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GDI

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Tilman Altenburg
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German Development Institute
Tulpenfeld 4 · D-53113 Bonn
Telephone +49 (0)228 94927-0 · Fax +49 (0)228 94927-130
DIE@die-gdi.de
www.die-gdi.de

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ABBREVIATIONS

ADB	Asian Development Bank
AFTA	ASEAN Free Trade Area
AIT	Asian Institute of Technology
AMD	Advanced Micro Devices
APEC	Asian Pacific Economic Cooperation
ASEAN	Association of South East Asian Nations
ATTC	Ayutthaya Technical Training Center
BIOTEC	National Center for Genetic Engineering and Biotechnology
BOI	Board of Investment
BMZ	German Ministry of Economic Cooperation and Development
BSID	Board of Supporting Industry Development
BUILD	Board Unit for Industrial Linkage Development
CCP	critical control point
CCST	Certificate of Competence in Storage Technology
CENTEX	Center of Excellence for Shrimp Molecular Biology and Biotechnology
CEO	Chief Executive Officer
CoC	Code of Conduct
CP (Group)	Charoeon Pokphand Group
DIP	Department of Industrial Promotion
ECEA	Electronics and Computer Employers Association
EDB	Economic Development Board
EEI	Electrical and Electronics Institute
EEI-TC	Electrical and Electronics Institute-Testing Center
EPB	Economic Planning Board
EU	European Union
FAO	Food and Agriculture Organization
FCR	feed conversion ratio
FIBO	Institute of Field Robotics
FDI	Foreign Direct Investment
FTI	Federation of Thai Industries
GAP	Good Agricultural Practice
GATT	General Agreement on Tariffs and Trade
GDI	German Development Institute
GDP	Gross Domestic Product

GNP	Gross National Product
GTZ	Gesellschaft für Technische Zusammenarbeit
HACCP	Hazard Analysis and Critical Control Point Systems
HDD	Hard disk drive
IDEMA	International Disk Drive Equipment and Materials Association
IDF	Innovation Development Fund
IC	Integrated Circuit
ICT	Information and Communication Technology
IMD	International Institute for Management Development
IMF	International Monetary Fund
IPR	Intellectual Property Rights
ISR	Industry Science Relations
IT	Information technologies
ITAB	Industrial Technology Assistance Program
ITB	Invigorating Thai Business
JV	Joint Venture
KMIT-NB	King Mongkut's Institute of Technology North Bangkok
KMUTT	King Mongkut University of Technology – Thonburi
KPI	Key Performance Indicators
LCR	Local Content Requirement
LIUP	Local Industry Upgrading Program
M&E	Monitoring and Evaluation
MITI	Ministry of International Trade and Industry of Japan
MoF	Ministry of Finance
MoI	Ministry of Industry
MoST	Ministry of Science and Technology
MPAD	Material Property Analysis Department
MSTQ	Metrology, standard, testing and quality
MTEC	National Metal and Material Technology Center
NACA	Network of Aquaculture Centers in Asia-Pacific
NCC	National Competitiveness Committee
NEC	New Entrepreneurship Creation Program
NECTEC	National Electronics and Computer Technology Center
NESDB	National Economic and Social Development Board
NFI	National Food Institute

NIEs	Newly Industrialized Economies
NIMT	National Institute for Metrology and Testing
NIS	National Innovation System
NRCT	National Research Council of Thailand
NSTC	National Science and Technology Committee
NSTDA	National Science and Technology Development Agency
OBM	Own Brand Manufacturing
ODM	Own Design Manufacturing
OEM	Original Equipment Manufacturing
OECD	Organization for Economic Cooperation and Development
OEM	Original Equipment Manufacturing
OTOP	One Tambon, One Product-Program
PABX	Private Automatic Branch Exchange
PCB	Printed Circuit Board
PM	Prime Minister
PMO	Office of the Prime Minister
PSDC	Penang Skill Development Center
PTEC	Electrical and Electronics Product Testing Center
R&D	Research and Development
RTO	Research and Technology Organization
S&T	Science and Technology
SCRD	Shrimp Culture Research & Development Co., Ltd.
SDP	Supplier Development Program
SMEs	Small and Medium-sized Enterprises
SPC	Subcontracting Promotion Club
SWOT	Strength Weaknesses Opportunities and Threats
TAI	Thai Automotive Institute
TAPMA	Thai Auto-Parts Manufacturing Association
TDRI	Thailand Development and Research Institute
TESA	Thailand Embedded Systems Association
TFFA	Thai Frozen Food Association
TFP	Total Factor Productivity
TGI	Thai German Institute
TIDI	Thailand IC Design Incubator
TISI	Thailand Industrial Standards Institute

TISTR	Thailand Institute of Scientific and Technological Research
TNCs	Transnational Corporations
TPI	Thai Productivity Institute
TRF	Thai Research Fund
TRIMs	Trade Related Investment Measures
VC	Value Chain
VCR	Video Recorder
WB	World Bank
NACA	Network of Aquaculture Centers in Asia-Pacific
UNIDO	United Nations Industrial Development Organization
WB	World Bank
WTO	World Trade Organization
WWF	Worldwide Fund for Nature

Summary

Knowledge-based competitive advantages, national innovation systems, and development

Knowledge has always been central for economic growth. Yet the speed at which knowledge is created, accumulated, applied, and distributed has increased, and so has the importance of knowledge as a source of competitive advantages relative to the cost of capital and labor. Competitive advantages that are based purely on lower costs are often not sustainable, because new competitors can easily undercut prices and invalidate existing cost advantages. If labor is cheap enough, for example, this may even nullify much higher efficiency. In contrast, the ability to provide unique or superior goods and services, or to provide them faster, allows a firm to achieve a premium price, which leads to higher profitability, provided costs are comparable to those of competitors.

The latter competitive advantages are based on knowledge. They require much effort, for example observing market trends, detecting new niches, recombining production factors in an innovative manner, and undertaking risky investments. At the same time, such knowledge-based advantages are harder to copy, and hence limit the number of competing providers and allow for above-average profits. As competitors will always seek to break into profitable markets, firms (and nations alike) have to engage in a permanent search for new differentiating opportunities. The long-term competitiveness of firms and nations thus depends on their ability to organize innovation systematically.

In the past, innovation was considered a unidirectional process in which findings from science and technology are transferred to new commercial applications. Today we have come to learn that innovations arise from continuous interactive and cumulative learning, searching, and exploring which involves manifold feedback loops. Innovation not only requires effective internal organization and substantial research and development (R&D) activities at the firm level, but also joint learning through interaction within supply chains and other forms of inter-firm cooperation as well as regular and systematic interaction between firms and institutions, for instance universities and other research and technology organizations.

The concept *National Innovation System* (NIS) is a useful analytical tool for understanding how innovations come about as well as for assessing the functioning of knowledge-based activities in a given economy. Moreover, it provides guidance for the design of policies. An NIS is a system of actors (firms, organizations, government agencies, consumers, etc.) who interact with each other in ways which enhance the innovation performance of a national economy. The main idea of the concept is that overall performance depends not only on how each individual actor performs, but also on how these actors work together in knowledge generation, acquisition, and use. The concept emphasizes the need to combine improvements at three interdependent levels:

— The *internal organization of firms*. Firms need to shift from simply using technology to creating and developing technology. This has to go along with continuous improvement of their internal learning routines.

— *Inter-firm relationships*. Firms rarely innovate alone. As they become ever more specialized, firms are obliged to operate in networks and to rely on interactions to acquire complementary know-how from external sources.

— *Relationships between institutions and firms*. Neither market forces nor inter-firm networks are sufficient to guarantee high levels of innovation. Market failure may occur especially in R&D, information, and training markets. Universities, schools, training centers, research labs, and other support institutions are needed to compen-

sate for market failure. Furthermore, governments should offer incentives for private sector R&D, support the transfer of knowledge, and provide for a political, legal, and economic framework that reduces uncertainty and encourages investment.

According to the NIS concept, supporting innovation is hence a cross-cutting issue affecting almost every field of economic policy. The innovative capacity of an economy depends on both *general* factors (including the macroeconomic environment, the regulatory context, labor market conditions, etc.) and *specific* innovation policies (e.g. R&D financing, start-up promotion).

At the outset, national innovation policy requires a vision of future development trajectories and windows of opportunity for international specialization. Such a vision needs to be based on a stakeholder dialogue and has to be translated into specific, targeted and coherent programs. Among these programs, promotion of innovative entrepreneurship is highly important, taking into account that the private sector constitutes the basis for innovative activities in an economy. Innovative firms not only create additional employment, they also help to continuously renew the entrepreneurial structure, to improve the allocative efficiency within a country, to build a culture of innovation, and thus to speed up structural change. This calls for specific programs to promote entrepreneurship in general and to support private-sector R&D. Moreover, innovation should be promoted through specific policies geared to increasing knowledge flows within entrepreneurial clusters and value chains and to encouraging cooperation between the private sector and scientific institutions.

Thailand's need to strengthen knowledge-based competitive advantages

For Thailand in particular, increasing the knowledge content of economic activities is an urgent need. In the 1980s and much of the 1990s, Thailand was one of the fastest growing countries in the world. From 1985 to 1995 its real annual GNP grew by 8 % on average. Increases in international trade and (mainly export-oriented) foreign direct investments (FDI) had been the driving force behind the Thai economic development in the past decade. In 1996, before the crisis, international trade accounted for 70.5 % of GDP.

The crisis of 1997 – when GNP fell by 10.4 %, and per capita GNP even decreased by 40 % compared to 1996 – revealed fundamental structural weaknesses. Thailand's economic boom had largely been due to growth of factor inputs, especially of capital stock. Most FDI was directed to Thailand for reasons of low wages, and not for the availability of a skilled workforce and other knowledge-intensive inputs. The rapid increase in real wages was not matched by increasing productivity. Total Factor Productivity (TFP) growth accounted for only 12 % of total growth during the 1980-2000 period and was mainly concentrated in agriculture. TFP growth in industry and services was even negative. Both foreign and domestic investment was confined to relatively knowledge-extensive sectors, such as agriculture, assembly of imported parts (e.g. in electrical, electronics and automotive industries), real estate, construction, and tourism. Furthermore, technologically more complex activities were (and still are) mainly performed by foreign companies whose technological capabilities and productivity far exceed those of local companies. Due to this technological gap foreign companies are reluctant to build linkages with local suppliers or research institutions. Some of the most important economic sectors thus continue to be technological enclaves.

Since competitiveness in Thailand's traditional activities is highly dependent on labor costs, competition from low-cost locations has become a serious threat. Since FDI is, if at all, very weakly embedded in the local entrepreneurial and institutional tissue, rising labor

costs for Thai workers are causing mobile transnational companies to seek cheaper locations, notably in China and Vietnam. If Thailand is to improve (or at least maintain) its current level of socioeconomic development, the country's economy will have to upgrade toward more knowledge-intensive and higher value-added activities and build indigenous innovative capabilities.

The present study shows that Thailand's NIS is not yet sufficiently developed. Compared to other countries in the region, both the government and the private sector in Thailand have invested little in education and technology development capabilities. The number of innovative firms is low and many organizational capabilities necessary for innovation are lacking; the quantity and quality of inter-firm as well as industry-science relationships is limited; and institutional support lacks both strategic orientation and implementing capacities. As a consequence, Thailand's international competitiveness indicators have systematically declined, and Thailand presently ranks low on global competitiveness indicators, especially in technology-related dimensions of competitiveness.

Innovation policies in Thailand

Against this background, the study looks into four areas of innovation policy which are crucial for the functioning of NIS, yet seem to be relatively weak in the Thai case. These are, respectively:

— the process of policy formulation, implementation, monitoring, and evaluation;

— inter-firm linkages;

— industry-science relations;

— formation of innovative entrepreneurs.

Other specific innovation policies, such as education and human resource policies in general or the development of technical and engineering skills in particular as well as integrated policies to strengthen the overall system of metrology, standards, testing, and quality assurance, are also very important to increasing Thailand's competitiveness in knowledge-intensive fields. It would be beyond the scope of this study, however, to analyze all aspects of these rather broad issue areas.

a) The process of policy formulation, implementation, monitoring, and evaluation

Both public and private effort requires direction. Strategic planning based on well-designed surveys, benchmarking studies, and a continuous stakeholder dialogue makes it possible to identify economic strengths and weaknesses and pursue proactive rather than reactive policies. Implementation of the policies identified should be cost-effective, and service delivery should be organized in a businesslike manner. This calls for the establishment of a clear performance measurement framework permitting the results of evaluations to flow into the future allocation of budget funds. These requirements are becoming especially important in times of fast-changing markets and growing competition as well as in the context of the complex shift of the economy from a labor-intensive to a knowledge-based economy.

Regarding the process of policy formulation, international experiences suggest that systematic foresight and benchmarking activities are important tools for achieving a strategic vision of future technology and market trends, and thus of competitive advantages. In addition, modern planning processes need to involve the important stakeholders, especially from the private sector. And finally, ministries and other institutions involved in the process of policy formulation need to be closely coordinated.

In Thailand, the process of policy formulation has traditionally not included visionary approaches involving foresight activities, and

stakeholder participation as well as ministerial horizontal cooperation have been low. Despite some reforms – e.g. a few recent foresight activities, increased participation in drafting the 8th and 9th National Plan, and the establishment of new coordinating bodies – Thailand still lacks vision and commitment with regard to innovation policy, and policy coordination remains weak. Moreover, ad hoc political decisions taken at high policy levels are increasingly interfering with the planning procedures and targets set by the ministries.

In a similar vein, shortcomings have been identified in the implementation, monitoring, and evaluation of innovation policies:

— The responsibilities for policy formulation, funding, and program implementation are not clearly separated;

— some implementing agencies are not customer-oriented, do not operate in a business-like manner, and their programs are not cost-effective;

— budget allocation is often not sufficiently linked to previous performance;

— monitoring and evaluation appear to be irregular procedures, with widely varying evaluation approaches and variable degrees of transparency. Plans often do not include performance indicators, and independent evaluation bodies are lacking.

Many of these shortcomings might be overcome by the newly established system of performance-based budgeting, which was decided upon by the government in 2002 and requires every ministry to define and monitor key performance indicators. Yet defining relevant and measurable indicators, training evaluation staff, and, above all, avoiding ad hoc political interference will be challenging tasks when it comes to implementing the new system.

b) Inter-firm linkages

The Thai economy is characterized by a dualistic structure, with, for the most part, large foreign corporations in the role of technology owners and most Thai firms displaying low levels of technological capabilities. Therefore, fostering vertical linkages between large technologically advanced companies and local firms is an urgent policy task. Incentive systems and programs are needed to augment technology transfer in favor of Thai firms, to develop innovative supply chain relationships, and to embed footloose foreign investors in national production systems.

However, promotion of inter-firm linkages is not a priority concern in Thailand. And what is more, the few existing instruments – most prominently, the OTOP program – focus on *horizontal* linkages between local firms in traditional industries, hence neglecting the need to bridge the technological gap between FDI and the local economy. There are no significant policy incentives to induce large companies to support local partners, and specific programs aimed at improving the performance of SMEs with a view to making them more attractive as suppliers to large firms are largely lacking. Currently, three entities are concerned with supplier development, but only one of them – the BUILD program – has gained a certain reputation, and even this program is poorly funded. In addition, BUILD activities are mainly limited to awareness-building and matching between SMEs and large customers. In order to fully exploit the benefits of spillover effects from large high-productivity firms, a more comprehensive approach to supplier development is needed. This would include targeted programs to strengthen the competitiveness of promising local suppliers. International experiences suggest that engagement of important large customer companies in the design and implementation of such programs is a decisive success factor. Moreover, it is important to pursue a multiagency network approach involving business associations and

sector-specific institutions (such as the EEI, TAI, or NFI) in order to provide, in a coordinated way, specialized and complementary support. This calls for better cooperation between BUILD and such sector institutions.

c) Industry-science relations

The performance of innovation systems depends on the density and quality of industry-science relations. Firms increasingly rely on inputs from scientific institutions, including technological solutions and skilled graduates. Academic institutions also benefit from cooperation with industry, as the private sector provides know-how, finance, employment opportunities for students, and helps to keep curricula up to date.

Thailand has a diversified infrastructure of research and technology organizations and holds strong potentials for industry-science relations. Besides the many universities, the government has set up specialized research and technology organizations: three large research institutions under NSTDA and several semi-public technology institutes in key industrial areas. In addition, different organizations for funding research were created.

However, a cultural gap appears to constitute a divide between the two "subsystems" of research and production. Thai universities have relatively poor research capabilities and most of their research has little industrial relevance. Scientific institutions rarely collaborate with industry. Teaching personnel lacks industry experience, a fact which is also reflected in a lack of cooperative education and industry internships, university curricula that are not industry-oriented, research organizations unable to win research contracts from the private sector, the very low number of new industrial enterprises created by university staff, etc. The challenge is to bridge this gap, bringing actors from both "subsystems" together in order to develop common approaches to relevant problems.

Public awareness for these issues has recently increased and some reforms are under way, but much remains to be done:

— Cooperative education should be promoted, supporting joint education with private firms, involving industry associations in curricula development, and integrating internships in university studies;

— personnel working in industry-related institutions should more often be recruited from industry;

— exchange of researchers and other staff between academic institutes and firms should be supported, e.g. by recognizing industry exposure for personal career schemes and by introducing more flexible regulations for remunerative secondary employment for scientists;

— incentives should be set at universities and other institutions to give greater weight to joint research and technology transfer;

— business start-ups by academic staff and fresh graduates should be supported;

— although some fiscal incentives have recently been created to foster private-sector R&D, incentive schemes need to be adapted to the needs of SMEs;

— whenever scientific institutions provide services to the private sector, they should focus on areas which are not commercially viable ("public goods") or otherwise charge cost-covering fees. This is important to avoid distorting existing service markets;

— academic institutions should give more attention to patenting and licensing of intellectual property.

d) Entrepreneurship development programs

Since innovations play a crucial role for the development and dynamics of a knowledge economy, it is important to support entrepreneurs who introduce such innovations in the market. This is especially true for Thailand, where technologies are mainly imported, the indigenous innovative capacity of firms is low, and the lack of innovative enterprise start-ups is obvious. In 2002, the government proclaimed the ambitious goal of establishing 50,000 new enterprises within the next two years and announced the allocation of 2 billion baht toward that end. At first sight, this suggests that entrepreneurship development ranks high on the political agenda. Nevertheless, a number of shortcomings remain:

— There is a lack of strategic orientation toward market creation, innovation, and competitiveness. Most entrepreneurship programs provide general management and technical training and financial support for SMEs in traditional industries. This may contribute to short-term employment creation in such industries, but it contributes little to technology development and the exploitation of new market opportunities. In Thailand the rate of entrepreneurial activity is already high, but largely confined to basic activities. Entrepreneurship programs should therefore support promising business ideas in innovative areas.

— There is a gap between political goals and implementing capacities. Up to now training programs and business incubators have had very limited outreach, and it unclear how the government target of 50,000 new enterprises is to be reached with the institutional capacities given.

— Some instruments for entrepreneurship development that are widespread and in common use in other countries are lacking. Thai policy focuses on training programs. The number of business incubators is very limited, and most universities and research organizations do not actively support spin-offs. The overall education system does not concentrate on promotion of entrepreneurship, e.g. there are only very few innovation awards. Moreover, funding of innovative start-ups is still a major problem.

— Thailand does not use a holistic policy approach. International experience suggests that none of the above-mentioned policy instruments alone can offer a solution. An integrated entrepreneurship development strategy is needed that includes the entire range of policy instruments and organizes support institutions in networks offering complementary and coordinated services.

Case studies

In this study, the electrical and electronics manufacturing and shrimp-farming sectors were selected to illustrate how building knowledge-based competitive advantages pertains to a wide range of economic activities. Both sectors are not only highly relevant to the Thai economy in terms of export earnings and employment creation but are also currently under pressure to increase their knowledge-intensity and innovative capacity. Innovation policies, albeit with a different focus for each sector, are therefore called upon to assist in the upgrading of local firms, creation of linkages between local and foreign firms, and efforts aimed at solving of specific (e.g. social and environmental) problems in collaboration with scientific institutions.

a) Strengthening knowledge-based competitive advantages in the electrical and electronics industry

The electrical and electronics sector is important for the national economy, since it contributes 4 % to the country's GDP, employs a

workforce of more than 400,000, and accounts for nearly 35 % of Thailand's exports. With exports amounting to US$ 23.6 billion in 2000, the sector is Thailand's biggest export earner, with a positive trade balance of US$ 6.2 billion.

For Thailand, it is useful to distinguish between the electrical and consumer electronics segment on the one hand and the electronic component and computer/peripherals segment on the other. The former displays a higher involvement of local companies. Firstly, local SMEs serve the needs of the domestic market in lower-tech product segments such as rice cookers, lighting equipment, fans, and radios. Secondly, many joint ventures have been set up between Thai and mainly Japanese companies in both electrical appliances and consumer electronics. In contrast, the electronic component and computer parts segment is export-oriented and almost entirely dominated by transnational corporations (TNCs). Its most important activities are assembly and testing of integrated circuits (ICs), printed circuit boards (PCBs), and computer parts such as hard disk drives (HDD). In this segment, the supplier base is very weak. National value-added is no higher than 10-15 %. More value-creating activities such as design, product engineering, and R&D are carried out abroad.

Thailand faces competitive pressure from two sides. Competing on factors such as quality, flexible production, and design capabilities, technologically-advanced countries like Malaysia and Singapore are currently attracting the higher value-added, technology-intensive investments. From below, latecomer countries such as Vietnam and China are competing on cost advantages. Catching up technologically, these countries are able to engage in labor-intensive mass production similar to that currently carried out in Thailand.

Currently, Thailand is worried about competition from China. However, realization of its inability to compete on factor cost could lead to a new strategic outlook: Rather than trying to compete in labor-intensive mass production, the best chances for sustaining Thailand's electrical and electronics sector must be sought in entering knowledge-based market segments currently occupied by Malaysia and Singapore. Industry trends render this optimistic scenario plausible: TNCs, while concentrating on product development, design and marketing, outsource manufacturing services to specialized subassemblers and contract manufacturers. At the same time, flexible production capabilities are required, i.e. supply of customized products in small batches on short notice. This implies an increased need for a local supplier base capable of quickly providing specialized tools and parts. Based on interviews in Thailand and experiences from neighboring countries, we have identified several promising opportunities:

— Chip design activities are in increasing demand. Given the number of well-educated chip designers and companies in IC and PCB manufacturing, IC and PCB design as well as embedded systems may be seen as a hitherto untapped market.

— Suppliers could engage in precision engineering (high quality tools, moulds and dies, jigs and fixtures) and high quality plastics and metal parts (for casings, keyboards, etc.) as well as indirect materials (foam, cardboard, packaging, printing manuals).

— In export manufacturing Thai firms could specialize in subassemblies (mass manufacturing on a contract basis for transnational customers).

— In the electrical parts and appliances segment, there is scope for Thai companies to design and manufacture niche market products and to create their own brands for both domestic and regional export markets. Examples of promising markets are seen in the fields of energy-saving technology and products requiring adaptation

to local environments (air-conditioning, PABX switchers, uninterrupted power supplies etc.).

Keeping the electrical and electronics industry competitive and tapping these opportunities requires a concerted drive that puts technological upgrading and embedding of the TNC-driven export sector at the heart of the agenda. The main challenges pertain to:

— *Policy formulation*, i.e. formulating a shared vision and implementing jointly designed programs. Electronics currently lacks political support and has not been included as one of the five priority "clusters" for government action. Even though a Master Plan was drafted in 1998, it neither provides a common, shared vision nor specifies concrete actions to be taken to achieve these goals. Important bottlenecks such as international standards certification are not even mentioned in the plan. The lack of political support and orientation can be attributed to the fact that industry players are unable to find a common platform and jointly address the government. Industry associations as well as the Electrical and Electronics Institute represent only certain subsectors. As a result, there is little joint action in the industry.

— *Human resource development.* Electrical and electronics companies in Thailand generally perform low- to medium-skill activities, mostly in assembly. Capabilities to design new products and production technologies or to provide specialized services are to a large extent lacking. Traditionally neither higher education institutions and training programs nor the firms concerned have invested sufficiently in skills development. Although Thailand now trains 60,000 electronic and electrical technicians and engineers annually, and companies are increasingly setting up in-house training facilities, these increases are not sufficient if the companies concerned intend to increase their global competitiveness. However, higher education institutions and training programs are still not systematically linked to the private sector.

— *Technological upgrading.* In order to tap the market opportunities described above, technological upgrading needs to take place at the firm and sector levels. At the firm level, upgrading with regard to quality, just in time delivery, technology intensity, product differentiation, design capacity, etc. is crucial. As the internal market is not very demanding, however, especially many Thai SMEs have failed to realize the urgent need to upgrade. Few national standards are mandatory, and competition is price-based, providing little incentive for product differentiation. Therefore, sector-wide approaches are needed to foster standardization and a culture of high-quality production, to enhance technological capabilities, promote inter-firm networks, and to attract technologically more complex investments to Thailand.

— *Linkage creation and embedding***.** Embedding denotes the building by foreign companies of linkages to local companies and institutions by integrating them into their value chains and by collaborating with research and technology organizations. The Thai government has paid very little attention to embedding the industry and proactively supporting the development of an indigenous supplier base capable of supplying quality products. Neither have there been supplier development programs focusing on capability development nor have leading companies been given incentives to create vertical linkages and to engage in technology transfer. Only recently has the BUILD program begun to seek to enhance the creation of vertical linkages, and a few cooperation projects involving TNCs, research centers, and universities have been initiated.

b) Strengthening knowledge-based competitive advantages in shrimp aquaculture

Thailand is the world's largest producer and leading exporter of farm-raised shrimp. Shrimp farms cover an area of 80,000 hectares, accounting for approximately 3.5 % of the country's total exports of goods and services. Favorable agro-climatic and economic conditions as well as the particular organizational structure of the Thai shrimp sector, including a large national conglomerate with cutting-edge technological expertise, account for Thailand's comparative advantage in shrimp production. The Charoen Pokphand (CP) is Thailand's largest transnational company and the world's largest shrimp feed producer. In Thailand, CP's operations range from feedmills, hatcheries and demonstration farms, laboratory testing and diagnostic services for shrimp farmers to shrimp processing plants. The CP Group alone employs 400 consultants who provide advisory services to farmers. Shrimp-farming has positive employment effects. Taking family members into account, the number of people dependent on the shrimp industry is approximately 300,000. Farm-raised shrimp production is one of the fastest-growing industries worldwide.

Economic success is being achieved at high environmental costs. For some years, shrimp farming was very profitable, as environmental costs could easily be externalized. Today, with diseases spreading throughout the country, and import countries banning shrimp that have been treated with antibiotics, environmental problems have increased to an extent that they challenge the viability of the sector itself:

— Wild-caught broodstock (shrimp larvae are difficult to reproduce in captivity) has become extremely rare. Revenues from shrimp-farming decrease as broodstock caught from the sea become scarcer and smaller, and thus have less economic value.

— In the past, many shrimp ponds were established in mangrove areas and other wetland ecosystems. The destruction of these ecosystems has far-reaching economic consequences for Thailand's seafood sector. Since two-thirds of the fish caught for human consumption live in coastal mangrove ecosystems or depend on them, their destruction threatens many species of fish and other marine resources. Fishing is becoming less and less profitable, and entire coastal communities that depend on fishing are becoming impoverished.

— Due to high stocking rates and disposal of wastewater into irrigation canals, virus diseases have spread throughout the whole country, leading to frequent crop failures and substantial economic losses. Short-term solutions focused on heavy usage of a wide range of industrial chemicals, mainly antibiotics; but these chemicals not only have a negative impact on the quality of soil and water, they also threaten exports as importing countries impose increasingly rigid conditions.

— Apart from chemicals, groundwater and soil quality are affected by *saline water* which is transported in enormous amounts to inland shrimp farms.

What is needed to cope with these environmental and economic challenges is knowledge-intensive innovations at different levels. If Thailand manages to become a leader in eco-efficient farming systems, this will both minimize the environmental impact of shrimp-farming and increase its efficiency. A shared vision about the future of Thailand's shrimp industry needs to be developed with the participation of all the relevant actors (including those indirectly affected by shrimp farming, such as fishermen, rice farmers, and environmentalists). Research priorities, codes of conduct, market differentiation, and marketing

strategies etc should be derived from such an integrated perspective. Looking at the most urgent reforms, Thailand has to

— intensify existing research cooperation between industry and science. For many of the above-mentioned problems of Thailand's shrimp aquaculture, technological solutions still have to be developed, and this in some cases requires considerable research effort. Among the most pressing research issues are domestication of broodstock, detection and treatment of diseases, genetic improvement, and secure and efficient pond management techniques.

— Improve pond and waste water management systems, e.g. closed-water systems for treating waste water in a sedimentation pond before releasing it into drainage systems. Moreover it is necessary to reduce stocking rates with a view to using fewer chemical inputs and feeding materials. The use of sufficient pumps and aerators is crucial to maintain good water quality. According to our empirical research, farmers have made positive experiences with less intensive farming systems.

— Reduce the use of chemicals. Although awareness has considerably increased, the use of antibiotics is still widespread among shrimp farmers. The fact that feed and chemical corporations are the main advisers to the shrimp farmers is hampering the search for less intensive but still economically viable farming methods, given that these firms are interested in maximizing their feed and chemicals inputs. Therefore the public sector should become more active in the promotion of eco-efficient farming methods, e.g. by supporting research on its viability, providing testing services, or exploring market opportunities for organically grown shrimp.

— Improve regulation and legal enforcement. Shrimp culture is affected by a large number of laws and regulations, including land laws, water laws, environmental laws, fishing laws etc. To guarantee enforcement of government regulations, it is essential to improve the coordination of the departments in charge of different issues related to shrimp production.

— Promote good cultivation practices. Bearing in mind that many thousand farms throughout the entire country are engaged in shrimp farming, any attempts to enforce command-and-control mechanisms for environmental protection would far exceed the capacities of Thailand's public administration. It is therefore necessary to complement government regulation through industrial self-regulation based on standards and codes of conduct. Such standards not only contribute to internalizing the environmental costs of shrimp-farming but they are also an important means to regaining consumer confidence, differentiating the market, and thus increasing the competitiveness of the shrimp sector.

To further boost the competitiveness of the sector, Thailand should embark on development of high-end markets, such as ready-to-eat products, delicacies, and organic markets. Value-added can be augmented by developing brand names.

There is a good possibility that Thailand will manage to meet these challenges. Several universities and the Department of Fisheries have placed emphasis on shrimp research, and BIOTEC funds a special Shrimp Biotechnology Program, which reflects a national research priority in this sector. Furthermore, several private-sector companies are highly committed to shrimp-related R&D. In some cases, there are concerted efforts under way to advance research. Much of public research is directed toward the achievement of eco-efficiency. Most farmers appear to have established extra sedimentation ponds, and land use regulation has improved. In other areas, e.g. avoidance of antibiotics and establishment of standards and codes of conduct, not enough is being done.

Introduction

Knowledge and innovation have always been important sources of competitiveness and thus the basis for sustainable economic growth. But today the effective creation, diffusion and utilization of knowledge determines economic success more than ever before.

Especially for Thailand, increasing the knowledge content of economic activities is an urgent need. In the 1980s and much of the 1990s, Thailand was able to achieve robust economic growth through an open-door policy towards foreign direct investment. Its rates of GDP growth and poverty reduction were among the highest worldwide. Yet both foreign and domestic investment remained confined to rather knowledge-extensive sectors, such as agriculture, assembly of imported parts (e.g. in the electrical, electronics and automotive industries), real estate, construction, and tourism. Furthermore, technologically more complex activities are mainly performed by foreign companies, whose technological capabilities and productivity far exceed those of local companies. Due to this technological gap, many export-based activities have not built significant local linkages, either with suppliers or with research institutions. Since competitiveness in these activities is highly dependent on labor costs, competition from low-cost locations such as China and Vietnam has become a serious threat, and some foreign investors have already relocated assembly operations in these countries. If Thailand is to improve (or at least maintain) its current level of socio-economic development, the country's economy has to upgrade towards more knowledge-intensive and higher value-added activities and build indigenous innovative capabilities.

Innovation is an incremental and systemic process. It not only requires effective internal organization and substantial research and development (R&D) activities at the firm level, it also calls for joint learning through interaction within supply chains and other forms of inter-firm co-operation as well as effective interaction between firms and institutions, for instance universities and other research and technology organizations. Successful transition towards a knowledge-based economy thus depends on the efficiency of interactions at three levels – intra-firm, inter-firm, and between firms and institutions – which together constitute the National Innovation System (NIS).

The present study shows that Thailand's NIS is not yet sufficiently developed: the number of innovative firms is low and many organizational capabilities necessary for innovation are lacking; the quantity and quality of inter-firm and industry-science relationships is limited; and institutional support lacks strategic orientation as well as implementing capacities. The study looks into four areas of innovation policy which are crucial for the functioning of NIS yet appear to be relatively weak in the Thai case. Each policy area cuts across the three levels of NIS mentioned above. Looking at each policy area, the report discusses its relevance, describes the current status in Thailand and gives some policy recommendations based on successful international experiences:

- The general process of **policy formulation, implementation, monitoring and evaluation** needs to be improved in order to create visions which give direction to innovation and help to focus support programs and improve the efficiency of program implementation;

- **Inter-firm linkages** need to be enhanced to foster learning, innovation and other synergies, with special emphasis on vertical linkages that involve technological spillovers from large corporations to local SMEs and contribute to embedding foreign firms in the national economy;

- **Industry-science relations** should be supported with a view to increasing knowledge flows from the academic sphere to the economy and promoting a culture of joint problem-solving in order to enhance technological upgrading;

- **Entrepreneurship development** programs are needed to create new innovative firms and foster structural change, but also to strengthen existing companies.

