AN INTEGRATED MODEL TO ANALYSE POLICY PROCESS: A CASE STUDY OF MALAYSIA'S NATIONAL BIOTECHNOLOGY POLICY

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By

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List of Abbreviations

ASEAN	Association of Southeast Asian Nations
AFTA	ASEAN Free Trade Area
BiotechCorp	Malaysian Biotechnology Corporation
B. C. E.	Before the Common Era
BCC	Biotechnology Cooperative Centers
CBD	Convention on Biological Diversity
DNA	Deoxyribonucleic Acid
EC	European Community
EFB	European Federation of Biotechnology
EPU	Economic Planning Unit
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IP	Intelectual Property
MARDI	Malaysian Agricultural Research and Development Institute
MAS	Malaysian Airline Systems
MBC	Malaysian Biotechnology Corporation
MABIC	Malaysian Biotechnology Information Centre
MDC	Malaysian Development Corporations
MIGHT	Malaysian Industry-Government for High Technology
MIT	Massachusetts Institute of Technology
MMBPP	Malaysia-MIT Biotechnology Partnership Program
MASTIC	Malaysian Science and Technology Information Centre
MOA	Ministry of Agriculture and Agro-Based Industries
MOHE	Ministry of Higher Education
MOSTE	Ministry of Science, Technology and Environment
MOSTI	Ministry of Science, Technology and Innovation
MSC	Multimedia Super Corridor
NBD	National Biotechnology Directorate
BIOTEK	National Biotechnology Division

NBP	National Biotechnology Policy
PORIM	Palm Oil Research Institute of Malaysia
PCT	Patent Cooperation Treaty
PWC	PriceWaterhouseCoopers
PPP	Purchasing-Power-Parity
R&D	Research and Development
RRIM	Rubber Research Institute of Malaysia
NAP3	Third National Agricultural Policy
UNCTAD	United Nations Conference on Trade and Development
UK	United Kingdom
UKM	Universiti Kebangsaan Malaysia
UPM	Universiti Putra Malaysia
USA	United States of America
USM	Universiti Sains Malaysia

List of Publication

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Penggunaan Model Integrasi Untuk Menganalisis Proses Dasar: Kajian Kes Dasar Bioteknologi Kebangsaan Malaysia

Abstrak

Bioteknologi adalah salah satu teknologi terpenting dalam abad ke-21 dan merupakan antara sektor yang mencatatkan kadar pertumbuhan yang mendadak di dunia. Seiringan itu, bioteknologi telah dikenalpasti sebagai enjin pemacu pembangunan ekonomi Malaysia melalui proses penyelidikan dan pembangunan, peluang perusahaan industri berasaskan bioteknologi, peningkatan kadar pengeluaran makanan, serta menjamin kelestarian alam sekeliling. Menyedari sumbangan penting bioteknologi ke atas ekonomi negara, Dasar Bioteknologi Kebangsaan telah digubal oleh kerajaan Malaysia untuk memastikan perkembangan industri bioteknologi negara berlaku secara sistematik dan tersusun. Maka penyelidikan ini dijalankan untuk mengkaji proses penggubalan Dasar Bioteknologi Kebangsaan dengan menggunakan kerangka bersepadu yang dibangunkan dengan menggabungkan model "multiple streams" dan "voluntary policy transfer network". Selain itu, penyelidikan ini juga bertujuan untuk menambahkan literatur mengenai proses penggubalan dasar-dasar awam yang terhad di Malaysia. Melalui rekabentuk kajian kualitatif dan eksplorasi, penyelidikan ini menggunakan pendekatan triangulasi bagi tujuan pengumpulan dan analisa data. Dapatan utama penyelidikan ini boleh diklasifikasikan kepada dua isi penting. Pertama, penggubal dasar di negara-negara membangun seperti Malaysia sering memainkan peranan utama dalam memulakan, membentuk dan melaksanakan dasar awam. Kedua, perunding dan rangkaian polisi yang cekap dan sistematik adalah unsur penting dalam memastikan penggubalan sesuatu dasar

awam secara berkesan. Berdasarkan penemuan kajian, penyelidikan ini menunjukkan keberkesanan kerangka bersepadu dalam menjelaskan proses penggubalan Dasar Bioteknologi Kebangsaan di Malaysia.

An Integrated Model to Analyse Policy Process: A Case Study of Malaysia's National Biotechnology Policy

Abstract

Biotechnology is one of the major technologies of the twenty-first century and in fact is the fastest growing sectors in the world. It is a fascinating field that has been identified as the next engine of growth for Malaysia, one that will deliver economic gains through research and development, creation of entrepreneurial opportunities for industrial growth, improvement of food security, health and environmental sustainability. Realising the important contributions of biotechnology to the country, this research seeks to examine the policymaking process of National Biotechnology Policy, which is aimed to provide a structured guideline in developing the industry. In the course of doing this, the study employs an integrated framework developed by combining Kingdon's (1995) multiple streams model with Evans and Davies's (1999) voluntary policy transfer network model to illustrate the policymaking events as a political process influenced by various policy actors and shaped by the developments of three distinct phases of public policymaking. Moreover, this study aims to add to the limited literature on public policymaking as well as on model testing, which has received relatively a little attention in Malaysia. This is a qualitative and exploratory case study research that employs triangulation approach for the purpose of data collection and data analysis. The major findings of this research can be classified into two. Firstly, policymakers in the developing countries like Malaysia often assume central roles in initiating, shaping and pursuing public policies. Secondly, a well mobilised policy consultants and policy network is important in ensuring a

successful public policy development. Based on these research findings, the study has demonstrated the utility of the integrated model in explaining the process of National Biotechnology Policy formulation.

