CHAPTER 1

INTRODUCTION

1.0 The importance of science and technology

After the Second World War, science and technology (S and T) become the most sought after commodities in many countries. This sudden crave for science and technology becomes the heart for economic growth and strategic competitiveness of many nations.

Two major developments are responsible for the demand for science and technology in a country (Charles W.L. Hill, 2009, pp.11-16):

1. The process of globalization where nations started to cooperate and coordinate international business activities and created a global economy. The world has become a market for all nations and productions of goods and services become integrated and interdependent. There are opportunities for economies of scale and price reductions and increased competition as well as the dynamic efforts on efficiency, investment and innovation.
2. The advances in information communication technology provide the strategic weapon to organisations to gain competitive advantage.

Organisations are challenged to change and adopt new technological approaches to remain creative and innovative to provide products and services to meet the needs of the markets. Industries are challenged too to accept new scientific and technological skills, knowledge and to capitalize on new efficient technological processes. The knowledge of science and technology becomes the imperative aspects of human resource development for the industries in the country in order to gain competitive advantage. This gives rise to the idea of "a symbiotic relationship between economic development and human resource development" (Goh Keng Swee, 1986, p. 81).

Abdus Salam (1986) in his paper "Of Science and Human Development" emphasized that "without highly motivated and highly trained manpower (scientists) in

a country, no lasting development could take place." He also pointed out that "technology, unsupported by science will not flourish" and that "science transfer is effected by communities of scientists" of "critical size" to create the scientific infrastructure.

Table 1.1: Human Resource Capital Indicators

Country	No. of professionals 2011 *	Population 2011**	Human resource capital /1,000 people
Denmark	57,170	5,515,575	10.4
Finland	54,526	5,255,068	10.3
Sweden	78,480	9,074,055	8.6
Norway	38,882	4,676,305	7.9
Singapore	37,013 (2010)	4,701,069	7.9
Japan	877,928	126,804,433	6.9
South Korea	335,228	48,636,068	6.9
Germany	562,600	82,282,988	6.8
Netherland	112,548	16,783,092	6.7
Canada	221,360	33,759,742	6.6
Australia	137,489 (2008)	21,515,754	6.4
France	392,875 (2010)	65,931,000	6.1
New Zealand	23,800	4,252,277	6.0
Russia	839,183	139,390,205	6.0
United Kingdom	358,583	62,348,447	5.8
China	2,882,903	1,365,500,000	2.1
Malaysia	57,405	28,274,729	2.0
Thailand	80,344 (2009)	67,089,500	1.2
India	391,149 (2005)	1,173,108,018	0.3
Indonesia	51,544	242,968,342	0.2

Sources: * Unesco: A global perspective on Science, Technology & Innovation (STI)
** Wikipedia: List of countries by population 2011.

Japan, the European Union and USA harness their science and technological capabilities almost immediately after the war, that together they become the triad nations to control 70% of the world trade. They are the world's largest economies and the important potential markets and locations for investments and engines of the world economy. They possess the competitive advantage in terms of their productivity and technology. They find their markets in the developing countries and as locations for their investments. They create complex technology in large scale enterprises and make demands on their people to develop the intellectual skills and the schools to build a

scientific and technological society (Harrison et al, 2000, pp. 173-174). These developed nations build their own pools of professionals, technocrats and innovators to serve their needs. Their human resource capital indicators range from 6 to 10 per 1,000 people. Therefore for a country to become a developed nation it should achieve the human resource capital indicator of 6 (Table 1.1). As for Malaysia, the government has set a target that by 2020 it should have 100 scientists and technologists per 10,000 of the labour force (Malaysia, Ministry of Science, Technology and Innovation, 2008).

The human resource capital indicators of the developed nations justify the fact that science and technology play and will continue to play an imperative role in the development and progress of these nations and enable them to remain highly industrialized and sustain their competitive advantages in the global market. The emphasis is supported by the fact that "for long term effectiveness, technology transfer must always be accompanied by science transfer" and that "the science of today is the technology of tomorrow" (Abdus Salam, 1986).

1.1 Background of the Study

In Malaysia primary and secondary education is free and compulsory. This is in line with the principle of the United Nations that everyone has the right to a basic education.

After independence in 1957, the education system of Malaysia has gone through many changes to be in line with the needs of the nation. The processes of globalization and the advancement of information and communication technology (ICT) have created new challenges to the education system. It is strategically crafted to ensure the long term competitiveness of the nation as it can no longer exist for the sake of just providing education for its citizens but to create knowledge-based workers. It has depended on labour intensive economy but has to move towards the development of knowledge

workforce for the industries and for the country to attain a competitive advantage over its neighbouring countries. It needs the education system to make this possible.

As early as 1967 the Higher Education Planning Committee recommended that the education system should place emphasis on the encouragement of more students to take up science than the arts in the proportion of 60 sciences to 40 arts at the secondary school and tertiary levels (in short known as the 60:40 policy). The need for creativity and innovation has made it imperative to have more scientists and technologists. Furthermore, Malaysia realizes that achieving the 60:40 policy is necessary for the country to become a developed nation by 2020 in accordance with the Vision 2020 policy**.**

The Vision 2020 Policy was announced by Tun Dr. Mahathir Mohamad (the then Prime Minister of Malaysia) on February 28, 1991and since then it has become a major guideline for any policy formulation in the country.

Paragraph 1.37, p. 1-9 of the Education Development Plan, 2001 – 2010, & Azman Mohd. Yusof, (1998), explained that the basic aim of the Vision covered:

Overall achievement in term of national unity, social integration, economic standard, social justice, political stability and improving the quality of life, both in the social and spiritual aspects as well as in instilling pride and confidence of the nation. It also emphasizes the essence of creating a progressive society with highly scientific and technological achievements which will require quality human resources with a base of quality education system.

According to Eng-Tek Ong (2006) the Vision called for "sustained, productivity-driven growth that will be achievable only with a scientifically and technologically literate, critical thinking work force." He pointed out that the success of the Vision policy depended on the achievement of the 60:40 policy.

1.2 The Education Policy: the 60:40 Policy

Since the introduction of the said policy, all the Malaysian Plans emphasized the development of the human resources in science and technology as imperative for the

industrialization process of the country. Schools and other institutions of learning are the centres for this human resource development. According to Sufean Hussin and Norliza Zakuan**,** 2009, p.6, in their book *Dasar Modal Insan 60:40 dalam Sains dan Teknologi*, four matters needed to be resolved to encourage students to participate in the fields of science and technology:

(1) The higher education institutions must have the capacity to take in qualified students wanting to do science and technology.

(2) Resources are available to improve the quality of teaching and learning in the fields of science and technology.

(3) Students studying science and technology at the secondary schools should be able to fill up the places in the higher education institutions.

(4) The students need to have the interest and inclination to take up the science and technological courses.

The 60:40 policy was initially expected to be achieved in 2000 (Eng-Tek Ong, 2006) but since the students were not very interested to enroll in science-based subjects that it was extended to 2020. In 2011 only 20% of the students in the secondary schools were in the science stream from the SPM results. It has taken 44 years to reach this far, and 7 more years are left to achieve the remaining 40% to reach the desired target of 60% in 2020.

