Chapter Four

Research and Development

Introduction

The management of Research and Development (R&D) is one of the focuses of science policy. R&D plays a significant role in the development of S&T. It refers to research in the fields of S&T, the development of scientific and technological tools and knowledge. Its impact on S&T development is massive to the extent that expenditures in R&D is called an investment in itself.[174] This is reflected in the perceived status of R&D in Malaysia. Under the Seventh Malaysia Plan (1996-2000), the sum of RM1 billion has been allocated for funding research projects under the Intensification of Research in Priority Areas (IRPA) program.[175] Hundreds of millions is allocated for other projects outside IRPA including the initial allocation of RM 200 million for MSC R&D Grant Scheme (MGS) for each implementation period.[176] However, this sum is far below minimum 2% percentage of GDP normally allocated for R&D in an industrialising country.

This chapter discusses the definitions, infrastructure, funding allocation, and classification of R&D in Malaysia. The discussion also includes the R&D linkages to industry.

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[174] Canada, *A Science Policy for Canada: Report of the Senate Special Committee on Science Policy ,Targets and Strategies for the Seventies,* vol. 2., (Canada: 1968), p.381.
[175] *The Seventh Malaysia Plan 1996-2000*, p.426.

Definition

Research in science and technology refers to the process of advancing knowledge through systematic investigation. It is defined as 'scientific investigation undertaken to obtain information or understanding that goes beyond established knowledge or accepted practice.'[177] R&D includes activities such as acquisition of scientific facts and techniques, their application, the design of new materials, and new processes.[178]

However, for management reasons. every country has defined R&D in the context of its socio-economic needs. The OECD countries define R&D as a "creative work undertaken on a systematic basis in order to increase the stock of knowledge, nd the use of this stock of knowledge to devise new applications".[179] Malaysia has adopted the definition by the OECD. However, the sole reason for adopting this definition is that it facilitates R&D survey and helps to develop relevant R&D indicators comparable to other countries.[180]

R&D is generally classified into two types: *fundamental research* and *applied research and development*.[181]

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[176] http://www.mdc.com.my/flagship/rd/index.html, "MSC Flagship Applications: R&D Clusters" 1997, p.3.

[177] Ronald N. *Kostoff*, "Research Evaluation: Assessing Research Impact: US Government Retrospective and Quantitative Approaches", *Science and Public Policy*, vol. 12., No.1., England: Beech Tree Publishing, 1994), p.13.

[178] *A Science policy for Canada*, Annex A,

[179] MASTIC, *1992 National Survey of Research & Development*, (MASTIC: December 1994), p.3.

[180] This definition is however the only and latest definition available as of the time of writing this thesis so it is used here as a working definition in the *1994 National R&D Survey* is the latest which has adopted the same definition.

[181] Oleg I. Lavichev & Alexey B. Petrovsky, "Methodological Problems of Scientific and Technological Research Programming, Practical Aspects of Scientific and Technological Research Programming: Case Studies from the USSR", *Science and Public Policy*, No. 27., (Paris: UNESCO: 1991), p.11.

Fundamental research, also called pure and basic research, refers to the kind of research undertaken for the sole purpose of finding answers for questions posed by the very nature of science. This type of research aims to extend human knowledge and the understanding of the laws of nature without penetrating the field of their utilisation.[182]

Applied research, on the other hand, aims at finding immediate solutions for specific practical problems associated with the needs of material production. It is an "original investigation undertaken in order to gain new scientific or technical knowledge directed primarily towards a specific practical aim or objective."[183]

The notion of scientific 'research' is usually closely linked with the notion of experimental 'development'. Development in this context refers to "an innovative and systematic application of scientific knowledge in the manufacture of materials, mechanisms; systems or methods."[184] Development also embraces systematic application of scientific and technical knowledge to the production of useful materials, devices, systems, methods, and the design and development of prototypes and processes.[185]

(R&D) then includes a whole range of investigations and procedures, from the most abstract theoretical analysis to the most down-to-earth trial and error. These may be found in all fields of S&T, whether motivated by a desire for fundamental understanding, as in cosmology, or by a desire to make a commercial profit, as in the manufacturing of weapon systems.[186] R&D activities in Malaysia

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182 Ibid.
183 *A Science Policy for Canada*, vol.2., p.429.
184 Ibid.
185 Charles Boyle,p.16.
186 John Ziman, *Technology for Profit*, p.122.

is driven more by the desire to make a commercial profit than the desire for understanding the fundamental of things.