Chapter 1: Introduction

1.1 Research Background

The emergence of new technologies such as the Information and Communication Technology (ICT), biotechnology and new material sciences have successfully altered the dynamics, composition and production patterns in the industrialised as well as developing nations (Chaturvedi & Rao, 2004). Biotechnology, in particular, will undoubtedly be the major technology of the twenty-first century. In fact, biotechnology is one of the fastest growing sectors in the world and is seen as a major area of investment and target for support by government worldwide (MOSTI, 2006). Over the past 55 years, biotechnology has supported many scientific discoveries and has become an integral component of the economies of many industrialised countries (Glassman & Sun, 2004). There are significant potential benefits to the nations committed to participating in the biotechnology industry, for instance, in term of higher crop yields, better healthcare and better economic returns (Daar et al., 2007).

Hence, in a short span of time, biotechnology has become a multibillion dollar industry. According to the Malaysian Biotechnology Corporation (BiotechCorp)'s Annual Report in 2008, there are more than 5000 biotechnology companies worldwide with a combined market capitalisation in excess of USD900 billion and an annual turnover of more than USD60 billion. United States is the world leader in biotechnology, while Canada, United Kingdom, Japan and Germany are significant players (Jasanoff, 2005). The biotechnology industry is also rapidly expanding into the developing countries such as

India, China as well as countries like Brazil, South Africa, Mexico and Argentina (Salicrup & Fedorkova, 2006; Bourinbaiar, 2006). As a result, those countries that have embraced the biotechnology innovations and applications have brought unprecedented prosperity to their people (Chaturvedi, 2005).

For an example, United States has the largest and most profitable biotechnology industry consisting of 329 public and 1086 private biotechnology companies in 2005, rising over US$ 50 billion per year and providing employment to over 160,000 people (Ernst & Young, 2006). In India, one of the rapidly developing countries in the world, the revenues generated by the industry has reached more than US$2 billion in the fiscal year 2007, registering a growth rate of 30 percent. The industry also promises employment creations of one million jobs by the year 2010 (Graydon, 2007; Singh, 2008). In a European Community (EC) paper entitled "Life Sciences and Biotechnology – A Strategy for Europe" released on 23 January 2002, the total world market for biotechnology was estimated to be USD2000 billion by 2010.

Recognising the potential contribution of biotechnology to the economy, many Asian countries, including Malaysia have begun to invest in the biotechnology industry. Although biotechnology can be considered as relatively a new industry in Malaysia, yet it has been identified as a potential engine of economic growth for the nation. Following the lead given by the development of Multimedia Super Corridor (MSC) which represents a successful investment in the ICT industry, biotechnology is considered as the next growth area in the industrial development for Malaysia (MOSTI, 2006). Hence, with the necessary motivations and great opportunities, biotechnology becomes the

subject of public policy aspiration in Malaysia. However, a structured policy is vital as it becomes the key for the implementation of activities in this sector. With a clear direction and indication, the progress and growth of this sector is not only immeasurable but the success will then be proven relative. The Malaysian cabinet then entrusted the Ministry of Science, Technology and Innovation (MOSTI) to lead the drafting of an effective policy for this industry.

On the other hand, literature on the public policy studies, especially policy analysis has increased tremendously over the years (Friedman, 2002; Dye, 2008). According to Dye (2008), policy analysis is a measurement tool to find out what government do, why they do it, and what difference, if any, it makes. For a layman, policy analysis can be defined as an explanation about public policy, a set of technical skills used to describe its rationale, determinants and consequences (Nagel, 1999; Weimer & Vining, 2005). Generally, policy analysis can be divided into two major fields, namely descriptive and prescriptive. The analysis of policy is considered descriptive if it attempts to explain policies and their development. If it involves formulating policies and proposals, then it is considered as prescriptive (Buhrs et al., 1993). For this study, descriptive analysis would be the suitable platform to understand the policy making process involved in the formulation of a biotechnology policy in Malaysia.

Realising the importance and significance of analysing the public policies, policy scholars began an in-depth exploration into the policy making process. As a result, they have developed a number of frameworks and models to facilitate the understanding as well as to analyse the public policies. In general, a model is an abstraction or

representation of some aspects of the real world. The models that shall be used in studying policies are called conceptual models (Jones & Baumgartner, 2005). These conceptual models are capable to facilitate in 1) understanding the fundamental aspects of public policy making; 2) understanding the public policies better by suggesting what is important and what is not; 3) suggesting the causes and consequences of public policy making; and 4) simplifying and clarifying the knowledge about public policy and policy making (Dye, 2008). Since policy analysis has evolved from diverse disciplinary bases, there are numerous frameworks and models found within literature to help explain the process of policy making (Neilson, 2001). Some of the framework includes rational comprehensive model, incremental model, interactive model, multiple streams model, voluntary policy transfer network model, and policy narratives model.