The policy has been accepted in 1991 to be the cornerstone for the country to become a developed nation in 2020 (Eng-Tek Ong, 2006). It has created the impetus to make education access to all citizens in the country (Education Development Plan 2001–2010, Section 1.46, p.1-10).

1.3 Definition of Policy and Implementation

(a) Definition of Policy

According to the Oxford Dictionary policy means "plan of action" or "statement of aims of ideals". In public policy it has to do with promises made by organisations. In the case of the education policy, it is made "on behalf of the state ……by its various instrumentalities to steer the conduct of individuals, such as teachers or students and organisations, such as schools or universities." (Sandra et al, 1997, p.1-2). Public policies although are made by the government are implemented by state bureaucrats.

Sandra et al, (1997, pp. 23-24) has examined a number of definitions of policy and the one most appropriate to the purpose of the study is from Harman (1984, p.13). Harman said that "a policy is a course of actions to be taken to resolve a problem, a conflict or to accomplish a set of goals." Looking from here, the 60:40 policy is a goal to be achieved. Harman's definition of policy gives the idea that the policy can be implemented in a straight-forward manner and that there is no problem to be encountered.

Fundamentally, the education policies are there to ensure that education is for all citizens. They stipulate conditions for the operation of the schools such as in the curriculum, pedagogy, assessment, teacher employment, school buildings and student attendance and evaluation of students' performance. They are subjected to changes to meet the expectations of changing social, economic, political and cultural demands. Therefore changes in education policy are actually made from the existing policies rather than making new ones. Consequently, the implementation of the education policies cannot be done in a straight forward matter and the realized outcomes of the implementation can be very different from the planned outcomes.

According to Dye (2002, p.9) the development of public policy involved two aspects as an art and a craft. As an art because it required creative approaches like reflection and thinking out of the box to identify societal problems, to come up with public policies to solve those problems and then to find out the outcome. As a craft because

the tasks required some knowledge of academic disciplines such as economics, law, sociology, political science, public administration and statistics. Therefore it is not easy to analyze or evaluate a public policy, besides there are no clear guidelines for such possibility. As a consequence it opens up the flood-gates for the development of different ways or models as attempts to understand public policy. Dye (2002, pp.11-30) identified eight models and that each model attempts to identify some significant aspects of public policy as well as to explain causes and consequences:

1. The incremental model involves adjustments and modifications to the existing policy to meet the requirement. It is not practical to develop a new policy as it takes considerable time and expenses to do so.
2. The institutional model shows that public policies are formulated by the various institutions such as parliament, courts, states, local authorities and agencies.

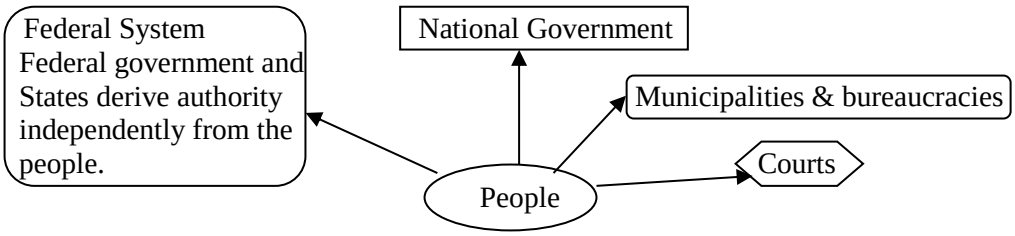

Figure 1.1: An Institutional Model
Source: Dye, 2002, p. 14.

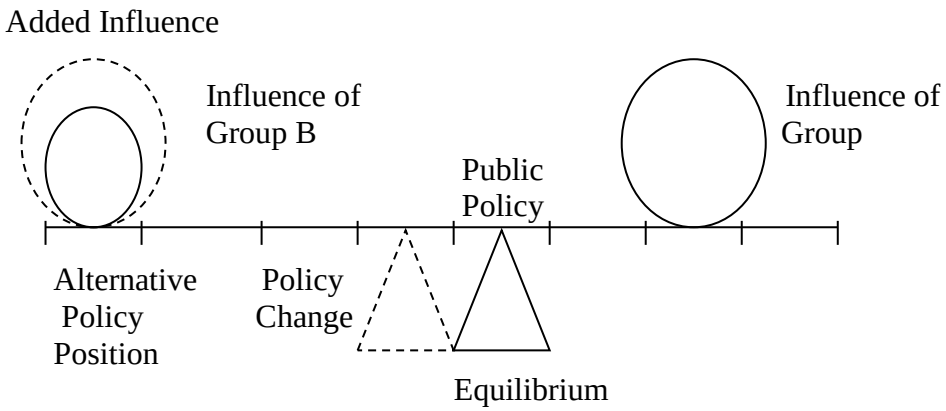

Figure 1.2: The Group Model
Source: Dye, 2002, p.22

3. The group Model (Figure 1.2) is based on the compromise of interaction of groups. This compromise is determined by the relative influence of any interest group and the groups that are influential can change or shift the policy.
4. The elite model is based on the likes and values of the few elites and the general public is expected to follow them. Any change in the policy is a reflection of the change in the values of the elites.

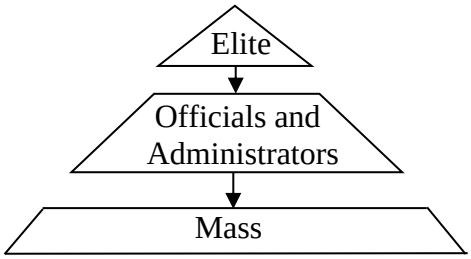

Figure 1.3: The Elite Model
Source: Dye, 2002, p. 24.

5. The rational model is based on the concept that for a policy to be accepted the returns from the investment should be good.
6. The public choice model is based on the consideration that a public policy is the outcome of collective decisions of some self-interest individuals.
7. The game model is based on the concept that the participants have to choose the available choices. Usually a compromise is reached among the participants with no one as a winner or loser.
8. The process model stipulates that the policy is made through a process involving different people at the different stages of development such as problem identification, information evaluation and selection of the appropriate solutions, formulation of the policy, legitimation, implementation and evaluation of the outcomes.

According to Dye (2002, p.3) a public policy is always derived from more than one model and this is the reason for the difficulty in analyzing any public policy.

(b) Implementation

The earlier idea considered policy implementation as separated from policy formulation in order to enable analysis to be done on the implementation aspect (Anderson, 1975). In 1983, Danial Mazmanian and Paul Sabatier changed this idea when they defined policy implementation to be made up of three sequential stages starting from policy formulation, policy implementation and policy outcomes. They emphasized the importance of goals and strategies to enable accountability, transparency and responsibility in implementing the policy. They also pointed out that the top-down approach to policy implementation requires collaboration, an interactive process, between the policy formulators and the policy implementers. It has led to the idea of feedbacks. It is to prevent any gap or deficit. At the same time, this interactive process calls for *flexibility* and *learning* to take place between the parties involved. Putting the various elements together a model is conceived and presented in Figure 1.4.