R&D in Malaysia

Malaysia can scarcely be regarded as a research-intensive country, because of the low level of R&D expenditure. According to the findings of a R&D survey, a total of RM611,2 million was spent on research and development in 1994. This equivalent 0.4 per cent of GNP, which is significantly less than Singapore (over 1% and Taiwan (1.7%).[187] This is considered low since at least one per cent of GNP is usually accepted level at which R&D can begin to effectively support socio-economic development in a country.[188] However, there are various reasons for the low level of R&D activities in Malaysia.

The Malaysian economy although growing fast, however is still in its early stages of industrialisation. This makes it difficult for the country to invest heavily in R&D especially when the economy is heavily dependent on the MNCs for supply of capital and technical equipment. The lack of participation by the private sector in R&D activity is another factor for the low level of R&D performance in Malaysia.

To overcome the problems, the government has taken steps to increase the R&D performance both in the public as well as private sectors. This is reflected in the establishment of modern R&D Infrastructure.

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[187] MASTIC, *1994 National Survey of Research & Development*, (MASTIC:1996),p.8.,and, This document is the latest survey on R&D in Malaysia. And will be quoted hereafter as '1994 R&D Survey'.
[188] *The Seventh Malaysia Plan 1996-2000*, p.422.

R&D Management Infrastructure

The development of R&D management infrastructure in Malaysia started with the launching of the Fifth Malaysia Plan (1986-1990), and the Industrial Master Plan (1986-1995). General activities, however, dates back as far as 1879 when the Forest Research Institute was established, followed by Institute of Medical Research in 1901, and Rubber Research Institute in 1925.[189]

But it was only after independence (1957) when research efforts took momentum, in particular, in the agricultural sector. Research efforts were intensified in this sector with the establishment of Malaysian Agriculture Research and Development Institute (MARDI) in 1969, and Palm Oil Research Institute (PORIM) 1979.

PORIM another agricultural institute established in 1979 conducts research activities on palm oil. It aims to improve the efficiency of extraction and refining and end-use research to increase the production and improve the performance of palm oil in existing uses, such as edible and inedible products, or in new uses.[190] In agriculture R&D focuses on increasing the productivity of traditional crops while giving equal attention to the development of new crops, including value-added products using better processes and techniques. And the areas of agriculture where R&D is conducted are in the areas of production

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[189] MOSTE, *The National Science and Technology Policy*, p.1., also in MOSTE, *Science and Technology Malaysia*, vol.1., No3., (Kuala Lumpur: MOSTE April 1992),p.4., and, Anwar Ali, *Malaysia's Industrialisation: The Quest for Technology*, (Oxford University Press, 1992), pp.95-96.

[190] PORIM, *PORIM in Brief*, (Kuala Lumpur: PORIM), n.d.

research, post-harvest research, basic and supportive research and agriculture development and environmental research.[191]

However, the most significant development in R&D management was the consolidation of S&T related policy formulation and implementation through the establishment of the Ministry of Science, Technology and the Environment (MOSTE) in 1976.[192] The Ministry set up R&D activities through better planning and management of research program.[193] The National Council complements the Ministry's role for Scientific Research and Development (NCSRD).[194]

Moreover, R&D efforts intensified when it was extended to other sectors of the economy. A notable example for this is research in the fields of quality and standards. With the establishment of SIRIM in 1993.[195] SIRIM develops processes, products and technologies for industry. It also promotes standardisation with quality, and provides technical services for industry for industry and the public.[196]

In Malaysia there are a good number of R&D institutions involved in R&D activities. However, given the resources constrain (money and people),

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[191]Ibid

[192] MOSTE, *Annual Report 1990* , (Kuala Lumpur: MOSTE, 1991), p.3. MOSTE has its origins in 1973 with the creation of Ministry of Technology, Research and Government.

[193] Ibid.

[194] NCSRD, established in 1975, is an advisory body to the government on policies and programmes for S&T development. NCSRD, *Annual Report1993*, (Kuala Lumpur: MPSKN, 1994), p.5.

