, Mohd Osman included 11 biotechnology SMEs in the sampled total of 86 respondents for the quantitative study. From these 11 biotechnology SMEs, six were further selected to participate in the next qualitative stage of his study.

In addition to the lack of specific study on biotechnology SMEs, little empirical research has also been conducted to explore the differences between biotechnology and non-biotechnology SMEs; and the specific success factors of biotechnology SMEs. To mention the few studies on the differences between the two SMEs, these include those of Brierley (2001); Liebeskind, Oliver, Zucker and Brewer (1996); Lynskey (2004a); Lynskey (2004b); and Reuber and Fischer (1994). Of the

studies on biotechnology success factors, those of Kropp and Zolin (2005); and Sapienza, Manigart and Vermir (1996) focused on entrepreneur characteristics, while Audretsch (2001), Deeds and Rothaermel (2003); Folta, Cooper and Baik (2006); Hall and Bagchi-Sen (2002); Nilsson (2001), Niosi (2002), Stuart and Sorenson (2003); and Zahra (1996a) studied factors related to the enterprise.

This research is an attempt to address the conundrum caused by the absence of a comprehensive treatment of all the factors found or suggested by earlier independent studies. It is the ardent belief of this researcher that if all the factors in these studies are simultaneously included within a single study, a more accurate assessment can be made of the relative impact of each of these factors on the success of biotechnology SMEs. This research, therefore, seeks to identify some of the more prominent differences between biotechnology and non-biotechnology SMEs in Malaysia; investigates the presumed effects of enterprise factors to the success of biotechnology SMEs in Malaysia; and to understand the role of perceived intensity of competition in moderating the relationship between enterprise factors and biotechnology SMEs success.

1.3 Problem Statement

This research is conducted in the context of the Malaysian biotechnology sector which has been receiving a great deal of attention from the Government. Based on literature precedence and a strategic approach, this study develops and presents an integrative framework for examining and understanding the strategic factors for managing biotechnology SMEs successfully in the Malaysian context.

Malaysia's efforts on biotechnology development have been dismally slow and hampered by a number of setbacks. The biotechnology sector in Malaysia is still in its infancy and occupies a market share of less than 0.5 percent of the total biotechnology revenue in the Asia Pacific region (Rajen, 2006). Its foray into big time biotechnology integration in May 2003 with the launching of the 80 ha BioValley has

thus far failed to materialize. In addition, despite being listed as a mega-diversity nation and placed in number twelve in the world and fourth in Asia, behind India, China and Indonesia, biotechnology has not experienced significant success in Malaysia.

In 2005, Malaysia was ranked ninth in the Ernst and Young Global Biotechnology Ranking for the Asia Pacific Region (Abu Bakar, 2005). This ranking was based on the number of biotechnology companies, number of employees, revenue, R&D expenses, and financial and survival indices (Ernst & Young, 2005). The number of biotechnology enterprises was 475 as listed in various databases (Current Study). Out of this, only 30 were classified as modern biotechnology enterprises (Ernst & Young, 2005). Moreover, the recent Ninth Malaysia Plan (2006-2010) further stated that the Malaysian biotechnology sector faces a challenging future with increasing global competition. To be competitive, Malaysia biotechnology enterprises will need to identify and build upon niche products and services in appropriate parts of the global value chain.

1.4 Research Questions

This research attempts to answer the following major questions:

- What are the differences between biotechnology and non-biotechnology SMEs in Malaysia?
- What enterprise factors contribute to the success of biotechnology SMEs in Malaysia?
- What is the effect of intensity of competition in moderating the relationship between enterprise factors and biotechnology SMEs success?

1.5 Research Objectives

The aim of this study is to contribute additional information to the existing body of knowledge that will help address the dismal situation of biotechnology

development in the country. This research attempts to fill a gap in the existing literature, especially in Malaysia, by explicitly focusing on the differences between biotechnology and non-biotechnology SMEs, their success factors and the moderating effect of the intensity of competition. More specifically, this research will address the following major objectives:

- To identify differences between biotechnology and non-biotechnology SMEs in Malaysia.
- To identify enterprise factors contributing to the success of biotechnology SMEs in Malaysia.
- To investigate the effect of external environmental factor in moderating the relationship between enterprise factors and the success of biotechnology SMEs in Malaysia.