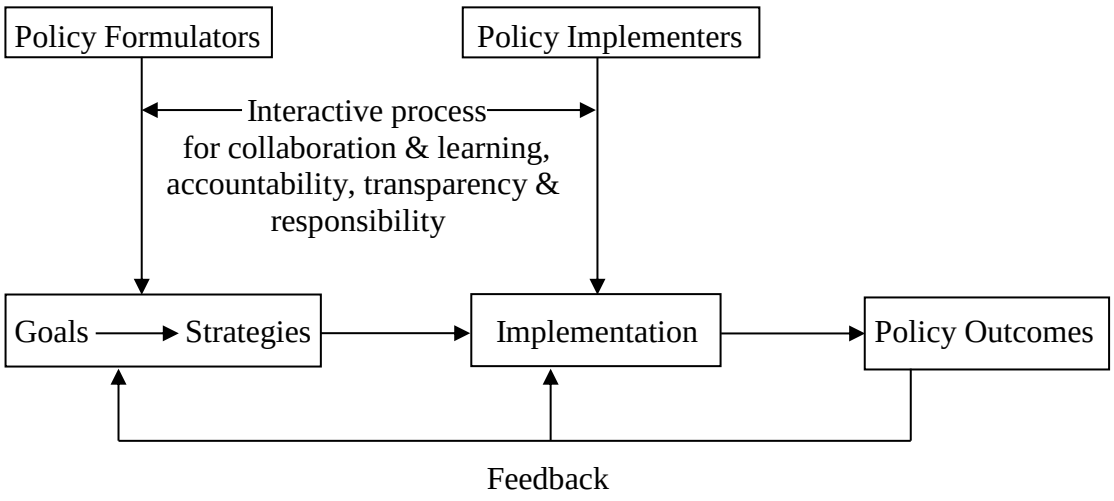

Figure 1.4: The flexible model
Source: Hill & Hupe, 2002, p. 45)

Generally the people who are involved in the formulation of the policy are not the implementers. This gives rise to conflict of interests because of different interpretations of the objectives of the policy. Implementers are influenced by their experience and knowledge and they make changes to the policy (Fulcher, G., 1989).

In 1975 Donald Van Meter and Carl Van Horn provided a model for the top-down policy implementation process with six variables: real and measurable policy standards and objectives, resources and incentives, quality of inter-organisational relationships between the policy formulators and policy implementers, characteristics of the implementing agencies, the prevailing economic, social and political environment and the disposition/response of the implementers (Figure 1.5). The disposition of the implementers relates to three aspects: their cognition (comprehension, understanding) of the policy, the direction of their response to the policy (acceptance, neutrality, rejection), and the intensity of their response to the policy. They realized that suitable control systems are required to assess the implementation against the set standards and objectives.

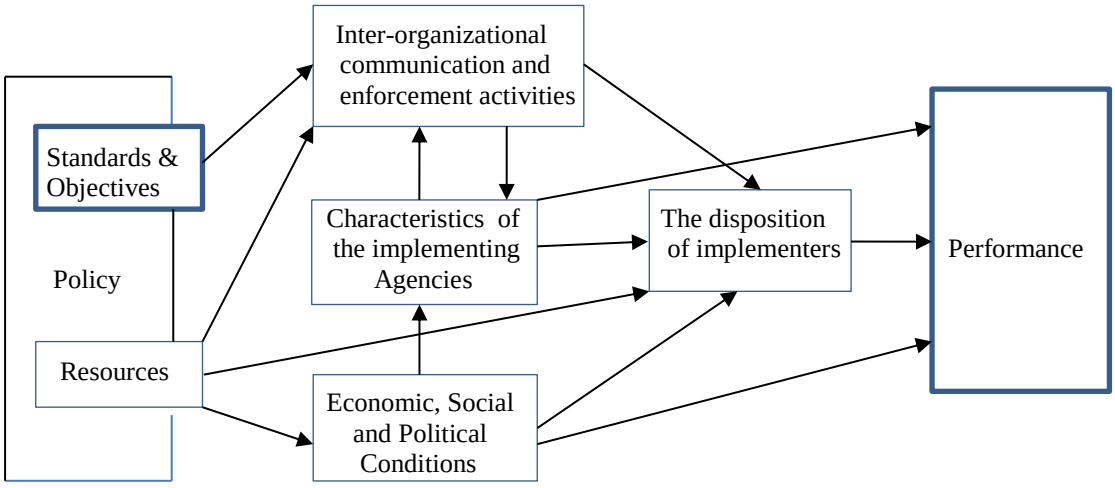

Figure 1.5: Van Meter & Van Horn's Model of the Policy-Implementation Process
Source: Van Meter and Van Horn, 1975:463 cited in Hill & Hupe, 2002, p. 47.

In the bureaucracy, it is the top people who make the policy and decide on the rules and regulations to be followed by those who are implementing the policy. As long as the implementers follow those rules and regulations the policy will be successfully implemented and there is no question of not achieving the objectives of the policy. By

its very nature, bureaucracy works well in a stable environment but not in a dynamic environment.

The problems encountered in the top-down implementation process have been enumerated by various researchers:

1. It is difficult to make the first line staff who used their experience and knowledge and discretion to implement the policy to be accountable (Lipsky, 1971 as cited in Hill and Hupe (2002, p. 51).
2. The implementers of the policy have different understanding about the policy and they make their own interpretations and changes to the policy and sometimes purposely create problems in the implementation (Susan Barrett and Colin Fudge, 1981, p. 251 cited by Hill & Hupe, 2002, p. 55).
3. Barrett and Fudge (1981, p. 258) warned that any compromise between the policy makers and the implementers can lead to policy failure (cited by Hill and Hupe, 2002, pp. 55-56).
4. O'Toole (1986) argued that the top-down policy implementation ignores the importance of conflict, negotiation and politics, the participants and the learning process (cited in Hill & Hupe, 2002, pp. 170-1).
5. According to Pressman and Wildavsky (1973, p. xxiv, cited in Hill and Hupe 2002, p. 7), the implementation of a policy is a complicated process where much can go wrong.

Subsequent to the problems identified in the top-down implementation process, Lipsky (1971) presented the idea of a *'bottom-up'* perspective of the implementation process to secure the accountability of the implementers. This gives rise to the idea of a "policy-action relationship" in the sense of an interaction process between the policy makers and the implementers. Barrett and Fudge, 1981 (cited in Hill & Hupe, 2002, p. 56) called it a "policy-action continuum" meaning a continuous process.

Table 1.2: Contributions to the study of Implementation of Policy.

Year	Top-Downers	Bottom-uppers	Synthesizers etc.
1973	Pressman and Wildavsky		
1975	Van Meter and Van Horn		
1977	Bardach		
1978	Gunn		Elmore
			Scharpf
1979	Sabatier and Mazmanian		
1980		Lipsky	
		Elmore	
1981		Hjern and Porter	
		Barrett and Fudge	
1982		Hjern and Hull	Ripley and Franklin
1984	Hogwood and Gunn		
1986			Sabatier
			O'Toole (multi-actor implementation)
1987			Lane
1990			Goggin et al.
			Palumbo and Calista
1991			Stoker
1995			Matland
1997			Kickert et al.
1998			Rothstein

Source: Michael Hill and Peter Hupe, 2002, p.82.

