THE STATUS AND QUANTITATIVE POLICY TARGETS OF SCIENCE AND TECHNOLOGY IN THAILAND

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Introduction

There is no doubt that the formulation and evaluation of science and technology policy require some reliable yardsticks. The problems, however, are what should be the yardsticks, and how reliable they are. For such a vast and complex sphere of activity, science and technology surely need multiple indicators each of which measuring certain, but not all, aspects and some of which are more reliable than others. For a developing country like Thailand there are both positive and negative aspects in collecting reliable yardsticks. The relatively small scale of science and technology makes it possible to collect total country-wide data, hence in many cases eliminating the uncertainties resulting from sampling survey. However the paucity of existing data, especially in their detailed aspects, and their incongruence, which partly stems from different assumptions and criteria used, mean that interpretation and extrapolation must be made with caution.

For the purpose of our discussion, it is convenient to classify indicators into input and output indicators. Input indicators include such items as budget for research and development (R & D), and manpower for science and technology: they form the basic provisions which make science and technology possible. Output indicators show the results of science and technology including the number of scientific publications, patents and, with some justification, the total value added of technology-intensive products, etc. It must be pointed out from the outset that this division is for convenience in discussion, and not entirely free from ambiguities. For example, should the number of students graduated in science and technology be classified as output of the educational system or input into the stock of manpower? Does the value added of technology-intensive products really reflect the technological potential, or is it simply the consequence of some economic policy? Furthermore, some important parameters do not yield to simple quantitative estimation. What is the input indicator representing a new law for promotion of R & D in the private sector? How do we measure the output of appropriate technology education among the rural population?

With these limitations in mind, it is nevertheless worthwhile to study the available input and output indicators. The scientific and technological status of Thailand has been periodically analysed[1–6]. With the exception of a recent analysis[7], however, the data mainly concerned only the public sector, by far the major sector of the country. Since Thailand is on the inevitable path to industrialisation, the need to monitor the status of the private sector in the future will become more pressing. This report summarises the present data and those from recent past on input and output of science and technology in Thailand, including the results of survey of the private sector. The results are compared, wherever possible, with the quantitative policy targets of the Fifth National Economic and Social Development Plan[8], and guidelines are suggested for further planning.

Input Indicators

Budget and Expenditure for R & D

The annual budgets for research development and survey activities of government agencies since 1973, compiled by the National Research Council[9], are shown in Table 1. To a certain extent, these figures roughly reflect the budgets for R & D, although they are an over-estimation because of inclusion of survey activity, which accounts for about a quarter of the total budgets. Some 20% of the budgets are also spent on non-scientific and non-technological activities. It is, nonetheless, possible to derive some conclusions and trends from these figures. The research, development and survey budget as percentage of gross national product (GNP) and as percentage of the total government budgets has been on the decreasing trend until recently. Presently, inspite of the over-estimation mentioned, the budget (1981) represents only 0.36% of the GNP, far lower than the figures of more than 2% for the R & D activities in developed countries like those in the EEC, Japan and the USA[10]. Developing countries like South Korea, Philippines and India are spending 0.5–0.6% of their GNP for R & D activities[11].

A target of 0.5% of the GNP has been set for R & D expenditure in science and technology for Thailand at the end of the Fifth Plan[8]. In addition, a more balanced distribution of expenditure among the fields of activities have been envisaged[2]. In the past, by far the lion share of the budget has gone to agriculture and irrigation, while only minor portions were alloted to other fields. For example, for 1982, 34% of the budget for research, development and survey was slated for agriculture and irrigation, while only 4% was alloted for industry and mining, and a meagre 0.6% for energy. This skewness in distribution of budget has to be remedied, especially in view of the rapid rise in prominence of the manufacturing sector in Thailand. Table 2 shows the investment plan for science and technology R & D as stipulated by a task force of the National Economic and Social Development Board[2].

Very few data are available on the contribution of the private sector to R & D activities in Thailand. A recent survey[7], however, for the first time gave a glimpse of the picture, which turned out, as might be expected, to be an almost empty one. A total of 105 companies which are members of the Association of Thai Industries, and represent a major fraction of large and medium-size companies concerned with a wide cross section of industry in Thailand, showed from this survey that their annual expenditure for R & D amounted to 240.3 million baht, while the annual sale amounted to 58,790.0 million baht. The percentage of the annual sale spent on R & D is therefore 0.41%. On closer inspection, however, it was found that most of the R & D expenditure (193.8 million baht) was reported from only one company dealing with rubber and rubber products. Subtracting this from the total figure yields the result of less than 0.1% of the annual sale being spent on R & D, a figure well close to being negligible.