1.6 Organization of the Thesis

The contents of this thesis are organized into eight chapters. Chapter 1 provides a brief introduction to biotechnology, the need for research on biotechnology SMEs in Malaysia, research questions, research objectives, scope of the research, definition of key terms, an overview of the biotechnology sector in Malaysia, biotechnology businesses and biotechnology SMEs. Chapter 2 reviews the extant literature on the differences between biotechnology and non-biotechnology SMEs, as well as the contributing factors to the success of biotechnology SMEs. This chapter also discusses the success measurement of biotechnology SMEs. Following the literature review, conceptual framework, research design, methodology and research methodology rationale are discussed in Chapter 3. The conceptual framework serves to link all known factors that contribute to the success of biotechnology SMEs in order to form the principal research focus. Chapter 4 reports in detail on the methodology used in the qualitative study. The following Chapter 5 draws the findings of this qualitative study. Chapter 6 is devoted to the quantitative study

methodology where the theoretical framework, underlying theory, details of each construct and the hypotheses derived from the theoretical framework are identified. Discussion on the measurement of different variables, analytical methods, and pilot testing is also included in this chapter. Chapter 7 reports on the findings of the quantitative study which includes the respondents' profiles, analyses of dependent and independent variables; and results of hypotheses testing. Finally, Chapter 8 draws the conclusions of this research with a summary and a discussion of the findings, research contributions, limitations as well as suggestions for future research directions.

1.7 Scope

This research is concerned with the differences between biotechnology and non-biotechnology SMEs; enterprise factors that contribute to the success of biotechnology SMEs; and the moderating effect of competitive environment on the relationship between enterprise factors and biotechnology SMEs success in Malaysia. It is conducted fully in Malaysia in the years 2005 to 2006 time period. Biotechnology SMEs are selected from those in the manufacturing of biomedical, agriculture and veterinary; food, environmental and industrial; and other biotechnology business activities listed in various directories in Malaysia.

1.8 Definition of Key Terms

1.8.1 Biotechnology

Biotechnology may be defined in terms of the use of biological organisms for the attainment of commercial ends (Fransman, 1991).

1.8.2 Small and Medium Enterprises (SMEs)

According to the National SME Development Council (NSDC) an SME in Malaysia is defined as:

- a. A small-sized enterprise in manufacturing (including agro-based and Manufacturing Related Services) with full-time employees of between 5 and 50, or an annual turnover of between RM250,000 and less than RM10 million.
- b. A medium-sized enterprise (including agro-based and Manufacturing Related Services) with full-time employees of between 51 and 150 or an annual turnover of between RM10 million and RM25 million

These definitions are applied by all Government Ministries and Agencies involved in SME development as well as by the financial institutions (Bank Negara Malaysia, 2005). In addition, a micro enterprise in manufacturing (including agro-based and Manufacturing Related Services) is an enterprise with full-time employees of less than 5 or with an annual turnover of less than RM250,000. Details of the SMEs definition in Malaysia are included in Appendix A.

1.8.3 Biotechnology SMEs

Biotechnology SMEs refer to small and medium enterprises that use biological organisms, through various biotechnological techniques (Smith, 1996), to develop products for human and animal in the area of biomedical, agriculture-veterinary, food, environmental and industrial, and other biotechnology business activities (BIOTEK, 2001; National Pharmaceutical Control Bureau [NPCB], 2005; and Shahi, 2004).

1.8.4 Technology based SMEs

Technology-based SMEs are enterprises whose products depend largely on the application of scientific or technological knowledge, or are businesses whose activities embrace a significant technology component as a major source of competitive advantage (Brierley, 2001). These businesses are generally located in

industries such as communication, IT, computing, biotechnology, electronics, and medical or life sciences.

