

Science and Technology Development for Industrial Competitiveness in Thailand: Problems and Lessons

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Thailand's economic growth since the late 1980s has been impressive. The country is also in a state of transition from a traditionally agro-based economy to a more industrially oriented one. Despite this economic success, however, there are still questions about the country's long term ability to sustain economic growth while improving international competitiveness. This is particularly true for the country's industrial sector.

Throughout Thailand's industrial development, there has been a strong reliance on imported technology. Despite this, few firms have managed to raise their performance levels to international standards and to carry out significant improvements to their products and production systems. A large number of firms remain technologically static even though they have been operating for many years (Chantramonklasri, 1986). In many large Thai and joint-venture firms, the innovative capabilities are still very weak (TDRI, 1992a). At the same time, the industrial sector as a whole has not developed into a coherent production structure, but has become an agglomeration of largely independent "islands" of manufacturing companies with no strong linkages between them or to other sectors of production. Except for some exports produced by foreign or joint-venture firms, most of the country's industrial products are not technologically sophisticated.

This situation clearly suggests that, unless the country manages to upgrade and strengthen its industry, its chances of becoming internationally competitive are limited. Further compounded by the fact that at present there are new market economies with much lower wages and more abundant natural resources, Thailand's traditional comparative advantages in terms of labor and resources may be rapidly eroded. As developed countries move toward more modern and automated production and make significant advances in new materials, certain exports from Thailand will become less competitive, and hence the survival of some industries may be at risk. It is thus highly possible that without substantial efforts to develop indigenous capability in science and technology to support industrial development, Thailand may even face a major economic and social crisis in the near future.

EXPERIENCE IN SCIENCE AND TECHNOLOGY DEVELOPMENT IN THAILAND

Development of Scientific and Technological Institutions

The call for investment in science and technology development is not new in Thailand. For more than 30 years, there has been a growing awareness of the need to develop science and technology. In 1956, the government established the National Research Council of Thailand (NRCT) to fund research activities in wide-ranging areas, from basic science to social science in the public sector, including universities. The Thailand Institute of Scientific and Technological Research (TISTR) was set up in 1963, originally as the Applied Scientific Research Corporation of Thailand. It was established as the main publicly-funded institute to carry out a specialized scientific and technological activity, i.e., research and development (R&D) to serve almost all production sectors of the economy. Fifteen years ago, the Ministry of Science, Technology and Energy was established. This clearly indicated the recognition of the role of science and technology in national development. There have also been some research activities in the country's universities, but on a limited scale. Much more research has been carried out in governmental agencies.

Since the establishment of the Science and Technology Development Board (STDB) in 1985, which was then

a US\$50 million United States-Thai cooperative project, research in universities has been strengthened. The STDB aimed to raise the level of Thailand's technological capability through R&D grant support to public-sector researchers, R&D grant and loan support to companies, as well as information and consultancy services. STDB's main emphasis, however, in terms of both efforts and resources, was on strengthening R&D capability in universities and government agencies and on mobilizing this existing public-sector capability toward a higher level of applicability.

STDB's establishment reflected dissatisfaction in the under-investment in R&D and, perhaps more importantly, under-utilization of public-sector capability for economic development. By the 1980s, it had become evident that not only the existing institutes (especially NRCT and TISTR) had spread their limited resources too thin, but also that the interaction between different scientific and technological components in the country was very weak. In particular, the so-called technology suppliers in public research institutes and universities and the technology users in industry failed to interact with each other; and the latter in many cases was not even aware of the existence of the former.

About the same time that the STDB project was launched, three national centers were established under MOSTE to provide funds to state universities, state enterprises and government agencies for R&D. These specialized in the areas of biotechnology, materials technology, and electronics and computer technology. These four initiatives, i.e., STDB and the three centers, were the predecessors of the National Science and Technology Development Agency (NSTDA), established by a special law, the Science and Technology Development Act, in December 1991. NSTDA supports both public and private sector organizations, and has plans to develop its own research laboratories in the three technological fields. Since NSTDA is still new, it is difficult to assess its current impact on industry. An assessment of its predecessors, however, suggests that few of the public-sector R&D projects supported by them have resulted in commercial application (TDRI, 1992b-g).