[195] SIRIM, *SIRIM: a friend and partner of industry*, Kuala Lumpur: SIRIM), nd., p.4. SIRIM was established was amended to provide more flexibility in order to cope with the accelerating national industrialisation and globalisation of markets.[195] On 1 September 1996, SIRIM was corporatised to be known as SIRIM Berhad. SIRIM Berhad incorporated under the Companies Act, vested with all the rights, privileges and obligations of SIRIM.[195] As a corporatised body SIRIM Berhad is a government-owned company, and will be managed as a business enterprise.[195]

[196] http://www.sirim.my/cpro_sb/about/object.html, "SIRIM"1997, p.1. Furthermore, in undertaking and promoting industrial research, SIRIM aims at improving and discovering technical process and methods. SIRIM also promotes, develop and promulgate standards for

Malaysia faces a problem when it comes to allocation of these resources for the variety of disciplines and projects in R&D. In this case, in order to make best use of its resources Malaysia has introduced the Intensification of Research for Priority Areas (IRPA) scheme.

Before going into the discussion of IRPA it is necessary to discuss R&D classification adopted in Malaysia because the criteria of priorities is based on this classification.

R&D Classification

Malaysian R&D classification system is premised upon two fundamental parameters: *Field of Research,* and *Socio-Economic Objective.*[197]

In Field of Research (FOR), R&D activities are classified according to their scientific academic discipline. This system shows international and universal variations, with national variations arising as to the grouping of different research fields.[198] The Socio-economic Objective (SEO) organises those common R&D activities by their purpose or presumed sectoral beneficiaries. This system shows greater national variation according to a nation's profile and priorities.[199]

The FOR classification allows the activity to be categorised according to the field of research undertaken. In this respect, it is the nature of the R&D itself which is being examined rather than the activity of the performing unit or the

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commerce and industry and for goods produced in or imported into Malaysia or for export or re-exported. Finally, SIRIM enhances public and industrial welfare, health and safety.

[197] MASTIC, *Malaysian Research and Development Classification System*, (Kuala Lumpur: MASTIC 1993), p.5. This was originally developed by the Australian Bureau of Statistics. they have been developed in alignment with international protocols for small country purposes via extensive consultation throughout the Australian Research Community.

[198] Ibid, p.5.

[199]Ibid.

purpose of the R&D.[200] On the other hand, in SEO classification R&D is classified according to the researcher's perceived purpose (i.e. who benefits from the research). It includes the processes, products, health, education and other social and environmental aspects of particular interest.[201]

However, under IRPA, which is going to be discussed shortly, R&D classification is based on a five-sector classification system. The sectors include agriculture, industry, medical, strategic and social sciences.[202] This system was found problematic. [203] It did not yield to sufficient information for policy and decision making.

Therefore, the 'combined system' of classification was introduced. This system uses both socio-economic objectives (SEO), and field of research (FOR).[204] The system allows the researcher to identify and process different information, such as the level of industrial technology-oriented research being supported within an agriculture sector SEO, and levels of IRPA support across all sectors for new and emerging technology field.[205]

The classification systems expands where appropriate to meet specific Malaysian information needs through review by Malaysian experts. With an international 'concordance' translator, the joint SEO/FOR system allows both

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200 Ibid,p.7.
201 Ibid, p.25.
202 Ibid,p.7.
203 Ibid,p.7. Under this classification , it is not possible to identify programmes or projects currently classified under agriculture which have objectives other than the primary production of commodities, such as food processing industries or public health care. It was also identified that the five-sector classification does not allow identification of the level of strength being supported in strategic research competencies such as computer science or molecular biology as these fields of research are likely to be included across a range of different socio-economic sectors. Ibid, p.17.
204 Ibid. The combined system was developed in alignment with international protocols for small country purposes via extensive consultation through out the Australian research community.
205 Ibid.

targeting of the data base to whatever level of detail or aggregation as appropriate to Malaysian needs as well as for international comparison.[206]

The major categories used for SEO and FOR categorisation are:

Field of Research Classification (FOR)

Mathematical Sciences

Physical Sciences

Chemical Sciences

Earth Sciences

Information, Computer and Communication Technologies

Applied Science and Technologies

General Engineering

Biological Sciences

Agricultural Sciences

Medical and Health Sciences

Social Sciences

Humanities

Socio-Economic Objective Classification (SEO)

Plant Production and Primary Products

Defence

Animal production and Primary Products

Energy Resources

Energy Supply

Manufacturing

Construction

Transport

Information and Communication Services

Commercial Services

[206] Ibid, p.8.