In order to promote R & D activities in the private sector, the Ministry of Science, Technology and Energy has drafted a law which will give tax and other financial incentives for the companies which will set up expenditure specifically for indigenous

R & D for improvement and innovation in their products and processes. This law, after passage by Parliament, will hopefully stimulate R & D in the private sector, crucially needed at this stage of development in Thailand.

Scientific and Technical Manpower

Data given by the National Economic and Social Development Board[2] indicate that, as of 1980 Thailand had a total of 55,790 scientists and engineers excluding medical science (with university degrees), 68,500 technicians (below degree level) and 161,500 craftsmen (below degree level). With a total population of 46 million, ratios of 12 scientists and engineers, 15 technicians and 35 craftsmen per 10,000 population were obtained. The figure for scientists and engineers may be compared with those of Japan (36) and USSR (51) for 1979[11], with the conclusion that Thailand is still weak regarding her scientific and technical manpower. However, since many developing countries have fewer than 10 scientists and engineers per 10,000 population, Thailand can be classified, with respect to scientific and technical manpower, as a country in the middle stage of development.

The manpower production of universities and public colleges are shown in Table 3. It may be noted that natural science is the only field where there is indigenous capacity for production of doctoral graduates. A doctoral programme for engineering is however presently under preparation.

There is in Thailand at present no other system for reliable prediction of scientific and technical manpower demand than compiling from projections of various institutions. A survey of the government sector by Ministry of Science, Technology and Energy in 1981[12] indicated a shortage of degree-level engineers but an oversupply of technicians and craftsmen (Table 4). The demand figures are probably over-estimated, since they represented the projections of individual agencies which had to be approved by the Civil Service Commission.

Table 5 shows the numbers and distribution of scientific and technical manpower in 105 private companies recently surveyed[7]. It also shows approximate demand for additional manpower in the next five years. The total number of employees in these companies is approximately 66,000. The percentages of scientific and technical personnel are therefore 2.2% (degree level), and 5.9% (below degree level). It is obvious from Table 5 that there is very little demand for personnel of high qualification, indicating weakness in scientific and technological capacity in the private sector.

The number of scientists and engineers active in R & D in Thailand is not known with certainty. From a survey of the government sector by the National Research Council in 1979[13], a figure of 2,010 was gathered with the following distribution: natural sciences, 341; engineering and technology, 222; agricultural sciences, 901; medical sciences, 546. These numbers are almost certainly under-estimated since they are based only on postal survey. It can, however, perhaps be reliably assumed that no more than 10% of the total scientists and engineers in the government sector are active in R & D. A survey of the private sector[7] gave a figure of 5.6% for the scientific and technical personnel engaged in R & D. However, taking into account the fact that the personnel spend on average only 46% of full time in R & D, it can be estimated that only 2.6% of the scientific and technical personnel in full time equivalent are engaged in R & D.

The Fifth Plan[8] has envisaged that the production of scientific and technical manpower is increased at an annual rate of not less than 10%, in anticipation of rapid growth in the manufacturing sector. It seems, however, that more accurate demand figures are needed, in various fields and at various levels of qualification, in order to arrive at suitable supply levels and their rates of growth. Of no less importance, though this cannot be quantitatively measured, is the upgrading of quality of the manpower. There has recently been an alarming decline in the preference of university entrants for choosing natural science as their career. This decline needs to be reversed by increasing the attractiveness of science as a career, and by other measures. The quality of technicians and craftsmen also need to be urgently promoted, since the present low status does not encourage suitable persons to take up the professions. The Ministry of Science, Technology and Energy is devising programmes both for promotion of scientific talents, and for promotion of skilled technicians and craftsmen.

Output Indicators

There is no single good indicator to measure the output of science and technology. Each indicator will only give a limited amount of information on some aspects, requiring even then a very cautions interpretation. For scientific output, indicators may be chosen with justification from the number of publications in journals of acceptable standards, the number of scientific authors, etc. For Thailand and other developing countries there are difficulties in counting such publications or authors since the local abstracting and indexing services are weak to the point of being almost non-existent. It is therefore necessary to rely on international indexing services such as those given by the Institute for Scientific Information (ISI) in the USA. Although a criticism may be made that ISI only scans some 4,000 journals from a total of tens of thousands that exist in the world, the fact that the bulk of scientific articles that are later cited as references, implying that they have generated scientific interest, are included in this data base ensures that it at least covers a substantial part of the international scientific arena. Only two journals from Thailand and one journal from the Philippines, out of the whole ASEAN region, are presently included in the ISI data base, and therefore the counts probably underestimate the scientific output from this region. However the data can at least roughly indicate, through its contribution to the international journals, the status of Thailand relative to other countries in the world.