Governmental support to directly stimulate the development of technological capability in industry has been nearly non-existent, apart from small private-sector R&D support of STDB, now under NSTDA, and a similar MOSTE funding program. A more recent development has been the establishment of the Thai Research Fund (TRF) in 1992; but its mandate is close to that of NRCT rather than aimed specifically at encouraging industrial technological development. The Industrial Finance Corporation of Thailand (IFCT) used to have a soft-loan program for private-sector R&D, but this no longer exists. In an attempt to stimulate investment in R&D within the industrial sector, the Board of Investment (BOI)—the key organization responsible for granting privileges to promote investment projects—has offered since 1989 various tax incentives associated with setting up R&D laboratories and the related imports of machinery and equipment for use in R&D activities. So far, these mechanisms have not been well received by the private sector.

Problems and Lessons

The limited utilization of public-sector R&D capability has been caused principally by the tendency of researchers to carry out scientific and technological activities in a manner which is isolated and disconnected from the real world. Despite attempts to launch commercially viable R&D programs, various "centers of research excellence" have often been unable to have an impact on the industry. A well-known argument often used to explain this ineffectiveness is that industrial firms have a tendency to utilize proven technologies from foreign sources, thus limiting the demand for local scientific and technological capabilities. This argument remains highly questionable because it presumes that those "centers of excellence" have available the kinds of products which are relevant to the needs of their potential clients. As noted by an empirical study, "industrial firms tend to doubt the ability and effectiveness of universities and public technical institutes to solve practical industrial problems" (TDRI, 1992a, p. 85).

Underlying this situation is the fact that despite the policy awareness of the importance of science and technology for development, the prevailing policy practice is problematic. When concrete policies and actions on science and technology development are made and implemented, there is usually a bias toward a specific area.

The policy approach taken in Thailand (as in many other developing countries) has three important features:

- The effort to promote science and technology development has almost exclusively focused on R&D, i.e., a specialized activity undertaken to create new technical knowledge which would become a starting point for the eventual production of new materials, new products or new processes. Behind this is the conventional wisdom which assumes that R&D is the prime-mover of a linear and sequential process of innovation—i.e., a process starting from "basic and applied research" to "development and engineering" and eventually "production and application."
- There is a belief that as most firms in the economy are too small or backward to undertake significant R&D, such activities should be undertaken by the government. Hence, the policy perspective has been even further distorted to emphasize the development of R&D capability in the public sector with an expectation that this would generate useful outputs. Resources and efforts are directed toward establishing and strengthening R&D institutions and R&D activities outside the structure of industrial production. This practice has drawn significantly on ideas and models from developed countries, despite various contextual differences between them and less developed countries.
- There has been little consideration given to utilizing international technology transfer, through which most industrial firms in Thailand were established, to complement local efforts in building up technological dynamism in industry. Local technology development and international technology transfer are often treated as isolated from each other. In the minds of many technology development promoters, they are seen almost as alternatives—either import goods, services and know-how from abroad or invest in local R&D.

Eventually, policy concern which begins with science and technology development becomes confined to R&D issues. Technology acquisition, consultancy and technical services are not totally excluded, but they are often dealt with vaguely and much less seriously. Thus, the development of science and technology in Thailand has been viewed as nothing much more than an under-investment in R&D. Policies and measures have mainly emphasized developing public sector R&D capability, policy concern has usually been about how to increase the total level of government funding for public sector R&D.

With the growing realization that there is a serious problem in the application of public-sector R&D, there have been some efforts to improve public institutes. But these have emphasized almost exclusively internal management improvement—especially giving more autonomy and flexibility. There is little analysis of the underlying principle that governs the establishment and operation of these institutes and on the structural problems of the existing pattern of industrialization. There has not yet been a systematic examination of the supply and demand of science and technology in the context of industrial development. Consequently, when no significant improvement and change in the existing institutes could be made, new institutes for generating or strengthening endogenous technological capabilities were established with a hope that they, under efficient management, would fulfill the expectation of effectively utilizing science and technology to promote industrial competitiveness. Various linkage measures, such as R&D grants and tax incentives for the private sector, have also been employed more recently to augment the mainstream efforts. Yet, it is highly questionable whether all these efforts—most of which are not concerned with the demand side of science and technology—are on the right track.