Even though there are many models available to explain the policy process, model review has received relatively little attention, especially in developing countries like Malaysia (Hartmark & Hines, 1980; Neilson, 2001; Jones, 2009). The reason may due to the fact that in real world these processes seldom occur in a neat, step by step sequence. Rather these processes often occur simultaneously, each one collapsing into each other (Porter & Hicks, 1995). In other words, policy making is seldom as neat as the process model. Besides, the existing policy making models have their own limitations and weaknesses which preclude its usefulness or relevance as the framework for public policy analysis.

For instance, Linear Model, which is known as the rational comprehensive model is once regarded as a main reference for policy making (Porter & Hicks, 1995). However,

the model has fell out of favour with most policy researchers, even though some may still consider it as an accurate and relevant description of the policy making process. Fundamentally, the model is criticised for its inability to capture a reality of the policy making process. The rational comprehensive model assumes that the role of a policy researcher is to research and present the policy options to the policymakers, who will examine each of the options available intensively before making any decisions (Stone et al., 2001). However, this is not true in many cases because most of the policymakers neither have the time nor the resources to access all of the policy options brought forth (Grindle & Thomas, 1991; Porter, 1995; Stone et al., 2001). Besides, the model also assumes that the only actors involved in the process is the 'policy elites' or those individuals who are considered to be government officials. This too is a limiting factor in term of using this framework for analysis since many instances of policy changes in developing countries involve external actors to the official or government apparatus (Neilson, 2001).

Another example is the Lindblom's incremental model. The incremental model states that policymaker does not begin the policy making process with some ideal goal in mind but from the existing policies (Lindblom, 2005). It is an attempt to reduce the uncertainty and complexity by making marginal changes over the time. According to Grindle and Thomas (1991), the more uncertainty exists in a given decision situation, the more incremental changes will be adopted. However, there are number of limitations associated with this model. Firstly, the approach does not give attention to agenda setting very well since it does not explain how issues are propelled into an agenda. Secondly, the model is limited to describe the crisis-related policy making, since

incrementalism does not explain drastic or fundamental changes (Kingdon, 1984). While Dror (1997) acknowledge that the incremental model is not useful to explain a policy making process in the developing countries since more often than not, these countries experiences big and fundamental changes. Hence, a new approach is needed to describe the policy making processes in these countries.

Some policy scholars argue that there is no one set of systematic framework could be developed to deal with the variety of public policy problems in this world. Critics also say that the geographic and political context for these problem is so far ranging that they do not have much in common, thus defying any standard approach (Patton & Sawicki, 1993). Dye (2008) also doubt if there is any model of choice or single model that is preferable to all others and that consistently renders the best solution in policy analysis. However, a process for approaching these problems has evolved and is being utilised. Called as an integrated model, the framework provides a new platform to understand as well as to examine the process of policy making. Integrated model in the common term can be referred as a combination of elements from two or more individual policy models into one framework. For instance, Bailey (2007) developed an integrated model that combined the policy making framework of Kingdon's multiple streams model and Mazzoni's power and influence model. The resulting framework was used to analyse an education policy making process in Maryland, United States.

Therefore, this research attempts to propose and explore the use of an integrated model in explaining a public policy making in Malaysia, in particular the formulation of National Biotechnology Policy. The proposed integrated model and the National

Biotechnology Policy has been chosen as a tool for investigation in this study because the stipulated topic is relatively new and emerging field, thus there is not much history within the academic literature, or any significant changes in thinking over time. Thus, this research aims to bridge the gap and contributes to literature regarding the policy models and public policy making.

1.2 Problem Statement

Generally, there are number of policy making models available to examine the events of policy making. However, it should not be viewed as the only way in which new knowledge can be gained. In fact, there are few or none of these models able to reflect the actual policy making scenario (Stone et al., 2001; Bouchard & Carroll, 2003). According to Dye (2008), none of these models was designed specifically to study public policy but each of them able to provide different ideas or thinking, the general causes and consequences of public policy. An inability to accurately portray the real public policy making process can result in dire consequences for society (Sutton, 1999). The impact could not only results in creating society that are ignorant about the public policies and policy making but also in producing the public policies that waste resources and destroys academic environment (Ely, 2009). The integrated model, on the other hand offers a new platform to renew understanding and to provide a plausible as well as viable explanation on the actual policy making process. Besides, the public policy literature points to a need on examining policy making events in the developing countries such as Malaysia. To date, there are limited literatures available on policy making as well as model review in the developing countries and this phenomenon is not encouraging (Hartmark & Hines, 1980; Neilson, 2001; Jones, 2009). Therefore, this

qualitative research tests whether the proposed integrated model has the capacity to provide a viable and comprehensive analysis on a public policy making process in Malaysia, in particular the formulation of National Biotechnology Policy. At the same time, this research attempts to add literature on policy making and model review in a developing country like Malaysia.