However later scholars known as synthesizers suggested the *mixed method* i.e. a combination of the top-down and the bottom-up perspectives in the implementation process. Richard Elmore (1985, cited by Hill and Hupe, 2002, p. 58)) suggested that the mixed method enables the policy makers and implementers to coordinate and collaborate to improve the making of the policy while Fritz Scharpf (in his 1978 essay) suggested that the interactions allow for sharing of resources between the parties. From here the idea of a policy network is evolved. Martin Smith (1993) identified that the collaborative network brings about the successful implementation of the policy in terms of the existence of consultation, confliction reduction, predictability and inter-organisational relationship. Jan-Erik Lane (1987) said that implementation involved two different considerations: the responsibility of the relationship between objectives and outcomes relates to the top-down approach and trust in the implementation of the policy relates to the bottom-up approach. This distinction enables the identification of the responsibility and accountability of the policy makers and the implementers. There

are other scholars who make contributions to the development of the mixed-methods but the interest in the top-down or bottom-up perspectives still remains strong.

Table 1.2 provides a brief summary of the alternative methodologies and the contributions by various scholars to the study of implementation of policy. According to Elmore (1978) and Sabatier (1986), the choice of the methodology depends on the subject and the circumstances of a research study to be conducted.

1.4 Creation of the Education Policy in Malaysia

The education policy in Malaysia has been initiated through the establishment of special committees to propose recommendations for changes and improvements, for example:

(1) The special committee led by Tun Abdul Razak in 1956 came up with the Razak's Report for the establishment of a national education system

(2) In 1960 a new special committee was set up to review the education policy and it came out with the Rahman Talib's Report which led to the enactment of the Education Act 1961.

(3) In 1979 a report from the Special Cabinet Committee chaired by Dr. Mahathir Mohamad (Mahathir's Report) who was the Minister of Education at that time, after a six-year study resulted in amending the Education Act 1961 and led to the establishment of the Education Act 1996 (Azman Mohd. Yusof, 1998, Education Development Plan 2001-2010, 1.1-1.3).

The Minister and Civil Servants in the Ministry of Education are responsible to overview such recommendations. Inputs are obtained from interest groups comprising of experts especially those from the National Union of the Teacher Profession (NUTP). Finally the proposed policy is put to the Cabinet for approval. Once the proposed policy has gone through the process and is passed by Parliament, it is enforced through the

Education Act. The education policy is implemented by the education institutions such as schools, colleges and other learning and teaching.

1.5 Vocational and Technical Education

The Education Act 1996 outlined technical and vocational education as the preparation for skills training, specialized training for specific occupations, retraining and other technical or vocational training. In order to increase the participation of students in the fields of science and technology in line with the 60:40 policy, technical subjects like Technical Drawing and Engineering Technology to prepare students with basic foundation in industrial skills are offered at regular secondary schools, fully residential schools and secondary religious schools (Education Development Plan, 2001-2010, paragraph 3.26).

Community colleges located in parliamentary constituencies are established to provide more opportunities for more students to participate in the vocational and technical education. Furthermore the Government encouraged the development of polytechnics, public and private higher education institutions and post-graduate levels in critical areas such as science and technology to meet the needs of a knowledgeable and skilled workforce.

Table 1.3: Number of MOE Secondary Schools

School type	No. of schools			No. of classes		
	1995	2000	2005	1995	2000	2005
Regular	1,319	1,461	1,812	44,468	54,833	62,826
Vocational/Technical	78	84	90	1,862	2,108	2,686
Fully Residential	35	38	54	859	867	1,241
Religious	41	53	55	837	1,211	1,377
Special Education	3	3	4	63	67	68
Sports	-	2	2	-	48	54
Special Model	-	4	11	-	-	381
Total	1,476	1,645	2,028	48,089	59,134	68,633

Source: Malaysian Educational Statistics 1995, 2000 & 2005, Educational Policy Planning & Research Division, MOE.

Table 1.3 shows that there are 2,028 secondary schools in the country making up of 7 different types in 2005. There are 90 secondary vocational/technical schools in the country, indicating that it is a very small proportion. By 2006, the total number of secondary schools has reached 2,285.

Table 1.4: Technical and Vocational Education

Technical/Vocational Education	1995	2000	2005
No. of technical/vocation schools	66	84	90 (4.4%)
No. of teachers	4,844	5,651	7,599 (5.56%)
No. of students	48, 362	60,425	72,838 (3.28%)
No. of secondary schools	1,464	1,645	2,028
No. of students in secondary schools	1,651,684	1,998,781	2,217,879
No. of teachers in secondary schools	88,408	113,249	136,598

Source: National Blue Print 2006-2010, pp. 22-23.

Table 1.4 provides further information about the technical and vocation education. In 2005 only 3.28% of students are studying in the technical and vocational schools and 5.56% of teachers in the secondary schools are teaching the technical and vocational subjects.

The Education Development Plan, 2001-2010, paragraph 3.56, p. 3-14 mentions of increasing demands for technical and vocational streams based on the applications received by the Ministry of Education. It is expected that there will be a shortage of 78,466 places for vocational education and 15,525 places for technical education in 2010.

Table 1.5: Number of Students in the Technical and Vocational Schools (2006-2015)

Year	2006	2007	2008	2009	Estimated 2010	Estimated 2012	Estimated 2015
No. of students in T & V schools	69,264	69,357	68,863	58,777	154,153	156,366	158,595
No. of students in upper secondary schools	766,216	291,769	822,393	841,937	849,167	860,484	848,809
% T & V students	9.04	8.76	8.37	6.98	18.15	18.17	18.69

Source: 10th Malaysia, Table 13, Appendix 2, p. 383.

The actual enrollments of students in the technical and vocational schools from 2006 to 2009 as well as the estimated enrollments of students in the said schools in 2010, 2012 and 2015 are shown in Table 1.5.

The number of students enrolled in the technical and vocational schools from 2006 to 2009 never reached 70,000 in any of the first four years. In 2008 the enrollment experienced a slight decline. In 2009 as compared with 2008, there appeared to be a 15% decline in the enrollment of the students in the technical and vocational schools. However, it is estimated that the enrollment of students in the technical and vocational schools will increase to more than 150,000 in 2010 and it will increase gradually from then on until 2015. In terms of percentage, it is estimated that after 2010 the percentage of students studying technical and vocational schools will jump from about 7% in 2009 to slightly more than 18% in the subsequent years until 2015. It is expected that more students will take up subjects relating to the sciences and technology in the secondary schools to make it possible to achieve the 60:40 policy.

1.6 Statement of the Problem

This issue is examined in the following parameters:

1. The 60:40 Policy
2. Enrollment of students in the science and technology studies.
3. Implementation of the science and technology policy
4. Various players involved in the policy
5. Macro versus micro level of policy formulation and implementation

1.6.1 The 60:40 Policy

It is difficult to envisage that the 60:40 policy is unrealistic to be achieved. Although it was proposed in 1967, it has since then grown in importance to become a national

policy in 1991 and as the cornerstone for the achievement of the vision policy to make Malaysia a developed nation by 2020 (Eng-Tek Ong, 2006).