The argument that local R&D efforts have not contributed much to technological development in industry is by no means a suggestion that R&D is unimportant. R&D is a key capability needed to generate technical changes and improvements in industry. But R&D is never sufficient by itself for generating new products, processes and services as well as various kinds of improvements needed by industry. A wide range of other technological and managerial resources and capabilities is needed. Perhaps more important than the R&D capability in the public sector is the development of technological and managerial capabilities, including R&D strength, *within* the industrial sector itself.

As suggested by numerous studies in recent years, there are two major differences between advanced countries and less advanced countries in their R&D investment. First, advanced countries have a higher level of national investment in R&D, both in absolute and relative terms. This is evident in [Table 1](#), which shows that while Japan spent about 3 percent of its GNP and newly-industrialized countries like Korea, Taiwan and Singapore spent about 1 to 2 percent of their GNP in R&D, the R&D investment in Thailand in recent years was less than 0.2 percent of GNP. The second and more important difference concerns the national share of private-sector R&D. In Thailand, this has been very small, i.e., only about 5 to 8 percent, as shown in [Table](#)

1. This strongly contrasts with the situation in the more advanced countries, where their private sectors accounted for half or most of the R&D investment.

There is reason to believe that unless industrial firms have built up significant in-house capabilities they cannot effectively draw on public sector R&D results. This limits the effectiveness of public-sector R&D. In other words, unless the technology users are sufficiently sophisticated to conceptualize and translate their needs into a requirement for products and services, they cannot exert an effective "pull" on the formal R&D system.

As mentioned earlier, the government has recently offered various incentives and financial support for R&D activities in industrial enterprises, but these have not been effective. A major problem is that these incentives are mostly aimed at small and medium-sized local firms—which usually do not possess sufficient in-house capabilities to engage in R&D activities. Moreover, firms can normally draw on sources of technology other than in-house and public-sector R&D. What is needed by most firms may not be new technical knowledge but re-creation and assimilation of knowledge from elsewhere, especially from foreign sources. This fact coupled with the general belief that technology can be readily acquired from foreign sources may lead firms to feel that there is little or no need to invest in R&D. Once firms obtain appropriate and efficient technical systems, they assume that everything will be all right. They then take a rather passive approach, until it is time to choose another new production system. Thus, they can simply undertake very limited technological learning, i.e., only at the minimum level needed to operate the systems. Indeed, there is a lack of awareness among many industrial firms of the importance of in-house technology development, not only R&D.

Economic policy for industrial development in Thailand has actually generated disincentives for companies to invest in developing in-house technological capabilities and has encouraged them to acquire only "ready-made" technology. The policy framework was designed with the following concepts in mind:

- To stimulate the growth of new industries, especially those producing for local markets, various protective measures, such as the import ban and high tariff, are needed to help these infant industries achieve competitive efficiency.
- Technology is almost equivalent to machinery and equipment; hence a major problem of industrial development is to promote investment in that "capital-embodied" technology by providing incentives to subsidize that investment and facilitate the transfer of that technology from abroad.

Consequently, policy measures have not been designed to generate *demands* by firms to pursue an aggressive investment strategy to ensure acquisition of in-depth knowledge along with their usual purchase of production facilities from abroad. Actually, no policy attention has been given to the issue concerning efforts by firms to acquire knowledge and expertise that would be required to build up significant technological capability within industry in the long term. On the contrary, some features of industrial policy have had a negative influence on investment in *knowledge* capital by industry. The most important is the "import-substitution" policy, accompanied by "infant-industry protection." Although there is now a slight change in policy toward more export-oriented and less protective regimes, that practice persisted for a long period and thus has effectively reduced or removed competitive pressure on firms. Without a competitive market, where firms perceive technical improvement and innovation as imperative to their survival and growth, there is little or no demand for investment and accumulation of technological resources and capabilities.

Experience in Industrialization and Technology Development of More Industrialized Countries

Given that certain countries, such as Japan, Korea, Taiwan and Singapore, have attained high degrees of technological dynamism in industry, it is useful to examine their experience in industrialization and technology development. Although much of their experience may not be completely applicable to the context of Thailand, a brief overview of their common patterns of development may offer useful insights.