1.8.5 SMEs Success

SMEs success refers to the effectiveness of an enterprise in accomplishing its objectives that are measured by financial profitability, growth and satisfaction.

1.8.6 Financial Profitability

The profitability measure is computed by averaging the financial profitability ratios of return on total assets (ROA), return on total equities (ROE) and return on sales (ROS) for the year 2004. ROA is operationalized by dividing net profit by the total assets in 2004 (Net Profit/Total Assets). ROE is net profit divided by total equities in 2004 (Net Profit/Total Equities). Meanwhile, ROS is operationalized by dividing net profit by total sales in 2004 (Net Profit/Total Sales). This research adopts the business performance composite measure (BPCM) as the mean values of ROA, ROE and ROS (Hashim, Wafa & Sulaiman, 2004; Lee, 1987). Thus, BPCM is operationalized as; $1/3 (ROE + ROS + ROA)$.

1.8.7 Enterprise Growth

The enterprise growth is operationalized as the average sales growth rate for three year period beginning 2002. Sales growth will be computed by averaging the percentage change in actual sales volume for a three year period (2002-2004). The rate of change of sales growth measures will be computed by taking the difference between two years and divided by the earlier year, resulting in each growth measure having two figures (i.e. 2002 and 2003; and 2003 and 2004). The average sales growth rate is derived by dividing the total sales growth rate by two for 2002 to 2004.

1.8.8 Satisfaction

Satisfaction refers to the perceived satisfaction of the entrepreneurs with their overall enterprise performance (Masuo, Fong, Yanagida & Cabal, 2001).

1.8.9 The Entrepreneur

The entrepreneur refers to the individual who is the founder or owner of the enterprise and actively manages the enterprise (Kets de Vries, 1996).

1.8.10 Product

Product refers to the output of an enterprise and includes both tangible goods and services (Kotler, 2003).

1.8.11 Entrepreneur Characteristics

Entrepreneur characteristics refer to entrepreneurial orientation and comprise of demographic factors that contribute to or detract from an individual's ability to become a successful biotechnology entrepreneur.

1.8.12 Entrepreneur Age

Entrepreneur age refers to the age of an entrepreneur measured in years as at January 2005.

1.8.13 Motivation

Motivation determines why an enterprise is established by the entrepreneur and whether or not it will succeed (Lynskey, 2004a; Storey, 1994). According to these two authors, the initial motivations for establishing enterprises are either based on positive or negative reasons. Positive motives include, spotting a business opportunity; a desire to accumulate wealth; and a desire to work for oneself. On the

other hand, negative motives include dissatisfaction with the existing employer; and the threat of unemployment and redundancy.

1.8.14 Knowledge-based Resources

Knowledge-based resources refer to intellectual capital of the entrepreneur or other enterprise personnels that contribute to the sustained competitive advantage of the enterprise in the form of educational qualification, training and experiences.

1.8.15 Property-based Resources

Property-based resources refer to property rights and controls that tie up a specific and well-defined asset (Miller & Shamsie, 1996). When an enterprise has exclusive ownership of a valuable resource that cannot be legally imitated by rivals, it controls that resource. Examples of property-based resources are enforceable long-term contracts that monopolize scarce factors of production, embody exclusive rights to a valuable technology, or tie up channels of distribution.

1.8.16 The Enterprise Characteristics

The enterprise characteristics refer to the immediate setting in which SMEs operate.

1.8.17 Enterprise Age

Enterprise age is the age of the enterprise measured in years as at January 2005.

1.8.18 Enterprise Strategies

Strategy may defined as major action taken or planned by the management of a business organisation, considering its resources, skills and environmental risks (Sulaiman, 1993).

1.8.19 Organizational Structure

Organizational structure has been defined by Khandwalla (1977, p. 482) as the “network of durable and formally sanctioned organizational arrangements and relationships”. Durable relationships exist between individuals in the organization, between individuals and machines and between work groups. Permanent arrangements determine reporting mechanisms, communication patterns between organizational participants, job functions and rules and procedures for linking together the activities of individual employees.