Malaysia is not the only country that is moving in this direction, Japan and East Asian countries are acquiring raw materials, technology and skills from abroad and improving their factor endowments by concentrating on education and on investment in research and development. These countries want to have pools of scientists and engineers to bring about scientific innovations to attain strategic competitive positions. They are also placing the importance of science and technology education to bring about economic development (Arief Sediment, 2006).

1.6.2 Enrollment of students in the science and technology studies.

Table 1.6: Enrollment of Students in Form 4 & Form 5 in 1988

Streams	Form 4	Form 5	Total	(%)	
Arts	122,721	118,082	240,803	67.0	
Science	44,922	49,498	94,420	26.3	33%
Vocation	9,877	8,969	18,846	5.3	
Technical	2,672	2,514	5,186	1.4	
Total	180,192	179,063	359,255	100	

Source: Hussein Ahmad, 2009, p.165.

The enrollments of students into the science and technology stream in the secondary schools showed a fluctuating and declining trend over the years starting from 33% in 1988 (Table 1.6) to 29.5% in 2011. With the introduction of the KBSM (integrated secondary school curriculum) in 1989 the enrollment of students into the science and technology stream experienced a decline with only 20% enrolled for the science electives in 1993 (Lee et al, 1996).

Other examples:

(1) The number of science stream students in the secondary school level comprised 25.7% of the total number of students in 1998 which was below the targeted

60:40 sciences to arts ratio (EPU, Government of Malaysia, 2000, *Developing Malaysia into a Knowledge-Based Economy*, Chapter 5, p.124).

(2) In 2012 the Minister of Education announced that 20% of 472,541 students who sat for the SPM in 2011 were in the science stream (Afterschool.my, 7/11/12).

(3) Table 1.7 indicated a declining trend of students taking up the study of science in the upper secondary schools (i.e. Form 4 and Form 5) from 30.1% in 2010 to 29.5% in 2011 & 2012. On the other hand, about 49% of the students were in the Arts stream. However the vocation and technology stream hovered around 17% - 18%.

Table 1.7: Enrollment of Students in Upper Secondary Schools (2010-2012)

Year	2010 (%)	2011 (%)	2012 (%)
Arts	422,874 (49.6)	413,903 (48.7)	419,949 (49.1)
Science	256,860 (30.1)	253,051 (29.5)	251,846 (29.5)
Vocation/Technology & Technical	147,222(17.3)	153,666 (18.1)	251,846 (17.7)
Others	26,398	28,918	31,178
Total	853,354	849,668	854,553

+ Religious, skill training (NVTC), short/special skill course & special edn.

Source: Adapted from Table 3.4, Malaysia Educational Statistics, Quick Facts 2012, p. 17, Educational Planning & Research Division, MOE, Malaysia, July 2012.

(4) The information on the enrollment of the upper Form 6 students from the Table 3.4 of Malaysia Educational statistics, Quick Facts 2012 provided that the enrollments of the students studying in the science stream declined from 17.4% (2010) to 16.2% (2011) and then to 15.4% (2012) compared to the enrollments of students in the Arts stream 77.4% (2010), 78.5% (201) and 77.9% (2012).

The problem is the number of students studying science in the secondary schools is not increasing and it is still far below the desired level of 60%.

1.6.3 Implementation of Science and Technology Policy

The Ministry of Education (MOE) implemented the science policy in the early 1970s in order to encourage students to do science by establishing full resident secondary schools and technical secondary schools and making it compulsory for bright students to follow the science stream in the higher secondary school (i.e. Form 4 and Form 5 and the sixth forms). However, this approach did not succeed to encourage more students to take up the science and technology courses at the higher learning institutions as shown in Table 1.8. The trend had been that there were more students registered for the Arts stream than the Science stream at the public universities. In 1999, only 35.63% of the students were in the science stream while 64.37% in the Arts stream.

Table 1.8: Percentage Enrollment of Students in Science and Arts in Public Higher Institutions of Learning in Malaysia.

	Enrollment (%)						
	Science Stream				Arts Stream		
Year	Science	Applied Science	Medicine	Total	Arts & Humanity	Special Arts	Total
1990	5,905	2,612	2,680	11,197	11,530	11,382	22,912
	(47.33)	(20.93)	(21.48)	(32.82)	(50.32)	(49.68)	(67.18)
1995	4,832	5,125	3,392	13,349	16,764	18,036	34,800
	(32.16)	(34.11)	(22.58)	(27.72)	(48.17)	(51.83)	(72.23)
1999	8,756	19,705	6,027	34,488	24,260	38,044	62,304
	(24.68)	(55.54)	(16.99)	(35.63)	(38.94)	(61.06)	(64.37)

Source: Trend Indicator, MOE (2001)

MOE (2001) had pointed out that in each year only 10% to 15% of total student's enrollment registered to do science and technology at the universities. According to the 9th MP (2006-2010), if Malaysia were to become a developed nation, it needed to have 50 persons in the science field to every 10,000 population. This implies that the universities should improve the number of students doing the science and technology courses. However, the universities are dependent on the science and technology students coming from the upper secondary schools in the country where the supply situation is uncertain.

In February 2006, the Berita Harian reported that every year Malaysia produced 60,000 graduates. In June 2006, the Ministry of Human Resources reported 20,217 jobless graduates registered with the ministry (Table 1.9). Most of them were graduates in S/T who could not get jobs suitable to what they had studied even though there were other jobs available.

Table 1.9: Courses studied by Graduates

Course/Subjects	Unemployed	%
Computer Science	3,942	19.5
Business Administration/Management	3,736	18.5
Engineering	3,096	15.3
Accountancy	1,923	9.5
Literature & Social Sciences	1,283	6.3
Pure Science & Applied Sciences	1,303	6.4
Architecture & Building Management	540	2.7
Agriculture, Fisheries & Forestry	401	2.0
Others	3,993	19.8
Total	20,217	100%

The average unemployment rate as shown in Table 1.10, has been 3.3% for the past 13 years (2001 to 2013). The unemployment rate has ranged from 3.1% (2012 & 2013) to 3.7% (2009). It has shown a declining trend and appeared to stabilise in the last two years.

Table 1.10: Unemployment Rates and GDPs (2001 - 2012)

Year	Unemployment Rate (%)	GDP Growth (%)
2001	3.5	0.5
2002	3.5	5.4
2003	3.6	5.8
2004	3.5	6.8
2005	3.5	5.3
2006	3.3	5.6
2007	3.2	6.3
2008	3.3	4.8
2009	3.7	- 1.5
2010	3.4	7.4
2011	3.2	5.1
2012	3.1	5.6
2013	3.1	4.7
Average	3.3	4.7

Source: The World Bank

The average economic growth rate for the same period measured in term of GDP is 4.7% (Table 1.10). Therefore on the average, the GDP growth has been higher than the unemployment rate in the past 13 years. There has been positive growth in employment opportunities in the country on the annual basis for most of the past 13 years.

Except for the years 2001 and 2009, the economic growth had always exceeded the unemployment rate each year. Positive GDP growth in each year means there was growth in the nation's production of finished goods in the country. From 2010 to 2013 the unemployment rate had declined from 3.4 to 3.1 respectively. This trend indicated that more jobs are made available and more people are employed.