The present study selected the electrical and electronics manufacturing and the shrimp-farming sector to illustrate how building knowledge-based competitive advantages pertains to a wide range of economic activities. Both sectors are not only highly relevant to the Thai economy in terms of export earnings and employment creation but are also currently under pressure to increase their knowledge intensity and innovative capacity. Innovation policies, though with a different focus for each sector, are therefore needed to assist in upgrading local firms, linking local and foreign firms, and solving specific (e.g. social and environmental) problems in collaboration with scientific institutions.

1 Knowledge, innovation and development

1.1 Why are knowledge-based competitive advantages important for development?

Economic growth is crucial for development, since growth can help reduce poverty and secure peoples´ living standards. In an increasingly liberalized global economy a nation's GDP can only grow if it builds competitive advantages which provide for increasing exports and economic sustainability of domestic production. Knowledge has always been central for economic growth.[1] Yet the speed at which knowledge is created, accumulated, applied and distributed has increased, and so has the importance of knowledge as a source of competitive advantages relative to the cost of capital and labor.

Early growth theories used capital and labor to explain growth rates. A sustained rise in the rate of savings and investment was considered to be the main source of economic growth. Besides capital, growth was seen as depending on the quantity of labor employed in the economic process. Yet already in the 1950s the neoclassical theorist Solow showed that an important part of output growth cannot be attributed to the accumulation of capital and labor.[2] This part – the famous "Solow residual" – was ascribed to "technological progress." Technological progress means that the traditional factors are being employed in a more efficient manner. This obviously requires knowledge: knowledge about who should act, what should be done and when, where work should be carried out, and how best to optimize effectiveness. Technological progress is thus of a largely qualitative nature and cannot be described and measured as easily as the traditional production factors.

Neoclassical theory considered technological progress to be exogenous and freely accessible for everybody. The mechanism behind technological change (learning, searching and formal R&D) remained inside a black box.[3] Due to this shortcoming, traditional theory was unable to account for differences in income growth rates or income levels across countries with similar capital and labor costs.

Later, Endogenous Growth Theory[4] sought to fill this gap by "endogenizing" technological change. This was done by modeling an R&D sector which steadily improves existing technologies. Not only the quantity of products but also their heterogeneity and quality is considered important. The new theory also emphasized the role of human capital and education as an engine of economic growth. Moreover, the theory incorporated the concept of externalities (spillovers) which are linked with investment.

We use the term "knowledge-based economy" to refer to this quantitative and qualitative (though always gradual) shift towards a new pattern of economic specialization that is driven by know-how rather than by factor-cost differentials. An economy can be defined as knowledge-based if

1 See David/ Foray (2002).

2 Solow (1956).

3 Rosenberg (1994).

4 See Romer (1986), Lucas (1988).

competitive advantage is less a function of natural resources than a function of technology and innovation.[5]

The present study defines competitiveness, following Krugman, as the "ability to produce goods and services that meet the test of international competition while (…) citizens enjoy a standard of living that is both rising and sustainable."[6] Looking at ways of achieving competitiveness, Porter distinguishes two basic types of competitive advantage: lower cost and product differentiation:

> *"Lower cost is the ability of a firm to design, produce and market a comparable product more efficiently than its competitor. At prices at or near competitors, lower cost translates into superior returns. (...) Differentiation is the ability to provide unique and superior value to the buyer in terms of product quality, special features, or after-sale service. (...) Differentiation allows a firm to command a premium price, which leads to superior profitability provided costs are comparable to those of competitors. The low-cost firm produces a given output using fewer inputs than competitors require. The differentiated firm achieves higher revenues per unit than competitors."*[7]

Competitive advantages that are directly related to lower costs face the risk of factor mobility. Lower costs in different forms of production or different locations can eliminate economic rents. The ability to differentiate leads to innovation rents, because knowledge-based competitive advantages are more specific and harder to replicate.

> *"Pure cost advantages are frequently less sustainable than differentiation. One reason is that any new source of lower costs, even one less sophisticated, can nullify a firm's cost advantage. If labor is cheap enough, for example, even much higher efficiency can be nullified, unlike the case with differentiation advantages which normally must be matched to be exceeded. In addition, pure cost advantages are more vulnerable because new product designs or other forms of differentiation can eliminate a cost advantage in delivering the old ones."*[8]

The crucial factor for differentiation is the capability to innovate. Innovation can relate to "a new product, but also a new process of production, the substitution of a cheaper material, the reorganization of production, internal functions, or distribution arrangements leading to increased efficiency, better support for a given product, or lower cost, or an improvement in instruments or methods in doing innovation".[9] The long-term competitiveness of nations reflects their engagement in permanent processes of innovation. Highlighting the various features of innovations in more detail will further illustrate the concept of knowledge-based economy.

1.2 The systemic character of innovation

The concept of innovation has gradually evolved from a unilinear model to the systemic view. In the past innovation was considered a single and linear event involving transference of findings from science and technology to new commercial applications. Today innovation is seen as a continuous and omnipresent, gradual and cumulative process of learning, searching and exploring which involves manifold feedback loops, rather than a unidirectional process.[10] Thus it is difficult to localize innovations as unique events in time and space. Innovation refers here not only to the first introduction of a piece of knowledge into an economy but to the overall process of invention, its successive diffusion and reinterpretation by

5 See OECD (1999), pp. 15 ff.

6 As cited in Haque (1991), p. 8.

7 Porter (1990), p. 37.

8 Ibid., p. 50.

9 Kline/ Rosenberg (1986), p. 179.

10 OECD (1992), pp. 24 ff.

using and trying out. Innovation comprises the development of new products, new techniques, new forms of organization and new markets.

The following features outline the systemic character of innovation:[11]

1. In today's economy, innovations are not extraordinary occurrences which cut through and abruptly transform otherwise "innovation-free" everyday business routines. Rather, innovation is a continuous, gradual process, one that takes place constantly and everywhere – although by no means with the same dynamism. This process results in constant changes in products, production techniques, organizational processes, marketing, etc.

   There are many areas in which innovations are systematically pursued. This is particularly evident in cases where specialized R&D departments are set up. But systematic pursuit of innovations can also frequently be observed in the routine operations of companies and institutions. Modern concepts of organizational development aim to create "learning organizations" with clearly defined goals and indicators that are used to constantly monitor goal attainment and ensure that no time is lost in effecting process adjustments as soon as discrepancies are noted between targets and actual results. Today, mechanisms designed to check performance against defined goal parameters are firmly established in many organizations. Employees are given incentives to be on the constant lookout for possible improvements. In business practice this becomes evident in the widespread adoption of concepts like continuous improvement processes. Under framework conditions in which technological parameters and markets are changing at an ever increasing pace, it is furthermore becoming more and more important for companies to be able to go beyond fixed parameters ("single-loop learning") and to establish procedures aimed at regularly and systematically questioning these parameters ("double-loop learning").[12]

2. The innovation process is increasingly moving away from the linear course of the past towards a circular-cumulative process involving numerous feedback loops. These loops occur not only within individual firms, as described in the above point, but also between the stages of a value chain. In the early phases of industrial development the phases "invention," "innovation" (that is the further development of an invention to the point of marketability) and "diffusion" (establishment in the market) usually followed one another in clear succession. What we have today is an iterative process in which innovations are continuously tested and adapted. Users' requests, for example, are incorporated in the development process at an early stage, established products or processes are systematically reviewed and modified.

   In this way innovation becomes an interactive process in which numerous actors work collectively to produce reciprocal external effects. Thus reality is increasingly departing from the picture drawn in Schumpeter's[13] early work, where innovations were to a large extent the individual achievements of creative individuals. Interaction takes place principally between firms in up- and downstream stages of the value chain (e.g. synchronized product development involving parts suppliers), but can also be observed among firms at the same stage of the value chain (where it serves e.g. to achieve economies of scale) and between firms and scientific, research, training, business-promotion, and other institutions. The importance of intensive cooperation with suppliers and research institutions has been stressed for decades now. More recently, interactions between manufacturers and demanding lead users have also been accorded

11 Based on Lundvall (1992); Nelson (1993); OECD (1999).

12 Morgan (1998), pp. 79 ff.

13 Schumpeter (1911/12).

great importance. Lead users frequently create incentives or apply pressure to induce producers to improve products. Porter refers, over and above this, to the innovation-driving effects created by challenging and differentiated demand.[14]

3. Knowledge can never be 100% codified; it is, qua experience, always bound in part to people and institutions (tacit knowledge) and as such is not readily transferable. Furthermore, a wholly private appropriation of the outcomes of investments in new stocks of knowledge is seldom possible. Spillovers, i.e. unintended transfers to third parties, is more or less unavoidable. The production factor "knowledge" is in this sense highly vulnerable to market failure. This, too, is of relevance to the question of business locations. Transfer of tacit knowledge hinges on interpersonal contacts; specialists are not totally mobile, and specialized regional pools of skilled workers are therefore at times essential. This means that production processes cannot be broken down at will and distributed across business locations with factor-cost advantages.

4. The interactive character of innovation processes implies a great need for coordination of the various actors involved. The amount of information needed on product features, markets, potential cooperation partners, technological options, organizational forms, and the like is constantly increasing, making decision-making more and more complex. The increasing specialization and differentiation of value-added processes leads at the same time to the creation of new interfaces between subsystems. New, knowledge-intensive forms of moderation are called for to ensure that this wealth of information is properly structured and communicated between the various actors involved, without this leading to an explosion of transaction costs. These "interfacing services" include, for example, the assessment, evaluation, and legal formulation of impending make-or-buy decisions, mergers or acquisitions, the coordination of logistic subsystems, establishment of quality standards along the value chain, moderation of communication processes in multicultural teams and among business partners, to mention but a few.

5. Locational specialization is shaped by historical developments and is to this extent path-dependent. Locations which are still in the early stages of the profile-building process have, initially, a multitude of specialization options – viz. all options which offer them comparative advantages based on cost factors. However, any initial specialization calls for specific investments, e.g. in relevant training programs. Since innovations are of a cumulative nature and build on existing stocks of knowledge, constellations of actors, preferences and interactions, this initial specialization inevitably pre-shapes the further path of development. Possible economies of scale and external effects must be considered in the future allocation of scarce resources, which means that that alternative patterns of specialization for which no initial investments were made are, comparatively, less profitable and are therefore abandoned.

6. High levels of private and public investment are required to create efficient, specialized business networks with high synergy potentials. Many inputs for knowledge-based clusters have, at least in part, the character of public goods, particularly in the fields of R&D, training, and regional strategy formulation. Such fields are in need of public institutions and policy instruments if a socially optimal outcome is to be achieved. The more target-oriented and specific these inputs are, the greater the path dependence of the regional specialization pattern.

7. The systemic character of innovation and networking among firms and between firms and the public sector requires development of Information and Communication Technologies. These technologies have dramatically

14 Porter (1990), pp. 109 ff.

reduced the costs of storing, handling, moving and combining information, and have made different patterns of national and international networking possible.15 This has increased the possibilities, and the pressure, to come up with new combinations of codified and tacit knowledge and interactive learning. While most earlier episodes of technical change have centered on particular products or industrial sectors, information technology is generic. It impacts on every element of the economy, both goods and services, as well as on R&D, production, marketing and distribution.

1.3 Challenges for developing countries in the knowledge-based economy

The knowledge intensity of economic affairs differs substantially between nations. Developing economies have starting points very different from those of industrialized countries. The economic growth trajectory and the role of developing economies within the global division of production are still mainly based on the comparative advantage of lower labor costs and endowments with specific natural resources, factors which are reflected in relatively low productivity, value added, and factor incomes. Modernization is often limited to small pockets of competitive enterprises, while a huge proportion of the population remains trapped in a vicious circle of low productivity and low income. Moreover, short-term strategies to exploit competitive advantages are often pursued at the expense of the environment, thus leading to depletion of resources. The knowledge-based economy thus poses the threefold challenge for these countries to *achieve integration into the global knowledge economy*, and combine this with a pattern of economic development that is *more equitable* and *ecologically sustainable*. The innovation systems of most developing countries are not well prepared to confront this threefold challenge:

— Only very few firms are able to make substantial technological innovations. Most firms even lack the technological capabilities required to systematically choose the most adequate technological alternative and to efficiently incorporate, utilize and adapt acquired technologies.

— The enterprise structure is often highly polarized, the degree of specialization low, and national value chains tend to be relatively short and dependent on imports of critical products and services (and the know-how incorporated in them). Linkages and knowledge flows within value chains are thus often poorly developed and do not contribute to substantial innovative synergies.

— In the same vein, research and technology institutions are usually not sufficiently up-to-date and diversified, and their linkages with the private sector are weak, which means foregoing potential synergies and spillovers.

— The ability (and sometimes even the willingness) of governments to create a broad consensus in society about innovation-oriented, competitive, ecologically sustainable and equitable development paths as well as to design and implement economic policies accordingly is often quite limited. Sometimes the general business environment (e.g. in terms of political stability, rule of law, property rights etc.) is anything but investment-friendly. But even those countries that succeed in creating a favorable investment climate mostly fail to build a common understanding of the concrete development trajectories they need to follow, and this is a crucial precondition for a focused and articulated national innovation policy. The process of policy formulation and implementation is often not systematic and target-oriented. Moreover, well-designed policies designed to cope with specific challenges in terms of human capital, entrepreneurship development, technology acquisition, research and development, industry-science relations, inter-firm linkages etc. are rarely in place.

15 Kline/ Rosenberg (1986), p. 280.

2 How to generate, acquire and use knowledge within a National Innovation System

As we saw in the section above, the creation, diffusion, and use of knowledge are vital to economic growth and change. Firms, researchers, and policy-makers are therefore challenged in many ways to find solutions for coping with steadily increasing flows of knowledge and new technologies. They not only have to understand how technological changes influence the economy and society but also have to design policies to cope with these changes.

Section 2.1 present and discusses the National Innovation System (NIS) approach with a view to developing an understanding of the components, relationships and attributes that underlie knowledge-driven development. Section 2.2 discusses the three main levels of NIS: the internal organization of firms, inter-firm relationships, and relations between firms and their institutional environment. Section 2.3 then explains how NIS contribute to upgrading economic activities. Section 2.4 identifies the most important areas of economic policy and introduces the distinction between promotion of *general framework conditions* conducive to innovation and *specific innovation policies* in a narrower sense.

2.1 The concept of National Innovation Systems as an analytical framework

An NIS is a system of actors (firms, organizations, government agencies, consumers, etc.) that interact with each other in ways which enhance the innovation performance of a national economy. The main idea of the concept of innovation systems is that overall performance depends not only on how each individual actor performs but also on how these actors work together in knowledge generation, acquisition, and use. The concept represents a useful analytical tool for understanding how innovations come about and for assessing the functioning of knowledge-based activities in a given economy. Moreover, it may also provide guidance for the design of policies.

The focus on *national* systems reflects the fact that national economies differ with regard to the structure of their production systems and institutional setups.[16] The success of an NIS thus depends on a variety of nation-specific factors such as market conditions, managerial and technological competences of enterprises, public infrastructure and regulations, norms and values, and the intensity and effectiveness of interaction between knowledge-using and knowledge-producing entities. It is because of these particularities that innovation activities differ among countries. Yet as nation-states become more open to cross-border trade and investment relations, NIS increasingly become subject to external influences. Transnational corporations in particular shape local production systems to a much greater extent than they did a few decades ago. Moreover, nation-states increasingly act in accordance with international agreements, and even some research and technology organizations exercise influence beyond national boundaries. On the whole, although the degree of nation-specific similarities justifies the analysis of *national* systems, NIS must always be viewed as open systems.

The concept of NIS emphasizes the need to integrate three different levels:

— The internal organization of firms;

— Inter-firm relationships;

— Relationships between institutions and firms.

Besides these three main levels, the concept recognizes the importance of general framework conditions, including a stable political and macroeconomic environment supportive of entrepreneurial activities, up-to-date infrastructure, an educational policy that promotes entrepreneurial spirit and innovative behavior, etc. A thorough discussion of all these conditions would obviously go far beyond the scope of this study. Therefore they are only briefly mentioned in Chapter 2.4, and the

16 OECD (1999), p. 21.

study will emphasize the role of some selected specific innovation policies.[17]

2.2 The three main levels of interaction within NIS

This section will discuss how learning at the three main levels is organized and how knowledge transfer can be effected as a means of laying the foundations for innovation.

2.2.1 The internal organization of firms

In an age of global competition firms need to adapt their internal capabilities to changing market conditions. Generation of and interaction between technological, organizational, and social innovations is important to ensure cost-efficiency, quality, diversity, and responsiveness, and to improve the innovative capability of a firm,.[18]

Technological innovations imply an internal shift from simply *using technology* (in the form of basic operations, skills and capabilities, technician and craft skills) to *creating and developing technology*.[19] However, creating technology does not simply mean a growing share of R&D-intensive production, it also refers to engineering skills, own design manufacturing (ODM), own brand manufacturing (OBM), and innovations in marketing.

Productivity gains tend to be higher if technological change is accompanied by **organizational innovations**. The most prominent change today is the transition from a "Fordist" style of production (standardized mass production) to more flexible, "post-Fordist" systems.[20] To produce cost-efficiently and to ensure quality as well as responsiveness to the market, profound organizational changes are needed within the production process. Such innovations enable the firm to deliver just in time and reduce stocks, to improve quality and detect errors earlier, to reduce the time span between the development of new designs and their introduction to the market, etc.

Social innovations, e.g. reduction of hierarchies, internal decentralization of decision-making powers, broader incentive schemes, promotion of participation and cooperation, and increased transparency are further important elements of innovation. To enhance communication and knowledge transfer within a given firm, and to generate process innovations, it is vitally important to establish feedback links and effective connections between different entities of the firm.

The competitive advantages and innovative capacities of firms are strongly related to their internal learning routines and feedback loops (see Figure 2.1).[21] In order to become or remain innovative, firms need to reinvent themselves continuously, rearranging both their mission and their internal structures. Since these tasks require the acquisition, transfer and utilization of knowledge at different stages of entrepreneurship development, continuous training of entrepreneurs and workers and support for organizational change are essential parts of any NIS.

17 The concept of systemic competitiveness (Esser et al. 1996) provides a useful analytical tool to analyze how political systems, macroeconomic conditions, social norms and values and other general factors interact with firms and organizations in their efforts to increase competitiveness.

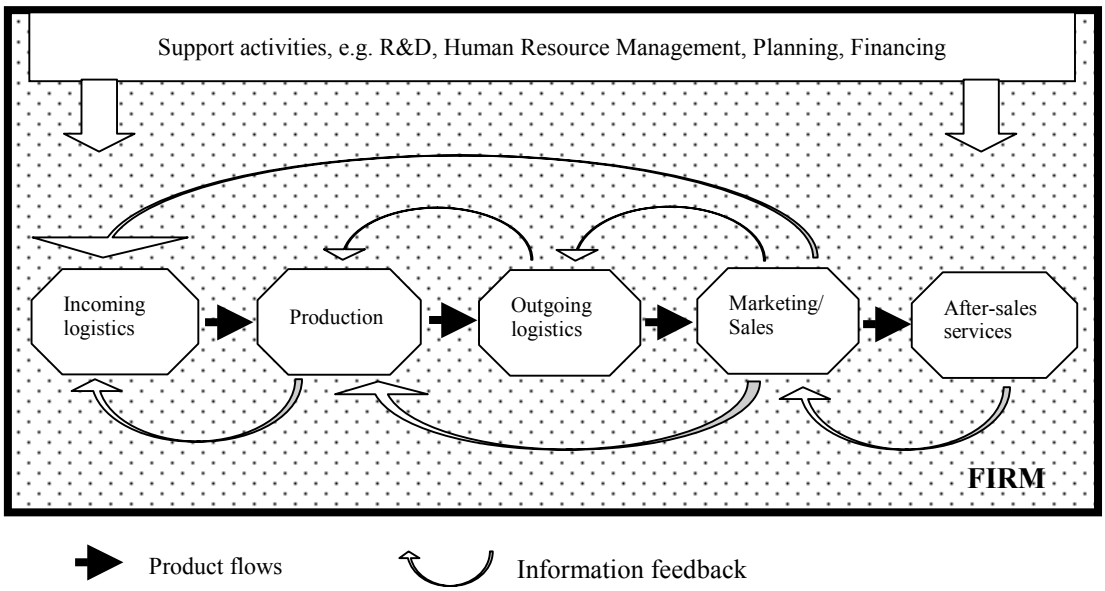
18 Altenburg/ Hillebrand/ Meyer-Stamer (1998), p. 9.

19 Indicators for measuring this shift towards developing technology include ratios of R&D expenditures, number of researchers, and patenting.

20 Altenburg (1996), p. 59.

21 Dosi/ Teece/ Chytry (1998), p. 209.

Figure 2.1: Product and information flows within an innovative firm



Source: Own illustration

Although innovative capabilities need to be developed in firms of all size categories, it is also important to acknowledge certain differences between large and small firms. SMEs differ from large corporations in terms of the skills and professional training of their managers. They tend to have more limited financial and human resources, less access to information, and shorter planning horizons. In addition, they are often more risk-averse and reluctant to call in outside help.[22] In most cases, SMEs depend more on technology use than on technology development, since they as a rule do not engage in systematic R&D. They prefer to perform trouble-shooting activities than to establish formalized mechanisms to systematically accelerate incremental innovations. In contrast, large corporations quite often use and deepen their economies of scale by engaging in systematic R&D activities and reinventing themselves continuously. To remain competitive, SMEs therefore need to specialize, to find niches of production and to deliver products and services that capitalize on their specific advantages – such as flexibility and quick decision-making procedures – and appropriately complement the scale-intensive production of large corporations.[23]

2.2.2 Inter-firm linkages

As we have seen, the innovative capacity of firms depends on their internal competences and flexibility. But firms rarely innovate alone. As product life cycles and delivery times grow ever shorter, and firms become more specialized, the latter are forced to operate in networks and to tap more external sources for complementary products and services. Among these external sources, inter-firm collaboration is by far the most important channel for acquiring and exchanging knowledge. Empirical studies have confirmed that, on average, collaborating firms are more innovative than non-collaborating ones.[24] These collaborations may be based on formal links like legal titles, contracts or property rights, or on informal mechanisms to

22 See OECD (1999), p. 51.

23 Pfirrmann/ Hornschild (1999), p. 62.

24 OECD (1999), p. 53.

exchange information or create trust. They can take on the form of *horizontal* or *vertical* linkages.

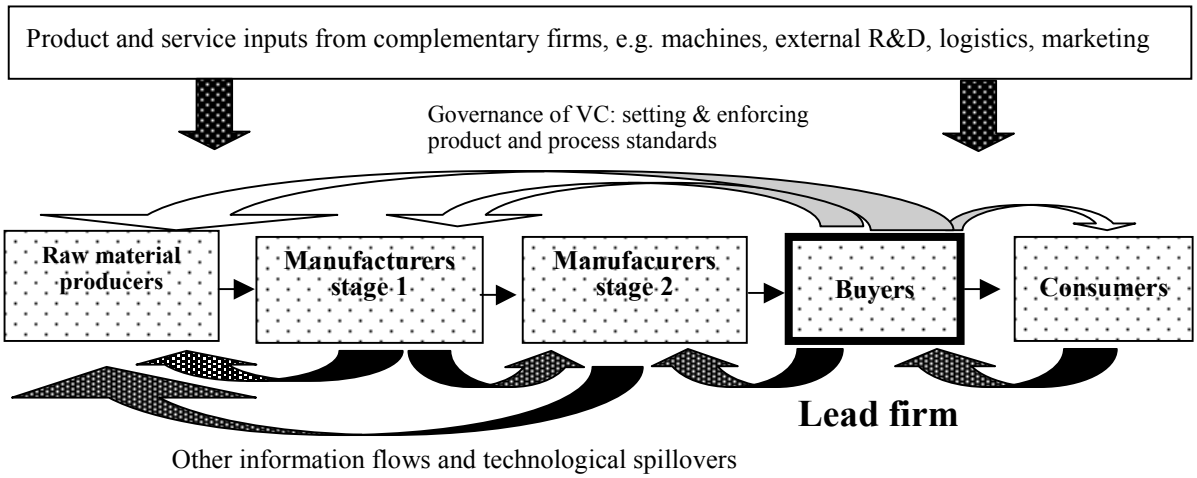
Horizontal linkages arise between companies operating at the same stage of the value chain. Although competition in product and process development may deter firms from cooperating, there is scope for horizontal cooperation in fields where firms pursue common interests (e.g. bargaining for lower input prices, sharing consulting costs, pooling resources for large projects, or increasing bargaining power vis-à-vis major customers). In this way individual firms may jointly increase their economies of scale.[25] Yet policy-makers often overestimate the willingness of firms to cooperate. Entrepreneurs are often reluctant to interact with other firms operating in the same market because they fear leakage of critical know-how that may lead to others imitating their products or capturing their markets.

For these reasons knowledge transfer is usually more intense within v*ertical linkages*, i.e. between firms operating at different stages of the value chain, like buyers and suppliers. As production becomes increasingly more complex, firms outsource activities and integrate into vertical cooperation, which allows them to develop specialized capabilities while intensifying links with external sources of complementary products and services.

As production can be seen as a sequence of value-adding stages, the term *value chain* (VC) refers to the full range of activities required to bring a product or service from conception to production, consumption, and final disposal after use. *Forward linkages* refer to relationships to the user, *backward linkages* relationships to the supplier within a VC. They can take the form of subcontracting, joint ventures, licensing, or franchising. Intermediary producers in one particular VC may also feed into a number of other VCs.[26]

The division of labor within VCs is becoming more and more complex. This is due to more stringent quality requirements, the need to trace products back from the consumer along the entire value chain to the first supplier, shorter product life cycles, etc. As a result, many VCs can no longer be based on anonymous spot-market trans-

Figure 2.2: Vertical inter-firm linkages and governance of value chains



Source: Own illustration

25 Pfirrmann/ Hornschild (1999), p. 62.

26 Kaplinsky/ Morris (2001), p. 4.

actions but require intense coordination regarding, for instance, agreements on product standards, harmonization of logistic concepts, electronic data exchange formats, etc. (see Figure 2.2). As a result, VCs gradually evolve from a simple, unidirectional succession of production steps towards integrated systems requiring differentiated forms of governance and knowledge management. The term *governance of value chains* has recently been introduced to describe how product and process standards are set and enforced. In many VCs lead firms emerge which undertake the tasks of defining standards, coordinating the VC, monitoring the process, and sanctioning in cases of non-compliance with standards. Kaplinsky and Morris suggest that the ability to govern a given value chain often resides in intangible competences such as R&D, design, branding, marketing, which are characterized by high entry barriers.[27]

In such a system the advantages of SMEs (flexibility, specialization, closeness to the customer) and the advantages of large companies (economies of scale, market power) may be combined in such a way as to gain synergy effects. Integration into VCs enables firms to use external knowledge, technology and finance, and thus to upgrade their activities and gain access to more profitable markets. Empirical studies show that access for SMEs to external markets increasingly depends on entering global production networks governed by TNCs.[28] Although SMEs often also face problems due to increased dependence on the respective lead firm,[29] TNCs play a significant and growing role for knowledge transfer within NIS. Despite the risk involved in transferring advanced technology and know-how to a less developed partner – it may foster the emergence of new competitors – it is a necessary element of TNC strategy to concentrate on their core competences.[30] In highly disputed international markets competitiveness increasingly depends on the ability to improve the quality and reduce the costs of upstream and downstream activities. Competition nowadays is not only a struggle between individual firms but also, and even more, a contest in which one lead firm pits the strength of its VC against the VC of a competing lead firm. This is why many TNCs engage in outsourcing and vertical networking to establish efficient local supplier structures, which they may support through the following transfer channels:

1. *Product technology*: provision of proprietary product know-how; transfer of product designs and technical specifications; technical consultations with suppliers to help them master new technologies; feedback on product performance; collaboration in R&D;

2. *Process technology*: provision of machinery and equipment; technical support on production planning, quality management, inspection and testing; visits to supplier facilities to advise on layout, operation and quality; formation of cooperation clubs geared to interacting with suppliers on technical issues;

3. *Organizational and managerial know-how*: assistance with inventory management and the use of just-in-time etc.; assistance in implementing quality assurance systems; introduction to new practices (network management; financial, purchasing or marketing techniques); assistance for employees to set up their own firms;

4. *Training*: training courses for supplier personnel; provision of access to internal training programs; sending teams of experts to suppliers; promotion of co-operative learning among suppliers;

5. *Information*: informal exchange of information on business plans and future requirements; provision of annual purchase orders; provision of market information; encouraging suppliers to join business associations;

6. *Financial support*: provision of special or favorable pricing for supplier products; help

27 Ibid., p. 66.

28 Gereffi/ Korzeniewicz (1994).

29 See Kaplinsky/ Morris (2001), p. 98.

30 UNCTAD (2001), p. vii.

with supplier cash flow; longer-term assistance.[31]

2.2.3 Relationships between institutions and firms

Neither market forces nor horizontal and vertical cooperation between firms are sufficient to guarantee high levels of innovation. Market failure may occur, especially in R&D, information, and training markets. Institutions[32] are therefore needed to overcome market failure, provide incentives for innovation and establish a 'learning culture' in society as a whole. Since the *provision* of knowledge has a major impact on innovation capabilities in the modern learning economy, knowledge-providing institutions such as universities, schools, training systems, research labs, databases, training systems etc. are very important elements of an NIS. In addition, institutions are needed to support the *transfer* of knowledge through telecommunication networks, libraries, databases, linkage programs, technology transfer centers, etc. And last but not least, institutions play an important role in *reducing uncertainty* in the political, legal and economic environment.

Market power within vertical cooperation may inhibit sufficient transfer of knowledge, since relevant knowledge for gaining national competence is transferred only in part within VCs. For obvious reasons, lead firms will provide know-how only insofar as this raises the efficiency of the upstream and downstream activities of its own business. Lead firms will especially seek to avoid any leakage of *strategic* know-how, e.g. concerning specific production technologies, market trends or sources and prices of inputs. If a supplier, or a group of companies at a certain location, takes the decision to engage in more complex stages of the value chain and start competing against the established lead firm, it will usually face tough opposition. If policy-makers at the respective location wish to support any technological upgrading that goes beyond enabling local firms to be suppliers to TNCs, they need to help local companies to tap additional sources of knowledge. Moreover, they may adopt measures to define parameters and influence the respective value chain in the public interest.[33]

Not every public intervention in a VC is helpful. Some institutions are overly bureaucratic, distort markets, and thus contribute to a suboptimal allocation of resources and retard necessary changes. To boost efficiency and innovation, the whole institutional setting should therefore be market-oriented and demand-driven, it should focus on delivery and on maximizing its outreach, and its internal organization should be businesslike.[34] Moreover, the diversity of the institutional setting is important, since diversity supports technical, organizational and institutional learning and broadens the knowledge base of the economy. Systems with a lower degree of diversity are often less able to adapt to structural change.[35]

31 See UNCTAD (2001), p. 140.

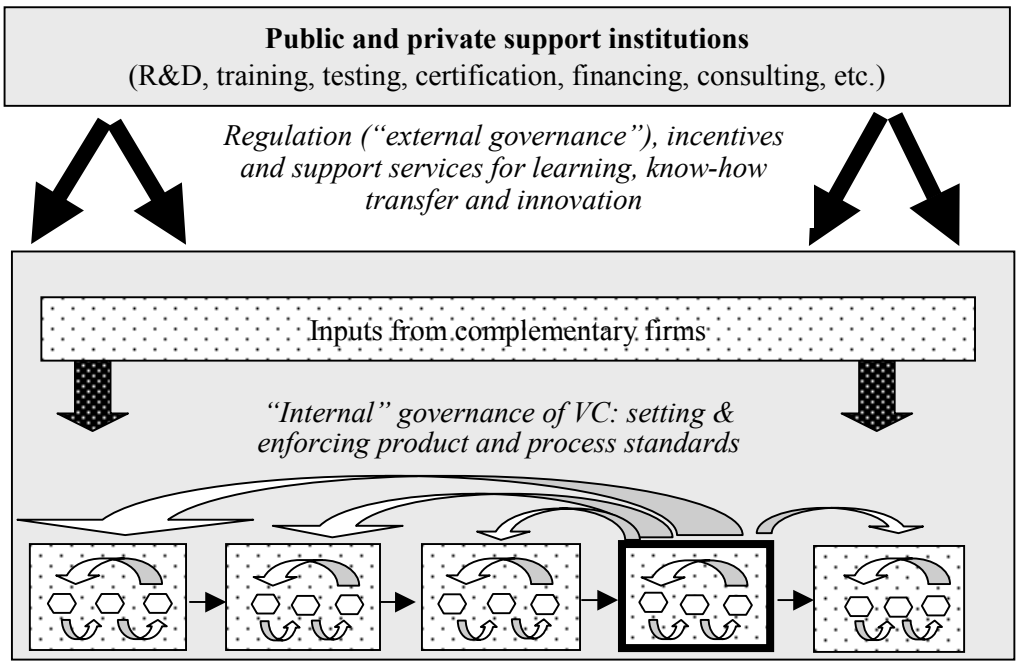
32 We will mainly concentrate on formal institutions and refer only in part to informal institutions (sets of habits, routines, rules, norms and laws, which regulate the relations between people and shape human interaction).

