Alexander Degelsegger, Florian Gruber, Svend Otto Remøe, Rudie Trienes (Eds.)

# Spotlight on: Stimulating innovation in Southeast Asia

SEA-EU-NET
partners in science

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Published by
Centre for Social Innovation (ZSI)
Linke Wienzeile 246
1150 Wien
Austria
www.zsi.at

www.sea-eu.net



Date of publication: August 2014
First edition,
250 copies



This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 311784.

Graphic design: Harald Göstl

ISBN 978-3-200-03710-6

Printed in Austria

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# Foreword

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The present study analyses the variety of innovation policies and support structures in a number of Southeast Asian countries. It provides information to policy makers, especially in the context of the ASEAN-EU Dialogue on Science, Technology and Innovation which takes place every year between senior officials. The study could also help the development of the next ASEAN *Plan of Action on Science, Technology and Innovation* and initiatives like the ASEAN Innovation Fund.

The SEA-EU-NET 2 project that supported the present work is a European Union initiative to engage cooperation in Research and Innovation with the Southeast Asian region. It enables the exchange of experiences and best practices at a time when, on the one hand, the Member States of the Association of Southeast Asian Nations are progressing towards the next phase of the ASEAN Economic Community at the end of 2015, and on the other, Europe has launched *Horizon 2020,* the new European Framework Programme for Research and Innovation. Seeking synergies between initiatives on both sides and ensuring that framework conditions for Research and Innovation are favourable to cooperation will further reinforce the EU-ASEAN relationship.

On behalf of the ASEAN Secretariat and the European Commission, we would like to express our appreciation for the work of the experts who contributed to this study.

# Introduction

Research and innovation have become salient features in policy-making in Southeast Asia and the region is increasingly being perceived as a knowledge hub. Southeast Asian countries are no longer merely considered low-cost production or assembly economies and destinations for foreign direct investment in labour-intensive industries, but are increasingly seen as innovative production centres. Moreover, it has become clear that Southeast Asia, with both its human and natural resources, can play an important role in solving some of the world's most challenging problems.

Recent studies on Southeast Asian innovation systems reflect this change in perception. For instance, the Organisation for Economic Co-operation and Development (OECD) recently finished its *Review of Innovation in Southeast Asia* (2013).[1] Related national-level studies and initiatives by other bodies like the World Bank are underway. Building on existing studies analysing Southeast Asian innovation systems from a macro perspective, this report focuses on the policy and programme side of science, technology and innovation (STI) support within the countries of Southeast Asia. It looks at the manifold ways in which public and private actors in the region support innovation.

To set the scene, the first part of the report provides the regional context, looking at economic data on trade and foreign direct investment. Evidence shows that the region is an attractive destination for investments, still mostly coming from outside the region. With an increasing number of free trade agreements in place and the prospects of the Association of Southeast Asian Nations (ASEAN) Economic Community, potential for trade is substantial.

[1] Several of the expert authors of the present report as well as from the SEA-EU-NET project in general supported the OECD study.





The regional overview chapter then narrows down its perspective to focus on STI related aspects, such as data on publications and patents, where a growth in research output can be observed. The overview continues with a regional comparison of STI policies and support programs and discusses the organisations that are responsible for the implementation of these programmes. It also showcases some common challenges for the countries of the region, like limited research investments, institutional path dependencies and a challenging policy environment. The third and final part of the overview deals with ASEAN-level integration as well as the innovation-relevant intra-regional and international linkages of the region. It presents recent regional policy developments like the Krabi Initiative and the development of a new ASEAN *Plan of Action on Science, Technology and Innovation*. Moreover, it touches upon such questions as the right level of integration and joint action in research as well as the most beneficial way to organise relations with partner countries.

The regional overview chapter is followed by country chapters, each following a similar structure: First, economic and business environment indicators are presented and the landscape of research performing actors is introduced. Secondly, the country's specificities in terms of STI governance and policy are outlined. The third and core part of each country chapter presents public innovation support programmes, indirect incentives and information on available investment support, venture capital and intellectual property protection. After an overview of international cooperation linkages, each chapter closes with the authors' interpretations of key strengths and weaknesses.

This common structure was chosen in order to make the data and findings comparable. The report should be read as a compendium of state-of-the-art innovation support systems (policies and selected programmes and instruments) in the region. In the country chapters, it becomes clear that most countries have an official innovation policy in place with strongly varying room for manoeuvre regarding resources for implementation and public support. The landscape of research programmes as well as direct and indirect innovation support measures is broad. Limitations, for the most part, do not arise due to the absence of specific programme types, but from the limited financial resources for these programmes and the sometimes lacking sustained political commitment from the programme implementing agencies.

The six countries selected by the SEA-EU-NET 2 project to be covered in this study are: Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. This selection results from the participation of the countries in the SEA-EU-NET 2 project; country support offered for the study; as well as, to some degree, economic and scientific clout. While the structure of each country chapter is similar, the depth of information and analyses provided varies according to data availability.

The methodology of the study can be briefly summarised as follows. The report is based on:

- desk research of existing studies and official data and statistics;
- data collected during a fact-finding mission of the SEA-EU-NET 2 analysis team in 2013, where European together with Southeast Asian project partners visited the countries covered; and
- information gathered at ASEAN-level events.

The fact-finding mission was organised in a cost-effective way with, as far as possible, European and Southeast Asian experts from the project visiting around 10–15 different stakeholders in each country for in-depth, semi-structured expert interviews. The interview guidelines were developed by the analysis team and provided to the interviewees in advance whenever requested.

The draft chapters were discussed with selected country innovation system experts and the wider public during the ASEAN-EU STI Days in Bangkok in January 2014. Feedback from the national-level interviewees during the fact-finding mission has kindly been provided. The entire team wants to thank the interlocutors for their time, interview inputs and comments.