1.3 Research Objectives

The primary objective of this qualitative study is to conduct an analysis and examine the process of National Biotechnology Policy formulation. Using an analysis framework based on the work of Kingdon (1995) as well as Evans and Davies (1999), which is described in detail in Chapter 2, this study documents and analyses the factors, events and policy actors that led to the development of the policy through interviews with the key respondents and a review of available official documents, records and reports. Such an analysis has not been found to be readily available in academic literature, particularly in the developing country like Malaysia (Jones, 2009). Yet, such an analysis may provide an insight on how policy making occurs generally, and specifically, how the National Biotechnology Policy was formulated in Malaysia.

The secondary objective of this study is to test the usefulness of the proposed integrated model, which is developed using the multiple streams model (Kingdon, 1995) and augmented by the components of voluntary policy transfer network model (Evans & Davies, 1999) to illustrate the process of National Biotechnology Policy formulation. In this study, the usefulness of the proposed integrated model is determined by using six criteria of usefulness adapted from Dye (1975). Besides, the study aims to add literature

on policy making and model review, which has received relatively a little attention, especially in developing countries like Malaysia (Neilson, 2001).

1.4 Research Questions

As mentioned in the previous section, the test of the integrated model is determined by how well it provides a credible explanation for specific policy making outcomes (Dye, 1975). The following sets of research questions is used to unpack the processes involved in the development of National Biotechnology Policy.

Problem Stream:

Why did biotechnology gain agenda status in Malaysia and who was involved in the process?

The response to this question may explain the reasons and factors for biotechnology to gain an agenda status in Malaysia. This section also may identify the policy actors that responsible to propel biotechnology into an agenda for the government action.

Policy Stream:

Who was involved in the formulation of National Biotechnology Policy proposal and why?

The response to this question may explain the key policy actors involved in the formulation of National Biotechnology Policy proposal. This section also may elucidate the reasons for their appointments as well as their functions in the policy process.

How did the policy actors gather information during the proposal formulation process?

The response to this question may explain the strategies and methodologies employed by the policy actors for data collection during the formulation of National Biotechnology Policy proposal.

How did the policy actors try to influence the proposal formulation process?

The response to this question may explain the interaction between the policy actors in this case study. Moreover, it may clarify the strategies employed by the policy actors to influence the outcome of the National Biotechnology Policy proposal.

Political Stream:

How did the proposal get decided and who was involved in the process?

The response to this question may explain how the policy proposal was analysed before decision was made. This section also may identify the actors involved in the process.

In sum, the responses to these questions may provide the fundamental description on the formulation of National Biotechnology Policy in Malaysia. Besides, by conducting case study research using an integrated model based on multiple streams model and augmented by voluntary policy transfer network model, the study also provides the foundation for gauging the validity and utility of the integrated model.

1.5 Significance of the Study

This study promises to extend the knowledge on public policy making in Malaysia in several ways. First, it contributes to the policy making literature on how public policies are developed, in particular the formulation of National Biotechnology Policy. Biotechnology, a set of revolutionary techniques, has been a subject of public policy aspirations for many years. Since this topic has never been analysed systematically, at least in Malaysia, this study examines the need to have a policy on biotechnology and the chronology of events in the policy making process. At the same time, this study describes and analyses the formulation of National Biotechnology Policy in which political aspects were in evidence.

Second, this study develops and tests the usefulness of an integrated model in providing insights about the public policy making in Malaysia, with National Biotechnology Policy as a test case. Besides reviewing the theoretical benefits of the combined properties, the model set to clarify the contextual conditions surrounding the policy issue. A dissertation by Kunjbehari (1981) and Bailey (2007) examined education policy making using an integrated model. They acknowledge the usefulness of using the integrated model to describe a policy making process. Besides, there are limited literatures available on model review (Hartmark & Hines, 1980; Neilson, 2001; Jones, 2009). Hence, this study has refocuses the attention on model review that was called for by policy science pioneers (Hartmark & Hines, 1980). Besides, it provides the public policy researchers a methodology for policy analysis that enhances viability (Klodnicki, 2003).

1.6 Research Scope and Limitations

It is important to acknowledge some of the concerns that might be raised with respect to the selection of National Biotechnology Policy as a case study and with the approach more generally. This study is delimited to the period from year 2003 to April 28, 2005, which was the period when circumstances caused the Malaysian government to regard biotechnology as a national agenda to the time when National Biotechnology Policy was launched. Besides, as the timeline indicates, this study was set to focus on the stage of policy formulation. This is to justify the objective of this study to analyse the process of National Biotechnology Policy formulation.

There are also several limitations to this study which should be noted. First, this study is limited to the researcher's interpretation of the data and the resulting description and analysis of the politics involved in the development of National Biotechnology Policy. Second, limited resources have affected the ability to review some archival documents which were unavailable without travelling to Ministry of Science, Technology and Innovation (MOSTI) in Putrajaya. The final limitations of this study were the degree to which its finding can be generalised to another setting. For instance, the integrated model used in this study may be suitable to analyse a policy making process in Malaysia but may not in another country. Although every study suffers from limitations, there is sufficient evidence from the data collected to support the findings.