33 Humphrey and Schmitz (2002, p. 12) argue that there may be a shift from parameter-setting by internal agents to parameter-setting and enforcement by external agents.

34 See Gibson (1997), p. 4.

35 Johnson (1992), p. 37.

Figure 2.3: National innovation systems



Source: Own compilation, based on Kline and Rosenberg

Figure 2.3 is based on the Chain-Link Model developed by Kline and Rosenberg.[36] The model emphasizes the multiplicity of interactions linking every phase of innovation within the firm, between firms, and between groups of firms and their wider economic, scientific and political environment. Central elements include feedback loops within the firm, and external feedback loops from the market, feedback from other firms (especially the lead firm) in the chain, and inputs from the institutional setting. There is a recursive relationship between all the different knowledge bases, one that can be strengthened by an engagement on the part of public policy. Public support should aim at promoting innovative entrepreneurs, bearing in mind that these are the principal drivers of innovation in market-led economies, providing incentives for inter-firm cooperation in value chains and local clusters, and improving the contribution of institutions in fields such as research, education and training as well as technology transfer.

2.3 Technological upgrading and embedding in NIS

To strengthen a nation's competitiveness, firms or groups of firms at certain locations or within certain sectors need to move from low-value to relatively high-value activities that generate higher incomes while seeking to be or to remain ecologically sustainable. This process is referred to as *upgrading*. Following Humphrey and Schmitz, [37] we distinguish four types of upgrading:

— *Product upgrading* implies moving into more sophisticated high-end product lines within the same segment of a VC. Instead of producing large quantities of the same product with low margins, what should be aimed for is a shift to either products with higher margins or a wider range of goods. For example, a firm in the garment industry may want to sew expensive high-quality suits instead of simple garments for mass markets.

36 Kline/ Rosenberg (1986).

37 Humphrey/ Schmitz (2002), p. 19.

— *Process upgrading* refers to the improvement of the efficiency of internal processes within one segment of the VC, i.e. how inputs are transformed into outputs. A firm may improve its internal logistics, adopt a new warehousing system, acquire more versatile equipment or develop a better plant layout. All these improvements may result in lower costs, higher productivity and product quality, quicker delivery etc.

— *Intra-chain functional upgrading*: Firms may acquire additional functions within the same VC, thereby increasing the overall skill content of their activities. Expansion of the range of activities performed is directed towards reaping a greater share of value added. For example, a firm assembling air conditioners may complement its main activity by adding packaging or designing new types of air conditioners or selling its products under an own brand name instead of supplying foreign companies. Firms may in this way progress from simple assembly or original equipment manufacturing (OEM) to own design (ODM) or even own brand manufacturing (OBM). An alternative path to expanding activities within a given VC would be for assembly companies to start to source independently (so called "full package supply").

— *Inter-chain functional upgrading*: Here the old VC is abandoned, and firms become part of a new, more sophisticated value chain. For example, the same competences applied in producing TVs are used to produce monitors, and thus a firm or a whole industry may move into a new VC, e.g. manufacturing computer peripherals.

All types of upgrading require additional knowledge and depend crucially on the possibility to contract outside expertise from specialized firms or institutions. Any particular firm willing to upgrade thus needs to intensify interactions with its NIS. In most cases upgraded firms not only *demand* more specialized complementary inputs but also *provide* more sophisticated goods or services to other actors in their environment. During this process highly interactive local networks of enterprises and supporting institutions ("clusters") emerge, sometimes with very unique attributes.

The lack of such synergetic relationships is one of the main weaknesses of developing economies. Foreign investors here often rely on foreign sources, usually the parent company and its established partners abroad, or they carry out many essential business functions in-house. This creates a competitive disadvantage vis-à-vis locations with mature entrepreneurial and institutional networks. At the same time, this obstructs the process of incremental sophistication of the host country's production structure. From this country's perspective it is crucial to *embed* such isolated foreign companies in its incipient NIS. The notion of embeddedness refers to the anchoring of sectors or firms in certain locations. As firms are increasingly integrated into local production networks through inter-firm relations or interactions with scientific institutions, they not only make more contributions to local development but also become more closely tied to the location, thus reducing the threat of relocations to other production sites.

2.4 Policies to promote NIS

Promotion of innovation is a cross-cutting issue affecting almost every field of economic policy. The innovative capacity of an economy depends on many general factors, including the macroeconomic environment, the regulatory context, labor market conditions, etc. Enhancing this capacity calls for integrated system management rather than a series of clearly defined tools,[38] and it is not possible to clearly delimit the term *innovation policy*. But for analytical reasons we will distinguish between *general policies* and *specific innovation policies*, even though this distinction is by no means clear-cut. Box 2.1 mentions the most important general policy fields. All such policies should be designed in such a way as to support innovative behavior, but a thorough analysis of all

38 See OECD (2002), p. 70.

Box 2.1: General policies: the role of a supportive business environment

- To reduce uncertainty, increase economic efficiency and free up resources for high-return private investment, **fiscal discipline** should be enhanced, inflation kept low, and **exchange rate** management should be fine-tuned so as to avoid overvaluations.
- Openness is a fundamental precondition promoting the diffusion of ideas and knowledge worldwide. Therefore, an **open policy on international trade and investment** should be maintained to reduce costs and improve international standards. In principle, this does not preclude the deliberate use of infant industry protection, but any selective and protectionist measures should be temporary and be designed with great care.
- As competition is important for knowledge transfer, competitiveness should be encouraged by means of a **competition policy** and **tax incentives** conducive to knowledge transfer and innovation.
- As financial resources are important for innovative investment, **financial systems** should be made more supportive of innovation. To foster innovative investment in enterprises, lending policies, cross-financing and guarantees should be reviewed. . A mix of greater firm transparency and investor protection is needed.
- Corruption and legal insecurity often restrict a smooth transfer of knowledge. Therefore, **good governance** and a sound **legal system** are needed to ensure an efficient and sufficient transfer.
- In the move toward a knowledge-based economy, **education policy** is crucial. Education is a prerequisite for acquiring the necessary skills to thrive in a globalizing economy. Inquisitiveness, achievement motivation and problem-solving behaviors should be supported at all levels of the education system.
- **Labor mobility** is an important mechanism for transmitting tacit knowledge. Labor market programs and **social policy** should therefore encourage mobility, and should be made more effective in bringing would-be workers into the job market, in helping workers affected by change and in ensuring that the benefits of growth are shared by all.
- Promotion of an knowledge **infrastructure, especially ICT** conducive to knowledge transfer, is another core basis for a well-functioning NIS.

Source: OECD (2001); Esser et al. (1996).

these factors is obviously beyond the scope of this study.

Besides these general national framework conditions, governments need to take *specific* actions to strengthen innovation policies. First of all, national innovation policy requires a clear vision of future development trajectories and windows of opportunity for international specialization. Such a vision needs to be based on a stakeholder dialogue, and has to be translated into targeted and coherent specific programs. Among these programs, promotion of innovative entrepreneurship is highly important in view of the fact that the private sector constitutes the basis for innovative activities within an economy. Innovative firms not only create additional employment but also help to continuously renew the entrepreneurial structure, to improve allocative efficiency within a country, to build a culture of innovation, and thus to speed up structural change. This calls for specific programs to promote entrepreneurship in general and to support private sector R&D in particular. Moreover, innovation should be promoted through specific policies designed to promote entrepreneurial clusters and value chains as well as by means of cooperation between the private sector and scientific institutions. As we have argued in the previous chapter, knowledge flows and cooperation between the different actors of the NIS are important sources for technology learning and upgrading.

3 The case of Thailand: An overview of its competitive challenges

3.1 Thailand's success story until 1996

During the past four decades the performance of the Thai economy has been impressive. Thailand was one of the fastest-growing countries in the world. From 1985 to 1995 its real annual GNP grew by 8 % on average. Together with seven other high-performing economies, Thailand has proven that poor countries do have possibilities to

Table 3.1: Growth Rate of GDP compared to other East Asian Newly Industrialized Economies (NIEs)									
	1980-89	1990-99	1997-99	1996	1997	1998	1999	2000	2001
Hong Kong	7.2	3.7	1.0	4.5	5.0	-5.1	3.0	10.5	0.6
Rep. of Korea	8.2	6.3	3.0	6.7	5.0	-6.7	10.7	1.3	3.0
Singapore	7.5	7.1	4.7	7.5	8.4	0.4	5.4	9.9	-2.0
Taiwan	7.7	6.2	5.7	6.1	6.7	4.6	5.7	6.3	-2.2
Thailand	7.4	5.2	-2.6	5.9	-1,7	-10.2	4.2	4.3	1.8
Source: ADB (2000) Key Indicators for Developing Asian and Pacific Countries 2000, Volume XXXI; http://strategicasia.nbr.org/; www.adb.org; www.worldfactsandfigures.com/gdp_country_growth_rate.php									

catch up with the developed world. Even in the early 1990s the International Monetary Fund and the World Bank praised Thailand for its macro-economic management, poverty reduction, export-push strategy, and high literacy rate.[39]

Since the mid-1980s Thailand's formerly agriculture-dominated economy shifted towards manufacturing and the service sector. In particular, the manufacturing sector has grown considerably both in terms of growth of production and share of total exports. Investment-friendly policies, low labor costs and a relatively rich resource base, together with less demanding environmental standards,[40] made it possible for Thai producers to offer their products at internationally competitive prices.

Growth in international trade and Foreign Direct Investments (FDI) were the driving force behind Thai economic development in the past decade. In 1996, before the crisis, international trade accounted for 70.5 % of GDP. Export-oriented FDI and other economic activities of international enterprises were the main drivers of economic growth, reflecting the 'shallow' nature of Thailand's industrialization. In particular, the export sector was not only the main source of foreign-exchange earnings, technology transfer, and industrial development, it also provided a large proportion of newly created jobs.

This employment creation has been a major factor in income generation and skills upgrading in Thailand. The shift of labor out of the agricultural sector into the urban-industrial sector has improved income distribution and the level of skills in the labor force, and it has dramatically reduced the number of people living in absolute poverty. Although the share of the labor force working in agriculture remains much higher in Thailand than in other NIEs of the region,[41] and industrialization had unequal social, sectoral and regional effects, altogether living standards and critical social indicators improved substantially.

3.2 The economic and financial crisis of 1997

Thailand has been faced with a deep economic and financial crisis since 1997. A sharp devaluation of the bath, capital outflows, and severe difficulties among financial institutions have led to regressive economic development, a massive increase in the foreign debt of the public and private sectors, high inflation, stagnation of production and demand, and a surge of unemployment and poverty. Thailand was one of the countries worst affected by the Asian crisis. In 1998 GNP fell by 10.4 %; compared to 1996, per capita GNP sank by 40 %. In a very short period three million people dropped below the poverty line.[42]

39 World Bank (1993).

40 Altenburg/ Reinecke/ Weihert (2002), pp. 2, 5.

41 In 2002, 34.7 % were still employed in agriculture, contributing 9.0 % to GDP (www.adb.org).

42 BMZ (2002), p. 2.

Following crisis management, which proved quite successful, and some reforms in the area of governance and modernization of the economy, annual economic growth rates have risen again since 1999 to about 4 %, and per capita GNP grown again to US$ 2,300. The unemployment rate is declining and the inflation rate has stabilized at 2-3 %. Despite this recovery, by the end of 2000 per capita incomes were still about 9 % lower than their 1996[43] levels, and it appears that Thailand will have further difficulties in returning to the high growth rates of the pre-crisis years. Studies have shown that the crisis of 1997 was not only a "financial" crisis. Competitiveness indicators had started to deteriorate years before, and reforms in key economic sectors – like banking, education, public administration – were long overdue.

3.3 Why Thailand's loss of competitiveness is structural

The crisis of 1997 revealed fundamental structural weaknesses in the political-administrative and socio-economic sectors in Thailand. Thailand's international competitiveness has been waning since the early 1990s. There are a number of factors that explain why Thailand is no longer gaining competitiveness and market shares in exports.[44]

Among the main factors is the evident mismatch between increases in real wages and increases in labor productivity. Real manufacturing wages in Thailand have risen by about 6.5 % a year in recent years, as the labor market tightened and demand for skilled labor in higher-productivity sectors led to rapid wage increases that were transmitted to other sectors of the economy. Since 1990 unit labor costs in Thailand have risen more rapidly than both productivity in Thailand and unit labor costs in competing countries. Thailand faces severe competition in world markets from other Asian economies with far lower per capita incomes and wages. Labor-intensive exports from China have been booming since 1994, and Bangladesh, India, Indonesia, the Philippines, and Vietnam all have emerged as competitors.

Thailand's economic boom was largely due to growth in factor inputs, especially capital stock. Total Factor Productivity (TFP) growth accounted for only 12 % of total growth during the 1980-2000 period and was mainly concentrated in agriculture. TFP growth in industry and services was even negative. On this basis, growth is not sustainable once inflows of huge amounts of capital have dried up.[45]

Low productivity is largely due to the fact that Thailand's achievements in education lag well behind those of other NIEs at a similar stage of development. Like other East Asian economies, Thailand has achieved almost universal primary enrollment. But only about a third of children attend secondary school. This is much lower than in other East Asian economies. There are also questions about the quality of Thai education and its suitability to the needs of a modern economy.[46] Tertiary education is highly biased towards liberal arts and law, and the number of engineering and science graduates turned out by Thai universities is much lower than in competitor economies. Also, vocational education and training is poorly organized. Although a significant amount of firm-based training does take place, this training does not equip the labor force with the skills needed for the next phase of Thailand's development, since most Thai firms are involved in basic assembly and other lower-skill activities.[47]

A comparison with other Asian countries shows that Thailand not only has a weak educational base but that it is also a regional laggard in industrial technology development. This picture is confirmed in the public as well as the private sector. The Thai government has invested much less in technology development capabilities than other

43 European Commission (2002), p. 11.

44 See UNIDO (undated).

45 Warr (2003).

46 See Chantramonklasri (1994).

47 See Intarakumnerd et al. (2003), pp. 22 ff.

governments in the region. Overall expenditure on R&D as a share of GDP in Thailand fell from 0.21 % in 1987 to 0.12 % in 1996, whereas in several other countries in the region R&D expenditure constituted a rising proportion of GDP. After the crisis, expenditure on R&D rose slightly, accounting for 0.26 % of GDP in 1999. Yet these rises are still far below the level of R&D in Thailand's competitor countries, even in comparable second-tier NIEs like Malaysia. The same trend holds for the private sector, where the proportion of total R&D performed in business enterprises represented around 10 % of total R&D in 1996, amounting to only about one-sixth of the levels in Singapore or Taiwan.[48]

As a consequence, Thailand's performance on indicators for international competitiveness have systematically declined, so that Thailand actually rates low in global competitiveness rankings (see Table 3.2). In the annual Global Competitiveness Reports produced by the World Economic Forum, Thailand fell from the 14th position in 1996 to the 31st in 2002. The World Economic Forum ranking shows that Thailand ranks especially low in technology-related dimensions of competitiveness. The cross-country comparison shows that Thailand is lagging behind its main competitors in the region. Moreover, a relative comparison of the current Thai economy with earlier economic indicators for Korea – i.e. when Korea had a level and structure of economic development similar to that of contemporary Thailand – shows that Thailand is lagging around 10-20 years behind the level and structure of technology development activity that Korea had reached in the early 1980s.[49]

Particularly low – 41st – was the ranking of Thailand's International Institute for Management Development (IMD) in regard to science and technology indicators. The main reasons for this negative assessment were the low budget share of R&D and the small number people active in R&D. In 2000 0.8 % of GDP was allocated for R&D. As a rule investment in R&D in developed countries accounts for 2-3 % of GDP, in NIEs the figure is around 1-2 % of GDP. Figures for research and development personnel were as low as 2 per 10,000 population, while the corresponding figures for Thailand's neighbors were much higher. The rate for Indonesia e.g. was 13 per 10,000 population or more than 5 times higher than that of Thailand. The proportion of scientists and researchers in developed countries is around 50-70 per 10,000 population, while the corresponding ratio in NIEs is around 20-30 per 10,000 population. The same applies for the ratio of scientists and engineers, which ranges from 5,183 in Japan, 2,305 in Singapore, 1,343 in Korea to 107 per 1 million population in Thailand.[50]

Even though the contribution of the manufacturing sector to GDP and exports has been constantly increasing, most government funding for R&D is allocated for the development of agricultural technologies rather than for industrial technologies. In 1997 R&D expenditure for agricultural sciences was 42 %, while spending for engineering and applied sciences was only 6.9 % of total government expenditure on R&D.[51]

As highlighted in its Ninth Development Plan (2002-2006), the Thai government has recognized the importance of improving skills and technological capability in all economic and social sectors. One specific goal for domestic markets and rural communities is to "increase production efficiency by promoting research and utilizing local knowledge as well as modern technological know-how." For industry, the policy supports cooperation in research, technology and product development between SMEs and other public- and private-sector organizations (including those in higher education). The aim is to assist Thai firms to obtain technology and intellectual property from all sources and ensure a supply of qualified personnel.

48 Arnold et al. (2000), p. 49.

49 Arnold et al. (2000), p. 48.

50 See Bhumirat/ ONEC Working Group (2001), p. 1.

51 World Bank (2002), p. 50.

Table 3.2: Rankings of competitiveness indices in 2002[a]

Country	Global Competitiveness Ranking	Technology Index Rank	Public Institutions Index Rank	Macroeconomic Environment Index Rank
Singapore	4	17	7	1
Korea	21	18	32	10
Malaysia	27	26	33	20
Thailand	31	41	39	11
Philippines	61	52	70	32

a International rankings such as the Global Competitiveness Ranking by the World Economic Forum and the World Competitiveness Yearbook by the IMD business school rest mainly on subjective business perceptions compiled from surveys and are therefore disputable. Nevertheless, they often match objective data and are used here as rough indicators to support the line of argumentat.

Source: Global Competitiveness Ranking, World Economic Forum: http://www.weforum.org/pdf/gcr/GCR_2002_2003/GCR_GCI.pdf

As shown above, Thailand is a small open economy, with exports accounting for a high share of GDP.[52] Trade performance is therefore one of the main indicators for its competitiveness. Exports have traditionally been Thailand's main economic growth engine, accounting for 60-65 % of GDP throughout the 1990s.[53] Since 1996 export growth in Thailand slowed markedly. While Thai exports grew on average by 23 % a year during the 10 years up to 1996, growth fell to 0 % in 1996. This abruptness of the decline in export growth can be traced back to a number of short-term factors such as the slowdown in world trade as a whole. However, the overriding longer-term factor seems to have been a loss of competitiveness, with labor-intensive exports the hardest hit.

Manufactured products are among Thailand's principal export items; they include computer parts, integrated circuits, garments, motor vehicles and parts, canned food, electrical and consumer electronic goods, precious stones and jewelry, footwear, furniture, plastics and rubber products.[54] In 2000 the Thai manufacturing sector accounted for 85 % of export earnings and contributed 35 % to GDP.[55]

The collapse of export growth in 1996 is made evident by the slowdown in growth of labor-intensive industries. This can be traced back to the structural problems that Thai exporters are facing. The so called 'China factor' is exerting heavy pressure on Thailand's export performance, with China winning market shares and eroding Thailand's pricing power across low- value-added industries. Other factors are the declining terms of trade for labor-intensive products, such as apparel, footwear, and consumer electronics, which has led to slower export earnings. For example, world prices for manufactured exports fell about 2 % in 1996, whereas semiconductor prices fell almost 80 % in the same year.

Thailand is a member of the Association of South East Asian Nations (ASEAN) countries, which receive a significant amount of FDI. Net inflows to Thailand in 1999 accounted for 0.7 % of world FDI flows. During 1985-1995, net inflows to Thailand amounted to US$ 1.4 billion, but declined after the crisis.[56] FDI has been spread out

52 In 2000, exports and imports accounted for 55.8 % and 51.3 % of GDP. See: UNIDO (undated).

53 Far Eastern Economic Review, July 11, 2002, p. 54.

54 UNIDO (undated).

55 European Commission (2002), p. 10.

56 During the first seven months of 2001, for instance, overall approved FDI decreased by 17 % in value over the same period in 2000. See European Commission (2002), p. 12.

across many economic sectors, including manufacturing, finance, trade, construction, services and real estate. Among the manufacturing industries, electrical appliances, machinery and transport equipment, and chemicals are among the major industries with substantial FDI.[57] This pattern shows that Thailand relies mainly on FDI to produce more sophisticated goods. But many of Thailand's "technology-intensive" products use simple technology to assemble a mass of imported components, with a low level of added value (e.g. an estimated 80-90 % of computer components are imported).[58] Most FDI is directed to Thailand for reasons of low wages and not for the availability of a skilled workforce and other knowledge-intensive inputs. Since FDI is at best inadequately embedded in the local entrepreneurial and institutional tissue, rising labor costs for Thai workers are inducing mobile transnational companies to seek cheaper locations, notably in China and Vietnam. This outflow of FDI gained momentum after the ASEAN Free Trade Area (AFTA) entered into force in 2002, when a considerable number of foreign companies moved to Indonesia, especially firms operating in the sector of electrical appliances, washing machines etc.

The case of Thailand has often been referred to as the 'nutcracking effect' or 'sandwich position.' Thailand, together with Malaysia and Indonesia, is one of the second-tier NIEs that have successfully industrialized since the 1980s. Thailand has not yet achieved a sufficient deepening of its industrial development to catch up with the first-tier NIEs, i.e. Hong Kong, Korea, Singapore and Taiwan. On the other hand, low-wage countries such as China and Vietnam are increasingly exerting competitive pressure and threaten to crowd Thailand out of important markets.

Thailand therefore faces serious structural competitiveness problems. Recent studies point to particular challenges in three areas: a weak and underdeveloped skills base, a technological structure characterized by simple activities, and public institutions unable to support firms in upgrading their human and technological capital.[59]

3.4 Assessment of the current business environment in Thailand

The monetary and credit policies pursued since the economic crisis of 1997 have stabilized the Thai economy and led to moderate economic growth rates of around 4 % annually. Thailand maintains its open and liberal policies in the domain of trade and investment. The country continues to have strong interest in promoting its exports, and a number of policies and institutions are in place to enhance Thailand's potentials in this field. While foreign investment is either not allowed or restricted in certain sectors, the business environment is generally favorable for foreign direct investment and international trade.[60]

Alongside this continuity, Thailand has initiated a number of economic, political and administrative reforms. In the economic sphere the salient characteristics include a thoroughgoing reform of the banking system, new labor market policies, a simplification and rationalization of existing tax laws and regulations, and a reconsideration of tax incentives under the Investment Promotion Act.[61]. In addition, the government has recognized the need for more active business promotion and more differentiated policies for small and medium enterprises. The new SME Promotion Act, the SME Promotion Committee, the SME Promotion Office and the SME Development Masterplan have set the framework for appropriate policy coordination and implementation.[62]

Looking at the political and administrative sphere, Thailand adopted a new constitution in 1997 which provides for greater transparency and accountability in government and aims at a compre-

57 Meephokee (undated), p. 2.

58 European Commission (2002), p. 10.

59 Lall (1998), World Bank (2002).

60 BOI (2002), pp. 21-31.

61 World Bank (2002), p. 27; BOI (2002), pp. 7-13.

62 BMZ (2002), p. 4, Régnier (2000).

hensive restructuring and decentralization of decision-making processes, ensuring participation of citizens and civic organizations. New laws and by-laws have been passed and new independent institutions established, e. g to promote small and medium industries, social security and environmental protection. The Educational Act and comprehensive educational reforms have been adopted to modernize the university system in particular. The groundwork for rule of law has been underpinned by the establishment of a Constitutional Court and an Administrative Court.[63] The government of Prime Minister Thaksin is now embarking on reforms aimed at decentralization and breaking up the traditional lines of activity, under which central government has performed all administrative functions. Instead, local administrations are being given more resources and responsibilities for the delivery of public services.[64]

However, Thailand still has to tackle reforms in at least four areas which affect the business environment:

Firstly, there are challenges in the **economic** sphere. Although there is a consensus that Thailand needs to develop knowledge-based competitive advantages and deepen its industrial structure, no clear strategic focus is identifiable. Furthermore, government policies concerning the business environment are still poorly coordinated. There are many gaps and duplications in the policy framework and in the matrix of government development programs. This lack of strategic planning and coordination has also served to reinforce regional disparities. The manufacturing industry is concentrated in and around the metropolis Bangkok, with the rest of the country mostly underdeveloped and poverty-stricken. Government incentives are lacking especially for innovation, with further shortcomings in evidence in the availability of support services in finance, consultancy, and manpower. Also, Thailand's support institutions and incentives are biased in favor of export promotion for larger enterprises and neglect support for local SMEs and their linkages with the TNC-driven export sector.

Secondly, although Thailand's **legal and regulatory framework** is seen as comprehensive, without being overly regulatory or restrictive, one deficiency lies in the fact that there are still a large number of micro- and small-scale enterprises which operate without formal registration. Another deficiency persists in the country's problems with business and consumer protection. Foreign companies express their concerns about the general flouting of copyright law. Quite a number of firms in Thailand's informal and (micro-) enterprise sector are engaged in the partial production and sale of replicas, such as watches, clothing, and electronics.[65] In view of these problems, an Intellectual Property & International Trade Court was established in 1997 to try civil and criminal cases involving intellectual property rights violations.[66]

Thirdly, the **political and administrative system** still suffers from "red tape" and corruption. Although these practices are difficult to quantify or corroborate, several reported instances show the scale of the problem. The Thai press has publicized some instances which describe the importance of influential contacts in winning larger contracts or the tedious and complicated process some enterprises have to undergo to obtain a certain range of special permits. International executives have assessed Thailand, along with Vietnam, Indonesia, Myanmar and Cambodia, as one of Asia's top five most inefficient bureaucratic systems.[67] As far as corruption is concerned, a 2002 survey of Thai businesses found that 79 % had to resort to bribing officials to get results and that these bribes added roughly 20 % to start-up and business operating costs.[68] And Transparency International, in its Corruption Perception Index,

63 BMZ (2002), p. 3.

64 World Bank (2002), p. 29.

65 BOI (2002), pp. 14-20.

66 Dhanani/ Scholtès (2002), p. 22

67 White (1999), p. 45. Several interview partners, especially from foreign firms operating in Thailand, confirmed the existence of bureaucratic obstacles.

68 Jarvis (2002), p. 317.

also ranked Thailand 64th of 102 countries in 2002.[69] A further deficiency is that several government programs lack independent monitoring and evaluation procedures, which makes it difficult to assess their outcome and impact. The party system in Thailand is weakly organized and programmatically underdeveloped. Politics is highly dependent on persons and networks. Bribery and vote-buying is a well known concomitant of elections. Generally, Thailand is marked by a strong and complex commingling of the political, administrative and private and banking sectors.

Fourthly, some **social and cultural factors** restrain the competitiveness of the Thai economy. Lack of English skills among the majority of the population is as an important aggravating factor in the business environment. Prime Minister Thaksin's emphasis on Thai cultural values and the prevalence of the Thai language may in some cases conflict with the needs of an outward-looking, open nation trying to find its place in a globalized learning economy. The lack of acceptance of failure in the Thai social fabric is also cited as a weakness factor in the business environment,[70] one that leads to risk-averse behavior and limits the number of company start-ups.

Despite these remaining problems, Thailand's performance since the outbreak of the crisis has been impressive. Progress is highly visible in the country's economic, legal, and political and administrative sectors. And thus the overall appraisal shared by analysts is that the government is providing for a business environment conducive to investment and economic growth.[71]

3.5 The NIS in Thailand: an overview

Following this brief assessment of the general business environment, we will now proceed to give an overview of the three main levels of Thailand's NIS: the internal organization of its firms, its inter-firm linkages, and the existing relationships between support institutions and private companies.

3.5.1 The internal organization of firms

Studies on technology development in Thai firms conclude that their most striking feature is their weak technological and innovative capability. Accordingly, the first R&D and Innovation Survey of Thailand's manufacturing industry carried out by the National Science and Technology Agency (NSTDA) and the Brooker Group PLC in 2000 shows that in the preceding three years three of four Thai firms had not engaged in any activities aimed at improving their technological capability. Most of the 1,019 responding firms, including the top 200 largest firms, carried out only simple testing and quality control, less than half of them had design capabilities, and only one third a capacity for reverse engineering.

The survey also revealed that medium and large firms in the Thai manufacturing sector spent more than 5.5 billion baht[72] on R&D in 1999, employing 5,291 research personnel consisting of researchers and support staff, including technicians, managers and other R&D staff.[73] R&D in the private sector is much less than that found in the public sector, and contributes only one tenth to total R&D expenditure. This discrepancy is typical for developing countries. In industrialized countries the ratios are the reverse, i.e. most R&D spending is accounted for by the private sector, with only a small percentage remaining with public research institutions.

The R&D and Innovation Survey of Thailand's manufacturing industry further shows that R&D undertaken by Thai firms is concentrated in a limited number of sectors, with companies in the

69 http://www.transparency.org/pressreleases_archive/2002/2002.08.28.cpi.en.html.

70 The Brooker Group (2001), p. 7.

71 World Bank (2002).

72 In February 2003, 1 euro was worth 46 Thai bahts.

73 The Brooker Group (2001), p. 4.

food, beverages and tobacco industry responsible for 48 %.[74] Internationally, this sector is not regarded as an industry of 'high R&D intensity,' which indicates that much of Thailand's declared "R&D" may in fact be relatively standard laboratory activities.

The study also showed that the number of innovations – though very small – effected by firms exceeded that of firms engaging in formally organized R&D. This shows that some firms are able to carry out product or process innovations without setting up formal R&D units.[75] Actually, expenditures by sample firms on innovation activities exceeded about 1.5 times spending on R&D and mainly went into the acquisition of machinery and equipment. This reliance on off-the-shelf imported technology in the forms of machinery and turnkey technology transfer from abroad or joint ventures with foreign partners points to an attitude typical of most Thai firms: not to attribute much importance to the development of indigenous technological capabilities. This may be explained by the historical development of most firms, which, coming from a trading background, have paid much more attention to high turnover ratios in the short term than to the development of indigenous production technologies.[76]

A closer look at different kinds of enterprises helps to identify key thresholds that Thai firms face in deepening their technological capabilities:[77]

— The majority of firms are SMEs in traditional industries which are resource-based and labor-intensive. They mostly lack the human resources, knowledge, infrastructure and financial resources available to larger enterprises to upgrade their process and product technologies. For these firms the key issue is building more basic operational capabilities, together with the craft and technician capabilities needed for efficient acquisition, assimilation and incremental upgrading of fairly standard technology.

— Only a small number of SMEs have attained sufficient capabilities to move into design and engineering.

— Many large domestic firms, some higher-technology SMEs and most large TNC subsidiaries still have to develop their design and engineering capabilities as a basis for embarking on significant technology development activities.

— For a minority of firms that have already built design and engineering capabilities, the relevant threshold is now to continue and expand the building of R&D capabilities and activities.

3.5.2 Inter-firm linkages

In Chapter 3.2.2 we argue that from an innovation system perspective, inter-firm collaboration is by far the most important channel of knowledge sharing and exchange. In Thailand, inter-firm linkages are generally weak and fragmented. A report on Science and Technology (S&T) Development for Industrial Competitiveness in Thailand states that "... 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."[78]

In OECD countries, most innovative activities emerge from interaction between firms that are linked as suppliers and customers at different stages along value chains. But the R&D/Innovation Survey shows that such technological links between producers and users and between produc-

74 World Bank (2002), p. 50.

75 Intarakumnerd/ Chairatana/ Tangchitpiboon (2002), p. 1448.

76 Intarakumnerd et al. (2003), p. 11; Thongpakde/ Puppahavesa/ Pussarangsri (1994), p. 129.

77 Arnold et al. (2000), p. 57; Intarakumnerd et al. (2003), World Bank (2002), p. 51.

78 Chantramonklasri (1994), p. 54.

ers and suppliers in Thailand have barely developed. This is confirmed by Arnold et al. (2002), who describe customer-supplier links in Thailand as weak, with intra-economy value chains often short and fragmented. These deficient customer-supplier links, together with the limited innovative capacities within firms described above, preclude any significant innovation-centered interaction. A recent analysis of the Thai automotive industry identified a lack of collaborative mechanisms within the supply chain of manufacturing TNCs. It showed that communication within the supply chain was largely informal, making little use of ICT-based systems.[79]

The importance of FDI for technology transfer to developing countries has been stressed in numerous publications. As stated above, Thailand is one of the major recipients of FDI in the region, with an inflow of US$ 6 billion in 1999.[80] Yet FDI in Thailand is concentrated in low-skill activities. TNCs have invested very little in R&D, and they have not been active in developing subcontractors or giving technical assistance to local suppliers. Nonetheless, the Thailand Industrial Survey reveals that foreign firms are about 50 % more productive than domestically owned firms. The higher revenue from labor and capital of foreign firms is assumed to result from their superior technology and management skills.[81] Therefore, even in relatively standard operations such as raw materials processing, assembly and testing, or wholesaling, foreign companies may be showcases for technological upgrading.

