

Technological Innovation of Industrial Enterprises in Thailand

Project Synthesis prepared by The Brooker Group plc. for the Regional Workshops on

INNOVATION IN THE MANUFACTURING SECTOR

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Introduction and Context

It is hard to know how to adequately demonstrate the importance of innovation for Thailand's future, but there is no doubt that R&D and other innovation activities will be a critical determinant of Thailand's future competitiveness. And Thailand's declining rankings in the global technological capacity sweepstakes must be seen as cause for serious concern.

Technology is moving very fast. Thailand's former "comparative advantages" are eroding; and new competitors are emerging in lower-cost manufacturing locations across the globe. It will be very hard for Thai-based firms to remain at the technology frontier without better information on local and global trends.

Urgent efforts are required to understand better the nature of innovation activities in Thailand's industrial base and the ways in which government agencies can greatly enhance them – because there is no doubt that a tremendous

increase in resources devoted to science and technology is of the utmost importance.

The new government and the 9th Economic and Social Development Plan explicitly recognize the importance of science and technology in Thailand's future.

With these factors in mind, the National Science and Technology Development Agency (NSTDA), in partnership with The Brooker Group Public Company Limited, implemented the Thailand R&D/Innovation Survey 2000. The survey was carried out in collaboration with the Department of Economic Geography at the University of Hannover, Germany (which has carried out similar surveys in eleven regions in Europe); the Centre for Management of Innovation & Technopreneurship at the National University of Singapore; and the Socio-Economic & Environmental Research Institute (SERI) in Penang, Malaysia.

On the Importance of R&D and Innovation

R&D and Innovation activities are generally recognized as being critical determinants of competitiveness, and as increasing in importance as technologies move very rapidly and global competition becomes more intense.

At the macro-level, indicators of R&D and innovation reflect the country's well-being. At the micro-level, they are seen as the determinant of a firm's success or failure – enterprises must continually strengthen their technological capabilities or disappear from the scene.

Both the public and private sectors increasingly face the challenge of developing new products, processes, and services to propel the firm, sector, and economy forward. National innovation systems that support technological activities at the firm-level are now a pre-requisite for successful competition in global markets.

A set of quotations is perhaps a good way to illustrate the point that R&D and innovation activities are critical for Thailand's competitiveness and prosperity:

- *"Innovation is one step removed from today's prosperity. Innovation drives the rate of long-run productivity growth and hence future competitiveness."* Michael Porter, Harvard University
- *"The new technological requirements of enterprises have forced countries to give a priority to technology. Attracting research centers, and developing cooperation between local universities and enterprises, is becoming just as important for the competitiveness of a country as attracting FDI."* Stéphane Gareli, IMD
- *"The intensity of business-performed R&D in Thailand would need to be increased to around 20 times its present level in order to 'catch up' with the intensity in Korea at that corresponding earlier stage of industrial development."* World Bank Report on Thailand S&T, 2001
- *"In today's competitive world, innovation is a key ingredient for success."* The Asian Innovation Awards 2001

Thailand R&D/Innovation Survey 2000: Objectives

The objectives of the Survey were as follows:

First, to develop a technology innovation database of Thailand's industrial enterprises that will greatly support TIAC's mission of providing valuable information services to the private sector.

Second, to enhance understanding of the levels and nature of R&D and other innovation

activities in Thai enterprises, and to provide a much more accurate picture of Thailand's S&T environment to support international business decisions.

Third, to identify critical policy measures to support R&D and innovation activities. NSTDA intends this survey to be simply the beginning of a process – one in which NSTDA will play an active and responsive role.

The Approach and Survey

The R&D/Innovation Survey 2000 of the manufacturing sector is the first of its kind in Thailand and it covers both R&D and other technological innovation activities carried out in Thailand. The survey adapted definitions and methodologies used in the OECD and other countries in Asia (namely Singapore and Malaysia) in order to facilitate international comparisons.