1.8.20 Organic Structure

Organic structures are characterized by informality, decentralization of authority, open channels of communication and greater flexibility (Khandwalla, 1977; Randolph, Sapienza & Watson, 1991).

1.8.21 Mechanic Structure

Mechanistic structures refer to structures that are highly formalized, non-participative, hierarchical, tightly controlled and inflexible (Khandwalla, 1977; Randolph, Sapienza & Watson, 1991).

1.8.22 Enterprise Image

Enterprise image is defined as the overall impression, functional and emotional; made on the minds of customers (Hall, 1992; Schwaiger, 2004). According to Schwaiger (2004), the combination of functional and emotional components conceptualizes reputation as an attitudinal construct, where attitude denotes subjective, emotional, and cognitive based mindsets. Thus, evaluating corporate reputation not only appraises subjective perceptions of a company's attributes such as "successful company" and "high quality products", but also allows

an intrinsic disposition towards these attributes in the sense of "this company is not that successful, but I like it anyway", or vice versa.

1.8.23 Enterprise Linkages

Enterprise linkages refer to linkages with academic research institutions and/or social networking with individual researchers of the academic research institutions.

1.8.24 Enterprise Internal and External Networking

Networking refers to enterprise engagements with other privately owned enterprises in and/or outside their fields. In this research, the term 'joint research projects' is used to differentiate productive networking that contributes to enterprise success from social networking.

1.8.25 Vertical Integration

Vertical integration refers to actions taken to control material resources (backward integration) or to control channels of distribution (forward integration) (Sulaiman, 1993). It is undertaken by an enterprise as a means of strengthening the enterprise's competitive position (Thomson & Strickland, 1996). Backward integration offers a differentiation-based competitive advantage where an enterprise, by virtue of performing in-house activities that were previously outsourced, ends up with a better quality product or service, improves the caliber of its customer service, or in other ways, enhances the performance of its final product. Forward integration, meanwhile, enables a manufacturing concern to integrate forward into wholesaling and/or retailing in order to build a committed group of dealers and outlets to better represent its products to customers. Additionally, forward integration into direct retailing can result in relative cost advantage and lower selling prices by eliminating many of the costs associated with normal wholesale-retail channels.

1.8.26 Innovation Activities

Innovation is defined to encompass development of new products or services, new methods of production, new markets, new sources of supply and the reorganization of methods of operation (De Brentani, 2001; Schumpeter, 1942).

1.8.27 Intensity of Competition

Intensity of competition refers to the level of competition in price, product, technology, distribution, manpower and raw materials (Khandwalla, 1977; Miller, 1987).

1.9 Biotechnology

Biotechnology may be defined in terms of the use of biological organisms for the attainment of commercial ends (Fransman, 1991). Biotechnology business refers to enterprises that use biological organisms, through various biotechnological techniques to develop products for human and animal healthcare, agricultural productivity, food processing, renewable resources, industrial and environmental management (BIOTEK, 2001; NPCB, 2005; Shahi, 2004).

An unknown Hungarian engineer, Karl Eveky, first coined the term biotechnology in 1919 to refer to the application of technology to agricultural processes that can expand the world's food supply (Smith, 1996). In the early 1970's, biotechnology received a significant boost from the introduction of a number of powerful new technologies known as genetic engineering. These techniques allow biotechnologists to alter the genetic structure of organisms by the addition of new genes that allow the organisms to perform new functions (Fransman, 1991). Genetic engineering together with other ways of manipulating and using biological organisms have provided a potent new set of possibilities with profound implications for a wide range of commercial activities in agriculture, pharmaceuticals, chemicals, food, industrial processing and mining.