Economic Framework	Health
Education and Training	Social Development and Community Services
Environmental Knowledge	Environmental Aspects of Economic Development
Environment Management and Other Aspects	Natural Sciences, Technologies and Engineering
Social Sciences and Humanities	

Malaysia as an industrialising country has limited resources (money and people). But the variety of possible activities involving, projects and industrial sectors is not necessarily small. Thus, Malaysia has to spread its resources more thinly over the available areas, or else select certain areas as priorities for R&D investment. In this case, the priorities are based on current specialisation, technological opportunities and exploitable advantages, and areas identified promising.[207] Notably, in Malaysia the growth of R&D in the past has only been closely linked to agriculture and primary product areas, rather than to manufacturing and secondary activities.[208] This makes prioritisation a much-needed system especially to cope with the shifts in socio-economic objectives.

[207] Dr. Vivien Walsh, "Technological Competitiveness and the Special Problems of Small Countries", *Science Policy Documents*, No.2. (Paris: UNESCO, 1987), p.104.
[208] M. Zawawi Ismail & Ismail MD Salleh, "Technology Development and R&D : Dynamic Input-Output Analysis and Sectoral Projection of the Manufacturing Sector: 1990-2000, n.d., np., p.16. IRPA programme was set up in 1988 to ensure that national R&D resources are invested in key sectors towards building the technological base required for further socio-economic development of the nation. *NCSRD 1993 Annual Report*, p.17.

IRPA

The Intensification of Research in Priority Areas (IRPA) was set up in 1988 as a mechanism to ensure that R&D resources in the country are invested in essential sectors.[209] Its aim is to engage the private sector into R&D activities. In addition, IRPA co-ordinates and manages the R&D budget allocated by the Government to research institutions and universities to carry out research activities.

Moreover, IRPA's programs focus on the development of indigenous research capacity for industrial development, especially, in new and emerging technologies. It facilitates linkages with training of skilled manpower and post-graduates education in areas of national need. It also encourages closer linkages between public sector research and industrial organisations.[210] This was reflected in the fact that in 19 out of 27 institutions under the IRPA being directly involved in agricultural R&D and the majority of these R&D institutions are well established with good infrastructure and staff support.

Funding of R&D

There are two types of funding for R&D: *direct* and *indirect*. In direct funding government funds are allocated directly to R&D executing agencies. The funds could be in the form of contracts or subsidies, which may or may not be reimbursable. In indirect funding the funds are given through intermediate organisations responsible for distributing them to the executing agencies.[211]

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[209] MOSTE, *MOSTE Annual Report 1996*, (Kuala Lumpur: MOSTE, 1994), p.7.
[210] MPSKN, *MPSKN Annual Report 1993*, (Kuala Lumpur: MPSKN, 1994), p.17.
[211] UNESCO, "An Introduction to Policy Analysis in Science and Technology", *Science Policy Studies and Documents*, No.4., (Paris: UNESCO 1979), p.39.

In Malaysia, R&D funding is direct through the national budget.[212] The government allocates the fund directly to R&D executing agencies, like MARDI in agriculture, IMR in health and MIMOS in microelectronics. Moreover, government funding takes different forms:[213]

R&D financing: In this, the government allows firms to conduct part of the R&D in government research centres. In addition, the government develops technologies that firms can latter use.

Steering technological development: In this scheme, the government through contracts provides a market for the technologies developed by the private sector. The government also favours certain suppliers and guides the technological specialisation of firms.

During the Fifth Malaysia plan, the state provided general guidelines on the proportion of resource allocation for basic, applied, and development research, giving an overall ratio of 18:35:47 respectively.[214] However, during this Plan period the government proposed a more centralised planning system. This measure necessitated a comprehensive review of the science policy organisation as well as the legal and institutional arrangements. The role of NSCRD was strengthened to provide effective intersectional jurisdiction in planning and

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[212] M Zawawi Ismail & Ismail MD Salleh, "Technology Development and R&D : Dynamic Input-Output Analysis and Sectoral Projections of the Manufacturing Sector 1990-2000", n.d., n.p., p.17. However, there are three categories of sources of fund as far as the major agricultural research institutions are concerned: research cess, Government, and the departmental allocation. For example, PORIM and RRIM are funded from the cess levy. In this case, the particular industries are self-financing in research. The amount of available funds for these two institutions depends on the volume of output. Omar bin Abdul Rahman, "Allocation, Monitoring , and Evaluating Agricultural R&D Financial Resources to Support Mission of Government Agencies" , paper presented at the Seminar on "Research Management", Kuala Lumpur: 1987, p.37.