Using a three-stage sampling procedure consisting of stratified random sampling, probability proportional to size (PPS) and systematic random sampling within each industrial sector in each stratum, a total of 2,166 firms were selected from the top 13,450 companies by revenues in 1999.

Questionnaire Design and Development

The R&D/Innovation survey questionnaire focused on determining the characteristics of firms that carry out R&D and other innovation activities. It also covered the types of R&D and other innovation activities as well as factors which influence firms' abilities to carry out R&D and other innovation activities.

The questionnaire comprised the following parts:

- Section A: General information on companies including type of products, year of establishment, number of employees, etc.
- Section B: R&D activities including definition of R&D, types of R&D activities, R&D expenditure and personnel, etc.
- Section C: Innovation activities other than R&D
- Section D: External collaboration for R&D and innovation
- Section E: R&D and innovation environment of Thailand

Sampling Strategy

The sampling methodology was developed in order to obtain unbiased estimates of the population R&D parameters to be measured - expenditure on R&D, and total R&D personnel in manufacturing enterprises. The Business On-line database, with comprehensive information on around 35,000 manufacturing establishments registered with the Commercial Registration Department, Ministry of Commerce was used.

The R&D/Innovation Survey 2000 Time Line

- Project launch and press conference – December 2000
- Survey and questionnaire design and pilot testing – December 2000-January 2001
- Survey launch – mid-January 2001
- Interim report on R&D indicators for the manufacturing sector in 1999 based on 681 responses – March 30, 2001
- Survey completion, 1,019 respondents – mid-April 2001
- Analysis and final report – end-May 2001
- Workshop at NSTDA Annual Meeting – June 21, 2001
- Regional Innovation Workshop – July 18, 2001
- Ongoing dissemination activities – June-July 2001

Response Rate

Of the 2,166 firms sampled, a total of 1,019 completed questionnaires were received representing approximately a 50 % response rate. Of these, 154 carried out R&D and 223 other innovation activities.

All R&D performing respondents followed up individually to check that they understood the meaning of R&D and innovation and to check the data.

Definitions of R&D and Technological Innovation

What is R&D?

Research and experimental development (R&D) in industry is defined as **creative work** which is undertaken on a **systematic basis** in order to create new or improved products, processes, services or other applications. R&D is distinguishable from other activities by the presence of a substantial **element of novelty** and by the **resolution of problems** and uncertainties using **scientific** or **technological** methods.

The three classes of R&D:

Basic Research:

It is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts without any particular application or use in view, e.g. publications in scientific and engineering magazines

Applied

Research: It is also original investigation undertaken in order to acquire new knowledge. It is however directed at determining possible uses for basic research findings or finding new ways of achieving some specific predetermined objectives.

Experimental Development:

It is systematic work, drawing on existing knowledge gained from research and practical experience that is directed at producing new materials, products, devices, installing new processes, systems and services or at improving substantially those already produced or installed.

Source: derived from the *Frascati Manual (OECD)*

What are Other Innovation Activities?

Technological innovation is the capability of firms to use their technological knowledge,

skill and experience to develop and produce new products, new production process or new services that respond to market demand, including:

- Acquisition of machinery, equipment and software linked to product and process innovation
- Acquisition of external technology linked to product and process innovation e.g. patents and licenses
- Industrial design and engineering, market research and marketing expenses linked to product and process innovation
- Training directly linked to product and process innovation

What is R&D?	What is NOT R&D?
Development of prototypes	Scientific and technical information services
Construction of pilot plants	Routine testing and standardization
Trial production (if it implies full-scale testing and subsequent further design and engineering)	Patent and licence work not related to any R&D project
Industrial design and drawing directly linked to R&D	General purpose data collection, including market research
Technical activities carried out on new products & processes after they have been turned over to the production unit	Feasibility and policy-related studies
Industrial engineering and tooling up directly linked with the development of new products or improved products or processes	Education, training, and after-sales services
Source: Thailand R&D/Innovation Survey	

Product innovation: Either the development of a **new product** whose technological characteristics or intended uses differ significantly from those of previously produced products, e.g. the development of a gel fuel from agricultural refuse to be used for cooking in poor agricultural countries; or the portable electronic dictionary that translates the English language into Thai ('Talking Dic'), or an **existing product** whose performance has been significantly enhanced or upgraded, e.g. the

environmentally -friendly motorcycle developed in Thailand, or the boosting of radio reception capacity to suit residents in remote areas.