Thailand is not properly exploiting this source of technical and managerial knowledge. It is commonly stated that technological spillovers from TNCs to the host economy are low. Studies in different sectors found that transfer of technology tended to be limited to the operational level.[82] TNCs have trained their workforces in such a way as to ensure they can efficiently produce goods without requiring technology transfer at higher levels such as design and engineering. But more detailed studies show that there are differences in technology transfer policies between firms. Some companies are willing to transfer certain types of knowledge.[83] This willingness mainly depends on the parent company's overall period of experience in the host country, the international orientation of the parent firm, and its reliance on indigenous firms.

The weakness of linkages between large investors and local firms reflects the weak absorptive capacity of Thai firms as well as deficiencies of the Thai economy in terms of institutions, universities and other support infrastructure. Thailand lacks supplier development and technology transfer policies. This compares unfavorably with Singapore, where links between TNCs and local firms have deliberately been supported and exploited to strengthen domestic technological capabilities.
Horizontal co-operation between firms operating at the same stage of the value chain is likewise marginal. Cooperative consortiums between firms – e.g. in Japan or Taiwan – to investigate particular technologies or jointly develop new products are rare in Thailand. The Innovation Survey found that most Thai firms do not consider their competitors as a source for learning and note that the flow of knowledge between firms in the same and related industries remains very limited.

3.5.3 Relationships between institutions and firms

As shown in Table 3.2, Thailand is ranked low with regard to the performance of its public institutions. Compared to other countries, Thai institutions and public programs have lacked effectiveness, particularly in helping firms to upgrade their skills development, training, and technology capabilities, and, generally, in fostering the development of a knowledge economy.

79 World Bank (2002), p. 57.

80 Mirza/ Giroud/ Köster (undated), p. 5.

81 Dollar/ Hallward-Driemeier (1998), p. 23.

82 Intarakumnerd/ Chairatana/ Tangchitpiboon (2002), p. 1451.

83 Mirza/ Giroud/ Köster (undated) , p. 43.

Overall, the institutional system does not demonstrate any clear vision on the development of a knowledge economy. Accordingly, it is characterized by a lack of targeting and coordination. Most of institutions are rather bureaucratic and strongly supply-driven, and their services are often unknown to or not well regarded by the private sector.[84]

The activities of public RTOs which have direct responsibility for developing the scientific and technological capability of the Thai economy mainly focus on R&D, neglecting support for lower-level capabilities, e.g. for technology assimilation and adaptation, design and engineering, the technological thresholds faced by most Thai firms. Additionally, RTOs not only focus on the inappropriate support levels, they are also delinked from the private sector, since they pursue a linear concept of innovation by delivering technological solutions to industry instead of promoting the development of indigenous technological capabilities within firms.

Furthermore, public support institutions display several overlaps with no coordination among them, and there is no clear-cut division of labor between policy formulation, funding, and implementation. Several institutions assume similar duties, such as providing technical support services, carrying out applied technology development and transfer, and undertaking strategic or basic research, and funding R&D. This structural feature of public institutions reflects the practice of the Thai government over the last 40-50 years of setting up new institutions without abolishing or reorganizing the existing ones.[85]

There are 24 public universities and 50 private universities in Thailand, which together have the capacity to educate 1.1 million students. Thai universities do not produce enough sufficiently qualified science and engineering graduates, and the number of Ph.D. and master degree graduates in science and engineering is very low. This is reflected in the low overall ranking of Thai universities and Thai institutions specializing in science and technology compared to counterparts in the Asia Pacific region. In Asia Week Magazine in 2000, e.g., Thailand's universities were rated in 25th place among the universities in Asia.

Generally, the research culture and capabilities in Thailand are weak. Thai scientists publish little in internationally recognized journals. According to the Science Citation Index, the number of publications by Thai researchers is three times lower than that of Singaporean researchers. One further aspect is that the little research undertaken seldom has industrial relevance and basic research is given higher priority.[86]

4 Thai policies for promoting NIS

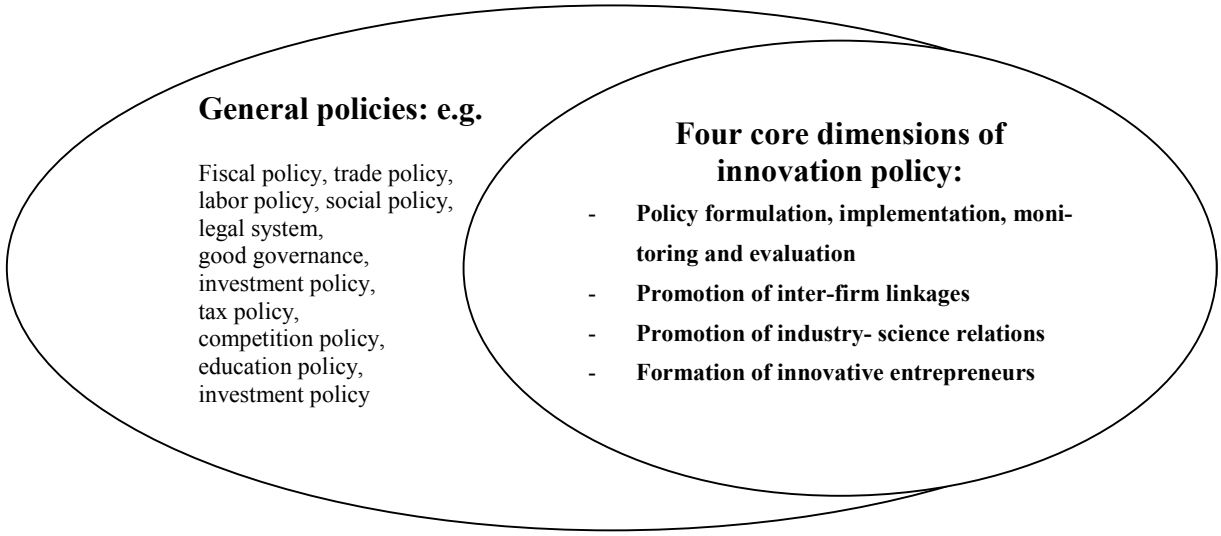
As described in Chapter 3.4, the general framework conditions in Thailand on the whole are judged to be conducive to business activities. In this chapter we concentrate on specific innovation policies directly related to the Thai NIS. Based on desk research during the first phase of our research project, and in accordance with the general diagnosis of Thailand's NIS presented on the previous pages, we have identified four core dimensions of innovation policy which we consider as especially important in the Thai context because they focus on the main bottlenecks of the Thai NIS. These are (see Figure 4.1):

84 World Bank (2002), p. 57.

85 Arnold et al. (2000), p. 140.

86 See Intarakumnerd et al. (2003).

Figure 4.1: Policies to promote NIS in the Thai context



Source: Own illustration

— **The process of policy formulation, implementation, monitoring and evaluation as such.** There does not appear to be a generally shared vision about Thailand's future role and patterns of specialization in the world economy, and technological efforts thus lack strategic orientation. The Thai government lacks a "focal point" responsible for delineating a coherent policy strategy or coordinating the government's response to the technological and policy needs of the Thai NIS. Furthermore, implementation as well as monitoring and evaluation of programs and projects does not live up to modern standards.

— **Inter-firm linkages**. As described above, the Thai economy is characterized by a dualistic structure, with mainly foreign large corporations as technology owners and low levels of technological capability among most Thai firms. Therefore, fostering inter-firm networks is an urgent policy task in Thailand. Incentive systems and programs are needed to augment technology transfer in favor of Thai firms, to develop innovative supply chain relationships and to embed footloose foreign investors in national production systems.

— **Industry-science relations**. Thailand exhibits a diversified infrastructure of research and technology organizations and holds strong potentials for industry-science relations. However, at present scientific institutions rarely collaborate with industry, and a cultural gap seems to separate the two "subsystems" of research and production. The challenge is to bridge this gap, bringing actors from both "subsystems" together, developing common approaches to relevant problems and creating incentives for cooperation.

— **Formation of innovative entrepreneurs**. Entrepreneurs are important actors who provide significant inputs to and advance innovation within NIS. In Thailand the indigenous innovative capacity of firms is low and there is an obvious lack of innovative business start-ups. Consequently, government action geared to entrepreneurship development should be refocused in that direction.

Other specific innovation policies, such as education and human resource policies in general or the development of technical and engineering skills in particular, as well as integrated policies designed to strengthen the overall system of metrology,

standards, testing, and quality assurance (MSTQ) are also very important to increase Thailand's competitiveness in knowledge-intensive fields. It would go beyond the scope of this study, however, to analyze all aspects of these rather broad issue areas. In the following chapters we will therefore only deal with selected aspects of these policies. For example, we will briefly address current initiatives for training and education in Chapters 4.4 and 5.1. The importance of MSTQ policies is taken up in Chapter 5.2.

4.1 Policy formulation, implementation, monitoring and evaluation

Both public and private effort requires direction. Strategic planning based on well-designed surveys, benchmarking studies and a continuous stakeholder dialogue makes it possible to identify economic strengths and weaknesses and pursue pro-active rather than re-active policies. Implementation of the policies identified should be cost-effective, and service delivery should be organized in a businesslike manner. This calls for the establishment of a clear performance measurement framework permitting the results of evaluations to flow into the allocation of future budget funds.

These requirements become especially important in times of fast-changing markets and growing competition as well as in the context of the complex shift of the economy from a labor-intensive towards a knowledge-based economy. Already before the 1997 crisis, there were indications of a loss of competitiveness in Thailand. Yet earlier governments did not take much action to specifically develop knowledge-based competitive advantages. Industrial policies failed to give high priority to the development of indigenous technological capabilities. Unlike some other Southeast Asian NIEs, here there was no explicit and proactive link between promoting FDI and upgrading local technological capabilities.[87]

Since the crisis governments have been more aware of the need to create competitive advantages. They are now more sensitive to private-sector needs and pay considerable attention to reform of government institutions, including the planning system, program implementation, the budgeting process, the system of higher education, etc. S&T policy also appear to rank higher on the political agenda; e.g., the government launched a comprehensive Information Technology (IT) 2010 strategy, which led to the establishment of a new IT ministry. Nevertheless, there are still major shortcomings in the way policy is formulated, implemented and evaluated.

4.1.1 Policy formulation

Traditionally in Thailand the process of policy formulation has not included visionary approaches involving foresight activities and participation of various stakeholders, and horizontal cooperation between ministries has been low. Despite some reform trends, some characteristics of this traditional approach to policy formulation still remain. Other characteristics, like a dual structure of policy formulation, with top-down political goal-setting interfering with participatory long-term strategic planning within the ministerial structure, have even been aggravated by new reform drives. In the following, these characteristics and reforms are discussed in more detail.

Vision. International experiences suggest that systematic foresight and benchmarking activities are important tools for achieving a strategic vision of future technology and market trends, and thus of competitive advantages (see Box 4.1). Although Thailand has not launched a comprehensive national foresight exercise yet, it has hosted the Asian Pacific Economic Cooperation (APEC) Center for Technology Foresight for the past 5 years and has conducted several major foresight exercises at three different levels, which is a good sign that the process of policy formulation is shifting towards a strategic orientation:

87 Intarakumnerd/ Chairatana/ Tangchitpiboon (2002), p. 1450.

Box 4.1: Foresight tools

"Foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy, the environment and society with the aim of identifying the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits."[88] It seeks to identify long-term trends and thus to guide decision-making. Some foresight exercises focus on trends in consumer needs, others attempt to predict what the key technologies of tomorrow will be. The following tools e.g. can be used:

In **Delphi Surveys** groups of experts are consulted on a range of possible future developments in their respective fields. Three main characteristics can be identified: anonymity (no physical contact between participants), iteration (several rounds of consultation), controlled feedback in the form of statistical presentation of the group responses.

Scenario analysis presents alternative images of the future bearing on highly interactive, intense and imaginative processes. This is a tool for ordering perceptions about unpredictable future environments.

Environmental scanning searches the world systematically and highlights the new and unexpected, as well the major and minor. It can reduce the randomness of information and provide early warnings for managers on changing external conditions.

Normative foresight tools, which are related to, are based on, or prescribe norms. One common tool is e.g. relevance trees, which systematically identify requirements for reaching specific goals.

Systematic benchmarking is another important instrument for formulating a national vision, as it offers the chance to compare the relative efficiency of a whole economy or of certain parts of an economy, e.g. a company, a sector, a policy, or an NIS. This can furthermore help to relate differences in performance to observable characteristics. To utilize the benchmarking instrument, it would be important to set up several dimensions of comparison (institutional arrangements, natures and relative importance of the channels of interaction, incentive structures) as well as quantitative indicators for performance measurement and comparison.

Source: Based on Johnston (2003)

— At the national level, the National Science and Technology Agency (NSTDA), a RTO under the Ministry of Science and Technology (MoST), in 1995 commissioned Chiang Mai University to conduct a Delphi survey of "Future Key Technologies for Thailand." Anther major project by ministerial order on "Science and Technology in the Year 2020" was conducted in 1999-2000. It aimed at creating awareness of the importance of S&T and at linking S&T to the social and economic development of the country.

— At the sectoral level, three major projects have been carried out: In 1998 foresight exercises were extended to integrate social aspects as well. The first project in that direction was on "Foresighting Thai Agriculture" to reposition agriculture after the economic crisis of 1997. In 2000 the foresight project on "IT for Education" was conducted during the drafting period of the Master Plan for ICT in Education. The "IT for SMEs" project was initiated in 1999 by the Ministry of Industry, when the country was desperate for economic recovery. A two-round Delphi survey was used as the key foresight technique.

— In addition, three public organizations[89] have used foresight tools for their strategic repositioning.[90]

Participation. Another change within the national policy planning process is a move towards greater participation: Traditionally, national plans in

88 Martin (2001), p. 5.

89 Facing the uncertainties of privatization, the Public Warehouse Organization, a state enterprise, used scenario analysis to develop a long-term strategic plan. The National Metrology Institute of Thailand, an autonomous public agency, took on foresight to clarify goals, and the Technology Promotion Association (Thailand-Japan), a not-for-profit private organization for technology transfer to Thai industry, used scenario writing to rethink its vision and strategy.

90 Sripaipan et al. (undated), p. 6.

Thailand were drafted by bureaucrats and involved only a few representatives of the private sector. Yet, starting with the 8th National Economic and Social Development Plan (1998-2002), a wider spectrum of individuals and institutions were invited to participate in the planning process. In the preparation of the 9th Plan (2002-2006), this model was expanded: hundreds of workshops were organized covering all provinces and involving more than 30,000 persons.[91]

These national plans constitute the basis for many specific master plans drafted by line ministries, such as the national S&T Plan conducted by the MoST. The planning process within this ministerial structure is relatively time-consuming, since it involves several feedback loops and workshops on different subjects, often with several hundred participants from the private sector, science and politics (see Box 4.2 on S&T policy formulation). But although the private sector is engaged in the planning process, several interview partners noted that its influence on real decision-making is rather limited. A majority of private-sector stakeholders dismiss the ministerial planning procedure as irrelevant, consider workshops as too time-consuming, and not keyed to their needs. The planning procedure lacks credibility, because too little information about the private sector is collected in advance. Therefore, few individual companies take part, leaving the voice of the private sector to be expressed by representatives of associations that often lack a clear devotion to the actual problems of their branch of industry.

Horizontal coordination. One important factor in addition to participation of the private sector is coordination between ministries. This is particularly true for cross-cutting issues such as S&T policy. One approach to policy coherence is the use of coordinating bodies equipped with a clear mandate for managing and overseeing the policy process. Cross-cutting bodies of the policy process can be grouped as following:

— Standing committees, agencies and councils located at the ministerial level with explicit cross-cutting roles;

— Special purpose review bodies, committees of enquiry and task forces set up on a temporary basis to examine issues with multi-ministry relevance;

— Routine organizational arrangements in the form of cabinet subcommittees involving the more S&T-intensive ministries.[92]

Yet coordination between ministries in Thailand is traditionally weak, a fact which results in a vertical "silo" structure of ministries with limited horizontal interaction. Despite the proliferation of committees in the last years,[93] the bodies often lack a clear mandate. Although a few cross-cutting projects are undertaken jointly by different ministries, there is still little coordinated planning. As seen in the example of S&T policy (see Box 4.2), the establishment of the National Science and Technology Committee (NSTC) might prove to be a good possibility to encourage dialogue between the different "silos" and their project coordination activities. In addition, the 10 different mega-projects[94] identified in the new strategic National S&T Plan (2002-2006) are expected to increase cooperation, because the projects are to be jointly implemented by various ministries under the coordination of MoST.

The power of the line ministries to take decisions on sectoral policies is influenced by two institutions with all-encompassing competences: The National and Social Development Board (NESDB) is responsible for screening ministerial policy proposals to make sure that they are in line with the national 5-year plans. The even more powerful

91 See Sripaipan et al. (undated), p. 2; the author concludes that "'participation' has become a buzzword and partly intended to provide legitimacy to every major planning activity of the state, such as the new Constitution, and new Health Act."

92 The Brooker Group (2002b), p. 56.

93 Bringing together representatives from the relevant ministry, the private sector and specialists.

94 Such as the construction of Bangkok's new international airport. The final list of "mega-projects" has not yet been approved by the cabinet.

Box 4.2: The S&T policy formulation process in Thailand

A new interim **National Science and Technology Committee (NSTC)**[96] was set up in 2001 to review national S&T policy and to report to the cabinet. Its establishment shows the importance which the new government assigns to innovation and technology policy. The NSTC **sub-committee,** with key persons from the private sector (such as CEOs of large Thai firms and executives of industrial associations) as members, is responsible for setting up the national S&T plan (2002-2006). **The secretary** (MoST, NESDB, NSTDA) helps in drafting the plan through SWOT-analysis. The process of policy formulation is carried out under MoST (NSTDA) in a participatory and long-term planning process with several feedback-loops: **three workshops** involving ca. 100-150 government and private-sector participants were held to define the vision, mission and objectives, to identify projects and programs and to work on implementation, evaluation criteria and monitoring of the plan. The results of the workshop are fed back to the sub committee.

Yet, since there are many different ministries and agencies involved in S&T policy – despite the NSTC – S&T policy is still fragmented. Several vertically integrated "silos" of S&T policy formulation, implementation and performance exist within the ministerial structures, but these appear to operate largely independently of each other.

To streamline S&T policy, a new "**National S&T Act**" (which still needs to be approved by the parliament) has been launched; it involves a clear "top-down" perspective on the policy process. The NSTC, chaired by the PM and responsible for R&D, S&T manpower, S&T infrastructure, and technology transfer, will then be transformed into a central body with sufficient power and influence to exercise effective oversight of the development of S&T and co-ordination of all government agencies responsible for increasing the country's competitiveness in S&T. Every year the NSTC will provide an assessment of the size of the S&T budget, decide on its framework and give advice to the cabinet. Although the Budget Bureau will finally allocate the funds, the NESDB and the Budget Bureau will follow the advice of NSTC, since it will report to the Prime Minister's Office (PMO). Thus one single agency will be created that is responsible for policy formulation, and this will leave the responsibility for implementation and monitoring with the line ministries and agencies involved in S&T (although they are also "involved" in the formulation of policies via their representation in the NSTC).

Source: Interview with Patarapong Intarakumnerd, policy researcher at NSTDA (21 February 2003) and The Brooker Group (2002b).

Budget Bureau decides on final budget allocation. Actual budget allocation thus largely depends on the ability of ministries to organize political support and defend their budgets in parliament.[95]

Dual structure of policy formulation. In addition, ad hoc political decisions taken at high political levels interfere with the planning procedures and targets set by the ministries. Based upon election platforms or party visions, new parties in power decide on their own priorities, which are not necessarily in line with medium- and long-term strategic planning within ministries, leaving open questions about policy coherence and long-term commitment to programs that have been adopted. In some cases politicians come up with projects which are more focused on short-term effects and political visibility than on financial sustainability, long-term improvement and project outcome. They may also cut across the responsibility of line ministries.

Prime Minister (PM) Thaksin set up the National Competitiveness Committee (NCC)[97] (chaired by

95 The Brooker Group (2002b), p. 19 ff.

96 NSTC is chaired by the Prime Minister and involves different ministries (including Commerce, Industry, Defense, S&T, Environment), representatives from the main private-sector associations and ten independent experts.

97 The NCC has 13 members, including the PM and the Deputy PM, the President of NESDB, 2 businesspeople (President CP Group and Managing Director of Siam Cement), one acknowledged academic, and one representative each of FTI, Chamber of Commerce, and the Banking Association.). The NCC has funds of 16 bio. bahts for ad hoc programs which are not considered in the ordinary fiscal budget. This budget has already been used to conduct activities like setting up the one-stop-service for export certification and two cluster studies by Michael Porter (shrimps and tourism). (Interview with Panithan Yamvinij, Director of Competitiveness Development Office, NESDB, 13 March 03).

himself) as the main planning and decision-making instrument for coordinating and controlling different ministries and agencies. The NCC defines national priorities, some rather general (Thailand's position vis-à-vis global governance, building an entrepreneurial society, etc.), others more specific:

— Sector-specific cluster definitions like: *Detroit of Asia* (hub for car manufacturing, esp. pick-ups), *Kitchen of the World* (Thai cuisine, food processing), *Tropical Fashion of Asia* (textiles, leather, gems and jewelry industry with high "design content"), *Software* (esp. multimedia, animation), *Tourism*.

— Other cross-cutting-initiatives, like the goal of creating 50,000 new enterprises within the next two years (see Chapter 4.4 for more details), or the "One Tambon one product" (OTOP) initiative (see Chapter 4.2 for more details).

As regards the former, apart from the tourism cluster, all the others are mentioned in the national S&T plan, reflecting NESDB's integrative role in the process of policy formulation; it is on the one hand responsible for screening ministerial master plans and on the other hand serves as the secretariat of the NCC. The latter seems not to be embedded in the strategic policy formulation process of ministries, since the targets formulated are either not realistic or not in line with the strategic goals and projects of the ministerial policy level. Thus visions created within the NCC seem to be mainly based on the personal preferences of some advisors of the PM. Looking at these so called "pet projects,"[98] the policy formulation process seems to be rather top-down and ad hoc than to systematically involve the relevant stakeholders: Some interview partners questioned the broad-based private-sector influence on the PM, although he sets up meetings with the private sector every Friday afternoon to discuss special projects. The private sector is mainly involved in political decision-making via individuals with access to high-ranking politicians. The fact that other committees besides the NCC, e.g. the NSTC, are also chaired by the PM merely serves to highlight the centralization of decision-making.

All in all, there appears to be a "dual track" of decision making, with the long-term ministerial policy formulation process on the one side and high level political policy decisions on the other, an arrangement which sometimes interferes with the targets and procedures of ministerial planning, or even competes with it for funding. Yet starting in October 2003 a new system of *budget integration* will be launched which may limit the influence of the Budget Bureau on budget allocation and strengthen the integrative role of the NESDB. Traditionally, budgets have first been allocated to the line ministries, which then allocate their respective budgets to specific programs, a procedure depending in large measure on the decisions taken by the Budget Bureau. Now NESDB has the authority to supervise overall budget allocation and to check whether it is in line with the „competitiveness drive" established by NCC. The NESDB will then supervise the allocation and spending of budgets according to priorities set by NCC/ NESDB. This new system might prove to be a good chance to better integrate the two policy tracks, but many problems still remain unsolved regarding the future demarcation of competences as well as implementation (especially concerning projects decided on at the highest political level). Given the close relationship between NESDB and the NCC, and thus also the Prime Minister's Office (PMO), and given the establishment of the NSTC (see Box 4.2), which is also chaired by the PMO, the "political" policy formulation track could gain competence and the role of the line ministries might be reduced to simply implementing strategies derived at that level.

4.1.2 Policy implementation

Although there are signs of change, implementation of policies in Thailand is still marked by the following features:

98 We use the term „pet projects" to describe politically motivated projects which were not necessarily based on a long-term, systematic and participatory planning process involving several stakeholders.

— The responsibilities for policy formulation, funding and program implementation are not clearly separated;

— some implementing agencies are not customer-oriented, do not operate in a business-like manner, and their programs are not cost-effective; and

— budget allocation is not sufficiently linked to performance.

Policy responsibilities. International best practices indicate the recommendability of clear assignments of responsibilities to ensure the smooth implementation of policies. A clear organizational and administrative line needs to be drawn between the different levels of policy responsibilities, especially between policy formulation, funding and the implementation of programs and projects. This separation serves two functions: First, it provides a clearer basis for the delegation of responsibilities and accountability and separates the details of program management from the broad guidance provided by ministerial policies. Second, it opens up the possibility of developing a more flexible organizational structure at the level of policy implementation by creating better possibilities for one single agency to implement projects stemming from different ministries.[99]

Yet in Thailand there is no clear division of responsibilities. In many cases the three functions of policy formulation, disbursement of funding, and delivery of services are taken on by the ministerial level, either by the ministries themselves or by their subagencies. MoST for example delegates implementation responsibility to NSTDA, which also manages and executes projects in the three large R&D Centers, namely the National Electronics and Computer Technology Center (NECTEC), the National Metal and Material Technology Center (MTEC) and the National Center for Genetic Engineering and Biotechnology (BIOTEC). Since ministerial subagencies such as NSTDA are also engaged in policy formulation (e.g. NSTDA's involvement in the formulation of the S&T Plan, see Box 4.2), the different levels of policy responsibility tend to overlap, leaving questions about accountability and flexibility at the implementation level.

Service delivery. Most Thai government programs are still mainly supply–driven, i.e. driven by bureaucratic decisions, a fact which results from weak private-sector involvement in program planning as well as from incentive structures within implementing agencies which serve neither to create a service mentality nor to enhance networking with industry. This supply orientation of programs, in part combined with a lack of human and financial resources, results in involvement of only a small number of corporate customers, and thus in low program outreach and impact. Even the most prominent SME programs, such as Invigorating Thai Business (ITB) or the Industrial Assistance Program (ITAP), are only able to reach a very small percentage of their potential target group. The same applies, for instance, for lab services (e.g. provided by the Electrical and Electronics Institute/ EEI)) or the few existing business incubators.

Moreover, programs and implementing agencies are almost never financially sustainable, which means that programs suddenly expire when the agencies run out of funds. This is partly due to the "public-goods" character of certain services (i.e. firms are not willing to pay for services if they cannot fully appropriate the benefits and recover their investment, e.g. in R&D, training or environmental protection); but it is also due to the fact that public agencies are not obliged to recover a significant part of their operating costs. Many programs subsidize 90 or even 100 % of service costs. This practice undermines the willingness of customers to pay for services and may crowd out those service providers who seek to deliver their services on a cost-covering basis.

For some public agencies, changes are on the way to improving service delivery, but a major reengineering of the public and semi-public implementing agencies will be needed to significantly increase efficiency, impact and outreach. International discussion on business development services suggests that programs implemented by

99 The Brooker Group (2002b), p. 27.

public agencies should be designed in a business-like manner, be demand-led and based on prior market surveys, the aim being to prevent any crowding out of private service providers. Substantial fees should always be charged to make sure that the beneficiaries are really interested in and esteem the service provided, but also because cost-effectiveness is important in times of growing public budget constraints (see Box 4.3). International experience also suggests that the establishment of a system of competitive bidding, which creates competition among public, semi-public and private service providers, increases efficiency, and thus leads to improved performance.

Box 4.3: Principles for efficient public service delivery to the private sector
- Check first whether there are any private providers serving the market. Avoid crowding out private competitors;
- Check carefully whether government intervention is really justified. Is there market failure, and why?
- Co-financing by the user is compulsory, otherwise the beneficiary may not esteem the service;
- Define an exit strategy: When and how can the break-even point be reached? Who should provide the service in the future?
- If self-sustainability is impossible, ensure long-term funding;
- Establish a direct link between performance and resource allocation;
- Ensure independent monitoring and evaluation of performance;
- Establish separate accountability for each service in order to monitor cost efficiency and demand etc.;
- Separate funding from the delivery of services;
- Promote competition between service providers. This creates pressure to improve performance;
- Continue to monitor the respective service market in order to see whether government intervention is still needed.
Source: Stamm/ Altenburg (2003)

Link between performance and budgeting. One general shortcoming of policy implementation in Thailand is the missing link between performance and budgeting. At present there are only few performance indicators in place to measure the output and outcome of projects and to feed the results back into the next round of budgeting. Only some agencies, like the Thailand Institute of Scientific and Technological Research (TISTR), have already started to establish clear performance indicators to set incentives for industry-related projects and to improve performance. This shortcoming might be overcome by the newly established system of *performance-based budgeting,* which was decided on by the government in 2002. Every ministry has to clearly define a set of *Key Performance Indicators* (KPI), which are tied to the allocation of positions and funds. The links between planning, budgeting and performance will be strengthened in this way. These reforms show the government's willingness to achieve more efficient and sustainable outputs, but the success of the new system will depend on its implementation and the quality and independence of evaluation bodies. Most of our interview partners were quite enthusiastic about the new system, but all complained about the difficulties involved in establishing it. Problems arise from the difficulty in defining relevant, guidance-oriented, and measurable performance indicators as well as in training sufficient and qualified evaluation staff. In addition, the actual influence of the new system on decisions taken at high political levels (e.g. the so-called “pet projects”) may be quite low.

4.1.3 Monitoring and evaluation

Monitoring and evaluation of public policies is important for improving the allocation of scarce public funds and the accountability and transparency of policies. In addition, new developments in S&T and innovation policy, which increasingly

focus on technology diffusion, organizational changes and innovative behavior, have entailed new requirements for evaluation. Thus, even though there is no optimal institutional design for evaluation that is transferable across countries, several international experiences show that some principles are widely accepted (see Box 4.4).

Box 4.4: Lessons from international evaluation experiences
- Evaluation should be designed together with the respective program or policy to be evaluated;
- It is necessary to formally oblige those responsible for policy-making to react to the results of evaluation;
- Evaluation ought to be "user-oriented," which means that it should address the needs of evaluation "clients";
- Evaluation should target not only incremental changes but also fundamental shifts in S&T policy, which implies broader information gathering and processing;
- Evaluation should adopt a portfolio approach rather than focus on individual projects;
- Performance indicators should be widely used,
- There should be convergence between ex post evaluation and continuous monitoring;
- Evaluation should be conducted on a programmed and proper resource basis, guaranteeing and providing for independent evaluation bodies and a feedback of results into the policy–making process.
Source: Papaconstantinou / Polt (1998), p.13.

Although there already are evaluation groups at several policy levels in Thailand, monitoring and evaluation still appear to play a fairly limited role in the policy process. Evaluation still appears to be an irregular procedure, with widely varying evaluation approaches and variable degrees of transparency. E.g. sectoral institutions like the National Food Institute (NFI) or the EEI are monitored and supervised by different line ministries, and each ministry defines its own criteria. In addition, in several cases only a small number of projects are included in an evaluation sample.[100] There is, in other words, no widely adopted portfolio approach in place.

Plans often do not include clear performance indicators, or indicators are not defined in such in a way as to increase the industry orientation of S&T programs: the main indicators for RTOs, e.g., refer to the number and quality of published papers, patent applications, prototype development etc., while acquisition of research contracts from industry is not taken into account.[101] Only some agencies have already started to set up clear performance indicators to increase industry orientation, but also to better influence future budgeting and salaries: e.g. TISTR set up a system of evaluation criteria which is closely linked to a bonus system. If its staff attains a higher rank in a given year, they receive up to two months' salary as a bonus. Performance requirements increase year by year. The above-mentioned new system of "*performance-based budgeting*" might also boost this trend.

Due to the non-inclusion of evaluation targets and indicators in policy planning, there is often no systematic process in place running upwards through different levels from projects through programs to broad strategies.[102] Evaluation does not include convergence between systematic ex post evaluation and continued monitoring. One example is the evaluation of the ITB program, which is only monitored on an ad hoc basis, with-

100 In the case of MoST, only 18 pilot projects of 156 are selected for evaluation. Yet, in the future, the methology chosen and proved for these projects could be extended to the other projects.

101 For example, evaluation at MTEC is mainly done in-house and is based on number of published papers, research projects completed, patent applications, prototype development as well as on technology transfer to companies. There is no incentive structure yet for acquiring contract research.

102 See The Brooker Group (2002b), p. 27.

out any systematic evaluation approaches. The same applies for other organizations, like e.g. the newly established Software Park, where evaluation and development of projects is done more by trial and error than by seeking to adapt and adjust to international best practices. Pet political projects are not evaluated systematically, and the focus is more on monitoring than on feeding evaluation results back into the further policy formulation process. There may be some recommendations for future programs, but no follow-up is provided for.

The independence of evaluation bodies also needs to be questioned. Evaluation is either done in-house or not conducted by independent agencies. Often university professors are hired, but their independence was questioned in some of our interviews because their personal income may be highly dependent on their access to additional government contracts. To support more independent evaluations, MoST is thinking about establishing an evaluation committee (members: NESDB, Budget Bureau, MoST, universities, private sector) to select projects and supervise the evaluation of S&T projects. Yet efficient and qualified evaluation is also hampered by insufficiently trained evaluation staff. In addition, criticism of people and actions is not well regarded in Thai culture. Therefore, evaluation reports in effect often paint a rosy picture of the real situation of the organization concerned.