[213] Pierre Dussauge, Sturt Hart and Bernard Ramanantsoa, *Strategic Technology Management* , (Paris: McGraw-Hill, 1987), p.122.

[214] *The Fifth Malaysia Plan 1986-1990*, p.268.

management, while an independent mechanism will be provided for evaluation and assessment.[215]

The government fund is, however, distributed unevenly across all the sectors. R&D expenditure by main socio-economic objective is funded overwhelmingly 96.7% of the fund provided by the government goes of socio-economic objective. On the other hand, the fund from the business sector was all to the economic development objective, which amounts to 99% of the total R&D expenditure. From both government and the private sector, s small portion (less than 1%) of the R&D expenditure was also aimed at health and environment related objectives, and for the advancement of knowledge.[216]

It is important to note here that during the implementing of the IRPA R&D agencies faced several difficulties.[217] To overcome this several changes were proposed to IRPA R&D Funding system. The IRPA funds was directed towards financing priority projects proposed by researchers including national projects identified by central agencies. It also includes capability and capacity development projects identified by the Standing Committee on S&T Development Management and the Co-ordinating Committee on the IRPA Program.[218]

Under the new IRPA R&D program, the project proposals are formulated based on pre-determined National R&D Priority Areas, SEOs and FOR. The five traditional IRPA sectors have also been expanded into nine sectors in the modified

[215] Ibid, p.269.
[216] Ibid, p.35.
[217] MPSKN, *MPSKN Annual Report 1995*, (Kuala Lumpur: MPSKN, 1996) p.18.
[218] Ibid, p.18.

scheme. The sectors currently receiving the IRPA fund Agro-Industry, Resources. Manufacturing, Services, Environmental, Health, Social, Economic and Sciences. To the coordinate and offer a better management of IRPA funds in the sectors a total of ten IRPA panels are formed. The panel include Agro-industry; Mineral: Energy; Manufacturing Services; Information Technology; Environment; Health: Science; and Engineering and Social Science and Economic Panels.

In the new IRPA scheme, grants for each sectors are approved according to project duration. [219]The project proposals from the sectors are evaluated at two levels; first, in a technical review by experts or peer groups, and than followed by a strategic review by the ten IRPA panels. Apart from these changes in IRPA funding system, the new scheme encourages collaborative research and industrial linkages. And finally, the MOSTE is responsible for the disbursement control, monitoring and evaluation of the IRPA fund approved by the NSCRD. This means that in the new scheme the management of fund is handled by a single entity.[220]

The new IRPA system subjects the research agencies and universities to competitive bidding process. Research institutions and universities bids for funding of projects that cut across socio-economic objectives and major fields of research. Given the limited IRPA resources the funds will be allocated to the best proposals. However, In the process of evaluating and selecting research project proposals, greater emphasis will be placed on ensuring, where possible, that the

[219] *The Seventh Malaysia Plan 1996-2000*, p.436.
[220] Ibid, p.436.

potential output of the project will be required by specific clients, whether Government or industry.[221]

In order to ensure that research outputs are relevant to address industry's requirements, the institutions and universities has been encouraged to collaborate intimately with the industry in research. To ensure this linkage the government has required that all such research institutions achieve self-financing targets in their operating budgets of 30% by 1995 and 60% by the year 2000.[222]

Private Sector

The private sectors participation in R&D is minimum at present. There are many reasons for that. The main reason is the private sectors desire for profit motive. This is the reason why it does not undertake R&D in basic research; because it is too risky in terms of payoff and is long term. However, the private sector's argument for not undertaking R&D activities is that, at present there are inadequate market research. [223] And there are also lack of R&D management know-how including a lack of proven analytical technique. Moreover, there is also a shortage of R&D personnel with required expertise that has caused competition and labour cost.[224]

The R&D definition as a ' Creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications', also cited before, is too general. It makes the understanding of R&D complicated and unclear as to what can be regarded as

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[221] Ibid.
[222] Given limited funds, the institutions are hardly allowed by the government to undertake pure research projects. *MPSKN Annual Report 1990-1991*, p.11.
[223]MASTIC, *1994 National Survey of R&D*, (Kuala Lumpur: MASTIC, 1996), p.30.
[224]Ibid.