An exhaustive analysis of scientific output in the Third World during the period between 1971 and 1976[14] yielded some general conclusions as follows.

a) As far as the number of authors are concerned many developing countries have only a small output (less than 20 authors per year), while the remaining countries can be grouped into moderate producers (below 80 authors) and large producers (more than 80 authors)

b) With respect to the rate of growth, developing countries can again be divided into three groups: stagnant or even declining countries with zero or negative growth, moderately growing countries (up to 60% growth during 1971–1976) and fast growing countries. The average growth for scientifically advanced countries during this period was 60%.

c) In terms of authors per capita, the lowest group has less than 2 authors per million of population, the middle group from 2 to 10, and the highest group between 10 and 60.

Where does Thailand fit into these classifications? During the period of survey, Thailand had on average about 150 scientific authors and can therefore be regarded as a large producer among developing countries. The rate of growth during the period was 147%, making it a fast growing country with respect to scientific output. It had on average about 4 scientific authors per million of population, and hence in this respect can be classified as belonging to the middle group.

Table 6 shows the conclusion for all ASEAN countries according to the criteria in this study. It can be seen that in the developing world, ASEAN countries already have a considerable scientific output and are moderate or fast growers.

The distribution of output from various institutions in Thailand, based on ISI data, has been monitored for the past few years[5, 6]. Table 7 shows the number of publications from various institutions in Thailand in international journals since 1977 based on ISI data[15]. Mahidol University and Chulalongkorn University are the largest producers of scientific publications in Thailand. Of all other institutions, only Chiang Mai University and the internationally run Asian Institute of Technology produced a significant output.

It is important to point out that measuring the scientific output through counts of authors and publications ignores output from scientific services, which is by far the major function of science, especially in the developing countries. Here an acceptable yardstick is needed, and it should be a major task for science policy people to device one.

If scientific output is difficult to assess, technological output is even more so. All the indicators that might be devised suffer from their dependence on non-technological factors as well as technological ones. The number and types of patents, the amount of royalty obtained from export of technology, the income from export of technology-intensive products, the total value added in the manufacturing sector – all – these parameters measure in some sense or other the output of technology of a given country, but are also complex functions of economic and other parameters. For Thailand, the difficulty is compounded by the fact that there is still a very young patent system. The Patent Act was promulgated in 1979, and so far fewer than 100 patents have been granted up to the present, out of over 1,000 applications. There is little information on exports of technology and technology-intensive products. One may, however, glean some information in this respect from data on imports and exports of engineering goods[16]. In 1979, imports of engineering goods totalled 57,223 million baht, while exports of engineering goods only amounted to 5,438 million baht, out of which almost half (2,535 million baht) was for integrated circuits alone. These figures indicate a weak status of the engineering industry in Thailand, which may in turn reflect a weak technological output. Caution should be made however in the extrapolation of these results. With due caution also, one may arrive at some indication of technological output from learning that the total value added in the manufacturing sector in Thailand has been expanding at an average annual rate of 16.2% at current prices during 1960–1979, and the share in GNP of this sector, totalling 126,000 million baht in 1980, will surpass the share of the agricultural sector in 1986.

Conclusion

The present study on input and output indicators has been cursory and should be taken only as a step towards a more systematic and continuing effort in the planning of science and technology in Thailand. In summary, these indicators have enabled us to see Thailand as a developing country with a good potential for further development of, and through, science and technology. In order to obtain more meaningful and reliable indicators, and to make policy decisions based on them, Ministry of Science, Technology and Energy has drafted a law for the establishment of the National Council for Science and Technology, which will be a high-level body chaired by the Prime Minister, with overall function and authority in the planning of science and technology. It remains to be seen whether this Council will be as effective as hoped to be. In any case the science and technology indicators will play a major role in science policy in the years to come.

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TABLE 1
GOVERNMENT BUDGET FOR RESEARCH, DEVELOPMENT AND SURVEY (RDS)

Year	RDS budget (million baht)	Percent of total government budget	Percent of GNP
1973	1,079	3.4	0.50
1975	1,191	2.5	0.40
1976	1,166	1.9	0.35
1977	1,277	1.9	0.35
1978	1,468	1.8	0.29
1979	1,331	1.5	0.24
1980	1,507	1.4	0.23
1981	2,549	1.8	0.36
1982	3,271	2.0	n.d.