1.7 Organisation of the Study

The first chapter provides an overview of the study. The chapter presents the motivation and intention to understand the policy making of National Biotechnology Policy using a

combined framework of multiple streams model and voluntary policy transfer network model. Chapter 2 provides a review of the academic literature, including the development of biotechnology institutions in Malaysia as well as the proposed integrated models employed in this study. The theoretical literature on biotechnology and policy process model serves as a foundation for the research and grounds the analytical framework that will guide the investigation. Chapter 3 describes the qualitative and exploratory case study design employed in this study. The chapter continues with a description of procedures used for data collection and analysis, as well as controls to minimise the biases and errors. Chapter 4 applies the proposed integrated model to the case study and describes the dynamics of each decision event respectively. The chapter answers the research questions, discusses the result of data analysis leading to possible interpretations and also presents an integrated model for the future review. Chapter 5 summaries the study, synthesises the findings, and develops the conclusions.

Chapter 2: Literature Review and Explication of Conceptual Framework

The purpose of this chapter is to review a literature on the policy issue and policy making models, including the proposed integrated model used in this study to examine as well as to interpret the process of National Biotechnology Policy formulation. The chapter begins with a discussion on the theoretical and descriptive literature of biotechnology, which includes the definitions, followed by the importance and the institutional development of biotechnology in Malaysia. Subsequently, the chapter describes eight major theoretical frameworks available in the literature used to analyse policy making as well as the theoretical orientation used to guide the case study analysis of National Biotechnology Policy formulation.

2.1 Policy Issue

2.1.1 Overview of Public Policy Making in Malaysia

Policy making is one of the pivotal stages in the political process (Colomer, 2005). All governments around the world have certain sets of rules or guidelines for policy making which can be in the form of a constitution, a specific written document, a set of customs or practices, or as is usually the case, both. Generally, the basic policy making differs along three dimensions, namely political, economy and socio-cultural. According to Robert Alford (1969), "decisions, policies and government roles can be explained by a combination of situational, structural, cultural and environment factors" (Ho, 2000, p. 12).

The uniqueness and variations in the Malaysia's public policy and the interactions of policy actors can be best explained when they are allocated in the political, economy and socio-cultural contexts. The relationship between public policy making and these contextual variables are very significant in the Malaysian setting (Ho, 1992). These contextual variables have exerted pressures on the building process of political agenda inside as well as outside the government. As a whole, these contextual variables act as a determinant of major policy issues, which made the Malaysian political process both volatile and impetuous (Snodgrass, 1995). A consideration of these variables is important for analysis as to gain a balance between the ideal and reality policy making in Malaysia.

The Malaysian political history casts a long shadow on present policy decisions. The country was a British colony, with migrants from the Malay Archipelago, India and China (Ho, 2000). The British and short Japanese occupation during the Second World War had a major impact on the Malaysian political structure. For example, after claiming independence from the British in 1957, Malaya (now Malaysia) adopted the framework of a constitutional monarchy from the British, in which the monarch is the head of state and the prime minister is the head of government. Thereafter, the National Front (Barisan Nasional) has been the dominant ruling political party and has effective control over the governmental bureaucracy and non-governmental sectors such as think-tanks and mass media (Jomo & Ng, 1996). Being the government of a multiracial society, the National Front employs a variety of strategies to consolidate its power base and garner popular support besides its primary mission of uniting the people. As a result, the nature of the Malaysian state has inclined to become more parliamentary, one-

party state, soft-authoritarian, and corporatist (Ho, 1992; 2000). By implication, public participation in policy making and civic consciousness of politics is quite at the minimal in the country.

Economically, Malaysia has developed tremendously after the implementation of the New Economic Policy (NEP) in 1970 and the subsequent National Development Policy (NDP) in 1990. Its rapid economic growth during the last five decades has transformed the economy from an agricultural based economy to a manufacturing-industrial based economy. As a result, the Malaysia's Gross Domestic Product (GDP) based on Purchasing-Power-Parity (PPP) per capita has increased from USD 2353.10 in 1980 to USD 14023.33 in 2008 (The World Fact Book, 2009). At the same time, Malaysia has developed the ability to tackle problems related to unemployment, health as well as education. In short, the quality of life in Malaysia today is much better than it was before the 1970s. Generally, Malaysians are not only educated and well informed, but also enjoy a higher living standard and better health care than before. The improvement in the quality of living standard implicates that Malaysians now are generally well informed of demands and supports of a political system. Thus, Malaysians have high expectations of the government's decisions and actions which the policymakers must take into consideration when developing and implementing a policy.