4.2 Promoting inter-firm linkages

In the following paragraphs we will discuss the importance of both *horizontal* (i.e. involving one stage of the value chain) and *vertical* (i.e. involving different stages) inter-firm linkages, and we will argue that vertical linkages, especially with foreign direct investors, are often the most important source of technological, organizational and market knowledge in developing countries. As Dunning states, "the findings of a large number of studies over the past 30 years are virtually unanimous that the presence of foreign-owned firms has helped raise the standards and productivity of many domestic suppliers, and that this has often had beneficial spillover effects on the rest of their operations."[103] For example, access to more profitable markets and information increasingly depends on access to global production networks governed by TNCs or local lead firms. In some cases, these technology drivers are global buyers without direct investment.[104]

Under certain market conditions the benefits of linkages are so clear to enterprises that no policy is needed to encourage firms to develop them. But markets often fail to develop a desirable level of inter-firm cooperation, for example when it is cheaper for a company to import the intermediate goods or services it requires. In such cases, what is cost-effective for the individual firm may result in competitive disadvantages for the location as a whole, because it fails to exploit the benefits of specialization and technological learning. According to this argument, there is a need for governments to encourage and support the creation and deepening of linkages.[105]

However, promotion of inter-firm relations is not a priority concern in Thailand. Neither the government nor the main industry associations, the Thai Chamber of Commerce and the Federation of Thai Industries, plays a strong role in promoting inter-firm linkages. And what is more, the few existing instruments focus on horizontal rather than *vertical* linkages. Considering the fact that the Thai economy is characterized by a marked dualistic structure and a considerable productivity gap between foreign enclaves and the local business community, this is probably not the right focus.

103 Dunning (1992), p. 456.

104 Knorringa/ Schmitz (2000).

105 UNCTAD (2001), p. 163.

4.2.1 Government commitment to promoting *horizontal* inter-firm linkages

Promotion of clusters is a distinctive feature of Thailand's current economic policy. "Cluster" has become a buzzword in government programs, political speeches and newspaper articles. Some of the most prominent government policies explicitly pursue a cluster approach:

1. The PMO has identified five priority sectors which it calls "clusters" (automotive, food processing, textiles, software, and tourism).

2. The NCC has hired Michael Porter, the most famous exponent of the cluster approach, to conduct studies on the tourism and shrimp-farming clusters.

3. NSTDA and its three research institutes (NECTEC, BIOTEC and MTEC) have been moved to a new location north of Bangkok. Together with the neighboring Asian Institute of Technology and Thammasat University, the new location now concentrates a large proportion of Thailand's industry-related research facilities. The Science Park, located in the same premises, is expected to attract private-sector R&D facilities seeking synergies with the nearby research institutes. Furthermore, five major industrial estates are located near this new research hub. It is expected that this spatial proximity may enhance industry-science relations, thus giving rise to a "North Bangkok Innovation Cluster," a term coined by NSTDA for the overall agglomeration.

4. Under the OTOP-Program, the Thai government is pursuing the same horizontal cluster approach, providing ample funding for cooperation among SMEs at the local level.

While the first two initiatives seek to exploit the benefits of intra-sectoral synergies at a nationwide level, the other two focus on increased spatial synergies, with a less prominent sector focus. Yet none of these cluster initiatives explicitly seeks to enhance *vertical linkages*, e.g. between large corporations, retail chains or global buyers and their local SME suppliers.[106]

4.2.2 Current activities aimed at strengthening *vertical* inter-firm linkages

The Thai government does not give due attention to fostering vertical linkages, esp. to "embedding" the TNC sector in the local production structure as a means of avoiding the dislocation of footloose industries. This is in sharp contrast to other Asian NIEs, which place priority on the enhancement of TNC-SME linkages, e.g. Korea or Singapore. Thai policies concentrate on general support of SMEs to relieve urban unemployment and rural poverty. Programs aimed at strengthening vertical linkages must target a much more narrow set of companies to increase industrial efficiency.[107] Specific programs aimed at improving the performance of SMEs to make them more attractive as suppliers to large firms are largely lacking.

In many important sectors, supplier structures in Thailand have developed as a result of local-content requirements (LCR), which were the most frequently used measure for establishing supplier relations in Thailand, although they have recently been phased out.[108] Foreign investors were obliged to increase the amount of domestic value added and content of their products by using national inputs. The Thai government used to use local-content requirements, especially in the automotive, machinery, and electrical industries.

106 For example, the cluster initiative for the food processing industry, labeled "Thailand: Kitchen of the World", mainly considers export promotion; the initiative for the automotive sector ("Detroit of Asia"), emphasizes investment promotion for mainly Japanese automotive companies, and OTOP places emphasis on linking local SMEs and improving their marketing.

107 Battat/ Frank/ Shen (1996), p. 21.

108 Local-content requirements are one of the trade-related investment measures (TRIMs) that were banned after the end of the GATT Uruguay Round and had to be dismantled. Thailand stopped using local-content rules in the beginning of 2000.

LCR created opportunities for domestic firms and established new industries, especially in the auto parts sector. Some of the industries that started out by supplying parts to domestic producers later became exporters. These include the battery and radiator subsectors.[109] Overall, however, little significant industrial deepening and embedding has taken place and many of the above-mentioned sectors are still dependent on imports and display weak local linkages. The suppliers developed under LCR now have to cope with the challenge of increasing competition, which calls for other promotional measures in line with the regulations of the World Trade Organization (WTO).

As far as public-sector initiatives are concerned, few internationally recognized measures are in place, and the existing programs are poorly funded. Basically, three entities are concerned with supplier development:

— The Board of Investment's (BOI) Unit for Industrial Linkage Development (BUILD);

— the Bureau of Supporting Industry Development (BSID) under the Department of Industrial Promotion (DIP);

— the Supplier Development Program (SDP), also under DIP.

Of these programs, only BUILD has gained a certain reputation. The other two were unknown to or dismissed as ineffective by almost all our interview partners, both in the private and the government sector. BUILD has been established to provide a wider range of investment-related services. BUILD functions as a "middleman" to forge links between customers and suppliers. The objectives of the program are to use technology transfer to reduce the import of parts and components, linking Thai suppliers with large companies and strengthening part makers in Thailand. BUILD promotes industrial linkages and stimulates domestic subcontracting of parts and components. The unit analyzes parts and components needed by both Thai and foreign assemblers planning to start production in Thailand. BUILD then surveys existing supplier industries in order to identify companies that are capable of producing competitively. The program also collaborates with other government agencies and private firms to help these potential suppliers to upgrade.

BUILD consists of five programs:

1. The **Vendors Meet Customers Program** was established to promote industrial linkages and stimulate domestic subcontracting of parts and components. Visits of manufacturers to factories are organized under this program;

2. The **Expansion Abroad Program** is designed to expand marketing channels and enhance high-technology capabilities. As under the VCM, companies are invited to visit multinationals;

3. The main role of the monthly **Parts & Components Marketplace** is to match customers and suppliers. Every month, BUILD invites 10-20 large companies and 200-300 potential qualified suppliers from a computerized database of supporting industries that includes about 800 companies believed to be capable of producing parts for parent firms. The marketplace consists of a morning seminar on different issues, e.g. increasing efficiency, a presentation by the potential customers on their supply demands, an exhibition of the parts needed, open discussions and opportunities for informal meetings.

4. **Subcontracting Seminars** provides SMEs with information on how to overcome difficulties in supplying large companies;

5. The **ASEAN Supporting Industry Database**[110] includes all important industries in the fields of mould-and-die, electronics, automotive, and chemistry in Asia and aims at facilitating matching in the ASEAN region.

109 Thongpakde/ Puppahavesa/ Pussarangsri (1994), p. 139.

110 See: http://www.asidnet.org.

With these activities, BUILD plays an important role as an information provider, facilitator and intermediary for vertical inter-firm linkages. Companies have reported increases of domestic content amounting in value terms to 10 to 20 % once they had become involved in BUILD projects.[111] Yet the impact of the BUILD programs is rather limited because of the small size of the BUILD bureau, which has only 10 employees and a very small budget, one, in addition, that was cut radically following the financial crisis. In 2002 BUILD had a budget of approximately 27 million bahts compared to the OTOP budget, which amounts to 800 million bahts. Considering the crucial role of vertical knowledge flows, there is a considerable mismatch between the substantial funds allocated to traditional SME programs (such as OTOP and ITB) and the poor funding of supplier development programs. Another shortcoming of the BUILD programs relates to its limited range of activities.

As a result of a perceived lack of attention from the government, some supplier development initiatives have been launched by industry associations and individual firms – though with very limited outreach so far. Firstly, several SMEs have decided to set up the Subcontracting Promotion Club (SPC).[112] This private-sector initiative aims at horizontal networking among Thai SMEs in the electronics, plastics, metal and polymer industries to enhance their capabilities to meet customer, i.e. TNC, demands. However, due to technological and marketing deficiencies, supplier relations are quite limited, and the activities of the SPC are currently not conducted in close cooperation with TNCs.[113] Instead, the main thrust of SPC's cooperation is directed at information-sharing, resource-pooling, logistics and marketing improvements. This horizontal networking is almost revolutionary within Thai business circles in view of the fact that, historically, distrust and reluctance to share anything have been widely prevalent in the country.

Secondly, in the hard disk drive industry, the International Disk Drive Equipment and Materials Association (IDEMA) is seeking to link TNCs with local suppliers and universities, but with relatively few tangible results thus far (see Box 4.5).

Thirdly, the Thai Auto-Parts Manufacturing Association (TAPMA), in cooperation with the Thai Automotive Institute (TAI), has succeeded in creating some linkages in the automotive sector. Toyota Thailand has played an active role in this process. Toyota has successfully developed long-term relationships with local suppliers that benefit the local industry (see Box 4.6).

4.2.3 What remains to be done?

Modern supplier development programs have shifted their focus towards voluntary promotional measures aimed at strengthening vertical co-operation, mainly through awareness-building, by organizing databases and fairs to match supply and demand, strengthening potential local suppliers, and encouraging large customer companies to increase their technology transfer.

BUILD's activities are mainly limited to awareness-building and matching between SMEs and large customers. Figure 4.2 shows that at present there are no measures going beyond these initial two steps.

111 Interview with Dr. Wisan Tanthawichian, BOI/BUILD, March 10, 2003.

112 The club was started with initial support of the Board of Investment (BOI) Unit for Industrial Linkage Development (BUILD) program.

113 Interview with Mr. Pattanasak (Vice-President) and Mr. Lersak Nuangjhamnong from the Subcontracting Promotion Club (SPC), on April 24, 2003 and April 30, 2003.

Box 4.5 The International Disk Drive Equipment and Materials Association (IDEMA)

The International Disk Drive Equipment and Materials Association (IDEMA) was founded in 1986 with the mission "to promote the international computer storage products industry by establishing communications channels for all its participants, thereby facilitating cooperation, progress, and growth."

IDEMA operates worldwide and has more than 800 members. IDEMA Thailand includes the following leading companies: Seagate, Read-Rite, Fujitsu, KR Precision, Magnecomp, and EngTek. Representatives from BOI, AIT, NECTEC, and The Brooker Group are also on the Management Committee.

IDEMA Thailand aims at raising awareness about the significant contribution of the disk drive industry for Thailand's economy. To maintain and enhance the competitiveness of the hard disc industry IDEMA, takes part in initiatives to strengthen a multidisciplinary supporting industry. One element used to strengthen efficiency is creation of a technology roadmap for the supply industry. The association provides training and information to help members keep up with technology development, which is especially important because technological advances in the industry are dynamic. Activities are carried out in close collaboration between industry, the academic sphere, and policy-makers. Its activities consist of promoting business networking, facilitating information-sharing through education programs and technical symposiums/conferences, market updates and advance technology seminars; and a platform to address issues of relevance to the HDD industry. To meet the educational needs of IDEMA members, the Asian Institute of Technology (AIT) and IDEMA jointly offer a *Certificate of Competence in Storage Technology*[a] (CCST) which is recognized by both institutions. In 2000 the program trained around 500 industry professionals.

IDEMA participates in a committee to strengthen open communications and collaboration between government, private-sector and other institutions. Some other members include BOI, MOI, the industry, and universities. IDEMA formulates a joint vision for the disk industry from a private-sector perspective and can therefore place priority concerns on the political agenda.

a Storage Technology essentially includes all elements of the technology that is embodied in the products of the HDD industry.

Source: IDEMA Backgrounder, prepared for the Press Conference at NECTEC, November 15, 1999, and http://www.idema.org.

Box 4.6: Toyota's Reinforcement Program for Current Suppliers in Thailand

The Reinforcement Program for Current Suppliers aims at increasing the international competitiveness of established suppliers. Toyota has a policy of developing long-term relationships and assisting its suppliers. The enforcement program comprises two components: the Toyota Target Value System and the Suppliers Support Program.

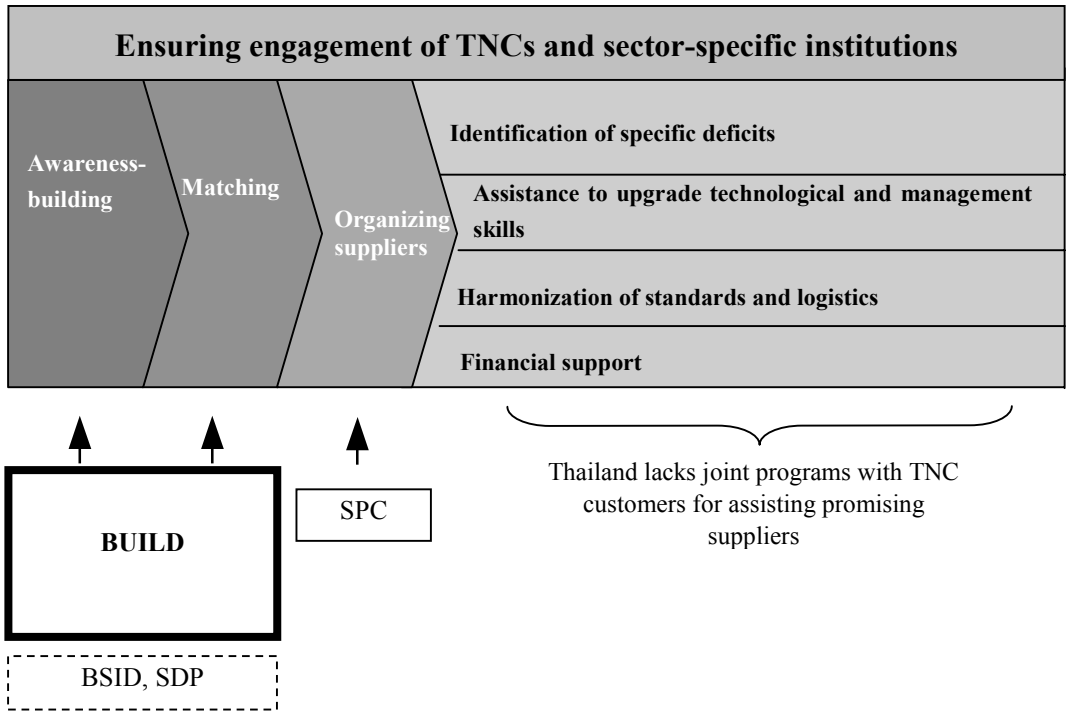
Under the *Target Value System*, Toyota and the supplier agree on a number of long-term issues and objectives to strengthen the supplier's competitiveness. The objectives are scaled down to annual targets to achieve a continuing circle of improvement. Toyota provides expertise to analyze problems, designs individual support measures and donates awards.

In its *Suppliers Support Program,* Toyota assists potential suppliers in the preparatory process of building and maintaining a strong position regarding quality, cost, delivery, engineering, technology and management. Toyota gives particular attention to R&D, encouragement of an enterprise culture of creativity, continuous learning and improvement, and strengthening information management.

Source: Muramatsu (2000), pp. 67-72.

International experience from programs designed to strengthen inter-firm linkages suggests that on its own none of the policy instruments named above can provide a solution. What is important is a holistic approach that integrates all the components and actors shown in Figure 4.2. Establishment of durable supplier relations calls for a long-term commitment to increasing the competitiveness of potential suppliers that goes far beyond the initial phase of matching, and includes technological and financial support to reengineer these companies.

Figure 4.2: Promotion levels of inter-firm linkages



Source: based on own research

By comparison, in Singapore, where the government has been very successful in emphasizing a comprehensive support scheme, more than 60 programs are being implemented at all different support levels. Using a multiagency network approach, the programs are coordinated by the Singapore Economic Development Board (EDB), which works closely with private-sector organizations, including financial institutions, chambers, associations and tertiary institutions.[114] Singapore's Local Industry Upgrading Program (LIUP) can also serve as a good example of how an integrated and holistic support program for inter-firm linkages can be designed (see Box 4.7).

One factor of special importance for Thailand is to strengthen the competitiveness of potential domestic suppliers. The main problem of vertical linkages lies in the insufficient resources, equipment, materials and professional management skills available to SMEs to meet the requirements of modern, internationally competitive value chains. The decision to source locally in a host country mainly depends on the cost, quality, reliability and flexibility of local suppliers. Since these attributes are often not as well developed in Thailand as among competing suppliers abroad, the government should focus on strengthening these factors. While large customer firms may help their SME partners in developing specific production technologies, government policies should concentrate on complementary aspects of innovation which are not provided by the customer firms, e.g. to upgrade the design and development capabilities of SMEs.[115] Public policy can provide for innovative methods of learning (like benchmarking initiatives to adopt best practices in management, innovation audits or visiting programs), target the process competence and innovation culture of firms and help to reduce infor-

114 Battat/ Frank/ Shen (1996), p. 25.

115 UNCTAD (2001), p. 173.

Box 4.7: Singapore's Local Industry Upgrading Program (LIUP)

Singapore's Local Industry Upgrading Program (LIUP) was established in 1986 to promote upgrading, strengthening, and expanding of local suppliers to foreign-invest firms, using foreign investors as a source of technology transfer. Inter-firm-linkages are enhanced through close cooperation between local suppliers and TNCs. The participating TNCs transfer technical, operational and managerial skills to their local suppliers. In return, local suppliers are enabled to provide good-quality, reliable goods and services at a competitive price. EDB complements private-sector activities by providing technical and financial support.

An experienced international engineer works for 2 or 3 years as a LIUP manager, who selects local suppliers for focused assistance. All actors involved agree on a set of focused and broad-based assistance programs, which include courses and workshops to address general technical, managerial, or operational issues.

The assistance programs consist of three phases: raising the overall operational efficiency of local firms; introducing new products to be supplied to TNCs and new processes to be used in the production of goods; and joint local firm-TNC R&D for new products and processes.

By 1994 the program had established 32 partnerships involving 180 domestic suppliers. Studies have found that LIUP had an impressive impact on suppliers, particularly in the beginning of the partnership. The productivity of suppliers rose by an average of 17 %, while value added per worker went up to 13.7 %.

LIUP uses a market-oriented approach that is intended to remedy market imperfections, while the government functions as broker, matchmaker, and facilitator. In contrast to LCR, this approach allows for freedom of decision for both local suppliers and TNCs. The program targets export-oriented industrial sectors and firms that have a good perspective for upgrading. It is not a broad SME program but builds upon strengths and participants that are most likely to succeed. The buyer firms play a key role in the transfer of technology and management know-how and show long term commitment.

Source: Battat / Frank / Shen (1996), pp. 28-35.

mation deficits at the firm level, e.g. by subsidizing ICT and electronic supply chain management. In addition, the Thai government should support SMEs in meeting the technological standards required by international customers.

Another crucial success factor is engagement of important customers in the design and implementation of support programs. Thai programs are mainly government-driven, and do not take sufficient steps to ensure private-sector involvement. Therefore it is important to create incentives for large companies to increase their involvement in and commitment to supplier development. In general terms, only very few large companies in Thailand are very actively committed to developing local SME suppliers. Toyota and Siam Cement are two positive exceptions to this rule. To encourage TNCs to increase their spillovers to the local economy, the Thai government might subsidize the cost of technicians seconded to SMEs by TNCs or research institutes. Besides that, fiscal and financial incentives for investors can be linked to the measure of technology transfer they provide. Incentives may also be offered for R&D cooperation with other firms. Because large firms are usually keen to improve their public image within the domestic market to spur sales, governments can use a form of moral persuasion to convince large firms to engage in cooperation projects with local companies and advertise examples of firms contributing to national development. Financial instruments such as credit guarantees, low-interest funds, tax credits for providers of long-term funding, co-financing of supplier development programs, are further alternative approaches for encouraging TNCs to increase technological spillovers.[116]

In OECD countries promotion of inter-firm linkages is usually not only a concern of the public sector but is increasingly implemented by business associations and private non-profit agencies with a business orientation. For example, chambers of commerce and business associations often organize subcontracting databases and fairs, or help to raise awareness about the pros and cons of industrial subcontracting and value chains. Since firms usually have more confidence in chambers

116 Altenburg (1997), p. 30.

and associations than in public institutions,[117] the former are often better suited as coordinating bodies. However, they too often need to improve their service orientation.

Finally, it is important to involve other actors, such as specialized sector-specific institutions (e.g. EEI, TAI, NFI), with a view to making use of their well-established industry contacts and support services for technological upgrading. A joint effort between government, companies, and private-sector associations is needed to create ownership and synergies.

4.3 Promoting links between science and industry

The performance of an innovation system, and thus national competitiveness, nowadays requires intensive industry-science relations (ISR). Firms increasingly rely on inputs from scientific institutions, firstly because international competitiveness presupposes access to different kinds of knowledge and technology that cannot be provided by a single firm; secondly, drawing on external knowledge resources may speed up innovation, time being an increasingly important factor for competitiveness due to ever shorter product cycles; thirdly, efficiency and quality are improved by specialization and sharing of costs between firms and scientific institutions;[118] fourthly, publicly funded education provides skilled graduates. From the point of view of scientific institutions, the reasons for taking up industry relations are also manifold: academic institutions want to ensure good employment prospects for their students, keep curricula up to date, obtain financial support and tap private-sector know-how for joint research.

4.3.1 Weak industry science relations: heritage of the past

In the past, Thai policy neglected the importance of strengthening R&D and ISR. As argued above, Thailand's economic development has been based on low-skill activities such as simple assembly and commodity exports. Even those exports that are statistically classified as "technology-intensive" (e.g. electronics and automotive products) are mainly based on relatively simple assembly of imported components, with a low level of value added.[119] Design, engineering and technology development capabilities were not given priority.

One consequence was the emergence of a university system that is largely delinked from industry: Thai universities have relatively poor research capabilities and most of their research has little industrial relevance; there is hardly any cooperation between universities and enterprises;[120] teaching personnel lacks industry experience, a fact which is also reflected in a lack of cooperative education and industry internships, in university curricula that are not sufficiently industry-oriented, the very low number of new industrial enterprises created by university staff, etc. The few linkages between individual researchers and companies that do exist are often based on personal relationships, and are mainly limited to short-term training or ad hoc use of consulting.[121]

4.3.2 Early reform in the 1990s

Beginning in the early 1980s, Thai five-year plans accorded consideration to the importance of science and technology, and included separate 'science and technology' chapters in planning documents. Yet as late as the 1990s Thailand emphasized the need to build links between industry and science and took relevant steps in this direction. In

117 For Mexico see, for example, Altenburg et al. (1998), p. 82.

118 See Reinhard (2001), p. 32.

119 UNIDO (undated).

120 Intarakumnerd/ Chairatana/ Tangchitpiboon (2002), p. 1451.

121 Own interviews.

that period, several public institutes were established to support science, to enhance technological labor skills and to stimulate technological development and R&D. The first important step toward reform was the foundation of NSTDA in 1991 as an autonomous organization operating under the Ministry of Science and Technology (MOST, formerly MOSTE). NSTDA both supports and implements R&D and offers a broad range of services to both the public and private sector. The agency took over the three existing National Research Centers, namely BIOTEC, NECTEC, MTEC.

In the late 1990s, in the wake of the Industrial Restructuring Plan, the Thai government set up several specialized semi-public technology institutes in key industrial areas; these include the NFI, the TAI, the EEI, the TPI, and the TGI.[122] The government also created different organizations for funding research and technology development activities. The National Research Council of Thailand (NRCT) acts, alongside its broader policy role, as a funding body for research. The Thailand Research Fund (TRF) was established in 1992 for the sole purpose of funding research and strengthening the country's research capabilities.[123]

4.3.3 Enhanced reform drive after the crisis

Following the financial crisis there was a new drive to revise science and technology policy. The Ninth Development Plan (2002–2006) acknowledges the importance of promoting collaboration between the public and private institutes and industries. The plan stresses the importance of several measures designed to improve industry-science relations, e.g. promoting incubators, enhancing the capability of public research institutes, facilitating career and employment opportunities for researchers, strengthening the flexibility of institutes in conducting research, development and transfer of technology, establishing science and technology networks, revising Intellectual Property Rights (IPR) mechanisms, and improving science and technology services.

Several important reforms have been embarked upon to modernize the most important scientific institutions:

— As outlined in Chapter 4.1.1, an interim **NSTC** has been created to advise the Cabinet on general strategy and policy orientation – for example, in the form of an Action Plan for S&T.[124]

— In 2002 Thai **universities** achieved a greater measure of management autonomy. Yet at the same time they are required to enhance their industry orientation, e.g. to generate more income from the business sector, and to modernize educational curricula and teaching methods in line with industry and labor market demands. Universities are obliged to include joint research projects with industry as one indicator for good performance of university teachers. As a result of this restructuring process, some links between universities and industry, e.g. collaborative R&D, training activities and industry sponsorships, have already evolved. See Box 4.8 for one successful example of such enhanced cooperation.

— Efforts are underway to reinforce the role of **NSTDA** and the research institutes under its umbrella as the leading actors involved in providing technological solutions for the private sector. NSTDA is now equipped with an excellent infrastructure, and the newly established Science Park will house NSTDA headquarters with full NSTDA services and more than 20 buildings which will include research buildings, incubators, multi-tenant buildings, a greenhouse, training and testing centers, pilot plants and apartment buildings.[125]

122 Dhanani/ Scholtès (2002), p. 23.

123 The Brooker Group (2002b), p. 23.

124 Arnold et al. (2000), p. 32.

125 Interview with Prof. Dr. Chachanat Thebtaranonth. See also Thailand Science Park at http://www.atpac.rg/park.htm.

Box 4.8: Industry linkages at the King Mongkut's University of Technology Thonburi (KMUTT) and its Institute of Field Robotics (FIBO)

One successful example of cooperation between industry and science is the Institute of Field Robotics (FIBO) that was established in 1995 at the King Mongkut's University of Technology Thonburi (KMUTT). FIBO performs industry related R&D in the field of robotics and automation technology. The institute conducts fundamental and applied research as well as industrial activities.

KMUTT is the second Thai University to become a corporate university with close industry links to industry. The internal incentive system is designed to make the university more attractive for researchers and to enhance industry-science linkages. Salaries at KMUTT are 1.6 times higher than those of public universities, and salaries increase yearly between 3-6 %, based on performance. An independent evaluation and monitoring system has been introduced, with performance measures linked to teaching assessments by students, publications, joint research with industry, and research activities that serve society as a whole, e.g. helping farmers to develop cultivation methods. KMUTT has more flexibility in managing its funds than the public universities in general, which allows it to adjust more flexibly to industry needs. Still KMUTT remains reliant on government funding, since only 10 % of its budget comes from the private sector.

FIBO is known as the most successful institute at KMUTT as regards cooperation with the private sector. The institute's demand orientation is reflected in its motto: "We don't design problems, problems design FIBO." Consequently, 80 % of FIBO's funding comes from industry and only 20 % from the government. Currently 24 joint university – industry projects are ongoing. For example, FIBO has received funding of US$ 100,000 from the TNC Read Rite to solve a technical problem. The project is of mutual benefit because Read Rite expects to save up to US$ 3 mio. in operating costs. Therefore the company not only provides funds to FIBO, it has also promised to hire several of its graduates. Another example is a collaboration between the manufacturing company Srithaitana Auto parts and FIBO to aimed at solving problems with the maintenance of old robots as well as other technical issues. In addition, training courses for workers and engineers are supplied by FIBO staff, and students are involved in the day-to-day work of the project.

KMUTT's internal governance structure stipulates that the income of a joint research project is to be split up between FIBO, which can utilize 50 % for purchasing facilities etc., the individual researchers and students involved, who can top up their salary by 30%, and the university, which receives 20 %.

FIBO students are required to do internships, work under one of its industry projects, and sometimes to carry out research for their thesis in companies the aim being to ensure that they learn R&D through real problems facing the industry. FIBO has a curriculum committee that invites scientist experts and representatives of the industry. FIBO seeks to enhance the creation of spin-offs, although thus far only one robotic manufacturer has started up operations based on an idea from a research project.

Our interview partners reported that it is quite difficult to change the university in such a way as to enable it to respond to the needs of industry. For instance, Thai professors have never experienced evaluations and have never been required to carry out joint research to be promoted.

Source: Interview with Dr. Djitt Laowattana (Director) and Dr. Thavida Maneewarn (Research Scientist), FIBO/ KMUTT, on 22 March 2003.

— The **semi-public-sector institutes** need to undergo a profound restructuring process in order to increase their industry orientation. They are scheduled to become financially self-sustainable after five years of operating time have elapsed, i.e. most of them by the end of 2003. Every institute is expected to generate sufficient income by selling its services to cover its own operating costs, while continuing to provide public services.

For all three types of research institutions – universities, NSTDA institutes and semi-public institutes – two fundamental changes are being introduced by the current government: a clearer focus on demand orientation and the establishment of formal evaluation plans and procedures, with future budgets linked closely to the achievement of performance targets. Besides these changes, the quality of scientific personnel is constantly increasing due to a new generation of young Ph.D.

and master's graduates who had been granted government fellowships to study abroad and are now coming back to Thailand to work in public institutions.[126] This new generation is highly qualified and motivated to cooperate with industry, but it often lacks industry experience.

In addition to the efforts undertaken to strengthen the capability of research institutes and universities, an increasing number of financial incentives have been created to enhance the technological capability of Thai firms. A recent World Bank study identified 47 separate schemes under the responsibility of the PMO, the Ministry of Finance, the MoST, the MoI, and the Ministry of Labor and Social Welfare. Besides these there is a group of promotion schemes with independent status, e.g. under the TRF.

4.3.4 What remains to be done?

Although the Thai government has taken some important reform steps in the right direction, several deficiencies can be identified in the university system, the three NSTDA institutes and the semi-public-sector institutions. Basically five issues need to be tackled:

1. To bridge the different cultures of the public and private sectors, support interaction and enhance market-orientation of public service providers;

2. To switch from a practice of government-driven innovation to an interactive and cumulative approach, with strong private-sector involvement;

3. To distinguish between public goods and private tasks and adapt funding and incentive systems accordingly;

4. To implement systematic monitoring and evaluation processes; and

5. To pay more attention to Intellectual Property Rights.

1. One very basic challenge is to bring the **different cultures of academia, public-sector employees and entrepreneurs** closer together. Whereas universities and public-sector institutions often lack a service orientation and an understanding of the private sector's needs, the private sector neglects innovative efforts and has no tradition of making use of public research.[127] Most knowledge-creating institutions and programs in Thailand are still not sufficiently market-oriented and do not operate in a businesslike manner. This is reflected in the inability of these institutions to win research contracts and to generate substantial income from service delivery. Most institutions do not systematically assess demand for technological solutions and have not established specialized divisions for the commercialization of research results. Many support programs such as the Miyazawa Initiative, the NSTDA-administered ITAP, and the ITB program under DIP are not well-regarded by the private sector, which sees them as overly bureaucratic and lacking sufficiently competent advisors. As a result firms are not willing to contribute a substantial share of the costs of these services (see Chapter 4.1).

Bridging the different cultures, establishing incentives for cooperation and creating spaces for public-private interaction are therefore important tasks. As described above, public awareness for these issues has recently increased and some reforms are on their way, but implementation is still far from being satisfactory.

— One problematic aspect is that personnel working in industry-related institutions is rarely recruited from industry and lacks private-sector experience. In other countries, e.g. in Germany, technical universities require new professors to have a minimum of five years of industry experience.

126 Of an estimated 3000 students who have been granted scholarships until now, more than 2300 returned to work at universities, government institutes or semi-public institutes (Interview with Dr. Djitt Laowattana, Director, FIBO/ KMUTT, on March 22, 2003).

127 The Brooker Group (2001).

— Low rates of labor mobility among scientists and researchers are a major obstacle to improvement of industry-science relations. To increase the understanding of business demands, it is important to support the exchange of researchers between institutes and industry. Exposure of public researchers to industry, or working experiences and training of industry researchers in a public research environment, can be promoted and should be recognized for personal career schemes. Regulations governing temporary mobility, regarding remunerative secondary employment for scientists, and affecting academic entrepreneurship should be carefully scrutinized. As mobility also has a global dimension, international cooperations should be strengthened.