Table 1.11: Employment by Major Occupational Group, 2006-2015

	Thousand Persons							
Major Occupational Group	2006 ('000)	(%)	Estimated 2010 ('000)	(%)	Estimated 2015 ('000)	(%)	2010 - 2015 ('000)	(%)
1. Senior Officials and Managers	903.9	8.1	941.9	8.0	1097.7	8.3	155.8	16.5
2. Professionals	613.8	5.5	741.7	6.3	1031.6	7.8	289.9	39.0
3. Technicians & Associate Professionals	1417.2	12.7	1660.0	14.1	2248.4	17.0	588.4	35.4
Subtotal	2934.9		3343.6		4377.7		1034.1	30.9
4. Clerical Workers	1048.9	9.4	1142.0	9.7	1256.4	9.5	114.0	10.0
5. Service Workers & Shop & Market Sales Workers	1729.6	15.5	1942.6	16.5	2274.8	17.2	332.2	17.1
6. Skilled Agricultural & Fishery Workers	1450.7	13.0	1295.1	11.0	1230.0	9.3	- 65.1	-5.0
7. Craft & Related Trade Workers	1249.8	11.2	1259.7	10.7	1322.6	10.3	62.9	5.0
8. Plant & Machine Operators and Assemblers	1528.8	13.7	1495.2	12.7	1362.2	10.3	-133.0	-11.1
9. Elementary Occupants	1216.3	10.9	1295.1	10.9	1401.9	10.6	106.8	8.2
Subtotal	8224.1		8429.7		8847.9		418.2	5.0
10. Total Employment	11159.0	100	11773.3	100	13225.6	100	1452.3	2.3

Source: Economic Planning Unit & Department of Statistic Malaysia, Table 12, Appendix 1, pp. 380-381, 10th Malaysia Plan (2011-2015).

Table 1.11 showed that from 2006 to 2010 the rate of jobs created for the first three categories of the managerial and professional groups was 102,000 per year and from 2011-2015 it would be more than half a million annually. For the service sector (categories 4 to 9) from 2006 to 2010 the number of jobs created was 41,000 per year while from 2011 to 2015, the projected job creation was expected to be 83,000 per year. This indicated an increase of 102% of employment opportunities for the service sector.

A total of 1,452,300 jobs would be created from 2011 to 2015 and out of which 1,034,100 (71.2%) would be from the managerial, professional and technocrat levels, while 418,200 (28.8%) from the service sector.

Further analysis of the data in table 1.11 suggests that employment opportunities for the skilled agricultural and fishery workers, plant operators and assemblers and craft and related trade workers would decline. The employment opportunities for service workers and shop and market sales workers would increase. This indicates a structural change in the employment arrangement.

In the industrial sector the rate of labour absorption is expected to decline due to plant modernization and automation. As a result more skilled workers would be needed and for the existing workforce there would be upgrading of skills. There might not be increase in job opportunities for others. The industries preferred qualified persons because they did not want to spend time and money to train unqualified people to reach the expected level of knowledge and skills. This was an expensive affair. This situation of development had caused many unemployable graduates reaching as high as 80,000.

The findings showed that job opportunities for the S/T skilled workforce and the professionals would be on a declining trend in the near future. This would be due to the fact that the GDP had not shown an increasing trend.

However it was reported that by 2020, 500,000 science and technology graduates would be required for the Malaysian development and that the MOE had allocated RM300 million to improve and upgrade secondary schools and primary schools laboratories, reintroduce practical science examination and increase pure science subjects' teaching hours to 5 times a week. The 60:40 policy would be enforced in the secondary schools to get more science students to universities (Universities News, 14/7/2013). The News Straits Times reported that 300,000 job opportunities in various fields would be created in Iskandar Malaysia (22/9/12). In spite of these prospects of

job opportunities in the near future, a problem of unemployable graduates arose. However it caused a set-back to encourage more students to choose the S/T stream in the secondary schools.

Norshimar Zainal Shah (2008) explained that graduates failed to find their first jobs because they lacked presentation and communication skills and proficiency in English. She also explained other causes for not getting employed such as work-ready and expectation the company to train them, not enough practical exposure and mismatches between courses studied and the job market requirements. This is just an issue because these graduates are the educated human resources and their deficiencies could be made good if opportunities could be created for them to improve.

An expectation of the Vision 2020 is to attain an average GDP growth rate of 7% per year. This implies that there must be expansion and modernisation in the industrial sector and for the agricultural sector modern methods of farming need to be introduced, to create the opportunities of employment for the professionals, scientists and technocrats. Both sectors of the economy play a significant role for the demand of S/T graduates and for the success of the 60:40 policy. Such a development will lead to the increase in the economic growth of the country in terms of productivity growth rather than dependent on depleting natural resources. It is to be noted that such a development is necessary to create the impetus for the service industry to expand. In the United States, the service industries contribute to 76% of the GDP, while the remaining 24% from the manufacturing sector (Dess & Lumpkin, 2003, p. 116). It is a question of demand and supply and generally supply situation changes quickly following the demand. Therefore creating the right demands for the human resources will lead to the creation of the right people by the institutions of learning.

1.6.4 Various players involved in the policy

According to Hill & Hupe (2002, p.1) implementation can come in different shapes and forms "involving a wide range of actors" who participated in the implementation process. They emphasized that accountability, transparency and responsibility should prevail in implementing the policy and that goals and strategies existed for governance to take place.

However, the players who are involved in the implementation of the 60:40 policy are more concerned on other issues because of conflict of interest. They are not objectively looking at the education policy as fundamentally important for the development of a k-economy. This makes the objective to attain the k-economy more complicated and complex. This is further compounded by the creation of short-term changes which cause more confusion to the policy e.g. the teaching of mathematics and science in English reverted to be done in Bahasa Malaysia in the national schools and Tamil and Chinese in the vernacular schools (national type schools) in 2011 by the MOE.

This change has created a state of uncertainty among the parents, the students who are affected when the change took place and the teachers who are involved in the teaching of the subjects. In the midst of the dilemma the 60:40 policy has not been given serious consideration or given the importance as the guiding principle for the achievement of the vision policy. There are apparently no newer ideas being suggested to achieve the 60:40 policy.

1.6.5 Macro versus micro level of policy formulation and implementation

The traditional or rational model of policy process is distinguished into two distinct stages:

1. Policy development/formulation is done by the people at the macro-level such as the politicians and special committees or groups.

2. Policy implementation is done by the teachers who are at the micro-level.

The rational model assumes that in a given set of perfect conditions policies can produce the desired results. In reality it is not as simple as the model envisaged, because it ignored the human diversity and organizational complexity as well as the importance of the social environment and its cultural settings. The people at the micro-level can accept, resist or change the policy to suit local circumstances. The people who formulated the policy and implementers are located at different places and they have conflicting interests and difficulties in communication. There is a lack of strategic partnership between the two levels of people (Sandra et al, 1997, p. 167). The absence of equity in the education system is another issue that developed resistance and marginalization in schools thereby hindering the proper implementation of the policy. Within the schools, teachers are not learning to accept changes in the education system as a continuing process. This is a problem in the institutionalization of change in schools (Sandra et al, 1997, pp.171-174).