1.10 Biotechnology in Malaysia

Biotechnology is definitely one of the fastest growing industries in the world and is now seen as a major area of investment by both government and private sectors (Ernst & Young, 2000). It is a dynamic industry spanning many disciplines in science and engineering and capable of not only enhancing human health but also fuelling economic growth. It has been acknowledged that biotechnology is the engine of growth for life sciences in the 21st century (BIOTEK, 2001) by creating platforms for new products and markets on many fronts (Ernst & Young, 2000). There are five competitive advantages of biotechnology for Malaysia (Gomez, 2005). These are; Malaysia's rich diversity of flora, fauna and people; the already existing agricultural-based biotechnology; the increasing number of government grants and venture capital funding; the existence of ICT infrastructure and experience in high technology industry; and the government's unrelenting commitment to biotechnology. In a paper prepared by the Science Advisor Office of the Prime Minister Department, Malaysia (2003), it was stated that:

Malaysia's competitiveness and key advantage is in her vast reserves of million years' old virgin rainforest and natural resources that ranges from a variety of flora and fauna to micro-organisms and marine heritage. For example, Malaysia's biodiversity and the traditional use of plants and herbs as medicines by the different cultures, provide opportunities for identifying useful compounds in plants and animal species that can tap into the estimated US\$ 100 billion global pharmaceutical market. (p. 4)

With its endless genetic species and diverse ecosystem, Malaysia is an unexplored treasure chest of medicines and useful plants and compounds (Gomez, 2005).

The Malaysian government has developed the Malaysian Biotechnology Corporation to spearhead the development of biotechnology in the country in 2005 (MOSTI, 2005). This corporation is aimed at being a dedicated and professional

one-stop agency with the main objective of developing the country's biotechnology industry. It is overseen by an Implementation Council and advised by an International Advisory Panel to coordinate biotechnology initiatives from all government ministries. Some of its functions include; catalysing commercial spin-offs to the private sector; facilitating market-driven R&D; and commercializing initiatives in agriculture, healthcare and industrial through funding and industry development services.

Another recent development in biotechnology is the creation of BioNexus Malaysia (MOSTI, 2005). BioNexus is essentially a network of centres of excellence throughout Malaysia and comprises of enterprises and institutions which specialize in specific biotechnology sub-sectors. Initially, three such centres of excellence will be established as part of BioNexus. The centres are; agro-biotechnology at MARDI and UPM, Serdang; genomic and molecular biology in UKM, Bangi; and pharmaceutical and nutraceuticals at Dengkil, Selangor. In addition, Malaysia offers competitive financial incentives under the Promotion of Investment Acts 1986 (PIA), other pre-packaged incentives, and various government grant programmes for biotechnology development in Malaysia (Mohd Osman, 2002).

1.11 Malaysian Biotechnology Policy

The National Biotechnology Policy envisions that biotechnology will be a new economic engine of growth for Malaysia. The policy aims to build a favourable environment for R&D and industry development whilst leveraging on Malaysia's already existing areas of strength. Details of the policy is included in Appendix B.

According to MOSTI (2005), the National Biotechnology Policy is underpinned by nine policy thrusts as follows:

- Agriculture Biotechnology Development
- Healthcare Biotechnology Development
- Industrial Biotechnology Development

- R&D and Technology Acquisition
- Human Capital Development
- Financial Infrastructure Development
- Legislative and Regulatory Framework Development
- Strategic Positioning
- Government Commitment

1.12 Biotechnology Business

Biotechnology business refers to “commercial activities involving biomedical; agricultural and veterinary; food; environmental and industrial; and other biotechnology related products that are associated with every aspect of human lives” (Shahi, 2004, p. 2). Table 2.1 below shows the multi-faceted nature of biotechnology business.

1.13 Biotechnology SMEs

Biotechnology is a new industry that is knowledge-based and is predominantly engaged by new start-ups and small firms (Audretsch, 2001). According to 2001 figures from the US Biotechnology Industry Organization (BIO), Washington D.C., and the Biotechnology Information database (BID) maintained at the University of Siena, Italy; there are 2,104 dedicated biotechnology companies in Europe and 1,379 in the USA (Alper, 2002). European biotechnology companies are on average much smaller than those in the US. Only 10 percent of European biotechnology firms have more than 50 employees and over half employ fewer than 20 people. Nearly 70 percent of Swedish biotechnology companies employ fewer than 10 people, even though Sweden has a far greater percentage of companies created before 1991 and a larger percentage created after 1996 than do other European countries.