- As a consequence of weak industry contacts on the part of scientists, there are very few spin-off business start-ups launched by academic staff and fresh graduates. As will be described in Chapter 4.4, enterprise creation is not sufficiently supported at universities and research institutions. There are only very few incubators in place, and they host an insignificant number of start-ups. Spin-offs can be seen as a central means of commercializing knowledge generated by public research. Spin-offs are firms founded either by public-sector researchers, start-ups which have licensed public-sector technologies, or firms in which a public institution has an equity investment.

— Cooperative education is not sufficiently established. The concept of internships is not integrated in university studies, and the curricula of engineering and technical studies are not systematically adapted to industry needs. A first improvement measure would be to involve industry associations in curricula development. Although there are initiatives in this area, such as the cooperative curricula formulation in the hard disk drive industry, many companies still complain that technical and engineering studies are still too academically oriented and that they do not provide students with sufficient capabilities to put their knowledge into practice. Graduate programs should emphasize interdisciplinarity and joint education with private firms, e.g. with students working in R&D in enterprises, student internship programs, or cooperation for teaching/ training.

— Both the public and private sector have failed to take note of the benefits of joint research. Incentives at universities and other institutions should be set to give greater weight to joint research and technology transfer.

2. As we have seen in Chapter 2, innovation is an interactive and cumulative process with numerous feedback-loops between firms at different stages of the value chain and knowledge-generating institutions. In Thailand many opportunities for innovation remain unexploited due to the lack of interaction in inter-firm as well as industry-science relations. Thailand's technology policy and institutional arrangements still emphasize a linear concept of innovation which favors research at public and semi-public institutions and aims at the subsequent transfer of the knowledge created to the private sector, rather than supporting innovative behavior in firms and fostering interactive processes geared to solving technological problems (on the weakness of inter-firm linkages and corresponding policies, see Chapter 4.2.). It is therefore necessary to switch from a practice of government-driven innovation towards an **interactive and cumulative approach with strong private-sector involvement.**

Recently a number of fiscal incentives (e.g. a 200 % tax exemption) have been created to foster private-sector R&D. These incentives have several deficiencies, particularly for SMEs: [128]

— Most promotion schemes target mainly advanced technology capabilities, defining R&D narrowly, both in terms of eligible applicants and the activities covered. Thus they do not offer sufficient incentive for most Thai firms, which need support to develop their capacity at lower technology thresholds.

128 Turpin et al. (2002), p. 38 ff.

— To access the R&D funds, firms are required to be included on a list of agents approved by MoF and NSTDA. This requirement discriminates against SMEs in particular that, in most instances, lack the organizational flexibility or constancy required for a separate R&D unit.

— Most of the current R&D support schemes are tax- or loan-based. These are not attractive compared to outside grants to SMEs, which already face problems with their cash flow or in raising collateral.

— Less than five percent of firms are aware of the existence of the various incentives.

As a result, only a very small number of companies have thus far been able to make use of such fiscal incentives. Correspondingly, R&D and other technology development capabilities within industrial firms remain rather limited.

3. In delivering services to the private sector, some scientific institutions do not clearly distinguish between **public and private goods.** Government and semi-public research institutes are expected to carry out some basic research, provide expensive testing facilities, act as coordinators and facilitators for sector-specific policy measures, etc. These are typically public goods that cannot be delivered to customers on a cost-covering basis. Subsidies are therefore justified, and basic public funding should be provided to ensure that these targets are met. At the same time, these institutes often provide standard services which are basically private goods. Delivery of such services, e.g. business consulting and simple product testing – for which users could be expected to pay cost-covering fees – should usually be left to private-sector companies or at least delivered under commercial terms. Otherwise, highly subsidized services may distort existing markets and crowd out private competitors. Therefore it is important to have a clear idea about what services have a public goods character and to what degree government intervention is needed.

In Thailand this does not always seem to be the case. University and research institutions deliver many standard services almost free of charge. In the case of semi-public-sector institutes, the government now seems to be shifting to the other extreme, demanding full financial self-sustainability five years following their foundation. This is neither a realistic target, nor is it justified, as these institutes also provide public goods. Still, it is appropriate to put pressure on the institutes to increase their efficiency and to raise their income from service fees. A recent evaluation shows f.i. that the number of participants in training courses is low, and there is a fair amount of unused capacity (see Box 4.9 for an more detailed overview of the results of the evaluation).

Box 4.9: Results of an evaluation of three semi-public institutes in Thailand

An evaluation of the performance and effectiveness of three semi-public institutes – the National Food Institute, the Thai German Institute and the Thai Productivity Institute – concluded that most customers are satisfied with the services provided by the institutes. A significant percentage of customers had obtained and applied new skills and made changes in various processes resulting in higher quality, lower cost, and improved delivery. However, the evaluation identified four critical aspects:

- The institutes do not focus on complementary service markets and target groups not covered by the private sector;
- Coordination between service delivery and customer needs has to be improved;
- Financial self-sufficiency is not likely to be achieved;
- Evaluation efforts are not fully integrated into the planning and budgeting process.

The operating revenues, e.g. at TGI, covered only 18.5 % of the institute's total operating expenses. TGI would therefore need to increase the number of participants in training courses to thirty times the current level or to raise prices by 1,166 % to cover its total costs, given the current cost structure and customer-paid fees. Similar figures were found for the other two institutes. The institutes will therefore need to reduce costs, increase capacity utilization, raise prices, and/ or shift their focus to higher margin services to become financially independent.

Source: Nexus Associates, Inc. (2000).

4. **Systematic performance monitoring and evaluation** of universities and other research institutions has not yet been fully implemented. Institutions need to place more emphasis on specifying clear objectives and indicators for performance measurement, establish independent monitoring and evaluation bodies, link results of evaluation to policy formulation, funding and implementation (see Chapter 4.1).

5. Another indicator of weak industry-science relations is the limited attention given to **intellectual property rights (IPR)**. Patenting and licensing of intellectual property are necessary to provide incentives for investment in R&D and to protect and commercialize outcomes arising from research. Clarification of these aspects is often a pre-condition for cooperation between science and industry. IPR can be supported by granting exclusive or non-exclusive rights as well as by defining what can be patented. Yet most of our interviewees in Thai industry did not consider IPR as an important issue, since they were not engaged in R&D. Even TNCs and joint ventures with foreign companies neglect local innovations and mainly rely on turnkey technology transfer from abroad, e.g. through licenses. As Thailand proceeds towards the creation of knowledge-based competitive advantages, IPR will become a much more important issue calling for improved incentive systems and regulations for patenting and licensing.

4.4 Formation of innovative entrepreneurs

Entrepreneurship promotion comprises support for the founding of new firms, activities aimed at upgrading existing enterprises as well as provision of an environment conducive to fostering an enterprising society.[129] Since innovations play a crucial role for the development and dynamic of a knowledge economy, it is an important policy task to support entrepreneurs who introduce such innovations to the market, generating growth. In 2002, Prime Minister Thaksin proclaimed the ambitious goal of establishing 50,000 new enterprises within the next two years and announced the allocation of 2 billion bahts toward that end. A new entrepreneurs promotion board, to be chaired by the Minister of Industry, Somsak Thepsuthin, will be established in pursuit of this plan.[130] Thailand has also recently begun to participate in the Global Entrepreneurship Monitor surveys, which can be used by policy-makers and implementing agencies as an important information and monitoring tool in the pursuit of entrepreneurship promotion activities as well as for benchmarking entrepreneurship in Thailand with a view to international experience.

At first sight, these developments seem to suggest that entrepreneurship development ranks high on the political agenda. Nevertheless, a number of shortcomings of the government approach can be identified:

— there is a lack of strategic orientation toward market creation, innovation and competitiveness;

— there is a gap between political goals and implementing capacity;

— some important instruments for entrepreneurship development are lacking; and

— Thailand does not use a holistic policy approach.

Lack of strategic orientation to market creation, innovation and competitiveness. In view of the fact that unemployment and poverty increased considerably in the wake of the economic crisis of 1997, the government set the target of creating 50,000 new enterprises within the following two years. Accordingly, the main concern of this initiative appears to be rapid employment creation rather than the pursuit of strategic entrepreneurship development by targeting enterprises which develop new products and services and generate growth. Most entrepreneurship programs (as well as SME support in general) provide general man-

129 GTZ (undated), p. 2.

130 Bunyamanee (2003), p. 7.

agement and technical training, marketing and financial support for SMEs in traditional industries and are not oriented to supporting innovative entrepreneurs.

The Thai rate of entrepreneurial activity is among the highest in the world. More than 18 % of adults between 18 and 64 years of age are involved in entrepreneurial activities in Thailand.[131] SMEs are a very important sector of Thailand's economy, and they create a large proportion of jobs, provide important goods and services, and contribute significantly to development and growth. At present, 97 % of enterprises in Thailand are SMEs, all of them employing fewer than fifty workers. But most of these "entrepreneurs" are not really innovators. Setting up a new business is mainly a result of necessity, and most entrepreneurs are compelled to start up their own business because they lack suitable alternatives to gain income as wage earners. In this context promotion of entrepreneurs with traditional business ideas may not contribute to increasing productivity growth and income and reducing poverty, because such new SMEs cater to already saturated markets, as is often the case in the informal sector. Newly established firms may even crowd out other market participants or reduce the earnings of all vendors.

Support programs in industrialized countries have therefore shifted away from mere employment creation and towards promotion of innovative enterprises as one means of fostering innovation and technology development and thus long-term growth. The economic relevance of innovative enterprises lies not in their creation of short-term employment but in their medium- to long-term growth potentials and the structural change to the economy effected by the introduction of new products and services as well as the creation of new markets, e.g. for exports. Especially in Thailand, where the rate of entrepreneurial activity is very high in traditional activities with low barriers to entry (in terms of the know-how and capital required to form a new enterprise), it is important to raise the ratio of innovative, growth-oriented business start-ups. This does not imply only promotion of high-tech sectors but applies for all products and services involved in the creation of new markets, e.g. also regional or with regard to new target groups.[132]

Gap between political goals and implementing capacity. The budget of 2 billion bahts earmarked for the creation of 50,000 new enterprises, though promised for 2003, has not yet been allocated to any institutions. In 2002 the New Entrepreneurship Creation Program (NEC) (see Box 4.10) e.g.,

Box 4.10: The New Entrepreneurship Creation Program (NEC)

One prime example for the shortcomings of strategic enterprise selection is the case of NEC. Although NEC seeks to target senior students, fresh university graduates and researchers for enterprise creation, it is striking that most of the enterprises supported by NEC operate in traditional areas such as furniture, textiles, ceramics, handicrafts, etc., where there is no reason to expect any significant market expansion.

This be due to the selection mechanism for the support of entrepreneurs, which mainly amounts to random selection. Most of NEC's clients are persons with no initial business idea, such as unemployed persons who come to NEC in search of new perspectives.

Although NEC mainly seeks to support entrepreneurs on the basis of defined target sectors, which are at present IT and food, these sectors do not rank prominently on their business approval list. Targeting priority sectors may be one way to pursue strategic orientation, but then the question is, how those areas have been selected and how they match up with priority sectors defined by the government. The main problem, however, consists in the lack of guidelines and criteria for use in selecting innovative businesses.

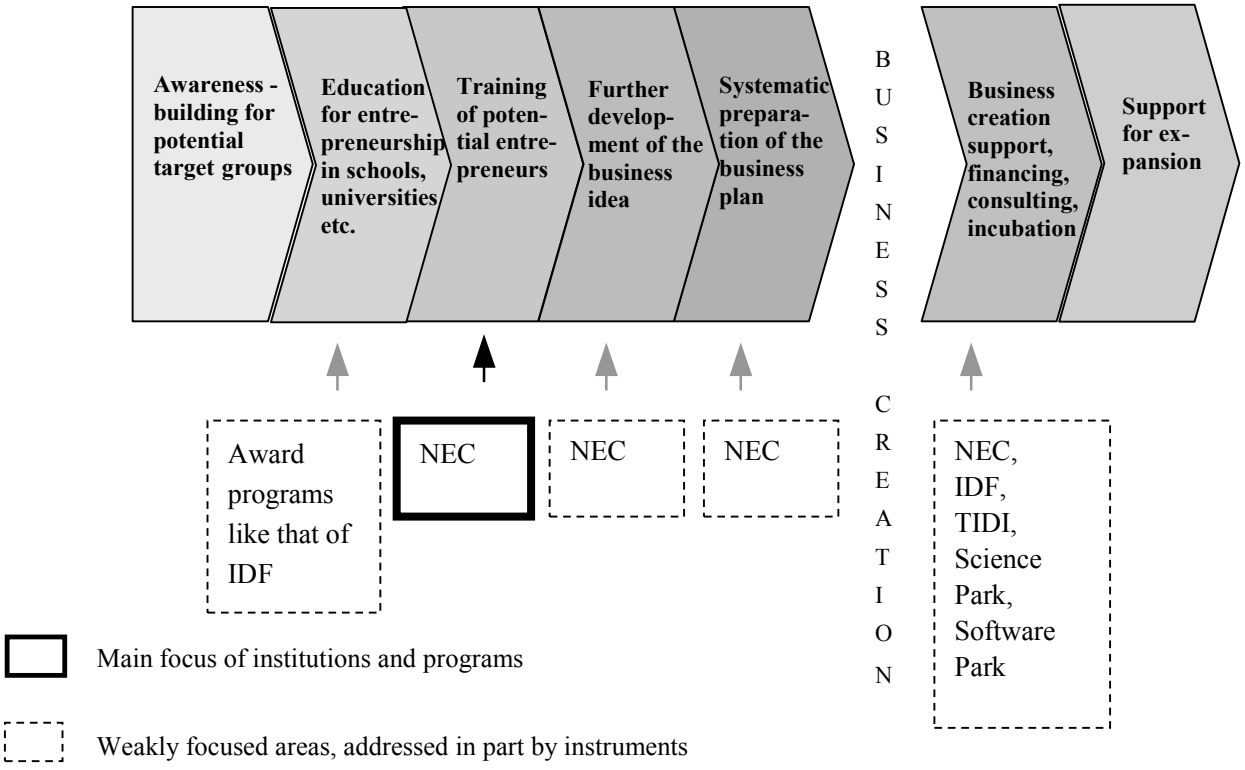
Source: Interview with Ms. Petcharee Vajirakachorn from the Bureau of Industrial Enterprise Development under DIP, on April 2, 2003

131 Global Entrepreneurship Monitor (2002), p. 6.

132 Eckardt (2002), p. 2.

which is the largest program for entrepreneurship creation via provision of training and other business development services and therefore has the main responsibility for implementing the target figure, has trained 7,450 people, 955 of whom afterwards established their own businesses. This rate of 12.8 % successful enterprise creations suggests that to achieve the goal of 50,000 entrepreneurs, NEC, together with the other institutions responsible for entrepreneurship creation, would have to train almost 400,000 individuals. Altogether, these aspects of financing and training capacity, as well as a lack of applications, cast serious doubt on achievement of the target of 50,000 new enterprises.

Figure 4.3: Promotion levels in business creation



Source: Own, based on Eckardt (2002)

Missing elements. A look at the institutional landscape for entrepreneurship promotion reveals only a limited number of institutions devoted to entrepreneurship creation – and lacking many instruments that are in widespread and common use in other countries. Most programs and implementing institutions are still too new to allow for an assessment of their quality. Figure 4.3 shows the different stages of an integrated entrepreneurship concept that ranges from early awareness-building to expansion of support for existing enterprises. The arrows underneath point to the intervention levels of existing institutions and programs in Thailand. The figure shows that only the training of entrepreneurs appears to be more or less intensively covered, while it is striking that especially the initial stages of entrepreneurship creation and follow-up support for new businesses are missing.

Most of our interview partners complained that the Thai education system does not concentrate on promotion of entrepreneurship. The education system in Thailand has traditionally been anchored in a teacher-oriented philosophy, with

learning by rote one of its fundamental characteristics.[133] Since the Education Reform Act in 1999, many reform efforts have been undertaken in Thailand which put emphasis on lifelong learning and initiate a learner-centered approach. The Ministry of Education plays a pivotal role in this reform process and sets initiatives geared to introducing entrepreneurship elements into the education system. But Thailand's "entrepreneurship culture" still appears to be quite underdeveloped, and our interview partners noted that setting up one's own business is not considered to be a valuable goal. Unlocking the entrepreneurial potential in Thai society calls for a long-term education policy and awareness-building for society as a whole which promotes the values of independence, self initiative, creativity, etc.

New projects such as the innovation awards initiated by the Innovation Development Fund (IDF) are steps in the right direction. One of the missions of IDF is to use awards, public relations, and training programs to support an "innovation culture." The IDF has initiated several annual awards such as the „Thailand Innovation Award" at the university level or the „Samart Innovation Award" for to ICT projects. Such award programs and start-up competitions are among the newest instruments for enterprise creation and are especially suited to selecting promising business ideas. They target innovative start-ups with high market potential, i. e. those enterprises which have been described above as strategically important. The initiatives can be designed in different ways: They can promote innovative business ideas in general or concentrate on sectors such as e-business, multimedia or biotechnology; they can be designed as business plan competitions that target entrepreneurs prior to the establishment of a business; or they may give support for the drafting of a business plan. In Germany, for instance, in 2002 there were 82 awards and start-up competitions organized by universities, public institutions, as well as private initiatives, e.g. by banks or newspapers. In contrast, in Thailand there are very few initiatives similar to the IDF awards. More such award programs and start-up competitions should be initiated.

Deficiencies with regard to entrepreneurship are also reflected at the level of universities and RTOs. Our interviews at such institutions revealed that very few new spin-offs emerge from these institutions, and the percentage of start-ups by university graduates and academic staff, the most promising target group for the promotion of innovative enterprises, is very low in comparison to total enterprise creation. This can in part be traced back to the education system, which not only does not promote entrepreneurship but is also hampered by a lack of infrastructure at the university level. Thai universities still have neither established technology transfer offices nor specialized chairs for business creation, which are common phenomena in OECD countries.

In a similar vein, there are also a very limited number of incubators in Thailand. Two examples of existing incubators are the Software Park Thailand and the Thailand IC Design Incubator (TIDI). The Software Park Thailand is a government agency under NSTDA, which was established as part of the National Information Technology Plan. The Software Park works as a support center for the Thai Software industry, and one of its main roles is to serve as an incubator of software entrepreneurs during their start-up period. In 2002, 20 of 60 applicant start-up companies were accepted at the Software Park. Of these 20, two are already producing for export, three more are expected to be successful, but the rest will probably fail. In 2003 there were already 200 applicants, and 40 companies were selected. The candidates are selected for their business potential, which is assessed by a panel interview with applicants. Subsequently, their business skills are improved by training. Other services include facilitation of technical infrastructure, legal services, ICT infrastructure, conference rooms, training rooms etc.[134] The Software Park has no own funding mecha-

133 GTZ (undated), p. 6.

134 Interview with Dr. Rom Hiranpruk, Director of Software Park, on March 21, 2003; see also: www.swpark.th.or

nisms and works mostly with venture capital from abroad

Another example is the Thailand IC Design Incubator (TIDI), initiated by NECTEC. TIDI's vision is to provide an IC Design infrastructure and to help Thailand's Design Community in world-class IC product and development.[135] One if its main functions is to serve as a small-scale self-sufficient facility to support in-house design and local IC start-ups, as one way of strengthening IC design capability for strategic projects. Although TIDI focuses on one sector of great importance for the upgrading of the Thai electronics industry (see the chapter on electronics), its impact is still limited, and it has thus far hosted only one start-up company. However, the introduction of technology and start-up centers is a very important measure in support of innovative businesses and should be used more widely in Thailand. Such centers and incubators should also be set up at or closely tied to universities and target additional promising innovative sectors (see Box 4.11).

companies. In our interviews, Thai start-ups were found to need about ten times the amount of money they were able to obtain. On a concluding note, entrepreneurship creation in Thailand is characterized by a lack of spin-offs, business angel networks, technology centers and incubators. Consequently, university graduates in Thailand frequently prefer to work for the public sector or large, mainly foreign, companies.

Lack of a holistic approach. International experience from SME development programs suggests that none of the above-mentioned policy instruments alone can offer a solution; and that the actors involved in entrepreneurship creation should not necessarily be multiplied but better coordinated and focused. An integrated entrepreneurship development strategy is needed that includes the whole range of policy instruments and organization of support institutions in networks offering complementary and coordinated services.

Box 4.11: Technology and Start-up Centers

The term technology and start-up centers is used as a generic term, refers to the instruments of e.g. incubators or technology parks, and is defined as entrepreneurial centers hosting young and newly established businesses for a certain period of time. The businesses located in such centers are mainly engaged in the development, production, and marketing of technologically new products and services and profit from extensive support by the technology and start-up center.

These centers mostly focus on knowledge- and technology-intensive enterprises and are often linked directly to universities. They offer technologically well-equipped premises at moderate cost. Furthermore, they provide access to networks of consultants, investors, business angels, and big companies.

The concept of technology and start-up centers is widespread at international level. The governments of Taiwan, Australia, Ireland, and the UK have explicitly included establishment of technology and start-up centers in their SME and entrepreneurship promotion policies. In 2001, the UK e.g. set up a "Business Incubation Fund" with a budget of more than 75 million pounds, and approximately 800 technology and start-up centers have been established in the USA so far.

Source: Eckardt (2002), pp. 23-30.

Moreover, funding is still a major problem in Thailand, a fact which is also reflected in a lack of financial infrastructure that rewards profitable business innovations such as Thai venture capital

Furthermore, funding should be allocated more often through public tenders and competitive bidding. This implies that the implementing agencies would have to present their promotion concepts and compete with each other to obtain public finance. One way to successfully promote cooperation and networking among different institutions, such as universities, business associations, banks, venture capital funds and business angel net-

135 Interview with Mr. Chumnarn Punyasai, Researcher at the IC Design Section of TIDI, on March 7, 2003; see also: www.tidi.nectec.or.th.

works, would be to allocate funds only to *groups* of applicants. This may lead to joint projects undertaken by public-private partnerships. In this context, the experiences with EXIST Regions[136] in Germany (see Box 4.12) could serve as a role model for the most important organizational characteristics of such networks.

Conclusion. Altogether, Thailand displays many promising starting points for an effective promotion of innovative entrepreneurs. There is a high rate of enterprise creation in the economy, and the government's attention has shifted towards promotion of entrepreneurs and SMEs. Furthermore, the education system has become more supportive of an enterprise culture, and there are important new initiatives in place, such as the introduction of award programs to raise awareness and to address people with innovative ideas. As outlined in the above chapter on industry-science relations, Thailand's scientific infrastructure is improving; it consists of public research institutions and universities that offer high potential, especially for the introduction of technology and start-up centers and promotion of networking. The task ahead is therefore to redirect programs towards promotion of entrepreneurs who use innovation to seize market opportunities.

Box 4.12: The "EXIST – University-based start-ups" program

The EXIST program is based on four principles:

- establishment of a permanent "culture of entrepreneurship" in teaching, research and administration at universities,
- consistent translation of academic research findings into economic wealth creation,
- targeted encouragement of the great potential for business ideas and start-up personalities at universities and research institutions,
- a marked rise in the number of innovative start-ups and the creation of new and secure jobs.

EXIST's aim is to improve the start-up climate at universities and increase the number of start-ups from academic institutions. Different ways of motivating, training and supporting entrepreneurial personalities have been tried out in regional networks. In these networks, universities work together with external partners from academia, industry, and public institutions, such as extra-university research institutions, companies, capital donors, technology and start-up centers, management consultancies, chambers of commerce, associations and local authorities. These partners jointly develop an integrated program designed to encourage students, employees and graduates to engage in innovative start-ups.

EXIST was initiated by the German Federal Ministry of Education and Research in 1997 as a competition of ideas. What was envisaged wascooperation between at least three different partners from a region, including an institution of higher education. In total, over 200 institutions of higher education took part, submitting 109 outlines of ideas for regional networks. An independent panel selected five model regions in a two-stage procedure. 450 new enterprises have been created in those five regions so far. However, the objective of the program is not only to augment the number of start-ups but also to change the image of entrepreneurship at universities and research institutions.

Since the summer of 2002, ten additional regional networks have been received supported in the EXIST framework. They are given financial support amounting approximately to a total of 10 million euros and profit from the know-how and experiences of the existing five model regions.

Source: www.exist.de

136 See www.exist.de

5 Sector studies

In the following case studies, the **electrical and electronics manufacturing** and the **shrimp-farming** sectors are analyzed with regard both to the challenges they face in building knowledge-based competitive advantages and the contribution of the NIS. The two sectors have been selected because they are important for the Thai economy, represent a broad spectrum of economic activities, and are both confronted with the need to upgrade technologically. Both sectors are faced with growing competition from neighboring countries and are marked by a lack of the policy vision needed to guide sectoral development. However, they also differ in various aspects: First, looking at the sectoral structure, the shrimp sector is dominated by a nationally-based lead firm which governs the major segments of the value chain, while the electrical and electronics sector displays a dualistic structure, with TNCs and SMEs focusing on different market segments. Second, there are imminent challenges bound up with the ecological and health-related (e.g. antibiotics) problems involved in shrimp-farming as well as with technological upgrading and creation of inter-firm linkages for electronics manufacturing. Thirdly, and as a result of the above, the NIS for both sectors address different issues, with varying degrees of determination and success: Whereas, for instance, industry-science relations are making significant contributions to solving the problems of ecological and economic sustainability in the shrimp sector (e.g. research on the domestication of broodstock, eco-efficient production methods), such collaborations in the electrical and electronics sector are still limited to a few pilot projects. The following sector studies will address these issues and consequently place different emphases on specific innovation policies.

5.1 The electrical and electronics industry

The electrical and electronics sector is Thailand's biggest export earner and hence important to its economy. The sector is marked by a dualistic structure: While foreign companies manufacture high-technology products for export markets, the bulk of local SMEs focus on the domestic market in lower-technology segments. Due to the technological gap, few vertical linkages exist between the two. The sector faces competitive pressure both from more advanced countries such as Malaysia and low-cost countries such as Vietnam and China. Therefore the Thai electrical and electronics industry will either be able to upgrade itself and thus remain attractive for foreign investors or risk losing its market shares. However, since Thailand exhibits significant potentials, the sector is not bound to become an economically irrelevant "sunset industry" if political support can be gained and four imminent challenges tackled: policy formulation, human resource development, technological upgrading, and linkage creation and embedding.

5.1.1 Relevance for the economy, characteristics and profile of the industry

The electrical and electronics sector is important for the national economy as it contributes 4 % to the country's GDP, employs a workforce of more than 400,000 and accounts for nearly 35 % of Thailand's exports. With exports amounting to US$ 23.6 billion in 2000, it is Thailand's biggest export earner, with a positive trade balance of US$ 6.2 billion (for further specification of exports according to product categories, see Table 5.1.).[137] Furthermore, the sector has attracted US$ 17 billion of FDI, and accounts for roughly 20 % of yearly investment inflows. [138]

For Thailand it is useful to distinguish between the electrical and consumer electronics segment and the electronic component and computer/peripherals segment. The former displays a higher involvement of local companies. Firstly, local SMEs serve the needs of the domestic market in lower-tech product segments such as rice

137 McKinsey (2002), p. 171.

138 Sudjit (2001).

Table 5.1.: Composition of the sector and export value in 2000	
Product categories	Exports in US$ billion
Electronic Components	**9.5**
Semiconductors	4.8
PCB/ PCB Assembly	1.1
Other parts (resistors, transistors, micromotors)	3.6
Computer and peripherals	**7.9**
Hard disk drives and parts	5.0
Monitors and parts	1.2
Printers and parts	1.1
Peripherals	0.6
Consumer Electronics (e.g. TVs, VCRs, radios, microwaves)	**3.6**
Electrical Household Appliances (e.g. AC, refrigerators, washing machines)	**1.4**
Telecom and office equipment (faxes, telephones, photocopiers)	**0.9**
Source: McKinsey (2002), p.174	

cookers, lighting equipment, fans and radios. Secondly, many joint ventures have been set up between Thai and – mainly – Japanese companies in both electrical appliances and consumer electronics. Pursuit of an import-substituting industrialization strategy in the 1960s and early 1970s and the use of local content requirements enabled local companies to benefit from technology introduced by their foreign partners. In this segment vertical linkages have been developed to some extent, and local suppliers play a significant role depending on whether the markets served are export or domestic markets. Notwithstanding the dominant technological role of foreign joint venture partners in the electrical and consumer electronics segment, a number of large local companies have been able to develop own technologies and export their products to regional markets, particularly air-conditioners and refrigerators.

In contrast, the electronic component and computer parts segment is dominated almost entirely by TNCs. Since the mid-1970s Thailand has focused on export-oriented production. In pursuing this strategy, generous investment incentives were handed out to TNCs who came in to take advantage of cheap labor costs to perform labor-intensive assembly tasks. Export production in Thailand focuses on electronic components such as integrated circuits (IC) and printed circuit boards (PCB) as well as computer parts such as hard disk drives (HDD). In this segment the supplier base is very weak as the technological gap between TNCs and local companies is too wide, and only a few companies are qualified to meet the demands of TNCs in terms of quality, cost, delivery, and service.[139] Such successful local companies are mostly engaged in subcontracting assembly (e.g. Hana Semiconductor, NS Electronics) or in supplying low-technology products such as simple metal parts, tools, packaging etc. Thus the electronics segment is not embedded in the Thai economy and has consequently been described as a "high technology enclave".[140]

With TNCs carrying out labor-intensive assembly activities in Thailand, and the country lacking a deep supplier base, national value added in the electronics segment is rather low, estimated to be

139 The World Bank (2000) has carried out a benchmarking study which showed Thai microelectronics companies lagging behind best international practices in most aspects (rejection rate, customer contact time, equipment age etc.).

140 Doner/ Brimble (1998).

around 10-15 %.[141] More value-creating activities such as design, product engineering and R&D are carried out offshore and then imported. Also, more sophisticated components and raw materials are imported, leading to a very low import content (85-95 %).[142]

Given Thailand's limited technological capabilities and specialization in mass production/assembly and testing, it faces competitive pressure from two sides. Competing in factors such as quality, flexible production and design capabilities, technologically-advanced countries such as Malaysia and Singapore currently attract the more value-added, technology-intensive investments. Singapore has achieved competitive advantages in high-quality engineering services and complementary business services, for instance regional coordination of supply chains and financial services.[143] Malaysia has gained a reputation for its abilities in flexible mass production, for the emergence there of a locally owned supplier base (especially in machine-tooling), and the incipient incorporation of design activities in manufacturing.[144]

From below, latecomer countries such as Vietnam and China are now competing in cost advantages. Catching up technologically, these countries can perform labor-intensive mass production similar to that currently carried out in Thailand (see Table 5.2. for an illustration of the regional division of labor). China in particular poses a threat since its large, expanding domestic market offers companies economies of scale. Thus Thailand is in danger of having its production sites relocated a well as of attracting fewer investments.

Table 5.2: Thailand's "sandwich position" illustrated by the regional production facilities of the American transnational company Advanced Micro Devices (AMD)

Location	Activity	
Singapore	IC design Testing of highly sophisticated processors Failure and device analysis	Increasing knowledge content ↑
Penang, Malaysia	Developing design packages for advanced logic and memory devices Assembly and testing of memory and logic devices	
Bangkok, Thailand	Assembly of plastic parts Testing, marking and packing of logic and memory products	
Suzhou, China	Assembly and testing of cost-sensitive high-volume devices Distribution	

Source: http://www.amd.com, Interview with Yuthana Hemungkorn, Managing Director, AMD Thailand, 31 March 2003

5.1.2 Opportunities

Currently, Thailand is worried about competition from China. However, if it comes to realize its lack of ability to compete on factor costs, it could move to a new strategic outlook: Rather than trying to compete in labor-intensive mass production, in seeking chances to sustain its electrical and electronics sector Thailand's will have to give

141 According to an Electronics Cluster Study, national value added in the main product categories of electronics are 20% in HDD (because of a longer supply chain, with many TNCs producing in Thailand), 10% in IC assembly, and 20-30% in PCB (BUILD 2001).

142 Konishi (2001), Wipplinger (2000), p. 4.

143 Best (2001), p. 44.

144 Rasiah (1998).

some thought to entering higher, knowledge-based market segments currently occupied by Malaysia and Singapore. Pursuit of such a strategy hold promises of higher investments, introduction of modern technologies and development of deeper inter-firm linkages. Industry trends render this optimistic scenario plausible: TNCs, while concentrating on product development, design and marketing, outsource manufacturing services to specialized subassemblers and contract manufacturers. At the same time, flexible production capabilities are required, i.e. supply of customized products in small batches on short notice, which calls for rapid development of designs and solutions. This in turn increases the need for a local supplier base capable of quickly providing specialized tools and parts.

Specialization in high-end activities and tightening labor markets are increasing cost pressure in Singapore and Malaysia. As a result, there is scope for Thailand to attract relocations and have manufacturing and supplementary services conducted in the country. Thailand displays several potentials which make the strategy of entering more knowledge-intensive markets realistic: There are over 835 companies in the electrical and electronics sector,[145] and a number of TNCs have invested in modern production facilities. The Thai workforce has acquired a lot of experience in performing medium-skill assembly activities and production engineering. In addition, Thailand can still compete in cost efficiency and reasonable wages for higher-skilled labor (see Table 5.3.).