1.7 The Model for the Research

The Van Meter and Van Horn's model is adapted for the development of the research model (Figure 1.6) and the reasons for the adaptation are:

1. It is based on the top-down approach.
2. It has the standards and objectives for the implementation process.
3. It takes into consideration of the resources and incentives of the schools in relation to the implementation of the policy.
4. It examines the quality of the relationship between the policy planners and the policy implementers.
5. It reviews the prevailing economic, social and political conditions in the external environment that influence the implementation of the policy.

6. It analyses the quality of the characteristics of the schools such as the teaching-learning facilities, teachers, students and curriculum and the environment for the implementation of the policy.

7. It examines the intrinsic quality (the disposition) of the implementers of the policy.

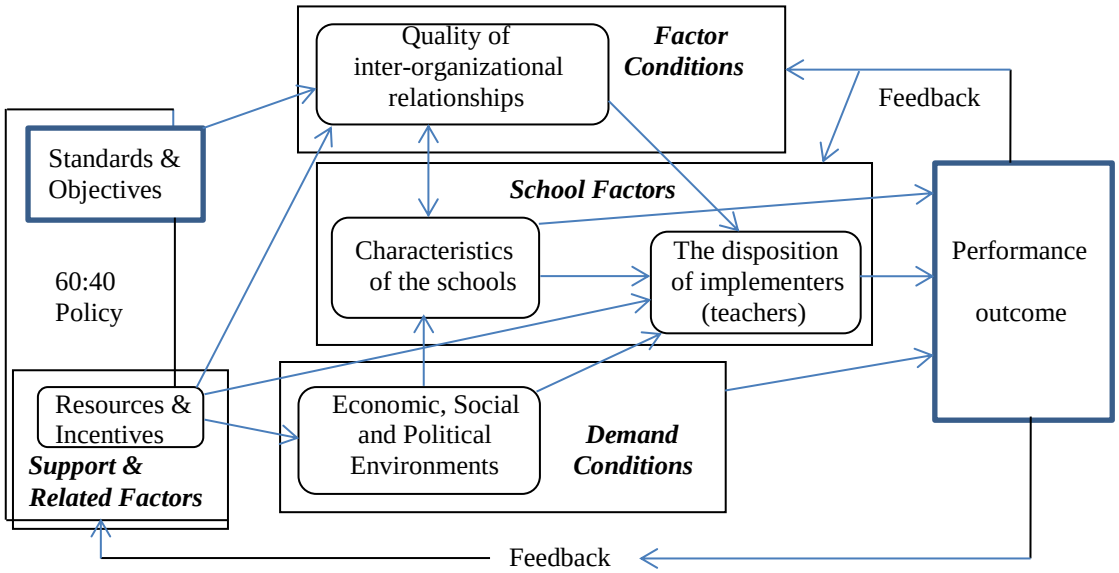

Figure 1.6: Research Model for Implementation of the 60:40 Policy

1.8 The Purpose of the Research Study

The purpose of the research study is to establish an understanding of the situation in which the 60:40 policy is being implemented in the three regular day secondary schools. The study is to examine the following areas as shown in the research model (Figure 1.6):

1. The *school factors* (teachers, students, infrastructures, curriculum content and disposition of the teachers): whether they influence the students to study science and technology subjects.
2. The *factor conditions* (competitive rivalry, strategy, structure and culture) in the schools: whether they encourage or hinder students to go into the science and technology stream.

3. The *supporting and related factors* (resources, incentives, parental support) available in the day secondary schools: whether they encourage or do not encourage the teaching and learning of science and technology.
4. The *demand conditions* in the industries, and opportunities for employment and advancement, and research and development: whether they influence students to study science and technology.

1.9 The Research Questions

Research questions are conceived and developed to ascertain the specific areas for the research study and to attain the information concerning the implementation of the policy in the secondary schools. The research questions cover the following aspects of study:

1. How have the school factors influenced students to study science and technology subjects?
2. What are the prevailing factor conditions that help to enhance students' interest towards the study of science and technology subjects in the secondary schools?
3. What are the support and related factors prevailing in the secondary schools that enhance the students to study science and technology?
4. What are the prevailing demand conditions in the industries and government sector that provide the impetus for students to pursue the science and technology streams in the secondary schools?

1.10 Significance of the Research Study

The research study reinforces the imperative of collaboration and coordination between the policy makers and the policy implementers to achieve the standards and objectives of the policy and to develop the strategies and the control systems to attain the goals.

As for the schools, the study provides an insight to the head teachers and the science and technology teachers of the requirements for the successful implementation of the policy within their schools as well as to enable them to gain a better understanding of the external factors to enhance the achievement of the policy.

On the other hand, the research study enables the head teachers to envisage programmes suitable for the development and training of teachers in the implementation of the policy.

Furthermore, the research study can act as a catalyst for further studies to be done in specific areas relating to the implementation of the policy.

A chart of the implementation process (Figure 1.7) is presented to indicate how the various aspects are tied to the implementation of the 60:40 policy in the secondary schools and the areas where further studies can be done and these are marked by the symbol *. The factor conditions and demand conditions are not within the control of the schools but they provide other aspects for research to be done.

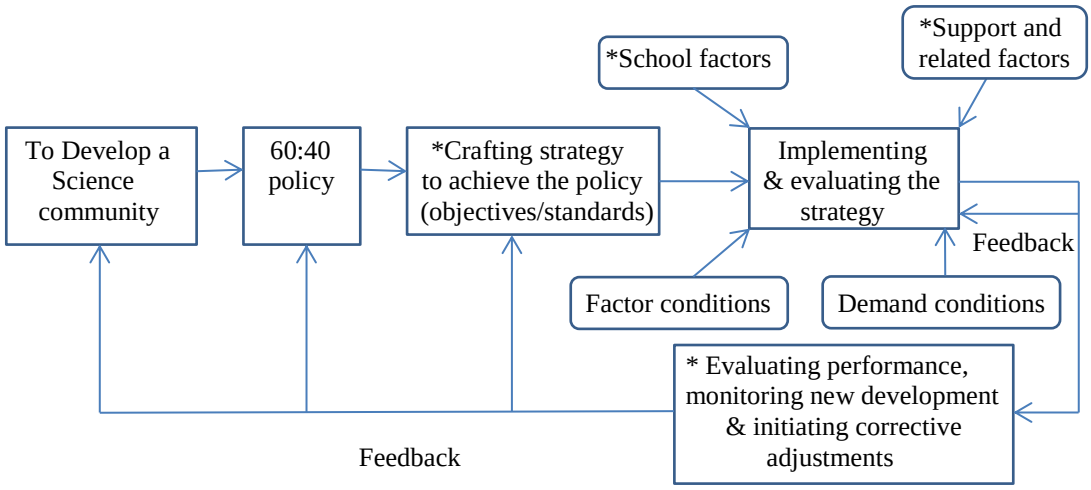

Figure 1.7: Policy Implementation Process Chart

1.11 Definition of Terms

The following definitions are applied to the terms used in this study:

* *Knowledge-based economy* refers to the human capital that has the capacity to create, innovate, generate and exploit new ideas as well as apply technology and exercise

superior entrepreneurial skills. It is to provide the platform to sustain a rapid rate of economic growth and enhance international competitiveness so as to achieve the objectives of Vision 2020 (EPU, Government of Malaysia, 2000). It is to strengthen Malaysia's capability to innovate and market new products thereby changing an input-driven strategy to a productivity-driven growth strategy. It is to sustain the economic growth of Malaysia in the medium and long term.