As is reflected in [Table 1](#), the most important aspect of their experience is the accumulation and utilization of technological capability *within* industry. Centralized research institutions have played a role in supporting

the development and application of science and technology as a complement to, not a substitute for, the efforts of the production sector itself. Moreover, the linkage between these institutions and industry has usually been of an *interactive* nature, rather than simply a one-way flow of output from the former to the latter. In other words, industry in these countries has played an important role in influencing the activities undertaken by centralized institutions. In some cases, the industry has even influenced the creation and evolution of the institutions. Furthermore, the experience in institutional development of these countries has demonstrated a process of institutional *innovation*, i.e., the design and development of different types of institutions to meet differing and changing needs. This path of institutional development was similar to that of some advanced countries in their early phases of industrialization, as pointed out by R. M. Bell (1985):

The evolution of the institutional structures for harnessing science and technology to economic development was not based simply on copying the models available in more industrialized countries. As with technology itself, selective and adaptive imitation of institutions was combined with a continuing succession of "homegrown" institutional innovations. These were developed out of the experience of the societies themselves (p. 11).

As also suggested by Linsu Kim and Carl Dahlman (1992) with respect to the case of Korea, the more successful public R&D institutes were not confined to the narrow function of R&D—contrary to the orientation of similar institutes in Thailand.

Therefore, it seems that the pattern in Thailand of 1) imitative rather than innovative institutional development, and 2) development of innovative capability outside rather than within industry, was not really the dominant trend in industrialized and newly-industrialized countries.

Another equally striking feature of their experience was the utilization of international technology transfer to augment local technological efforts in industrial firms, and behind that, the supportive role of the public sector. Japan's experience in its early days of industrialization is a good example, as described by R. M. Bell (1985):

Japanese firms made considerable efforts not just to import technology in the form of machinery and operating know-how, but also to acquire it in the form of underlying knowledge and principles that would add to their own capacity to generate technical change.By the twentieth century, the complexity of industrial technology often required firms to make different kinds of effort to ensure that, in importing technology, they also built up a technological capacity to generate their own subsequent path of technical change....by investing in "deeper" technological training, in the development of engineering expertise, and in their own research and development. (In the 1950s and 1960s) such complementary efforts linked to the importation of technology were commonplace among Japanese firms; and, at least in key industries, government policy (implemented through MITI) explicitly ensured that firms actually made those efforts (p. 10).

Various kinds of mechanisms have been employed by the governments of these countries to systematically encourage and reward such efforts by firms. The Korea Technology Banking Corporation (KTB), for example, provided funds, soft loans and technical assistance to such activities as foreign technology acquisition, technology upgrading, and technical training as well as R&D. The Economic Development Board (EDB) of Singapore has not only played a key role in directing investment into strategic industries, but also orchestrated various governmental and private efforts to upgrade the technological levels of local and foreign firms through the provision of incentives, including generous loans and grants, and a wide range of technical and business advisory services. Other schemes were launched to assist local firms in upgrading their operations by acquiring foreign expertise, sometimes with the help of multinational companies—not to mention the establishment of venture funds and many specialized training institutes. Similarly, the Taiwanese government has not only provided its local industrial firms with fiscal and financial supports, but also employed substantial resources and efforts to facilitate international technology transfer, including forging strategic alliances between foreign and Taiwanese firms. The situation in Thailand contrasts sharply with those of the countries cited above.

The governments of these countries have also been highly interventionistic in creating the *demand* for technological development. Among various measures employed, government policies that enhanced market competition seemed to play the most important role. This is highlighted in the case of Korea, as noted by Linsu Kim and Carl Dahlman (1992):

Korea's outward-looking policy appears to have been another important mechanism..... While the Korean government highly protected the local market to foster infant industry growth, it promoted exports as something of a "life or death struggle" in order to bring about economic growth goals within a small domestic market. Thus, the government pushed and pulled firms with threats and promises. Export promotion continually places pressure on firms to acquire foreign technology and to use it effectively in order to be able to compete in foreign markets. (p. 442) ...As producers entered the international market, the keen international competition forced them to invest more in technological efforts. In addition, informal technical assistance offered by foreign OEM (original equipment manufacturer) buyers to ensure that Korean-made products met their technical specifications provided invaluable help to Korean firms in acquiring the necessary technological capability (p. 451).

Similarly, the gradual liberalization of the Korean domestic market in more recent years made it "imperative for Korean firms to enhance competitiveness by elevating their technological capabilities through foreign technology transfer as well as through intensifying their own R&D efforts" (Linsu Kim and Carl Dahlman, 1992, p. 447).