Table 1.2

Areas of Biotechnology Business

Biomedical	Food related Biotechnology Businesses	Agricultural and Veterinary
<ul style="list-style-type: none"> ▪ Healthcare ▪ Pharmaceuticals ▪ Biomedical biotechnology ▪ Herbal and traditional medicine ▪ Medical devices ▪ Diagnostics ▪ Cosmetics 	<ul style="list-style-type: none"> ▪ Food processing ▪ Food biotechnology ▪ Food services 	<ul style="list-style-type: none"> ▪ Agriculture ▪ Fisheries and aquaculture ▪ Animal husbandry ▪ Forestry and lumber ▪ Agro-biotechnology ▪ Recreational animal industry
Environmental and Industrial	Other Biotechnology Business Activities	
<ul style="list-style-type: none"> ▪ Management of biodiversity ▪ Environmental bioremediation ▪ Waste management ▪ Environmental biotechnology ▪ Marine biotechnology ▪ Industrial biotechnology 	<ul style="list-style-type: none"> ▪ Bio-IT and the application of information and communication technology in the life sciences ▪ Bioengineering ▪ Nanotechnologies as applied to the life sciences and biotechnology ▪ Life science and biotechnology education ▪ Life science and biotechnology research and development (R&D) ▪ Life science and biotechnology contract services 	

Source: Shahi (2004) and NPCB (2005).

New technology-based firms (NTBFs) have been a key feature of growth in high technology development in the US and the UK (Oakey, Rothwell & Cooper, 1988). Morse (1976) reported that much of the growth in the high technology sphere in the US was provided by small firms in the 1970s. During the 1980s, there has been a growing acceptance that small firms play an important role in the growth of high technology industries by providing a type of 'teamwork' driven innovation that is

difficult to achieve in larger enterprises (Morse, 1976; Oakey, 1984; Rothwell & Zegveld 1982). Indeed, the attempts of large firms to internally replicate small firm attributes through various forms of 'intrapreneurship' are a tacit acknowledgement of the value of this informal small group approach to R&D and subsequent industrial innovation (Roberts, 1977).

In recent years, a large number of NTBFs have been formed on the peripheries of universities and colleges (Dahlstrand & Klofsten, 2002). These firms are considered to be very important for national and regional economic development, primarily as important sources of technological innovations and new job creations (Jones-Evans & Klofsten, 1997; Malecki, 1991). Biotechnology is generally regarded as high technology which has a bearing on knowledge intensity (Daly, 1985). In biotechnology, this knowledge intensity involves relationship between basic science and commercial activities. According to Daly, new biotechnology firms (NBFs) in the US are new entrepreneurial firms formed generally since 1976 with the assistance of venture capital (1985). Daly also identified that many of the firms' founders or co-founders were academic scientists wishing to exploit their expertise commercially in areas such as recombinant DNA technology (1985). Typically these firms are research intensive with a high proportion of the staff involved in R&D and do not manufacture their own products in their early years. Initial R&D expenses are financed by venture capital, through public stock offerings, contract R&D, product licensing and other financial mechanisms.

As mentioned earlier in Section 1.2, the Malaysian biotechnology sector is also dominated by SMEs (BIC, 2001). Currently, biotech SMEs are not clustered in any specific geographical location. Most of the companies are concentrated in Kuala Lumpur and Selangor, while others are scattered across the country in places like Penang, Melaka, Johor Bahru as well as East Malaysia, in Sabah and Sarawak.

1.14 Summary

Biotechnology is recently receiving greater attention from the Malaysian Government as reflected in the amount allocated for biotechnology programmes in various Malaysia Plans. With the introduction of Malaysia Biotechnology Policy and various biotechnology development programmes, it is envisaged that biotechnology is the next engine of growth for Malaysia that will accelerate the transformation of the country into highly industrialized nation by the year 2020. At this juncture, the success of biotechnology SMEs as major players in the sector is crucial to the rapid development of biotechnology for Malaysia.