Process innovation: Adoption of technologically new or significantly improved production methods through the introduction of new process equipment or re-engineering of operational processes, e.g. the introduction of a robot in the spray painting unit in a car factory in order to increase efficiency of the production process, or the use of CAD/CAM to help assemble bicycle components to lower process times.

Source: derived from the *Oslo Manual (OECD)*

R&D in Thailand's Manufacturing Sector

The national-level statistics from the Thailand R&D and Innovation Survey – 2000 showed that medium and large firms in the Thai manufacturing sector spent more than 5.5 billion baht on R&D in 1999, employing 5,291 research personnel consisting of 2,725 researchers (Ph.D. and non-Ph.D.) and 2,566 support staff (including technicians, managers and other R&D staff).

The most encouraging sign is that in 1999, the manufacturing sector's estimated total national R&D expenditure is much higher than previously estimated - demonstrating that overall, the Thai business sector, while not yet at the levels of other major competitors, has been taking a much greater interest in R&D and innovation activities than previously thought.

Total R&D in Thailand – Some Estimates

Overall, Brooker estimated optimistic and pessimistic scenarios for R&D in Thailand. The optimistic scenario involves an estimate of total R&D in Thailand for 1999 of some 13.5 billion baht (or around US\$ 358 million). In addition to the 5.5 billion baht carried out by the manufacturing sector, this includes a guesstimate of 1 billion baht of R&D for the rest of the Thai private sector (SMEs, services, etc.) and a

budgeted amount for R&D of 7 billion baht in the public sector.

While this still amounts to only 0.29 percent of total GDP, considerably less than comparative levels in Singapore and Malaysia and the 0.75 percent of GDP targeted in the 8th National Economic and Social Development Plan, it does provide a solid platform from which to plan future R&D activities.

Brooker Optimistic Scenario:

Manufacturing sector R&D estimate from R&D/Innovation Survey:	5,554 m. baht	147 m. US\$
Non-manufacturing sector R&D and SME R&D (guesstimate)	1,000 m. baht	26 m. US\$
Public sector R&D (assuming the total budget was spent)	7,000 m. baht	185 m.
		US\$Total R&D 358 m. US\$

Brooker Pessimistic Scenario:

Manufacturing sector R&D estimate from R&D/Innovation Survey:	5,554 m. baht	147 m. US\$
Non-manufacturing sector R&D and SME R&D (guesstimate)	0 m. baht	0 m. US\$
Public sector R&D (assuming ~60 of total budget was spent as in 1997)	4,000 m. baht	106 m.
		US\$Total R&D 253 m. US\$

Memo Items - 1999: Population: 61.7 million; Baht/US\$ avg. exchange rate: 37.84; Manufacturing sector GDP: 1,435,369 m. baht; Total GDP: 4,615 b. baht

Sources: NSTDA R&D/Innovation Survey; IMD 2001 Global Competitiveness Yearbook; Bank of Thailand; National Science and Technology Development Agency; Brooker estimates.

R&D and Innovation Among the 1,019 Sample Firms

Sample firms spent 1,350 million baht on R&D in 1999. Companies in the food, beverages, tobacco sector carried out the most R&D in 1999 (~ 48% of the total), with fabricated metals, machinery & equipment second (~ 35%). Companies in the jewelry and related industries sector contributed least to total R&D (< 1%).

Firms engaged in R&D activities spent 72% of their expenditure on experimental development, and 66% of their total R&D expenditure on product-oriented R&D.