Finally, a large part of the economic success of these countries is due to their aggressive strategies in human resources development. Again, this can be summed up by the case of Korea. "It was Korea's heavy investments in human resource development that made it possible to acquire technological capability rapidly and, in turn, to achieve rapid industrialization" (Linsu Kim and Carl Dahlman, 1992, p. 451).

Current Problems and Challenges Ahead

Various domestic conditions and Thailand's current international economic environment are quite different from those faced by the more advanced countries when they embarked on industrialization. Apart from the frequently cited differences in politics and socio-cultural settings, there are several important factors which are likely to create additional problems, obstacles and challenges for Thailand's sustained industrial development.

First, Thailand has faced and will continue to face a severe shortage of technical manpower, especially engineers, scientists and technicians. Moreover, most technical human resources in industry are used for routine production and maintenance rather than innovative activities. Taking into account the potential demands for manpower for broader and deeper technological development, the shortage will become even higher. Almost all universities are now facing problems in retaining their limited staff and hence are unlikely to be able to produce the needed manpower at a level that can fulfill industrial demands in the future. In addition, given that the momentum of technological changes will become increasingly rapid, formal education by itself may not be adequate in the long term to meet the changing and more specialized requirements of the production sector.

Furthermore, the issue is not simply about generating knowledge elites in high-level educational institutions. To sustain future economic growth and increase international competitiveness, Thailand will require, among other things, a substantial upgrading of its industries, including adopting increased automation. Consequently, the days when companies would hire cheap and unskilled workers and keep them employed for years will soon end. But, the country may not have enough educated and skilled people to serve higher knowledge-based work.

There is strong evidence to suggest that the industrialized world is now in the process of a technological revolution of enormous scale. This will entail significant changes in many production activities and will pervasively affect almost all aspects of social and economic development. Micro-electronics/information technology and biotechnology are playing a prime role in this process. Given that in the industrialized world

billions of dollars are being invested to develop these new technologies and that they can generate significant productivity and quality gains, their rapid diffusion across a number of production activities can be expected. Such changes in the industrialized world can eventually undermine the competitive advantages Thailand has in certain exports. There is also growing evidence that the access to advanced know-how is increasingly constrained by both the complexity and size of the technology itself as well as by the fact that its appropriation is increasingly under the control of industrialized-country firms and organizations. Local firms in many industries may eventually have to enter into a new era of technological dependence on foreign sources of machinery and expertise. It is imperative that a wide range of efforts and measures be systematically deployed to enable Thailand to benefit from the new technological changes while keeping their threats or negative effects to the minimum.

The world economic environment since the 1980s has changed significantly. In the wake of recession and international trade problems and growing unemployment in some advanced countries, protectionistic policies have been employed in several world markets. Conversely, more liberal trade regimes in some economic regions, such as the North American Free Trade Agreement (NAFTA) and the coming ASEAN Free Trade Agreement (AFTA), imply intense international competition. Thai industries may have to compete against foreign or multinational companies in both domestic and international markets. These changes, coupled with the changes in the area of intellectual property rights, will have significant implications for the future development prospects of Thailand.

The increasingly intensive competition at the interfirm and international levels will lead to major changes in corporate strategy. Indeed, the recent surge in interfirm cooperation among the developed country companies and transnational companies signals a new mechanism for addressing a wide range of corporate objectives. In the domain of technological innovation, many firms are forming strategic alliances to gain access to complementary technologies. Thai industry, however, has had a very limited historical accumulation of the skills, knowledge, organizations and relationships that constitute the basis for international competitiveness. The chance that Thai firms can enter into cooperative agreements as a means to achieve internationalization is limited. Therefore, there may be a need for supports, or pressures, to stimulate and facilitate the internationalization of Thai industry. This is not just a matter for trade policy. A range of national programs and policy measures is needed to foster greater development of technological and managerial capabilities in industry. They must be highly focused on specific industries and also take into account the rapidly changing international environment.

In the light of the analysis in this article, perhaps the most important challenge for Thailand is the ability to recognize the limitations of its past pattern of science and technology development. Without that recognition, it is unlikely to be possible to formulate and implement a new approach to policy and institutional development that is qualitatively different from the dominant efforts in the past and has an international and dynamic perspective.

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