Data are based on ref 9

TABLE 2
INVESTMENT PLAN FOR R & D IN SCIENCE AND TECHNOLOGY IN THAILAND

Year	1984	1985	1986
Estimated GNP (million baht)	1,269,000	1,502,000	1,776,000
Government investment (million baht)	4,570	6,310	8,880
Percent of GNP of government	0.36	0.42	0.50
Government investment/Private sector investment	90/10	80/20	70/30
Percent of GNP or government investment by sector:			
Agriculture and irrigation	0.13	0.14	0.15
Industry and mining	0.05	0.07	0.10
Energy	0.02	0.03	0.05

Source: Ref. 2

TABLE 3
SCIENCE AND TECHNOLOGY GRADUATES PRODUCED IN THAILAND IN 1979

	Below degree level	Bachelor degree	Master degree	Doctoral degree	All degree levels
Natural science	176	1,056	243	5	1,304
Agriculture	6,913	1,195	76	–	1,271
Engineering	28,513	1,400	51	–	1,451
Total	35,602	3,651	370	5	4,026

Source: Ministry of Science, Technology and Energy

TABLE 4

A. SUPPLY AND DEMAND OF SCIENTISTS AND ENGINEERS IN THAILAND

	Total	**Natural science**	**Agricultural science**	**Engineering**
Demand	42,991*	7,604*	9,487*	25,900*
Supply	40,109	8,280	9,429	22,400
Now employed (1981)	33,209	6,380	7,429	19,400
Now in science & engineering colleges 1981	6,900	1,900	2,000	3,000
Balance	–2,882	+676	–58	–3,500

B. SUPPLY AND DEMAND OF TECHNICIANS AND CRAFTSMEN IN THAILAND

	Natural science	**Agricultural science**	**Engineering**
Demand	5,055*	15,510*	68,564*
Supply		28,868	104,646
Now employed (1981)	4,689	13,258	61,646
Now in vocational colleges (1981)		15,610	41,000
Balance		+ 13,358	+36,082

**Government sector only*
Data from ref 12.

TABLE 5
MANPOWER FOR SCIENCE AND TECHNOLOGY IN THE PRIVATE SECTOR IN THAILAND

Total number of companies surveyed: 105

	Below degree level	Bachelor degree	Master degree	Doctoral degree	All degree levels
PRESENT STOCK					
Natural science	395	197	9	3	207
Agricultural science	167	70	6	1	77
Engineering	3,353	967	140	6	1,113
Medical science	10	75	7	2	84
Total	3,925	1,309	162	12	1,483
ADDITIONAL REQUIREMENT DURING NEXT 5 YEARS					
Natural science	2	25	2	0	27
Agricultural science	0	19	0	0	19
Engineering	429	226	11	2	239
Medical science	0	0	0	0	0
Total	431	270	13	2	285

Source: Ref 7

TABLE 6
ASEAN COUNTRIES AS PRODUCERS OF SCIENTIFIC OUTPUT

Countries	**Classification by**		
	No. of authors	**Growth**	**Authors/capita**
Indonesia	Moderate	Fast	Low
Malaysia	Large	Moderate	High
Philippines	Large	Moderate	Middle
Singapore	Large	Moderate	High
Thailand	Large	Fast	Middle

Data are based on ref 14.

TABLE 7
INTERNATIONAL SCIENTIFIC PUBLICATIONS FROM THAILAND

Institution	Number of publications		
	1977	1979	1981
Mehidol University			
Faculty of Science	50	66	64
Faculty of Medicine, Ramathibodi Hospital	14	16	7
Faculty of Medicine, Siriraj Hospital	15	14	29
Faculty of Tropical Medicine	5	6	3
Others	2	–	3
Total	86	102	106
Chulalongkorn University			
Faculty of Science	7	13	21
Faculty of Medicine	10	12	8
Faculty of Veterinary Medicine	1	3	4
Faculty of Pharmacy	1	2	4
Others	2	3	5
Total	21	33	42
Chiang Mai University			
Faculty of Medicine	13	4	10
Faculty of Science	1	1	4
Faculty of Agriculture	1	2	3
Faculty of Pharmacy	–	1	–
Total	15	8	17
Kasetsart University	2	6	7
Silpakorn University	–	5	1
Khon Kaen University	3	4	7
Prince of Songkla University	1	4	5
King Mongkut Institute of Technology	6	15	4
Thailand Institute of Scientific and Technology Research	2	1	3
Ministry of Science, Technology and Energy	–	–	3
Ministry of Agriculture	1	5	9
Ministry of Health	1	4	9
Asian Institute of Technology	12	17	27
Others	3	34	29
Grand Total	153	238	269