In total, there were 1,087 research personnel employed in surveyed firms in 1999. Companies indicated that 52% of total R&D expenditure was allocated to R&D personnel

Expenditure on other innovation activities in 1999 totaled 2,084 million baht, considerably more than the amount spent on R&D.

Companies in fabricated metals and M&E contributed the most to the expenditure on other innovation activities (~49%), with food, beverages, and tobacco second (~32%). Firms in wood/wood products spent least (< 1%).

The most common other innovation activity in 1999 was the acquisition of machinery and equipment linked to product and process innovation. The least popular activity was the acquisition of external technology.

Firm Strategies for R&D and Innovation - The Key Drivers and Constraints

The key drivers of R&D during the three-year period 1997 to 1999 were: (a) to improve product quality; (b) to reduce production cost; and (c) to extend product range. The main objectives for carrying out R&D coincided closely with the perceived needs of customers, namely 'quality' and 'reducing production cost in order to provide competitive pricing'.

Ranking of Objectives for R&D Activities (1 – not important, 5 – very important)	
Objective	Ranking
Improved product quality	4.4
Reduce production cost	4.2
Extend product range	4.1
Increase market share	4.0
Open up new market	4.0
Learn about new technology	3.9
Reduce energy consumption	3.7
Replace products being phased out	3.7
Reduce environment effects	3.6
Improve work conditions	3.5
Fulfill regulations & standards	3.4
Improve product flexibility	3.4
Improve cycle time	3.3
<i>Note: Opinions from firms that did R&D</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

The major factors limiting R&D in Thailand were: (a) lack of government R&D incentives; (b) inadequate support services; and (c) insufficient supply of R&D personnel

Ranking of Factors Limiting R&D (1 – not important, 5 – very important)	
Factor	Ranking
Lack of government R&D incentives	3.7
Inadequate support services for R&D	3.6
Insufficient supply of R&D personnel	3.5
In-house lack of R&D personnel	3.4
Lack of information on opportunities	3.3
Lack of R&D infrastructure in the firm	3.2
Lack of R&D strategy at the firm level	3.1
Limited financial resources	3.1
No competition in domestic market	2.9
Management sees no need for R&D	2.5
<i>Note: Opinions from firms that did R&D</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

The key drivers of other innovation activities from 1997 to 1999 were: (a) to help reduce production cost and improve yield; (b) to improve product quality; and (c) to extend product range/open up new markets/increase market share.

Ranking of Objectives for Innovation (1 – not important, 5 – very important)	
Objective	Ranking
Improved product quality	4.3
Reduce production cost/improve yield	4.3
Extend product range	4.1
Increase market share	4.1
Open up new markets	4.1
Learn about new technology	4.0
Reduce energy consumption	3.9
Improve production flexibility	3.8
Improve work conditions for employees	3.8
Reduce environment effects	3.8
Improve cycle time	3.7
Replace products being phased out	3.7
Fulfill regulations & standard	3.6
<i>Note: Opinions from firms that did innovation</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Major factors limiting innovation included: (a) the perceived cost was too high; (b) lack of government support; and (c) lack of qualified personnel.

Ranking of Factors Limiting Innovation (1 – not important, 5 – very important)	
Factor	Ranking
Lack of government support	3.6
Perceived cost too high	3.6
Lack of qualified personnel	3.5
Inadequate support services	3.4
Lack of information on markets	3.3
Lack of information on technology	3.3
Limited financial resources	3.1
Perceived risks too high	3.0
Lack of customer interests in innovation	2.9
Lack of competition in the domestic	2.6
Internal resistance to innovate	2.2
<i>Note: Opinions from firms that did innovation</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Firm Strategies for R&D and Innovation – Knowledge Sources and Collaboration

Sources of Information

The most important source of information for companies carrying out R&D and other innovation activities was 'their clients'. This was followed by 'sources within the enterprise' and the 'parent/associate companies'.