The third facet of the policy context is the nature of the Malaysian population. As mentioned before, Malaysia is a multiracial country with the population embracing different sets of culture, religion, and language. Malaysian population, as of September 2008, is estimated at 27,730,000 in which Malays and other Bumiputera groups make up

65 percent of the population, Chinese 26 percent, Indians 8 percent and other unlisted ethnic groups 1 percent (The World Fact Book, 2009). In terms of religion, Islam is the largest and the official religion (60.4 percent), while other large religions include Buddhism (19.2 percent), Hinduism (6.3 percent), and Christianity (9.1 percent). Besides, other minority religions practiced here are Sikhism, Daoism, Confucianism, Shamanism, and Animism, which make up 5 percent of the total population. Similarly, there are also many languages spoken in Malaysia, namely Bahasa Malaysia (Malay), English, Mandarin and Tamil.[1]

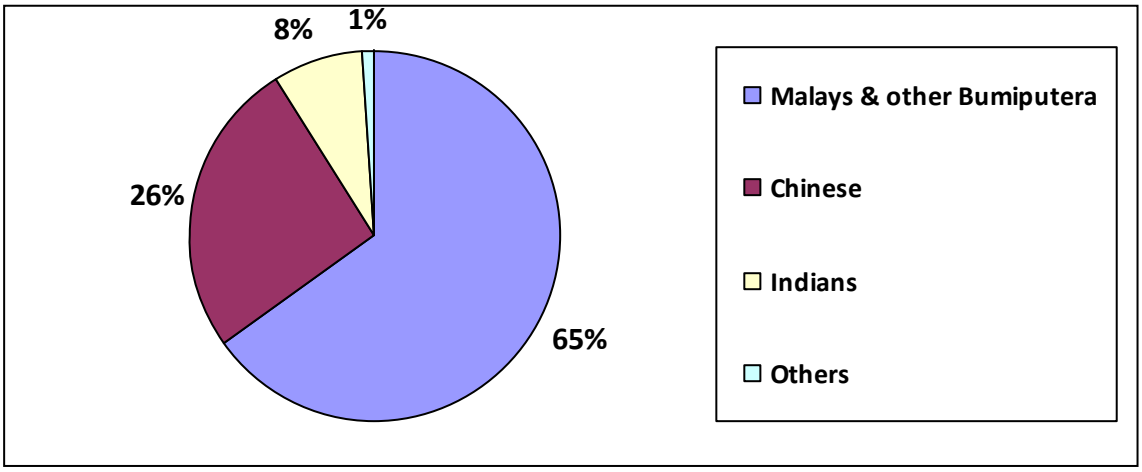

Figure 2.1: Malaysian Population According to the Races

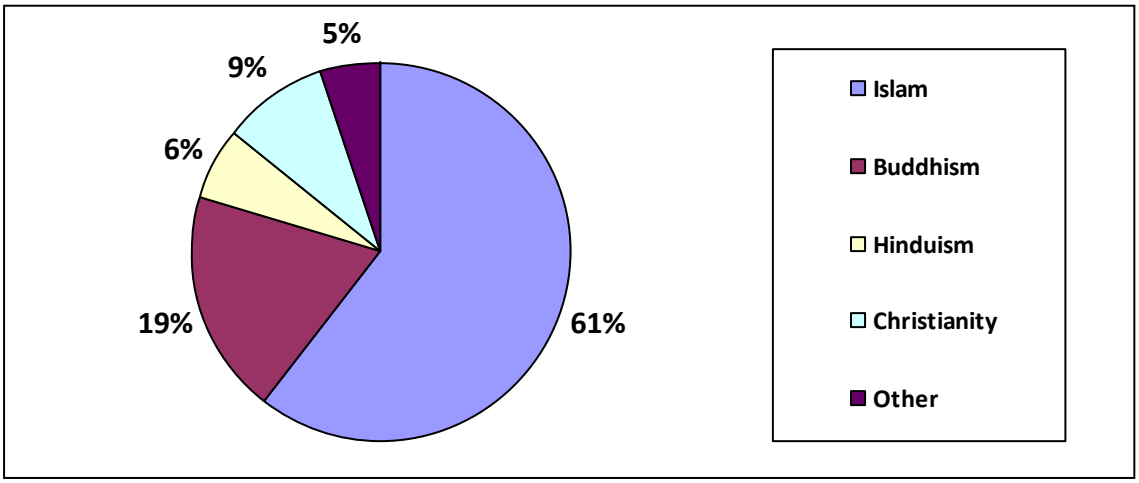

Figure 2.2: Malaysian Population According to the Religions

Therefore, the public policy making in a country as diverse and multiracial as Malaysia is intrinsically a more complex task than in other political unit with homogenous population. The process of policy development in Malaysia can be considered as a 'top-down' affair, where policy decisions are made by top political leaders with some participation from the relevant stakeholders such as interest groups or non-governmental organisations at various stages of the policy process (Basiron, 2007). Even though there are some traces of networking involved, the final decision on the approval and adoption of a national policy is a task reserved for the Malaysian Cabinet. The sequence of events leading to the adoption of national policy appears to be simple and straightforward enough, but is often a lengthy process.

Generally, the process of policy making begins with problem recognition, where issues and problems are considered as an agenda when it is perceived as the social problems that need government action. Once the issue has the attention of policymakers, the process is followed by the decision of whether or not to make an official policy on the issue. If the policymakers decide not to make any decision, this is still a policy but called a policy of non-decision (Bruce, 2003). Otherwise, if the policymakers decide to make an official policy on the issue, the process continues with policy formulation. In between the process, interaction between the various policy actors helps shape the policy.