R&D activity. This is reflected in the complaints from the private sector. More than a quarter of those who encountered problems had difficulties in trying to understand the R&D definition. [225]

Other problems also encountered by the private sector include the narrow scope of eligibility as, and lack of awareness regarding the incentives and not knowing the way to apply for it. More than one fifth mentioned that the scope of eligibility was too narrow and about 44% (combined) of the total respondents were not aware of the R&D incentives plus not knowing how to apply for them.[226]

However, despite the difficulties there are a number of private companies involved in R&D. According to the latest survey, companies are those with large revenue of more than RM100 million. In terms of employment size, the companies contributing 24% of the total, was those employing 75 to 200 workers. Small and medium sized companies (employing 75 workers and less) contribute only 13% of the total.[227]

The total of money spent on R&D by the private sector, in Malaysia, amounts to RM292.6 million in 1994. The industry group that spent the most was the electronic sector. It contributed 28% of total private sector R&D expenditure. The second and third biggest industry group were Agriculture and Electrical Machinery sectors respectively. By contrast locally-owned Food and Rubber and

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[225] Ibid
[226] Ibid, p.30.
[227] Ibid, p.22.

Plastic industries (combined) contributed only 11% of total R&D spending.[228] Moreover R&D expenditure in the private sector was concentrated in the areas of engineering sciences, applied sciences and technology and information and computers. As a major objective, manufacturing dominated Malaysian R&D expenditure, accounting for approximately 60% of the total expenditure followed by 12% Plant production and plant primary products. The objectives of environmental management, defence, education and health were all less than 1%.[229]

It is important to note that, the private sector R&D are mostly carried out by the local companies. In 1994, 40.7% of the total companies that carried out R&D activities were locally owned. Together with those companies that were locally controlled they made up nearly 59% of the total.[230] The foreign-owned companies carried out only 28% of the total R&D activities. In this, the Japanese companies make up the biggest number of foreign owned/controlled companies who carry out R&D activities in Malaysia. The number of Japanese companies involved in R&D reaches to 13 companies, followed by the United States and German companies.[231]

As an attempt to get the private sector into R&D activities, the government has introduced several measures, including the industrial R&D which supports product development. This is to strengthen the industrial organisation's position in

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[228] Ibid, p.23.
[229] Ibid, p.27.
[230] Ibid, p.25.
[231] Ibid,p.25.

the marketplace and to facilitate the private sector's R&D needs in the short term.[232] Furthermore, the government encourages private sector participation in R&D, through SIRIM. SIRIM gives top priority to the promotion of contract research and development activities. This includes the provision of R&D services to companies on a fee-for-service basis. In addition, a Joint Research Venture Program (JRVP) has been introduced to reinforce the present partnership of SIRIM with industry.

SIRIM Tripartite Research Venture (STRIVE) program is yet another measure to amalgamate further the co-operation of research institutes, industry and academia.[233] STRIVE was launched in 1993 to generate active interest and participation among the public and private sectors in joint research projects relevant to the needs of industry. The program provides the communication, support and co-operation for research to meet the needs of industry.[234]

It is important to point out that Joint R&D has in principle at least three important inherent advantages. It can eliminate purely duplicative research of the individual company R&D and divert the resources to additional research. It can achieve a larger scale in terms of both assembling a critical mass of researchers working on any particular problem in providing research equipment. Joint R&D then is a way to realise the economies of scale in R&D. It can diversify the research over several approaches to a given problem, thus reducing the risk that no feasible solution will be found.[235]

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232 Philip H. Francis, *Principles of R&D Management*, (New York: Amacom, 1977), p.2.
233 SIRIM, *Berita SIRIM*, Bil.2., (Kuala Lumpur, 1994), p.2.
234 Ibid.
235 Francios Chesnais, *Technical Co-operation Agreement between Firms* , No.4. *1988, p.105.*
Joint R&D can be organised either through the establishment of joint laboratories where R&D

SIRIM, as the research institute in the tripartite arrangement acts as the lead partner. The universities which make up one of the three component members undertakes basic as well as applied research. In addition, as a condition. the research project identified under STRIVE must be commercially viable and may be initiated by any member of the tripartite and has to be agreed upon by all before a partnership is launched.[236]

R&D Personnel

The 1992 survey found there are a total of 2330.4 personnel employed in R&D in the government sector. Which is made up of 720.4 researchers, 745.4 technical staff and 864.6 other R&D support staff.[237]

The relatively lower share of output of science graduates, though supplemented by Malaysians trained overseas, had affected the number of qualified personnel available for R&D activity. The current number of full and part-time researchers and scientists is estimated to be at 8.300. This gives a ratio of 400 per million population which is considered low compared with ratios ranging from 1,000 per million to 1,500 per million population found in some Newly Industrialised Economies (NIEs), when they were at Malaysia's current level of economic development.[238]

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investments are pooled and the activity organised in a centralised manner or, on the contrary, through the co-ordination of separate R&D activities which continue to be funded by individual firms (with financial support from governments in case of joint government-industry projects) and executed in the firm's own laboratories. Ibid.p.105.