* *Driving forces* refers to the changes of the factors in the external environment and that these changes create pressures on the firms to bring about the necessary changes in order to remain competitive and eventually affect the competitiveness of a country especially Malaysia which is a developing nation. These forces of change are brought about by the process of globalization. The world trade and investments are growing rapidly making all economies become more linked and interdependent. More opportunities are created for developing countries to enter developed markets thereby creating threats for domestic and multinational companies. The consequential effect is that customers, products and standards are becoming more global. There is also more convergent development in terms of technology and production processes. However underneath the rapidly changing business and economic environment, there is still prevailed the wide array of differences in "the world culture and social institutions" (Cullen, J.B. and Parboteeach, K. P. (20055, pp. 6-28). These driving forces create the challenge for Malaysia to be more scientifically and technologically prepared in order to remain competitive and to achieve economic sustainability.

* *Strategic intent or vision* refers to the desired future state. It is about the leveraging or improving the country's resources, capabilities and competencies to accomplish its goals in a competitive environment (Johnson, Scholes and Whittington, 2005, p. 13). It is about the application of a set of strategy that is constantly applied over a period of

time to achieve the set of objectives for example 60:40 policy. This policy is expected to attain its strategic intent by 2020 to enable the country to become a developed nation.

* *Policy* has been referred to as "the implicit or explicit specification of courses of purposive action to deal with a recognized problem or to accomplish a desired set of goals" (Harman, 1984 cited in Sandra et al, 1997). The research model to study the process of implementation of the 60:40 policy indicates the various elements that can influence the implementation of the policy in order to achieve the goals.

* *Strategic competitiveness* means that Malaysia is able to achieve the stage of sustained competitive advantage. The 60:40 policy is to enable the country to achieve the capability and competencies to innovate products and services to meet the needs of the markets and enjoy an economic return better than its neighbouring countries.

* *Competitive advantage* refers to the situation where the economy has performed better than the neighbouring countries and gaining above average growth in its GDP in comparison to the GDPs of the neighbouring nations. This is the expectation when the country has attained its developed status.

* A *case study* is actually an in-depth exploration of a school and/or a group of teachers based on extensive data collection (Creswell, 2007). The method is suitable for exploring about a situation where no information is available on an issue or where very few studies had been conducted. The study has adopted this method to gather information on the implementation of the 60:40 policy at the three selected secondary schools. The reason attributed for this choice of the method was based on the idea that the policy implementation related to the experience of the group of teachers in each selected school. The case study being qualitative in nature provided the means to get an understanding of the experience of the teachers and the meaning of their behavior. This cannot be done in the quantitative approach.

* *Standard* refers to the real and measurable objective that is intended to be achieved within a certain time frame. It forms the basis for comparison with the actual performance and for remedial actions where necessary. Van Meter and Van Horn had emphasized the importance of having concrete and specific standards for assessing performance so that policy adjustments could be made over times (1975, p.464 cited in Hill and Hupe, 2002, p. 125). According to Hill and Hupe, (2002, p. 126) this development created difficulties for quantitative studies. The standards actually enforced the creation of the controlling systems to ensure the successful implementation of the policy and as the means for accountability, responsibility and openness of the policy makers and the implementers.

* *Purposeful* sample refers to "the intentional selection of individuals and sites to learn or understand the central phenomenon" (Creswell, 2008, p. 214). This approach is used in qualitative research sampling and it refers to identifying samples or sites (locations) for the purpose of the research study. The idea of choosing the participants and the sites is to ensure they are "information rich" and that favourable climate prevailed for the collection of the data. This approach is used in the research study. For example three schools, 30 teachers and 100 Form 4 students are selected for the study.

* *Interview* is a subjective understanding of the meaning of the way people carry out their experience and it requires frequent site visits and meeting with the participants to get the real meaning of the central phenomenon that is being studied. According to Gay, Mills & Airasian (2006, p.418):

Interview is a purpose interaction in which a person is trying to obtain information from another. It can get important information that cannot be obtained by observation. Information of past events or the way things used to be before can be obtained from peoples' own words. Interview can explore or probe participants' responses to gather more in-depth data about experiences and feelings. They can examine attitudes, interests, feelings, concerns and values more easily than they can through observation.

The study makes use of interviews to reinforce or to clarify responses stated in the questionnaires from the teacher respondents. Interviews in actual fact show to the

teachers of an interest to understand their experiences and the meaning of they made of that experience (Irving Seidman, 1998, p. 4).

* *Observation* concerns the process of gathering open-ended, firsthand information by observing people and places at a research site (Creswell, 2008. p.221). It is observing to get an understanding of the natural environment in which the participants exist, without any interference or intrusion. Observation is most appropriate to gather information about the layout of the place such as the school or laboratory or work layout or the existing facilities. However it is not suitable to observe and to gather information about the intrinsic values of a person such as attitudes, values, feelings, concerns or interests. In qualitative research observation can be of limited use. For the case study which involved an in-depth understanding of the meaning of a person's experience and his actions, observation is of limited use because it is not possible to observe a person's values, interests, beliefs or attitudes. For example at the interviews with the teachers, observation of the person is useful in the sense that it can give the researcher an inkling of whether the other person is telling the correct thing or something else through the person's facial expression and bodily language. In dealing with the case study, non-participative observation is used. It requires the observer to be present and not to become a member of the participating group. It is time-consuming. The observer cannot become bias because it will affect the validity of the observation study.

1.12 Conclusion

The Vision 2020 policy is intended to make Malaysia a developed nation by 2020 in order to have the competitive edge in the face of globalization, liberalization and information and communication technology advances in the world today. For this to happen, Malaysia required the scientific and technological capability to participate fully in the global economy. The 60:40 policy is the driving force to bring about the

necessary transformation of the human resources in the secondary schools, colleges and universities to produce scientifically and technologically literate creative thinking workers.

Although the MOE has taken steps to enhance the vocational and technical education as a strategic imperative to enable the country to sustain its strategic competitiveness in this region of the world, there is still much to be done to provide more opportunities for students interested to do the vocational and technical courses at the schools.

The implementation of the 60:40 policy is not a simple process. It is a top-down approach where the policy is formulated by the politicians and public administrators but its implementation is done by the schools and other institutions of learning. If the implementers do not get the full understanding of the policy and the intended change required by the policy formulators then it becomes doubtful that the objectives of the policy will be achieved. Therefore a greater structural flexibility is needed for close collaboration and coordination between the formulators and implementers.

An important critical factor that has impeded the success of the 60:40 policy over the past 40 years (since 1970) has been the lack of interest of students to take up the science and technical subjects at the secondary schools. This situation continues in spite of the steps that are taken to correct the situation. The problem does not confine just to the secondary schools, the universities too have their limitations and restrictions that discourage students to follow the science and technology courses.

A model for the implementation of the policy is proposed to assist in the research study and research questions are defined to direct the study to the specific areas relating to the implementation of the 60:40 policy in the secondary schools.