2.1.2 Definition of Biotechnology

Biotechnology is a science and technology platform that provides a highly advanced multidisciplinary approach to develop a knowledge economy. According to the Organisation for Economic Corporation and Development (2005), biotechnology is

highly multidisciplinary since it has the foundation in many disciplines such as microbiology, biology, molecular biology, chemistry, and process engineering. Although often described as new, the term biotechnology was coined as long as the year of the Russian revolution in 1917 (Bud, 1993). The word was first used by Karl Ereky, a Hungarian agriculture engineer in 1919, who referred the term as "all lines of work involved in creating products from raw materials with the aid of living organisms" (MOSTI, 2006, p. 4). It may also be viewed as an umbrella term that covers various techniques for using the properties of living things to make products or provide services (Grace, 2006).

The Malaysian Biotechnology Corporation (2008) defines biotechnology in the two different ways. Firstly, it can mean any technique which uses living organisms to make or modify products, improve plant or animal productivity or to develop microorganisms for specific use. Secondly, it can be defined in a narrower scope as new high-end technology, involving recombinant deoxyribonucleic acid (DNA), cell fusion and novel bio-process engineering techniques such as gene transfer and embryo manipulation. Similarly, the European Federation of Biotechnology (EFB) considers biotechnology as "the integration of natural sciences and organisms, cells, parts thereof, and molecular analogues for products and services" (Raju & Sreenivasulu, 2008, p. 1). Generally, the EFB definition can be applied to both 'traditional' and 'modern' biotechnology. Traditional biotechnology refers to the conventional techniques which have been practiced for many centuries to produce foods and beverages such as wine, beer, cheese, and bread. While the modern biotechnology refers to biological processes that make a

practical use of the recent scientific advances in areas like molecular genetics (Smith, 2004).

Even though these definitions may be all encompassing, yet there are many attempts at refinement. New ideas and interest are continuously replaced and the term has acquired many annotations all these while. For instance, Choudhury and Islam (2002) acknowledges that biotechnology in its simplest annotation can be defined as a technology based on biological system such as plants, animals and microbes or parts of it (cell, tissue, gene) to derive the best products and services for the benefits of human being.

In sum, biotechnology is an interdisciplinary pursuit and should not be regarded as a product or range of products like microelectronics. Rather, it should be acknowledged as a range of enabling techniques which offers significant application opportunities in many industrial sectors (Smith, 2004). As asserted by McCormick (1996), "there is no such thing as biotechnology, there are biotechnologies" (p. 224).

2.1.3 Rationale and Importance of Biotechnology to Malaysia

In this day and age, it is a common desire of all nations to be strong, secure and prosperous. Recognising the advent of new challenges related to science and technology, it is imperative that the developed as well as the developing countries are formulating strategies to achieve sufficient level of scientific and technological competence, in particular in the emerging technologies (Padolina, 2002). Among the new technologies, biotechnology has been observed with great interest. The twenty-first century is the age

of modern biology, as has said by Walter Isaacson, “Ring farewell to the century of physic, it is time to ring in the century of biotechnology” (Sharma, 2002, p. 45).

From the historical context, biotechnology can be regarded as an artisanal skill rather than science. For instance, people of the Stone Age era have applied biotechnology in their daily activities without realising the underlying biological principles (Bud, 1993). Generally, many of today’s modern biotechnological processes have their root in ancient and traditional biological techniques such as brewing of beer and the manufacture of cheese, vinegar, and bread (Bhatia, 2005). In fact, the earliest evidence of traditional biotechnology in food processing can be traced to the Neolithic era where human have used natural elements in the environment like yeast to prepare wine and bread (Fari & Kralovanszky, 2006). Thus, biotechnology should not be considered as a sudden discovery but rather as continuation of a technology that was initiated several decades ago (Elander, 1985; Smith, 2004).

According to Anyango and Shiundu (1999), there are three major generations that characterise the evolution of biotechnology in the world. The first generation was dated back in the Stone Age era and was basically based on the empirical practices and had minimal scientific inputs. As long as 3000 to 4000 B.C.E., for instance, bread and beer were already being produced by the Egyptian bakeries and Babylonian breweries (Hutkins, 2006). The second generation was much advanced with the incorporation of scientific knowledge and applications. The discovery of antibiotic in 1929 and the subsequent development of bio-chemical engineering have contributed to the phenomenal development in biotechnology, not only in fermentation but also in other

new methods like bio-conversion and bio-catalysis (Smith, 2004; Raju & Sreenivasulu, 2008). Eventually, this helped in the production of numerous useful bio-chemical products like antibiotics, enzymes, polysaccharides, vaccine, and hormones (Shastri, 2006). The third generation was characterised with major changes and modification in the outlook of biological sciences, which began in the 1970s (Anyango & Shiundu, 1999; Colwell, 2002). This generation is also acknowledged as the modern biotechnology and generally based on the advances in underlying disciplines such as genetics, biochemistry, microbiology, molecular biology and coupled with the advances of the Information and Communication Technology (ICT) sector (McKelvey et al., 2004).