Table 5.3.: Labor costs in the hard disk drive industry in US$/ month, 1999

	China	Thailand	Malaysia	Singapore
Direct labor	75	170	205	390
Engineers	170	425	680	1,290

Source: Panichapat (1999)

Opportunities for Thai companies are therefore manifold (see Table 5.4), and all such chances require an upgrading of existing capabilities. In the electronics segment, becoming parts suppliers and subcontractors to large Original Equipment Manufacturing (OEM) companies is a realistic option, as the latter are increasingly interested in procuring parts locally. This trend is largely due to more customized demand, but also due to the devaluation of the baht. The supporting industries path, which consists of supplies of high quality machine-tooling, mould & dies, plastic and metal parts, is worth pursuing. Engaging in supplier relations, however, demands capabilities in technology management and, increasingly, design and reengineering.

Both near-term and future opportunities may be seen in chip design activities, which are increasingly in demand. This market segment is particularly attractive because the value added in design is high. Given the number of well-educated chip designers and companies in IC and PCB manufacturing, IC and PCB design as well as embedded systems represent a hitherto untapped market.

In the electrical parts and appliances segment, there is a potential for innovative Thai companies to design and manufacture niche market products and to create their own brands. Companies engaged in Own Design Manufacturing (ODM) and Own Brand Manufacturing (OBM) can serve both domestic and regional export markets. Examples of promising markets are found in the fields of energy-saving technology and products requiring adaptation to local environments (air-conditioning, PABX switchers, uninterrupted power supplies etc.).

145 Sudjit (2001).

Table 5.4: Opportunities for Thailand's electrical and electronics sector		
	Domestic market	**Export market**
Customer-specific PCB/IC design and embedded systems	X	(X)
Precision engineering (high quality tools, moulds and dies, jigs and fixtures)	X	(X)
High quality plastics and metal parts (for casings, keyboards etc.)	X	X
Indirect materials (foam, cardboard, packaging, printing manuals).		X
Subassemblies (mass manufacturing on a contract basis for transnational customers)		X
Electrical components (customized transformers, capacitors, uninterrupted power supplies, PABX switchers, energy saving devices, adapters	X	(X)
Electrical Appliances (AC, refrigerators)	X	X
Consumer Electronics (TVs, VCRs, radios)	X	X
Source: own interviews; X denotes current opportunity, (X) denotes future opportunity		

5.1.3 Challenges

Keeping the electrical and electronics industry competitive and tapping these opportunities requires a concerted drive that puts technological upgrading and embedding of the TNC-driven export sector at the heart of the agenda. Since the country currently lacks political commitment, the first of four impending challenges is thus policy formulation, i.e. formulating a shared vision and implementing jointly designed programs. These need to address the remaining challenges in the fields of human resource development, technological upgrading, and linkage creation and embedding.

Policy formulation. The sector currently suffers from benign neglect by the government. It has not been included as one of the five priority clusters, a fact that indicates that the government – due to low local content, value added, and indigenous technological capabilities – regards electronics as a "sunset industry" that is losing its competitive advantages. How little attention it receives from the National Competitiveness Committee and the Ministry of Industry is reflected in the slow progress that has been made in revamping the tax and tariff structure, bringing national standards to international levels and supporting private-sector initiatives within the sector (more below).

Even though a Master Plan of Electrical Appliance, Electronics and Information Technology was produced in 1998, it does not provide a commonly shared vision and a specific action plan. Despite some initial private-sector enthusiasm for formulating a plan that would guide the sector's development, this involvement has gradually faded. Today there is no ownership for a plan that is widely regarded as neither providing a guiding vision nor focusing the efforts of sectoral players. More often than not, it sets very general, ambitious strategies ("To increase the value-added processes of the Thai portion of assembly and production," "Initiating Thai-owned brand names and aggressive marketing plans"), but without specifying the actions that need to be taken to achieve these goals. At the same time, commonly identified bottlenecks such as international standards certification are not even mentioned in the

plan. Furthermore, the drafting of the plan was not based on systematic benchmarking or foresight.[146]

The lack of political support and orientation can be attributed to the inability of industry players to find a common platform and to jointly address the government. On the one hand, TNCs are pursuing their goals independently of industry associations such as the Federation of Thai Industries (FTI). They address the government directly, mostly through foreign chambers of commerce or through their own industry association, the Electronics and Computer Employers Association (ECEA). Consequently, the FTI and its Electrical and Electronics Club do not represent the whole sector and therefore have only limited lobbying power. In the same vein, the Electrical and Electronics Institute (EEI), the main sectoral institution with a networking role, focuses solely on the *electrical* segment, with almost no interaction with foreign companies engaged in the *electronics* segment. This failure to join forces politically reflects just how little embedded the whole sector is.

Given the limited lobbying power of the private sector and the lack of communication between sector agents, policy support is generally thought to be weak. Other countries show how public- and private-sector efforts can create sector dynamics. For example, Malaysia has used a region-based cluster approach and installed something akin to a cluster manager responsible for creating networks (both horizontally and vertically) that involve local and foreign companies[147] as well as institutions in finance and education. Closely cooperating with TNCs and focusing on technology management and skill formation, the region of Penang has succeeded in creating a regional innovation cluster that involves a growing local supplier base.[148]

Even though Thailand is pursuing cluster approaches, surprisingly little has materialized on the ground in the country. And this despite the existence of several clusters (such as the PCB assembly cluster in Lampoon Province) that would provide an ideal ground for such networking. A strategic political initiative and convincing targeting of key foreign companies might therefore prove beneficial for stimulating regional innovation clusters.

Human resource development. Electrical and electronics companies in Thailand generally perform low- to medium-skill activities. Most of these are in assembly, but not in high-value-added production and services. Capabilities to design new products or production technologies are to a large extent lacking. Hence the scope for value-added activities is limited.

Thailand faces a pronounced labor shortage, particularly as regards qualified technicians and engineers with high-end capabilities in design as well as in research and development. This despite claims that 60,000 electronic and electrical technicians and engineers are being trained annually,[149] and the statements of some TNCs that they have no difficulties in hiring qualified labor. The human resource problem is bound up with with quality, which is of particular concern to SMEs interested in engaging in design activities or becoming suppliers to foreign companies.[150] These shortcomings are a result of low regard for training in firms and the fact that vocational training and engineer education in public institutions is insufficiently oriented towards the needs of the industry. The latter include independent problem solving, application of theoretical knowledge to industrial processes, capabilities in electrical, mechanical and software engineering, and creativity in design.

146 One positive development is the technology foresight project for the electronics and electrical industry decided upon by the MoI, which might be able to identify promising technological targets within the sector.

147 Best (2001, p. 73) emphasizes the importance of targeting „entrepreneurial firms“ to drive regional growth. Such firms are characterized by high technological capabilities and the capacity to create many niche markets for SMEs in complementary areas, e.g. product development, supply of parts or after-sales services.

148 Best (2001), p. 52.

149 Wanapha (2002).

150 McKinsey (2002), p. 179.

This situation is beginning to change: At the firm level, companies are increasingly setting up in-house training facilities. Also, there is a trend to spend more company money on training. Microelectronics companies' expenses rose from 3.7 % to 4.8 % from 1995-2000.[151] However, such increases are not sufficient if these companies intend to increase their global competitiveness. At the institutional level, higher education institutions and training programs are not yet systematically and broadly linked to the private sector. Even though a few initiatives in cooperative education are being introduced to universities such as Kasetsart University or the King Mongkut Institutes of North Bangkok and Ladkrabang, these are only pilot projects. It is necessary to incorporate such industry-science cooperation schemes in operational routines of institutions of higher education.

A systematic approach to human resource and skills development needs to be highly demand-oriented and coordinated with the private sector. A best practice model can be found in Malaysia, where the Penang Skills Development Center (PSDC, see Box 5.1) displays how regional growth dynamics can be linked with skills formation. A key success factor of the Penang model lies in closely incorporating foreign companies in the management of the training center, thus ensuring a skills development that matches the industry's needs. As a result, the Penang region has been able to upgrade its operations and is now in possession of a vibrant local supplier base.

In comparison, skills development in Thailand consists of isolated initiatives that lack an integrated approach. Nevertheless, a number of initiatives and institutions stand out for their close cooperation with industry in skills development and training efforts. The Thai-German Institute (TGI), for instance, provides training in fields such as tool & die technology, automation technology etc., using high-tech precision machinery, state-of-the-art equipment and a learning-by-doing teaching philosophy.[152] A further example is the joint establishment of the Ayutthaya Technical Training Center (ATTC) by the Hi-Tech Industrial Estate and the King Mongkut's Institute of Technology North Bangkok (KMIT-NB), which conducts training and assists companies in recruitment.[153] Pointing in a

Box 5.1: Penang Skills Development Center

The Penang Skills Development Center (PSDC) was established in 1989 with a mission "to be a resource for the promotion of the shared learning for manufacturing and service industries by providing proactive human resource initiatives to strategically support and strengthen business requirements." A joint initiative of the State Government of Penang, the Penang Development Corporation and 24 TNCs, this training institution is led by the industry. Involvement of private-sector representatives, especially from foreign companies, in the management council and joint development of curricula ensure that the needs of the regional electronics cluster are being served. With a membership of over 80 companies, and courses offered for over 8,000 students and employees a year, the PSDC has not only contributed to the upgrading of existing companies but also to technology diffusion to local SMEs. Thus it not only serves as an example of how a local supplier base can be formed, it also shows how foreign companies can be brought in to contribute to the development of local industries.

Source: Rasiah (1998), Best (1999)

151 According to the Thailand R&D and Innovation Survey, 20 of 26 firms have a separate human resource development unit.

152 Interview with Walter Kretschmar (Director, TGI) and Dr. Michael Grosse (SME Development Project, TGI), 25 March 2003; http://www.tgi.or.th.

153 It has received training equipment and new technology from a number of Japanese companies, led by Canon Ltd. In 1996 the Mitutoyo Corporation donated about 30 million bahts worth of precision instruments and measuring equipment for the Mitutoyo-ATTC Metrology Center. While still only at the vocational level, the ATTC offers the potential for KMIT-NB to interact with private companies and identify their longer-term training needs. At the same time, private firms can access a range of university services beyond the training provided by the ATTC. The Brooker Group (2002a), p. 18.

similar direction, the Asian Institute of Technology (AIT) and IDEMA, the association of the hard-disk drive industry, have developed a training program specific to the industry and issue a Certificate of Competence in Storage Technology (for more details on IDEMA, see Section 4.6).

Technological upgrading. To tap the market opportunities described above, technological upgrading needs to take place at the firm and sector level. Firstly, at the firm level, *process and product upgrading* with regard to quality, just-in-time delivery, technology intensity, product differentiation, design capacity etc. is crucial for Thai SMEs. Only then will they be able to make themselves available to international value chains, create linkages and thereby embed the sector.[154] Secondly, enhanced capabilities at the firm level would pave the way for *intra-chain upgrading*. More functions of value chains could be shifted to Thailand: technologically-complex production, mass customization, product design and R&D activities etc. As a consequence, the profile of Thailand's electrical and electronics sector would more resemble Singapore's or Malaysia's. This upgrading of the value chain requires organizational changes in companies' operations as well as intensified inter-firm linkages and industry-science relations.

However, the necessary upgrading drive is proving slow in getting on its way. On the one hand, many Thai SMEs do not realize the urgency of the need to upgrade. Their complacency is only reinforced by Thai consumers, who emphasizing price, not quality, thus providing little incentive for product differentiation.[155] At the same time, the Thailand Industrial Standards Institute (TISI), the agency responsible for setting standards, has set only 11 mandatory standards for electrical products safety and quality. Given the varying quality requirements in domestic and export markets, local companies find it difficult to compete internationally, and this compounds the dualistic structure of the sector. Some private-sector agents in Thailand have realized that the issue of quality and standards is hampering industrial development. For example, the FTI is planning to launch a quality mark (Q-mark) which could help companies to command premium prices in the domestic market. The EEI envisages introducing an EEI "test-mark" for quality products that comply with standards higher than the mandatory domestic standards set by TISI.

On the other hand, the technological environment in Thailand is not yet conducive, and institutional support is rated insufficient by private-sector agents. There are still too few clear government incentives, public-sector programs resemble patchwork, are supply-driven, and have low outreach or limited capacity. For instance, even though the government is supporting a drive to achieve greater quality and reliability of Thai SME products by subsidizing consultancy services for companies seeking ISO certification, the outreach of these projects is rather low, any only 51 companies have benefited from the scheme.[156]

Another example, the EEI Testing Center (EEI-TC) is a well-regarded institution that tests products for their compliance with safety or electromagnetic compatibility standards. However, it is not endowed with the technical and financial resources (e.g. for new testing equipment) that it needs to meet national demand for such services.[157] More testing facilities are needed because tests related to improving new products or material tests are crucial for product innovation, and few such service providers exist. Further reflecting the lack of strategic outlook, TISI has been slow to obtain international accreditation, so that

154 Upgrading and linkage creation/ embedding are dialectically related, since upgrading is a precondition for creating vertical linkages with TNCs. On the other hand, linkage creation is expected to contribute to upgrading as technology is transferred to local companies. Therefore these notions cannot always be strictly separated.

155 Interview Chotiwutti Innada (Industrial Engineer, BSID), 14 March 2003.

156 NSTDA (2002), p. 8.

157 According to Katiya Greigarn, Vice-Chairman of the FTI Electrical, Electronics & Allied Industry Club, the EEI-TC had a budget of 30 million bahts, while it would need 1,000 million bahts to buy testing equipment (Interview, 14 March 2003).

the EEI-TC and other institutions are unable to issue international standard certificates.[158] As a result, local companies have to pay high fees to international agencies to get certification for their products.

The contribution of public RTOs to technological upgrading is not yet at a sufficient level and has not lived up to its actual potential, given the impressive infrastructure at the Science Park. For example, NECTEC, a main player in the scientific landscape, is in the process of coordinating its research activities more closely with industry. Currently, there are interesting cooperation projects with foreign companies, focusing on latest technology such as laser diodes or nano-technology. Furthermore, NECTEC is pursuing a push in IC design capabilities and has set up the Thailand IC Design Incubator (TIDI), which aims at providing infrastructure and design services for local companies. Such research in generic technologies as well as related efforts in IC design point in the right direction of successful industry-science relations and calls for further public support.

However, a focus on what one interviewee described as "fancy technology" will have its price if local SMEs are neglected. This may inhibit local innovative firms from upgrading products (for instance, enhancing transformer capability from 50 to 100 Hz) and from entering new markets, thus compounding the dualistic structure. As a result, public research institutions and universities find themselves ranked at the bottom of potential sources of technology.[159] On a different note, this discrepancy can also be attributed to the fact that Thai companies are not demanding R&D support or are not capable of further developing prototypes.

With public-sector programs not showing the expected results, and private-sector initiatives too few in number and not sufficiently supported by the government, what is called for is a more systematic and coordinated approach for support of upgrading – in networks operating in specific market segments. As an example of intra-chain upgrading, Thai companies could move into the market for IC design and embedded systems, which constitute the "brain" of electrical and electronic products. Demand for such customer-specific solutions is expected to increase considerably both worldwide and in Thailand, where the growing automotive industry is creating new markets for auto electronics. Well-trained young electrical engineers designing chips and prototypes, for instance at the TIDI and the Institute of Field Robotics (FIBO) at King Mongkut University of Technology Thonburi, constitute the human po-

Box 5.2: Thai Embedded Systems Association (TESA)

The Thai Embedded Systems Association (TESA) is a private-sector initiative founded in 2002. "Embedded," as defined on TESA's homepage, is a "small computer system that is hidden inside equipment (machine, electrical appliance, or electronics gadget) to increase the intelligence of the equipment for better or more efficient functionality (...) (that) involves both the software and hardware co-development." The association comprises developers, some large TNCs such as Seagate, local companies and university professors. It aims at collaboration among these agents, promotion of the embedded systems R&D network, and development of SMEs and supply chain networks. To achieve these objectives, it has already initiated several activities, the most prominent of which the embedded systems contest. 150 projects participated in the first year, revealing both the considerable potential in the country and the success of the initiative to foster creativity and competition. As a promising follow-up, establishment of an embedded systems incubator is envisaged.

Source: www.thaiesf.org; Interview Prof. Apinetr Unakul (King Mongkut Institute of Technology – Ladkrabang, Computer Engineering,) 05 March 03.

158 Interview Kanis Muangsiri (Acting Manager, Marketing Department, EEI-Testing Center), 28 Feb. 2003.

159 The Brooker Group (2002a), p. 28.

tential needed by these markets.[160] Transforming developed technical solutions into commercialized products as well as diffusing created knowledge and technology are the tasks ahead for the NIS in electronics. These are best tackled by agile entrepreneurs and developers organized in networks like the Thai Embedded Systems Association (TESA, see Box 5.2). The public sector should support innovative entrepreneurs and network initiatives within the private sector by furnishing R&D funding, forum sponsorship and public services (e.g. testing facilities), thus helping to expand such networks in order to reach a critical mass of firms.

Linkage creation and embedding. Embedding denotes the building by foreign companies of linkages to local companies and institutions by integrating them into their value chains and by collaborating with RTOs. Unfortunately, there is too little of this in Thailand, where the electronic component industry in particular may be characterized as footloose with regard to local supplier linkages.[161]

The Thai government has paid almost no attention to embedding the industry and proactively supporting the development of an indigenous supplier base capable of supplying quality products. Neither have there been any supplier development programs focusing on capability development nor have leading companies been given incentives to create vertical linkages and engage in technology transfer.[162] Consequently, despite the multitude of investments in the country, the outcome has not been integration of SMEs into international value chains. Foreign companies in electronics prefer to source either outside the country or to force their international suppliers to move to Thailand (as has been the case in the hard disk drive industry).

Only recently has there been a shift in outlook, with the BUILD program seeking to enhance the creation of vertical linkages. However, the technological gap prevents any significant linking of SMEs to TNCs. Partly as a result of this gap, the Subcontracting Promotion Club (SPC) has been set up to enhance the capacity of local SMEs in electronics, plastics, metal parts and polymers. However, the approach followed focuses more on horizontal networking, since many of the companies concerned do not yet feel qualified to approach TNCs on their own.

On a more positive note, cooperation between TNCs and RTOs and universities is on the rise. Personal networks have led to initial contacts between the two agents. As public sector institutions show signs of greater openness to collaboration, companies such as Read-Rite and Fabrinet are carrying out joint research projects with MTEC, NECTEC and universities (FIBO at King Mongkut).[163]

Taking these positive developments as a starting point, and drawing on experiences of neighboring countries (for instance the LIUP of Singapore, see Box 4.7), a redirected embedding effort could be launched. Such an effort would use a more focused approach aimed at dynamic market segments. For instance, Singapore, in cooperation with large customers, has fostered promising local SMEs in establishing machinery shops. In response to industry trends favoring local purchasing of specialized tools for automated large-volume manufacturing, a supplier base of precision tooling companies has been established. However, at the moment neither such incentives nor high-end capabilities exist in Thailand. A joint effort is therefore necessary to supplement the operations of TNCs with machine-tooling services, high-quality mould & dies or plastic parts.

160 Interview with Dr. Djitt Laowattana (Director FIBO), 20 March 2003; Dr. Suthee Phoojaruenchanachai (Researcher, NECTEC), 7 March 2003.

161 Doner/ Brimble (1998).

162 Instead, KR Precision, a company in the hard disk drive industry, has had its proposal to establish a National Tool and Die Institute turned down.

163 Interview Mr. Tawan Suppapunt (Vice-President) and Mr. Chakkrit (Development Director) of Read-Rite, 28 April 03; Interview Dr. Djitt Laowattana (Director FIBO), 20 March 2003; Doner/ Brimble (1998).

Taking large customers' needs as the point of departure, efforts aimed at enhancing local companies' capabilities would have to involve a commitment by TNCs and broad support by private- and public-sector institutions such as universities, the National Institute for Metrology and Testing (NIMT), MTEC, EEI and the Material Property Analysis Department (MPAD).

5.1.4 Conclusions

As the present analysis has shown, there are potentials and opportunities for Thai companies in the electrical and electronics sector. However, ambitions to tap into higher-technology market segments call for commitment of both public and private agents in the NIS to induce the necessary upgrading and embedding by enhancing industry-science relations and inter-firm linkages. Best practice experiences from other countries suggest that such initiatives should be conducted in networks involving TNCs, promising SMEs, industry associations, and public sector institutions such as universities, sector institutions (EEI) or research institutes (NECTEC, MTEC). Furthermore, they ought to be driven by private-sector agents, with governments playing a complementary role in coordinating the various stakeholders, providing infrastructure and fostering capability development. It is therefore essential to overcome current hesitations regarding financially support for private-sector initiatives, and support should be provided for evolving networks such as IDEMA or TESA. Such an approach might just create the dynamics the sector needs in Thailand, and prevent it from becoming a sunset industry after all.

5.2 The shrimp aquaculture sector

5.2.1 Relevance of the Thai shrimp-farming sector

Thailand is the world's largest producer and leading exporter of cultured (farm-raised) shrimp, supplying 35 % of the world market for Black Tiger shrimps (*Penaeus monodon*).[164] This accounts for approximately 3.5 % of it's the country's total exports of goods and services. In 2001 exports of farmed shrimp amounted to 280,000 MT[165] and earned Thailand US$ 2.2 billion. The largest export markets for Thai shrimps are the United States and Japan, which account for 46 % and 17 %, respectively.[166] Favorable agro-climatic and economic conditions, the country's 2,600 km coastline in the Central, Eastern and Southern provinces as well as the particular organizational structure of the Thai shrimp sector – with a large national conglomerate with leading technological expertise – account for Thailand's comparative advantage in shrimp production.

A drop in production from 200,000 tons in 1996 to 170,000 tons in 1997, as shown in Figure 5.1., is due to serious outbreaks of a virus disease ("white spot disease"). The devaluation of the baht during the Asian Crisis in 1997 led to increased revenues for the shrimp-exporting industry and set incentives for shrimp farmers to further intensify farming methods, e.g. by increasing stocking rates, which in turn facilitated the spread of diseases.[167]

Shrimp-farming has positive employment effects. In addition to 15,800 registered farms (1998),[168] with several people working at each farm, employment is created by related industries such as processing factories, feed companies, middlemen/brokers etc. It is estimated that approximately 150,000 people are directly employed in the shrimp industry.[169] Since illegal immigrant workers are frequently hired by shrimp farmers, the real employment figure is assumed to be even higher. Taking family members into account, the

164 Patmasiriwat/ Kuik/ Pednekar (1998), p. 30.

165 http://www.globefish.org/publications/commodity update/200206/200206.htm.

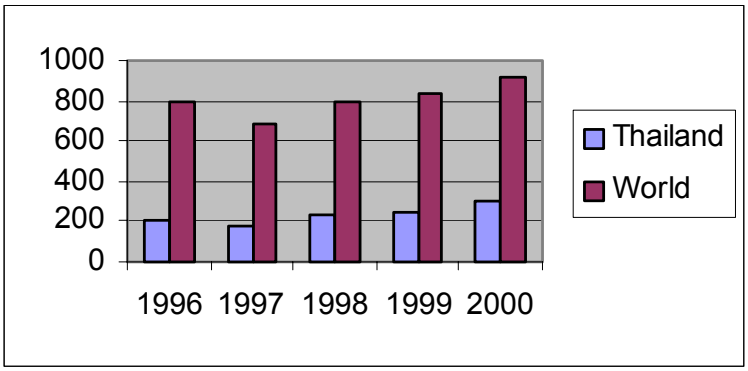
166 Kagawa (2003), p. 118.

167 Kagawa (2003), p. 32.

168 Kagawa (2003), p. 33.

169 Patmasiriwat / Kuik / Pednekar (1998), p. 30.

Figure 5.1**: World shrimp production, 1996 – 2000 (in '000 metric tons)**



Source: World Shrimp Farming, Annual Reports

number of people depending on the shrimp industry amounts to approximately 300,000.[170]

Farm-raised shrimp production is one of the fastest-growing industries world-wide, and global demand for fish products is rising, with shrimp being by far the most valuable species. In response to the global market, a drastic reorientation of agricultural priorities from basic food crops, such as rice, to higher-value and more capital-intensive export products, such as shrimp, is expected in the long term.[171]

5.2.2 The value chain of shrimp aquaculture: an overview

Shrimp aquaculture is a very complex and knowledge-intensive activity. To understand the competitive and ecological challenges of the sector and identify the needs for improving the innovation system in this sector, it is necessary to briefly describe the main characteristics of the production chain in Thailand.

— Gravid female brooders are called **broodstock.** These mature female brooders which are caught in the sea and sold to hatcheries have become smaller and increasingly rare due to overfishing. So far, it is not commercially viable to reproduce Black Tiger shrimp in captivity. R&D endeavors in the shrimp industry mainly focus on the domestication of broodstock, i.e. the reproduction of shrimp fry in laboratories or research centers.

— In **hatcheries** shrimp fry is grown for approximately two weeks. After several stages they become "post-larvae" and are sold to shrimp farmers. There are several thousands of hatcheries in Thailand, some of them being very small enterprises.

— **Shrimp farms** cultivate the shrimp for another 90-100 days before they can be harvested. On average, shrimp farms in Thailand are small: 80 % of all farms are smaller than three rai.[172] Altogether, shrimp farms in Thailand cover an area of 80,000 hectares.[173]

— **Feed production** is dominated by the Charoen Pokphand (CP) Group with a market share of 75 %; further feed companies are Thai Union (10 %), Grow Best (10 %), Gold Coin (3 %).[174] **Chemical companies** provide hatcheries and farms with the pesticides and antibiotics which have increasingly been used to control

170 Kagawa (2003), p. 33.

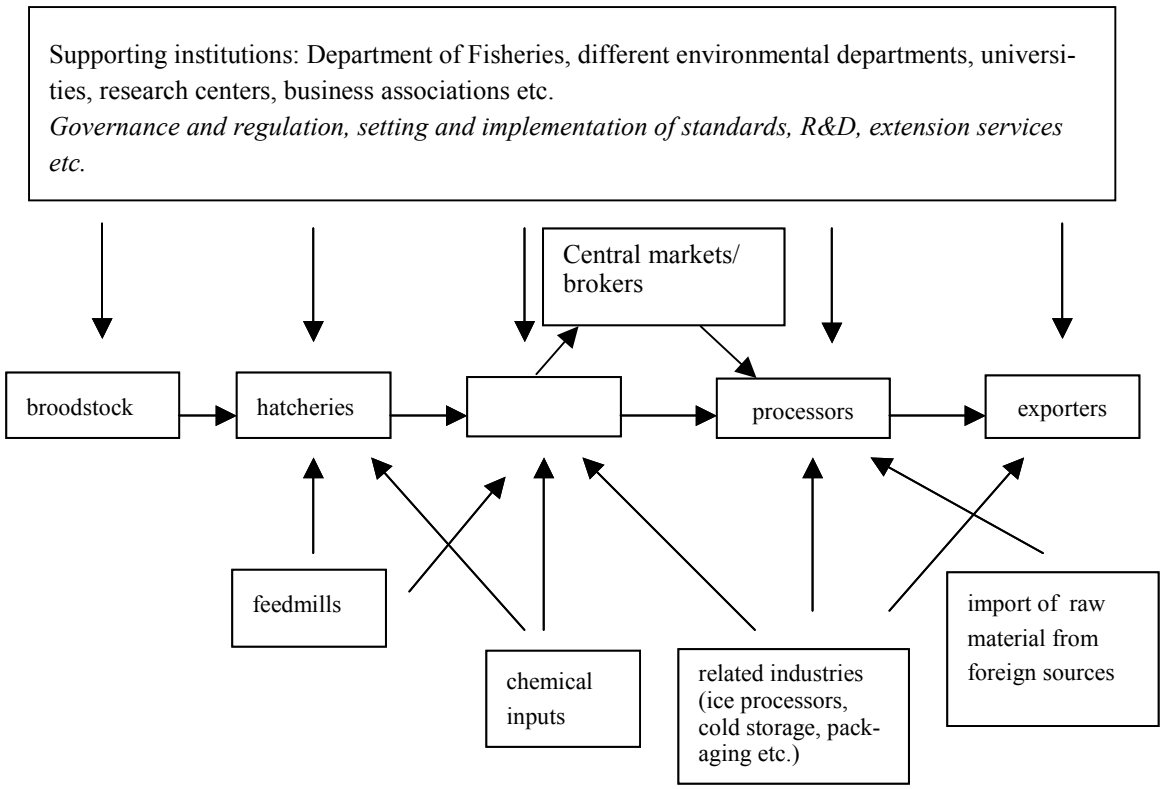
171 Flaherty / Vandergeest/ Miller (1999), p. 2050.

172 Lebel (2002), p. 317. 1 rai is the equivalent of 0.16 ha.

173 Kagawa (2003), p. 24.

174 For details see interview with Gold Coin.

Figure 5.2: Production chain of the Thai shrimp industry



Source: Own illustration

the outbreak of diseases. Feed and chemicals together account for the lion's share of production costs. At the same time, large companies which supply these inputs are the main providers of farming technology and also offer a variety of services such as seminars and water-testing services. The CP Group alone employs 400 consultants to provide advisory services.

— Whereas some farmers sell their shrimp yield to **brokers**, other deliver to the central wholesale market themselves. Still others sell to processors directly.

— At the **processing company**, shrimp are processed into raw and value-added product forms, such as sushi ebi and tempura.[175] Very often, processors are also exporters. 90 % of Thai shrimp production is exported. Thai processing companies also import shrimps, mainly from Japan, process them and reexport them to the Japanese market.[176]

— A large number of **institutions** have been created to promote and regulate shrimp-farming, represent shrimp farmers' interests, minimize ecological damage, conduct research, provide extension services, set and implement standards, etc. Among the most relevant research institutions are Kasetsart University, Mahidol University, the Shrimp Culture Research & Development Co., Ltd. (SCRD), the Center of Excellence for Shrimp Molecular Biology and Biotechnology (Centex), and the BIOTEC research program.

175 Kagawa (2003), p. 120.

176 Kagawa (2003), p. 122.

The main actor in the field of shrimp culture is the CP Group, a Thai-based agro-business transnational. In the mid-1980s, CP became the industry leader in the Thai shrimp sector. Since the mid-1990s, CP has been Thailand's largest transnational company, Asia's largest agro-industrial conglomerate,[177] and the world's largest shrimp feed producer, controlling 60-70 % of the world shrimp feed market. In Thailand, CP's operations range from feedmills, hatcheries and demonstration farms, laboratory testing and diagnostic services for shrimp farmers to shrimp-processing plants. Several extension centers equipped with laboratories and staffed with experienced biologists provide water-quality testing, disease diagnosis and seminars. Furthermore, CP is engaged in research activities regarding the domestication of broodstock, improvement of feed, and genetics.[178]

In developing and emerging economies, the dominance of an entire sector by national companies is rather unusual; the more common case is that TNCs from developed countries govern the value chain. Market leadership and control of technology packages by a nationally based company create a competitive advantage for Thailand as a business location. However, since the CP group runs operations not only in Thailand but also in Vietnam, China, India, Cambodia and Bangladesh, there is a risk that the company might shift important activities away from Thailand to these countries, e.g. because of relatively higher wages or disease problems at their Thai home base. To retain a competitive edge in Thailand,

Box 5.3: The farm-level economics of shrimp farming

The production process of intensive shrimp-culturing can be broken down into four stages: pond preparation, stocking, culturing and harvesting.

At the first stage, farmers drain the ponds and remove the wet mud by tractor or water jets. Dikes and drains are repaired, pond sediments are sterilized with lime. Preparations for the next production cycle can take up to one month.

The second stage comprises the stocking of shrimp larvae. For the Black Tiger Shrimp, a stocking rate of 69 animals/m^2 is common; and even densities as high as 100 animals/m^2 are not unusual. The major production method is intensive farming; in 2000 intensive farming methods accounted for 85 %, with semi-intensive farming methods accounting for 5.8 % and extensive farming methods for 9.2 %.[179] The average output of intensive farming is more than 600 kg/rai. In the economic and environmental management of farms, stocking density is considered as a key variable.

At the third stage, culturing, water management is a central element; it includes water exchange (on average 2.6 times per crop), feeding, aeration, and disease management. Almost 80 % of intensive shrimp farms use manufactured shrimp feed, only 20 % use fresh fishery products. The feed conversion ratio (FCR), defined as the ratio of the dry weight of the feed administered and the wet weight of biomass increase, is a further key variable. The average FCR attained is 1.7, i.e., 1.7 kg of feed produces 1 kg of shrimp biomass (ADB/NACA, 1995). Disease management includes treatment of ponds with chemicals or antibiotics.

The fourth stage, harvesting, usually takes place about 120-140 days after stocking. Usually the pond gate is covered with a net. while the water is let out of the pond.

In terms of production economics, the average size of a shrimp farm in Thailand is 3.6 ha. Typical yields of – commonly – two crops per year are between 5 to 9 tons per ha per crop.

Source: Patmasiriwat /Kuik/ Pednekar (1998), p. 13.

177 Goss /Burch/ Rickson (2000), p. 516.

178 Patmasiriwat /Kuik / Pednekar (1998), p. 11.

179 Kagawa (2003), p. 24.

policy-makers should seek to further increase the degree of national embeddedness of shrimp production, especially the more knowledge-intensive and value-adding stages of the value chain. As we shall see further on, this may require enhanced inter-firm co-operation, establishment of jointly agreed codes of conduct, closer ties with national research facilities, etc.