Top Five Sources of Information for R&D and Other Innovation Activities (1 – not important, 5 – very important)	
Factor	Ranking
Clients	4.2
Parent/associate companies	3.9
Sources within the enterprise	3.9
Foreign-owned suppliers	3.6
Competitors	3.4
<i>Note: Opinions from firms that did R&D/Innovation</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Sources of Finance

Of the firms that carried out R&D and other innovation activities, only 9% obtained capital from venture capitalists or angel investors, indicating that these sources of support remain limited in Thailand.

Intensity of Collaboration

Companies engaged in R&D activities cited customers/buyers as their most important collaboration partner, followed by foreign-owned suppliers and parent/associate company overseas.

Level of Intensity of Interaction with Top Five Collaboration Parties in R&D (1 – not at all, 5 – intensely)	
Factor	Level
Clients	4.2
Parent/associate companies	3.9
Sources within the enterprise	3.9
Foreign-owned suppliers	3.6
Competitors	3.4
<i>Note: Opinions from firms that did R&D</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Companies engaged in product innovation activities cited customers/buyers as their most important collaboration partner, followed by foreign-owned suppliers and locally-owned suppliers.

Level of Intensity of Interaction with Top Five Collaboration Parties in Product Innovation (1 – not at all, 5 – intensely)	
Factor	Level
Customers, buyers	4.0
Foreign-owned suppliers	3.1
Locally-owned suppliers	3.0
Parent, associate company overseas	2.8
Technical Service Providers	2.4
<i>Note: Opinions from firms that did innovation</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Companies engaged in process innovation activities cited foreign-owned suppliers as their most important collaboration partner, followed by customers/buyers and parent/associate company overseas.

Level of Intensity of Interaction with Top Five Collaboration Parties in Process Innovation (1 – not at all, 5 – intensely)	
Factor	Level
Customers, buyers	2.9
Foreign-owned suppliers	2.9
Parent, associate company overseas	2.8
Locally-owned suppliers	2.7
Technical Service Providers	2.4
<i>Note: Opinions from firms that did innovation</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Reasons for Collaboration

The most important reason cited for collaborating in R&D/innovation activities was to 'gain know-how transfer'. This was followed by 'faster time to market' and 'the need to establish long-term strategic partnerships'.

Overall, customers/clients play an influential role in R&D and other innovation activities in Thailand. Strengthening linkages between these partners and Thai firms must be a critical component of policies to promote R&D and innovation.

The Environment for R&D and Innovation in Thailand

Overall, R&D performing companies identified the openness of customers and suppliers to innovation, and the attitudes of people to innovation as the strongest elements of the R&D and innovation environment in Thailand.

On the negative side, the availability of government incentives for innovation and the regulatory environment were judged poor, with the availability of supporting services in finance, consultancy, and manpower only marginally better. The lack of acceptance of failure in the Thai social fabric was cited as a factor of weakness in the business environment.

Assessment of the R&D and Innovation Environment in Thailand (1 – very weak, 5 – very good)	
Element of Business Environment	Assessment
Availability of government incentives for innovation	2.2
Regulatory environment	2.3
Acceptance of failure	2.4
Availability of finance for innovation	2.5
Availability of other technical supporting services	2.5
Consultancy support services	2.5
Listing requirements on SET stock exchange	2.5
Availability of suitable manpower in scientific technical sector	2.6
Intellectual property protection	2.6
Local university for technical support and R&D collaboration	2.6
R&D institutions for technical support and R&D collaboration	2.6
Technological sophistication of local suppliers	2.6
Availability of suitable manpower in business sector	2.7
Openness of government departments & regulatory authorities to innovation	2.7
Quality of telecommunications and IT services for enabling innovation	2.8
Attitude of people towards innovation	2.9
Openness of suppliers to innovation	3.2
Openness of customers to innovation	3.5
<i>Note: Opinions from 143 firms that carried out R&D</i>	
<i>Source: Thailand R&D/Innovation Survey 2000</i>	

Use of Public Services

Overall, the firms that reported using public services valued the information, technical, and training services provided by the government compared to other monetary incentives which were not used very extensively. University laboratory services were used a lot by the sample firms.