[236] Ibid, p.3.

[237] The figure is based on the report submitted by twenty-six agencies. *1992 National Survey of Research and Development*, p.20.

[238] The total number of support staff including sub-professionals and technicians was estimated at 12,450. The public sector represented the largest source of R&D manpower in the country, a substantial portion of whom were engaged in applied and development research. The proportion of R&D personnel in market-oriented research, however, was limited, thus the consequent low impact of R&D on industry. The pool of R&D personnel in the private sector was too small to

Conclusion

The definition of R&D adopted from the OECD countries as was perceived by the private sector is too general. It is defined in view of general scientific research emphasising pure sciences. In the Malaysia situation, several other elements have been added to it include the design, quality and production at the firm levels. Inspite adding the new elements, the fundamental elements of the definition remain, particularly, the demand for originality and quest for new knowledge.

S&T have been recognised as vital for the country's socio-economic advancement,[239] however, technology receives more attention than the sciences. This is because, in Malaysia's industrial development vision, technology is a strategic commodity. It is the engine of growth. The primary task of R&D, thus, is to sustain economic growth, accelerate overall development and lay the foundation of the attainment of a scientific and technologically advanced industrial society by the year 2020.[240] R&D is not perceive at all just acquiring scientific knowledge in it epistemological sense.

In fact, R&D allocation for pure science is very scant. Under IRPA, manufacturing-oriented research receives most of the support. The level of manufacturing-oriented research supported under IRPA is one-third higher than

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stimulate significant indigenous market-driven research. *The Seventh Malaysia Plan 1996-2000*, p.429.
[239] *The Fifth Malaysia Plan 1986-1990.*, p.187.
[240] Ibid.

otherwise indicated under the present five sector classification system. Research oriented towards *new and emerging technologies* accounts for 11% of total IRPA grant allocations, and of this amount two-thirds was allocated to biotechnology-related areas."[241]

This reflects government's objective of steering research towards industrial applications. The interest is in the industrial, commercial, and profit-making aspects of S&T. Another area of concern in R&D management in Malaysia relates to the central control of funds. In Malaysia, as indicated earlier, the R&D funds is centrally controlled. The justification for this is apparently that the rapid economic and technological changes at the international level and the widening technological gap between the industrial and the developing countries justifies state intervention to effect the technological change needed for a sustainable industrial growth.

Moreover, the government intervention in S&T planing is based on the conventional belief that government has a role in factor creation. Thus government policies can influence the improvement of factors such as human resources, scientific knowledge, economic information and infrastructure.[242] The defining role of S&T in the socio-economic infrastructure and the need for S&T in national policies leads to strengthening of the national S&T enterprise and therefore the demand for a transparent policy for S&T.[243]

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[241] *MPSKN, Annual Report 1993*, p.19. More on IRPA and the five sectors classification will be discussed in chapter on R&D.
[242] Omar Abdul Rahman, "Achieving the Industrial Targets of Vision 2020 - The Science and Technology Perspective", p.15.
[243] Ibid, p.16.

In the industrialised countries the case is rather different. In these countries, technology development is usually generated by the private sector, while the state is more concerned with projects that involve large capital outlays and long gestation periods or which possess numerous economic externalities. For example, most of the basic research in the areas of defence, atomic power, outer space, oceans, the environment, and national health come under the purview of the state.[244] Obviously, this is not feasible in the industrialising countries.

However, an alternative approach would be to forge public-private sector collaboration so that the R&D funds are easily available to researchers in both sectors. But the public-private sector collaboration, in Malaysia, is still in its infancy. Collaborating with the private sector, the state could be the prime mover in establishing technological priorities. But its involvement in the private sectors especially concerning decision-making at the firm level, might be seen as unwarranted interference.[245]

[244] OECD, *Science and Technology Policy Outlook*, (Paris: OECD, 1985), pp.56-8.
[245] Anwar Ali, pp.99-100.