5.2.3 Challenges for shrimp-farming in Thailand

Favorable agro-climatic and economic conditions have contributed to Thailand's leading position in the world shrimp market. However, economic success is being achieved at high environmental costs. For some years, shrimp-farming was very profitable as environmental costs were easily externalized. Today, as diseases spread throughout the country and import countries ban shrimp treated with antibiotics, environmental problems have grown to such an extent that they challenge the viability of the sector itself. What follows is an overview of the main ecological problems related to shrimp-farming:

1. In the past, many shrimp ponds were established in mangrove areas and other wetland ecosystems. The destruction of these ecosystems has had major impacts.[180] Since mangroves are essential to protect coastal areas from erosion, storm damage and flooding, their destruction renders these areas much more susceptible to natural disasters. The *deforestation of mangroves* not only affects the ecological equilibrium, it has also far-reaching economic consequences for Thailand's seafood sector. Since two thirds of the fish caught for human consumption live in coastal mangrove ecosystems or depend on them as nursery areas for their larvae, construction of shrimp ponds in mangrove areas threatens many species of fish and other marine resources. Fishing is therefore becoming less and less profitable, and entire coastal communities which depend on fishing are impoverishing.[181] Thanks to overexploitation and the deforestation of mangroves, wild-caught Black Tiger broodstock has become extremely rare. Revenues from shrimp-farming decrease as broodstock caught from the sea becomes scarcer and smaller, a factor which reduces their economic value.

2. A further problem involved in shrimp cultivation is drainage of *wastewater* from shrimp ponds. Frequently the effluent, containing chemicals and feed residues, is directly discharged into irrigation canals, a practice which seriously affects the profitable usage of coastal land and adjacent paddies. The consequence is that infections very easily spread through wastewater to neighboring shrimp farms.

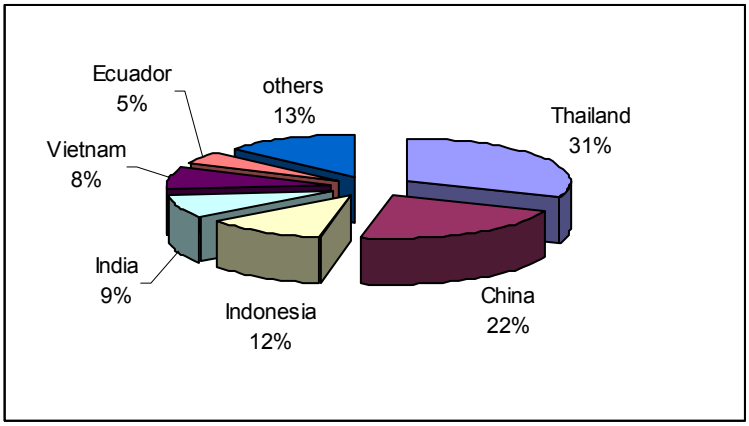
3. Apart from chemicals, groundwater and soil quality are affected by the *saline water* transported in enormous amounts to inland shrimp farms. Growing demand for shrimps is leading to an expansion of shrimp-farming from coastal areas to the inland, e.g. to the Central Plains (traditionally Thailand's 'rice bowl'). Numerous rice farmers have taken up the more lucrative, but also more risky, business of shrimp-farming. At the end of the 1990s, inland shrimp-farming accounted for between 40 % and 50 % of Thailand's total cultured shrimp production.[182] Since 1998 expansion of inland shrimp farms has been banned by the Thai government. However, existing farms are allowed to continue cultivation. Contamination of groundwater has led to declining yields and repeated crop failures. In the long run it even renders land unsuitable for cultivation.

180 Lebel (2002); Flaherty/ Vandergeest/ Miller (1999), pp. 2050 ff.

181 http://www.american.edu/TED/THAISHMP.HTM.

182 Flaherty/ Vandergeest/ Miller (1999), p. 2049.

Figure 5.3: Thailand's share of world shrimp production



Source: Institute for Management Education for Thailand Foundation

It has always been clear that ecological damage caused by shrimp-farming has economic repercussions for other activities, especially for the agricultural sector and inland and coastal fishery. In some cases, this has even led to serious conflicts with other user groups.[183] Today these unresolved environmental problems have reached a new dimension, and they threaten the viability of shrimp production itself. In a worst-case scenario, shrimp-farming might even collapse, as it did in Taiwan in 1988, as a result of an overly intensive shrimp production at high environmental costs.[184] Due to high stocking rates and discharge of wastewater into irrigation canals, diseases have spread throughout the whole country. Several viruses, e.g. white spot disease, have become a serious threat for shrimp cultivation, leading to frequent crop failures and substantial economic losses. Short-term solutions have focused on the heavy usage of a wide range of industrial chemicals, mainly antibiotics such as nitrofurane, to control diseases, aquatic vegetation, and to disinfect water. These chemicals not only have a negative impact on the quality of soil and water but also threaten exports as importing countries impose increasingly rigid conditions. In particular the European Union (EU) has recently introduced a zero-tolerance policy for antibiotic residues and rejected contaminated shrimp.[185]

This in turn affects Thailand's competitiveness in the world shrimp market. If Thailand does not succeed in establishing eco-efficient production, countries with fewer disease problems, better access to healthy broodstock and lower land and labor costs, such as China – with its world market share in shrimp production of 22 % – Indonesia (12 %), India (9 %), and Vietnam (8 %),[186] may challenge Thailand's leading position.

183 E.g. Vandergeest/ Flaherty/ Miller (1999); interview with Mr. Asea Sayaka, Director of the "Wetlands International" Thailand Programme, 4 April 2003.

184 Kagawa (2003), p. 23.

185 See *Bangkok Post*, March 28, 2003. Because of the small export share of Thai shrimp to the EU (only 5 %), the harm caused by EU's zero-tolerance policy to the Thai shrimp industry is yet not dramatic. More dramatic for Thailand is the pending threat that Japan and the USA, the main exporters of Thai shrimp, may follow the European example.

186 Institute for Management Education for Thailand Foundation (2002), p. 5.

5.2.4 Coping with the challenges and developing knowledge-based competitive advantages in the shrimp sector

To cope with the above-discussed environmental and economic challenges, knowledge-intensive innovations are called for at different levels. If Thailand manages to become a leader in eco-efficient farming systems, this will both minimize the environmental impact of shrimp-farming and increase its efficiency, thus offsetting price-based disadvantages. In eco-efficient farming systems pond management is optimized, chemical inputs are reduced, virus infections better controlled, saline and organically contaminated wastewater reduced, and overexploitation of marine resources avoided. In sum, the concept of eco-efficiency implies that the use of natural resources is optimized to reduce environmental damage, while at the same time the net revenue of a company or an economic sector increases.

To develop eco-efficient farming systems, it is necessary to intensify existing research cooperation between industry and science and enhance the regulatory capability of national institutions with a view to domesticating broodstock, strengthening disease control and genetic research, improving pond and wastewater management systems, reducing chemical usage, enforcing environmental regulations, promoting good cultivation practices, implementing standards and establishing a testing infrastructure and certification bodies. To further increase the competitiveness of the sector, Thailand should embark on development of high-end markets, such as for ready-to-eat products, delicacies, and organic markets. Value added can be augmented by developing brand names.

Improved pond and wastewater management

Pond and wastewater management refers to the removal of uneaten food and other waste products from a pond by exchanging its water. Improved water management systems, e.g. closed-water systems, treat wastewater in a sedimentation pond before releasing it into the drainage system, thereby reducing the detrimental impact of organic residues and chemicals on adjacent paddies and ecosystems.[187] Furthermore, construction of sufficient pumps and aerators is crucial to maintaining good water quality. Whereas in 1997 only a few farmers had an extra sedimentation pond in addition to their grow-out ponds (since this reduces production), our field survey has shown that this practice seems nowadays to be widespread.

A common problem in water management is overfeeding, a practice which reduces the efficiency of feed conversion and pollutes pond water. Water management is a very critical process, as some farmers do not change the water of their ponds as frequently as they should, because they are afraid that diseases might spread to their ponds with new water, which may be contaminated by neighboring farms.

Sustainable farming systems with lower stocking rates permit chemical inputs and feed materials to decompose faster and more easily, countering the spread of diseases. In combination with less intensive farming methods, ‘clean solutions’ such as closed-water systems with a focus on the treatment of wastewater should be promoted to reduce the detrimental impact of wastewater and chemicals on adjacent paddies. As we found during our empirical research, farmers have made positive experiences with less intensive farming systems. Most farmers reported that with lower stocking rates and less chemical input, they had lower outputs; but since this approach enabled them to cut expenditures and produce shrimp of larger size and economic value, their overall revenues had increased.

Shrimp producers obtain the major part of their technological “packages” from large feed and chemical companies. This includes know-how concerning the use of aerators and pumps, the use of chemicals, stocking rates, feed conversion etc.

187 For more information concerning sedimentation ponds, see Thongrak et al. (1997).

Obviously, these input-producing companies are interested in intensive farming systems with high inputs and high outputs. Nevertheless, it can be stated that awareness of the need for sustainable farming systems is rising, a fact manifest in an increasing number of farms with sedimentation ponds over the last few years. Further enforcement of regulations concerning sustainable pond and wastewater management, e.g. implementation of eco-efficient closed-water systems, would increase Thailand's competitive advantage in shrimp production.

Reduction of chemicals

Antibiotic residues in shrimp, mainly nitrofurane, have become a major consumer concern in industrialized countries. Although the use of most antibiotics had already been banned for food-producing animals in the EU, Thailand, the US, and Canada several years ago,[188] the ban was extended to a zero-tolerance policy by the European Union in April 2003. The zero-tolerance policy means that at the European borders batches of frozen shrimp are checked even for metabolites, which are products of the decomposition of antibiotics. Consequently, the export of Thai shrimp to the European Union is expected to decrease significantly.[189]

Although awareness has increased considerably, the use of antibiotics is still widespread among shrimp farmers. The search for less intensive but still economically viable farming methods is being hampered by feed and chemical firms, which are the main source of information for farmers but are interested in maximizing inputs, such as feed and chemicals.

Given these particularist interests of the feed and chemical corporations and their prominent role as advisers to shrimp farmers, the public sector should become more active in the promotion of less intensive farming methods, e.g. by supporting research on its viability, providing testing services or exploring market opportunities for organically grown shrimp. This would reduce the dependence of shrimp farmers on a small number of private corporations. Moreover, successful initiatives to trace residues back to the producers, e.g. on the basis of movement documents, should be further promoted.

Enforcement of land-use and related environmental regulations

The effective enforcement of land-use and related environmental regulations is often problematic, because the same government agencies are responsible for in part contradictory tasks, e.g. enforcement of environmental policy on the one hand and industrialization and export promotion on the other hand.[190] Adding to this complexity is the fact that shrimp culture is affected by a large number of laws and regulations including land laws, water laws, environmental laws, fishing laws etc. To ensure that government regulations are enforced, it will be necessary to improve the coordination of departments in charge of different issues related to shrimp production needs.

Several regulations have been successfully implemented, e.g. expansion of inland shrimp-farming was banned in 1998, because it increases salinity levels in soil and groundwater, and this has led to a considerable reduction of inland shrimp-farming. Other regulations, e.g. concerning the drainage of saltwater into public freshwater systems or farming areas,[191] and further deforestation of mangroves have not been fully enforced. It appears that visible aspects, e.g. sedimentation ponds and the ban on inland shrimp-farming have by and large been enforced, whereas regulations concerning the reduction of antibiot-

188 http://www.deltha.ece.eu./int/en/news_2002/chloramphenicol_in_shrimps.htm.

189 Bangkok Post, March 28, 2003.

190 Flaherty / Vandergeest / Miller (1999), p. 2053, refer to Kaosa-ard et al. (1995).

191 Which was announced by the Department of Fisheries in 1999.

ics, regulation of discharge of effluents are more difficult to put into effect.

Promotion of good cultivation practices

Taking into account that many thousand of farms throughout the whole country are engaged in shrimp-farming, trying to enforce command-and-control mechanisms for environmental protection would far exceed the capacities of Thailand's public administration. It is therefore necessary to complement government regulation on by means of industry self-regulation based on standards and codes of conduct. Such standards not only contribute to internalizing environmental costs of shrimp farming, but they are also an important means of regaining consumer confidence, differentiating the market and thus increasing the competitiveness of the shrimp sector. If seafood companies are to gain access to international markets and also to maintain their competitiveness, they are going to have to comply with international quality standards in the global market.

Several standards have already been introduced, but none of them has gained sufficient outreach and impact to solve the problems mentioned above:

— The *Hazard Analysis and Critical Control Point System* (HACCP) is an international hygiene standard for food processing and was implemented in the Thai shrimp production sector in the late 1990s.[192] HACCP determines critical control points (CCP) in the production process and establishes critical limits as well as corrective actions for each CCP. HACCP is applied to control different stages of production, such as sanitation and manufacturing practices, including phytosanitary or pesticide residue requirements.[193] It sets standard practices for plant staff to avoid hazards and establishes rules to monitor and audit these practices, e.g. by establishing quality control laboratories which test bacteria levels. Introduction of the HACCP code in the Thai shrimp sector has improved hygiene standards. It requires some governance of the supply chain, e.g. in contract farming arrangements, and HACCP standards are required and enforced.[194]

— The *Code of Conduct* (CoC) for shrimp-farming provides guidelines for the development of voluntary management systems to reduce negative social and environmental impacts. It comprises systems for impact identification, formulation of standards, identification of indicators etc.[195] The program was initiated by the Department of Fisheries in 1999. So far only approximately 2,000 hatcheries and farms have been certified.[196]

— The *Good Aquacultural Practises* (GAP) comprise regulations concerning internal farm management, such as appropriate area use, buildings and structure, water quality for shrimp culture and consumption. In addition, certain standards concerning culture methods, culture periods, feed quantity, water transfer volume etc. are required as well. Since the GAP requirements are not as rigid as the CoC requirements, e.g. controls for chemicals are not necessary,[197] GAP is considered as a first step towards the CoC.

— *Green labels* for "organic" markets are more demanding than any other standard. The market share of certified "organic" shrimps is still very small, but it has been rising constantly over the last few years because of the increasing influence of the green consumerism movement. Cultivation of shrimp under ecologically sound conditions is thus becoming a promising option. Developing technological

192 Unnevehr/Jensen (1999), p. 626.

193 Gibbon (2001), p. 101.

194 See Patmasiriwat/ Kuik/ Pednekar (1998).

195 Consortium Program of WB, NACA, WWF, FAO (2002).

196 For further information about the Code of Conduct see www.thaiqualityshrimp.com.

197 See Interview with Dr. Waraporn Prompoj, Department of Fisheries.

solutions for this "organic" high-end market may be a profitable and knowledge-based niche market for Thai producers. In Ecuador, for example, a GTZ project in cooperation with the German organic food producer *Naturland* fosters ecologically sound production systems.

So far, self-regulation by the shrimp industry has not been very effective. In the case of HACCP, and even though shrimp processing plants and exporters are certified, the system still fails to ensure that no banned antibiotics are used upstream in the value chain, and contaminated batches cannot always be traced back to the farm of origin. The CoC is neither compulsory nor has the government succeeded in developing a premium market for certified CoC shrimp. Without such a label the code provides no economic benefits to participating farmers, which explains the rather low number of certified farms. Recently, the hyper-market chain Carrefour has shown interest in promoting a CoC label for shrimp. The CoC will only gain general acceptance among farmers if such initiatives on the marketing side prove to be successful. Ecological labels such as the German Bioland or the Japanese alter trade also aim at developing high-end markets, but introduction of organic shrimp-farming is still in its very beginnings. If CoC and ecological labels are to gain consumer confidence, it will be to establish certification bodies and a transparent tracking and tracing system along the whole value chain to enable authorities to trace a batch of shrimp back to the producer.

Industry-science relations in the shrimp sector: Domestication of broodstock, disease control and genetic research

For many of the above-mentioned problems of Thailand's shrimp aquaculture, technological solutions still have to be developed, and these in some cases require a considerable research effort. Among the most pressing research issues are

— domestication of broodstock, because sea-caught broodstock is becoming increasingly rare and therefore threatens the survival of the whole industry; in addition, only domesticated broodstock can guarantee disease-free parent generations,

— detection and treatment of diseases,

— genetic improvement; and

— secure and efficient pond management techniques, including the development of low-salinity culture techniques.

Several universities[198] and the Department of Fisheries have placed emphasis on shrimp research, and BIOTEC funds a special Shrimp Biotechnology Program, reflecting a national research priority in this sector. Furthermore, several private-sector companies, like CP and the Belgian INVE corporation, are highly committed to shrimp-related R&D. In some cases, concerted efforts are undertaken to advance research. The Center of Excellence for Shrimp Molecular Biology and Biotechnology (CENTEX), for instance, is a joint research center of Mahidol University and BIOTEC which has close research contacts with the CP group. In addition, the Shrimp Culture Research & Development Co., Ltd. (SCRD) has been set up as a public-private cooperation project aimed at the domestication of broodstock. Much of public research is directed towards the achievement of eco-efficiency. CENTEX, for example, has set the goal of achieving „healthy & healthful, domesticated shrimp cultivated in biosecure ponds with no negative environmental impact" by 2007.

All in all, shrimp aquaculture is one of the most prominent examples in Thailand of how research and technology institutes can pool resources and cooperate with the private sector to create knowledge-based competitive advantages. Research is being conducted to address the main challenges facing the sector, and linkages between science and industry are intense, compared to the electronics sector.

198 E.g. Chulalongkom University; Mahidol University, Kasetsart University, Prince of Songkhla University.

Increasing value added of shrimp exports

As an additional measure aimed at enhancing its competitiveness in the world market, Thailand should increase the value added of its shrimp exports by focusing on its advantages in the processing business, e.g. its knowledge of export markets and the specific processing skills and techniques that are required especially by the Japanese market.[199] Product diversification includes high-value processed foods, e.g. microwave (ready-to-eat), "eco-shrimp" and sushi, as well as sophisticated packaging for demanding customers. In addition to product diversification, diversification of business, such as customized processing, is a strategy that can be used to increase value added in the shrimp sector. Some processing companies in Thailand already import frozen shrimp from all over the world, e.g. from Norway, and process it for export markets. Several Thai companies have developed own brand names for export, another measure adding value to the product. The government initiative to promote Thailand as a "kitchen of the world" may help to tap into international high-end markets.

5.2.5 Conclusions

In sum, even though Thailand has progressed significantly in handling the economic and environmental problems of the sector, much still needs to be done. Above all, what seems to be lacking is a shared vision of the future of Thailand's shrimp industry as well as policy coordination. A shared vision needs to be developed with the participation of all the relevant stakeholders of the private and public sector (including those indirectly affected by shrimp-farming, such as fishermen, rice farmers, and environmentalists) and focus on the promotion of the above-discussed issues concerning eco-efficiency and the development of high-end markets. Research priorities, codes of conduct, market differentiation and marketing strategies etc., should be derived from such an integrated perspective.

199 Kagawa (2003), p. 83.

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Annex 1: List of interview partners

Firm/ institution	Interview partner	Date
1. AMD (Thailand) Ltd.	Mr. Yuthana Hemungkorn, Managing Director	31.03.03
2. Aquatic Animal Health Research Center	Dr. Kidchakan Supamattaya, Associate Professor	04.04.03
3. Asian Institute of Technology (AIT)	Prof. Huynh Ngoc Phien, Dean, School of Advanced Technologies	24.03.03
	Dr. Nitin Afzulpurkar, Associate Professor, Industrial Systems Engineering & Microelectronics Program; Coordinator Industrial Systems Engineering Program	24.03.03
	Mr. Khosak Achawakorn, Lab Supervisor, School of Advanced Technologies	13.03.03
	Dr. Voratas Kachitvichyanukul, Associate Professor	13.03.03
4. Association of Electronics and Computer Employers Association (ECEA)	Mr. Yuthana Hemungkorn, Chairman	31.03.03
5. National Center for Genetic Engineering and Biotechnology (BIOTEC)	Dr. Sakarindr Bhumiratana, Senior Specialist	20.03.03
6. Black Tiger Shrimp Association	Mr. Somsak Paneetatyasai, Trade Advisor	04.04.03
7. Board of Investment (BOI)	Dr. Wisan Tanthawichian, Head, BOI Unit for Industrial Linkage Development (BUILD)	05.03.03
8. Brilliant Shine Co. Ltd.	Mr. Korakot, General Manager	01.04.03
9. Brooker Policy Research Co. Ltd.	Dr. Peter Brimble, President	12.03.03
10. Bureau of Supporting Industries Development (BSID)	Ms. Uraiwan Chandrayu, Director, Subcontracting Promotion Division	06.03.03
	Mr. Chotiwutti Innada, Industrial Engineer	14.03.03
11. Center of Excellence for Shrimp Molecular Biology and Biotechnology (CENTEX)	Prof. Dr. Timothy W. Flegel	26.03.03
12. Chiang Mai University	Dr. Louis Lebel, Researcher and Science Coordinator, START Program	23.03.03
13. Chulalongkorn University	Dr. Naiyavudh Wongkomet, Department of Electrical Engineering	01.04.03
14. Consultant	Dr. Martin Godau, Senior Consultant	28.02.03
15. Department of Fisheries	Dr. Waraporn Prompoj	29.04.03
	Dr. Pornlerd Chanratchakool, Fish Pathologist	11.03.03
16. Department of Industrial Promotion (DIP): Industrial Promotion Center Region 1	Mr. Wanchai Radchadamat, Director	17.03.03
17. Electrical and Electronic Institute (EEI),	Mr. Charuek Hengrasmee, President	06.03.03
	Dr. Kovit Masarat, Div. Director, Technique/Standards and Marketing	06.03.03
	Mr. Kanis Muangsir, Manager (Acting), Marketing Department, Operation and Standard Center	28.03.03

18. Federation of Thai Industries (FTI), Electrical, Electronics and Allied Industry Club	Dr. Katiya Greigarn, Vice Chairman Ms. Yupaporn Tantijitaree, Office Manager	14.03.03
19. GemCity Engineering Co. Ltd.	Mr. James W. Gibson, Managing Director	28.04.03
20. German-Thai Chamber of Commerce (GTCC)	Mr. Stefan Buerkle, Chief of Business Economics and Advisory Division	11.03.03
21. Gesellschaft für Technische Zusammenarbeit (GTZ)	Mr. Juergen Koch, Program Director Mr. Peter Bolster, Project Manager Ms. Ricarda Meissner, Head of Advisory Team, SSIPP Project	25.02.03 19.02.03 27.02.03
22. Gold Coin Specialties (Thailand) Co. Ltd.	Mr. Wuttichai Phichaiyut, Chemist, Q.C. Manager	12.03.03
23. Green Net	Mr. Vitoon, General Secretary	10.03.03
24. Innovation Development Fund (IDF)	Dr. rer. nat. Wantanee Chongkum, Assistant Director Mr. Supachai Loriowhakarn, Director	13.03.03
25. Intronics	Mr. Chaiyasit Thampeera, Owner Mr. Viravat, Sirayobhas, Managing Director	13.03.03
26. King Mongkut's Institute of Technology Ladkrabang (KMIT-L)	Mr. Apinetr Unakul, Computer Engineering Assistant Professor; Embedded Systems Lab, Research Director	05.03.03
27. King Mongkut Institute of Technology – North Bangkok (KMIT-NB)	Prof. Helmut Maier Mr. Sinchai, Department of Engineering	04.03.03
28. King Mongkut University of Technology – Thonburi (KMUT-T)	Dr. Djitt Laowattana, Director of Institute of Field Robotics (FIBO) Dr. Thavida Maneewarn, Research Scientist, FIBO	20.03.03
29. Lanna Agro Industry Co. Ltd.	Mr. Chotiroj Wongwan, Managing Director	19.03.03
30. Leo Foods Co. Ltd.	Mr. Worasin Kuttiya, Assistant Managing Director	18.03.03
31. Mangrove Action Project (MAP)	Mr. Jim Enright, South East Asia Coordinator	13.03.03
32. Material Properties Analysis and Development Centre (MPAD)	Dr. Sutiporn Chewasatn, Director	05.03.03
33. Ministry of Science and Technology (MOST)	Mr. Alonkorn Laow-Ngam, Director, Strategy Development Section Ms. Kobkeao Akarakupt, Director, Office of Policy and Strategy	29.04.03
34. Ministry of University Affairs	Dr. Sumate (Senior Advisor & Specialist for Policy and Planning)	02.04.03
35. National Economic and Social Development Board (NESDB)	Mr. Wanida Pichalai, Director, Industry Division Mr. Panithan Yamvinij, Director, Competitiveness Development Office	13.03.03 13.03.03
36. National Electronics and Computer Technology Center (NECTEC)	Dr. Thaweesak Koanantakool, Director Dr. Suthee Phoojaruenchanachai, Researcher Mr. Chumnarn Punyasai, Researcher, IC Design Section	02.04.03 07.03.03 07.03.03

37. National Food Institute (NFI)	Dr. Amorn Ngammongkolrat, Director, Technological Service Department Dr. Jocelyn O. Naewbanij, Director, Department of Information Services	25.03.03 25.03.03
38. National Metal and Materials Technology Center (MTEC)	Dr. Paritud Bhandhubanyong, Director	05.03.03
39. National Science and Technology Agency (NSTDA)	Prof. Dr. Chatchanat Thebtaranonth, Vice President Dr. Chatri Sripaipan, Vice President Dr. Patarapong Intarakumnerd, Policy Research	02.04.03 02.04.03 25.02.03
40. National Thai Co. Ltd.	Ms. Chanphorn Phisanbut, Executive Director	26.03.03
41. Network of Aquaculture Centers in Asia-Pacific (NACA)	Mr. Hassanai Kongkeo, Special Advisor Mr. Jesper Clausen, Research Assistant	11.03.03 11.03.03
42. New Entrepreneurship Creation (NEC)	Ms. Petcharee Vajirakachorn	02.04.03
43. Nithifood Co. Ltd.	Mr. Surapol Thaveelertnithi	18.03.03
44. North Bangkok Innovation Cluster (NBIC) / Thailand Science Park	Dr. Sutham Vanichseni, Faculty of Engineering, Chulalongkorn University	28.03.03
45. Office of Industrial Economics (OIE)	Mr. Damri Sukhotanang, Director General	13.03.03
46. Office of SME Promotion (OSMEP)	Mr. Pak Tongsom, Director, Research and Planning Department Ms. Pairin Yamchinda, Chief, SMEs Promotion Policy and Planning Section	05.03.03 05.03.03
47. Pollution Control Department (PCD)	Dr. Wijarn Simachaya, Director, Inland Water Branch; Director, Center for Environmental Modeling and Risk Assessment	24.03.03
48. Prince of Songkla University	Dr. Wutiporn Phromkunthong, Associate Professor, Aquatic Science Research Center	13.03.03
49. Read Rite (Thailand) Co. Ltd.	Mr. Tawan Suppapunt, Vice President Mr. Chakkrit, Development Director	28.04.03
50. RWTH Aachen	Prof. Dr.-Ing. Rolf H. Jansen, Project Chair, Dean of EE & IT Faculty; New Thai-German Graduate School of Engineering	29.03.03
51. Shrimp Culture Research Center (SCRD)	Dr. Boonsirm Withyachumnarnkul	28.03.03
52. Siemens	Dr. Ockert van Zyl, President and Chief Executive Officer	27.03.03
53. Software Park Thailand (NSTDA)	Dr. Rom Hirnpruk, Director	21.03.03
54. Subcontracting Promotion Club (SPC)	Mr. Pattanasak, Vice President Mr. Lersak Nuangjhamnong	24.04.03 30.04.03
55. THACOM, Thai Compressor Manufacturing Co., Ltd.	Mr. Arnon Simakulthorn, Executive Chairman	03.04.03
56. Thai Development Research Institute (TDRI)	Dr. Somkiat Tangkitvanich, Research Director (Information Economy), Science and Technology Development Program	26.02.03
57. Thai Energy Conservation Co. Ltd.	Ms Korapin Intarawicha, Production and Operations Manager	03.04.03
58. Thai Frozen Food Association (TFFA)	Ms. Chinda Chongkamanont, Vice President Mr. Lers Thisayakorn, Secretary General	27.03.03

59. Thai-German Institute (TGI)	Mr. Walter Kretschmar, German Director of TGI Dr. Michael Grosse, SMEs Development Project	25.03.03 25.03.03
60. Thai Industrial Standard Institute (TISI)	Representatives of several departments	26.03.03
61. Thailand Institute of Scientific and Technological Research (TISTR)	Ms. Sumalai Srikumlaithong, Senior Expert Ms. Dr. Nittaya	04.03.03
62. Thai Research Fund (TRF)	Dr. Suteera Prasertsan, Director of the Industry Division	21.03.03
63. Thaitel Engineering Co. Ltd.	Mr. Kritpaisit, General Manager	31.03.03
64. Thai Union Seafood Co. Ltd.	Ms. Matana Maka-apirak, General Manager	12.03.03
65. Trang Seafood Products Public Co. Ltd.	Mr. Boonchu Saisakphong, Audit Director	13.03.03
66. United Nations Industrial Development Organization (UNIDO)	Mr. Nguyen Khac Tiep, Technical Advisor	10.03.03
67. Vanusnun Co. Ltd.	Mr. Chadcharn, Managing Director	17.03.03
68. V&P Freshfoods Co. Ltd .	Mr. Yongyut Chobtamdee, General Manager	17.03.03
69. Wetlands International – Thailand Programme (NGO)	Mr. Asea Sayaka, Director	04.04.03

In addition, interviews were conducted with approx. 30 shrimp farmers, owners of hatcheries, and processors.

Annex 2

Thailand: Key Economic Ratios

	1980	1990	1999	2000
GDP (US$ billion)	32.4	85.3	122.1	121.9
Average annual growth	1980-90	1990-2000	1999	2000
GDP	7.6	4.2	4.2	4.3
GDP per capita	5.7	3.3	3.4	3.5
Exports of goods and services	14.1	9.5	9.9	15.4
Structure of the economy (% of GDP)	1980	1990	1999	2000
Agriculture	23.2	12.5	11.2	10.5
Industry	28.7	37.2	39.3	40.1
Manufacturing	*21.5*	*27.2*	*31.1*	*31.9*
Services	48.1	50.3	49.5	49.4
Average annual growth	1980-90	1990-2000	1999	2000
Agriculture	3.9	2.1	2.6	2.2
Industry	9.8	5.3	9.8	5.1
Manufacturing	*9.5*	*6.4*	*11.9*	*5.9*
Services	7.3	3.7	-0.1	4.1
TRADE	1980	1990	1999	2000
Total exports in US$ million	6,449	22,881	58,549	67,942
Manufactures	..	*16,588*	*49,339*	*59,766*

Source: Thailand at a glance, World Bank Thailand Office, 9/07/01, http://www.worldbank.org/data/countrydata/aag/tha_aag.pdf

Financial Incentives for R&D and innovation activities in Thailand

Scheme		*Objective*	*Mechanism*	*Target*
BOI promotion for R&D activities	Promotion of R&D as: R&D activities already included in a promoted investment project R&D as an addition to an already promoted investment project Activities separate from firm's other business activities	Promote firm-based R&D	Tax concessions	Firm located in any zone involved with R&D activities
Depreciation allowances for machinery and equipment for R&D	Depreciation rate of 40%	Encourage firm-based R&D	Tax concessions	Firms engaged with R&D
200 % tax concessions	200% deduction for R&D expenditure	Encourage firm-based R&D	Tax concessions	Firms conducting R&D or hired to do R&D. They must be approved by MOF. NSTDA is the certifying body.
Deduction or exemption from R&D machinery import duties		Encourage technology acquisition	Tax concessions	Firms importing specific types of machinery: esp. Scientific tools, R&D testing equipment, electronics parts and computer parts
Research and Technology Development Fund (MOSTE)	R&D soft loans of 10-20 million bahts per project	Soft loans to improve and develop production processes and invest in R&D results	Loans	General
Company Directed Technology Development Program		Assist SMEs to invest in technology development	Loans and grants	SMEs
Innovation Development Fund	Grants and soft loans for business innovation and start-ups	Grants and soft loans for strategic projects	Grants and loans	General

Financial Incentives for R&D and innovation activities in Thailand (continued)				
Scheme		*Objective*	*Mechanism*	*Target*
Thai Research Fund R&D Grants	Science and technology for production, marketing and services Industrial R&D for production processes and product development	Raising levels of R&D to develop processes and products	Grant	SMEs
MOI Productivity Improvement Plan	Soft loans for improving productivity and upgrading machinery	Improving firms' machinery and productivity	Loans	SMEs
NSTDA Industrial Consultancy Services	Provides up to 75% of consultancy costs	Enhancing production capability in SMEs through the use of consultants	Subsidies	SMEs
Support for Technology Acquisition and Mastery Program (STAMP)	Financial support and arrangement of factory visits (abroad)	Support for technology acquisition	Subsidies	SMEs
BOI Unit for Industrial Linkages Development		Improving linkages between manufacturers and local suppliers		
Skills development: 150 % tax concession for training expenditure		Encouraging private sector to invest in training	Levies	Firms that do not conduct training themselves

Source: Turpin (2002)