Company Proposals

In an open-ended question asking opinions on what the government can do to promote R&D and other innovation activities, some interesting opinions emerged:

The most common opinion provided was for the *provision of better information* on R&D, innovation, new products and new technology. Firms felt that better information both from within and outside the country, including analysis of the benefits to be obtained from R&D and innovation activities and ideas on new markets, would be beneficial.

The second most common opinion of firms was that the government should help *develop the human resource capabilities* (including researchers and technicians) in the country by providing a better education system, especially with regard to the types of human resources needed to develop R&D and innovation activities. Firms also felt that the government should provide grants and scholarships for their employees to train overseas as well as running more training workshops and providing industrial experts to help them in improving their human resources.

The third most common opinion was that the government should *provide funds, incentives, and loans* to R&D and innovation activities as well as reducing import duties on machinery and equipment.

A number of firms called for the creation of a centralized government organization that is solely responsible for R&D and related services, while others wanted better cooperation between government organization, universities and private sector in order to identify the needs of the private sector and then provide relevant solutions. This could involve regular meetings in order to share ideas and information as well as to discuss challenges faced by the private sector and ways of solving them.

The Impacts of R&D and Innovation – Two Case Studies

R&D in an Electronics Firm

A manufacturer of microprocessor-controlled systems founded over 15 years ago, the company spends between 4-6% of its sales revenue on R&D annually.

The benefits of R&D to the company include:

- Increase its export market share and revenue by 15% annually
- Reduce production cost on an annual basis by 60%
- Gain new customers

Innovation in an Engineering Firm

An engineering company offering turnkey services for various types of food-related processing plants.

The benefits of carrying out extensive innovation include:

- Building in-house capabilities to meet its customer's needs (customized)
- Remaining competitive in terms of price and quality
- Developing & designing products under its brand name

What does Thailand Need to do Next? – Towards a 3-Pronged Action Plan

1. *Strengthen R&D and innovation activities in the private sector*

- Enhance awareness of the importance of technology investments in business through disseminating results of NSTDA survey – and highlight the key findings that indicate directions that need to be taken to create a better innovation environment.
- Support behavioral change at the firm-level with carefully designed incentive packages, including those designed to stimulate larger firms to interface more closely with small and medium suppliers.
- Build linkages and networks between all key players and “incentivize” them where called for and where significant spillover benefits can be seen to exist.
- Use the MNC base already in Thailand to support efforts at enhancing the technological capability of the Thai private sector (through an “extractive” policy that aims at mutual benefits).

2. *Improve efficiency of public sector investments in S&T and related infrastructure – both quantitatively and qualitatively*

- Refocus institutions to support business innovation activities, rather than lead them.
- Create specialized institutions with focus on key areas of R&D and innovation support.
- Build up the “new infrastructure” to support ICT applications, logistics, related human resources, etc.

3. *Coordinate all efforts at improving the S&T environment and other elements of the business climate for innovation and competitiveness*

- Form a high-level competitiveness working group chaired by the Prime Minister.
- Concerted efforts by selected agencies to examine the various elements of competitiveness and plan for related improvements.

Next Steps of the R&D/Innovation Project

- The Regional Innovation Workshops in Bangkok (July 18) and Penang (July 20) to consider the regional implications of the research work. This ability to learn from other country experiences will greatly enhance Thailand's policies to support and promote innovation. Given the increasingly global nature of knowledge, the project has placed importance not just on learning more about R&D and innovation in Thailand, but also on “benchmarking” Thailand against other countries in the region and across the globe.
- Intensify ongoing dissemination activities to all stakeholders.
- Derive further policy implications from the data gathered for the Thailand R&D/Innovation Survey 2000.
- R&D/Innovation survey of the services and IT sectors being planned.
- Thailand R&D and innovation directory being planned.