The rapid evolution and advancement of biotechnology have created a broad spectrum of commercial opportunities covering all the major sectors affecting global economic growth (Gaisford et al., 2001). A glimpse back at the last century shows that the technology has begun to overcome the bottlenecks that favoured chemical substitutes against biological ones (Trivedi, 2002). As the knowledge base of biotechnology grows stronger, the number of platforms that depends on it also increases to generate new fields and industries (UNCTAD, 2004). Examples of such industries include modern agriculture, healthcare, and industrial biotechnology.

Agricultural biotechnology is related to the application of biotechnology in food and agricultural industry, generally to forestall the problem of hunger, food insecurity, and disease in many countries, especially in the developing nations (McCullum et al., 2003). According to Ozor (2008), agricultural biotechnology represents one of the novel

approaches with the capability of increasing the productivity of agriculture to meet the varying demands of human being. On the other hand, healthcare biotechnology is related to the applications of biotechnology in medicine and healthcare industry. The recent scientific progress in genetics has opened up a range of potential new application in healthcare industry which includes the treatment of vulnerable diseases like cancer through advanced diagnosis and therapies (Aguilar et al., 2003). Last but not least, industrial biotechnology is related to the application of biotechnology in environmental management and conservation. Examples of industrial biotechnology research and applications include the development of genetically modified bacteria that naturally break down chemical spills, waste dumps, and even clean up radioactive waste sites (Leung, 2004). Besides, many industrial processes such as fiber processing in the textiles and paper industries have been made more environmental friendly by the use of biological catalysts called enzymes (Hoondal et al., 2002; Dale, 2003). Enzymes are not only non-toxic and biodegradable, but also more economic in energy and resource consumption compared to traditional methods (Ahuja et al., 2004).

Malaysia, just like the rest of the developing countries, should not miss the opportunities brought forth by the biotechnology revolution. The biotechnology industry in Malaysia can be considered relatively new even though food and additives produced by the conventional techniques such as fermentation have been in existence for decades in the country (Arjunan & Kelvin, 2004). By virtue of its nature, Malaysia has much to offer for the development of biotechnology industry. In fact, Malaysia is considered one of the most bio-diversified countries in the world (Badawi, 2007). The tropical rainforests, the oldest and most biologically diverse ecosystem on earth indicates that Malaysia has the

rich gene pool comprising of an estimated 15500 known species of plants, 300 species of mammals, 150000 species of invertebrates with insects being the largest single group, 1200 species of butterflies, 12000 species of moths and over 8000 species of fishes (Latiff and Zakri, 2000). Like other natural resources available in the country, these assets require exploration and production activities in order to create values as well as wealth for the nation.

Besides, due to the increasing socio-economic importance of green chemistry or green technologies, biotechnology offers unmatched opportunities to take advantage of our rich biodiversity. There are unprecedented opportunities to utilise the countless new genes and metabolic pathways for the production of new bio-products, bio-chemicals and bio-materials, which carries a bright economic potential (Chatterji, 2007). According to the Global Bulk Drug Industry report in 2006, the industry that utilises genetic resources to develop new and improved drugs was estimated to be worth RM276.5 billion in 2005 and was expected to rise at a compounded annual growth rate (CAGR) of 10.6 percent by the end of 2009. Furthermore, it has been reported that 33 percent of drug products in the highly industrialised countries are derived directly from plants and most of these are tropical plants growing in equatorial countries such as Malaysia (Jusoh, 2006). Therefore, a crucial injection of high technology such as biotechnology would be able to transform these bio-resources to be more productive and at the same time efficiently conserved.

On top of that, there is a real need for Malaysia to engage biotechnology since it is originally an agricultural country. Prior to 1990, agriculture has been a major contributor

to the economic growth of Malaysia. Even after Malaysia shifted its focus into manufacturing and heavy industries in the mid-1980s, agriculture continue to contribute a significant amount of shares in the economy (Ahmad et al., 2001; Asid, 2010). Today, the agricultural sector contributes about 9.7 percent to the overall gross domestic product (GDP) of Malaysia (AMMB Holdings Berhad, 2009). However, the agricultural sector in Malaysia is left with few major challenges. The major challenge facing the Malaysian agriculture and plantation industries is the need to increase food production, and value-added products and crops (Arjunan & Kelvin, 2004). According to the Consumers International Asia Pacific report on Malaysian Food Price Structure in 2000, local rice production was capable to cater approximately 60-65 percent of domestic requirements only and the shortfall is being supplemented by imported rice from the other countries like Thailand and Philippines. Besides, the emergence of new strains of pest and diseases, and introduction of new weeds also affected the economic returns of agricultural enterprises as well as the food security (Daud, 2002).

In consideration of these challenges and opportunities, Malaysia has certainly identified biotechnology as an appropriate vehicle that can deliver economic gains through research and development. With the strong support of natural resources, Malaysia is all set to venture into this high end technology that able to improve food security, create national wealth and at the same time promote a sustainable use of natural resources.

2.1.4 Development of Biotechnology Institutions in Malaysia

It is interesting to find that biotechnology has emerged as one of the major technologies having potential for economic growth and in fact, some of the developing countries are