This report was written by the analysis team of SEA-EU-NET 2, a project funded by the European Commission to support STI cooperation between Europe and Southeast Asia.

**The SEA-EU-NET 2 project**

The SEA-EU-NET 2 project (www.sea-eu.net) is a European Union supported four-year initiative to assist and encourage research cooperation between Southeast Asia and Europe as well as related policy dialogue. SEA-EU-NET 2 builds upon and leverages strong European–Southeast Asian science and technology (S&T) relationships, developed through past support and coordination actions, deepening engagement and building momentum in S&T cooperation. It broadens the scope of Europe–Southeast Asia cooperation by stimulating sustainable innovation collaborations. To ensure maximum value, SEA-EU-NET 2 focuses on three societal challenges: 1) health; 2) food security and safety; and 3) water management. This is where the greatest opportunities can be leveraged from joint European–Southeast Asian research.

SEA-EU-NET 2 serves as a platform for all stakeholders across governments, funders, practitioners, and the private sector, to ensure a complete and integrated approach to developing sustainable STI collaboration, in aid of jointly tackling societal challenges. The consortium's composition and responsibilities are balanced between European and Southeast Asian partners to ensure equal input and direction from both regions in all areas.

# Regional overview

Svend Otto Remøe[1], Rudie Trienes[2], Florian Gruber[3]

## 1 Bird's-eye view of economy and innovation in ASEAN

### 1.1 Economic situation

The economic situation in Southeast Asia has been developing rapidly over the past few decades. Compared to other world regions, it has made significant advances in terms of output, productivity and human capital, and has grown from a mostly low to an increasingly higher-income cluster of countries. The economies of Southeast Asia have become increasingly interconnected as well as integrated into regional and global production and knowledge networks and have advanced their position in global production chains. Science and technology have gained a central place in policy planning within these countries, signifying its important role in innovation and economic advancement. This focus on science, technology and innovation (STI) is seen as crucial in tackling future grand societal challenges, e.g. those connected to climate and demographic changes and the consequences of environmental degradation.

Even though the countries of the region are still socially, culturally and economically quite diverse, the regional economic integration spearheaded by the Association of Southeast Asian Nations (ASEAN) is advancing rapidly, with the possibility of a further integrated regional community on the horizon.

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#### Economic growth in ASEAN

From 1960 onwards, an initial group of Asian countries emerged as economic powerhouses – later known as the Asian Tigers. Among them was the small city-state of Singapore, which became a role model for the second generation of Asian Tigers – Indonesia, Malaysia, Thailand and, to a lesser degree, the Philippines.

These countries had comparable preconditions – economies based mainly on exploitation of resources with little prior industrialisation. Trade was often based on formal and informal networks that have been in place for centuries. By implementing structural reforms these countries could emulate the export growth models of the first generation of Asian Tigers, with an emphasis on manufacturing as an engine of growth and development.

Other Southeast Asian countries such as Vietnam, Cambodia, Lao People's Democratic Republic (PDR) and Myanmar are beginning to adopt similar reforms. However, apart from the quick initial economic gains from being integrated into regional and global economic networks and production chains, these countries still have big growth potential in terms of upgrading their technological and industrial capabilities.

These efforts to catch up with more developed countries were set back by the 1997–1998 Asian financial crisis and the more recent crisis originating in the United States of America (USA) and Europe, with subsequent increased efforts being necessary to close the development gap. Table 1 gives an overview of geographic, demographic and economic indicators.

In terms of economic wealth per capita, the two high-income countries are Singapore and Brunei Darussalam, with Singapore being the region's most important financial and logistical hub. Brunei Darussalam gains major revenues from the extraction of oil. The higher middle-income group encompasses Malaysia and Thailand, the former also benefiting from natural oil resources. The lower middle-income countries are Indonesia, the Philippines and Vietnam. Myanmar and Cambodia are low-income countries, while Lao PDR is in between.

In terms of labour productivity, Singapore is most productive, being a leader in this field in the whole Asian region (International Labour Organization 2013). The other countries have more modest levels of labour productivity, even though Malaysia has made significant progress in recent times. In descending order it is followed by Thailand, with Indonesia, the Philippines and Vietnam rather low in comparison.

Illicit capital flows are a big problem in the region, as shown in a recent study (Kar, Freitas 2012) which stated that Asia was still the main source of these money flows, coming out of developing countries. In fact three of the ten countries with the largest illicit outflows are located in Southeast Asia: Malaysia, the Philippines and Indonesia. Corruption is being combated but is still a problem. Another challenge is the size of the informal economy which in many of these countries is rather large. This leads to an underestimation of the total economic activity and negatively affects public tax revenues.

#### Trade in ASEAN

As Southeast Asia is nowadays strongly connected to global economic networks, the economic prospects of the region are strongly related to developments in the world, especially those affecting major trade partners. The countries of Southeast Asia are quite open to foreign trade, which in the past accounted for a significant share of economic success. However, the partner structure within the global value chains has changed, with Japan and the USA declining in importance and China emerging as the dominant destination of intermediary goods exports from Southeast Asia.

Being a regional logistical hub, Singapore accounts for roughly a third of the whole of imports and exports of the region in terms of volume (OECD 2013). Half of the total is shared by Indonesia, Malaysia and Thailand.

The catching up process of Southeast Asian countries has been heavily financed by foreign direct investment (FDI). This, however, will also be a pivotal challenge in the future – i.e. remaining attractive to foreign investors in a competitive global environment. Currently, the region seems to be performing very well, as according to a recent United Nations Conference on Trade and Development report, the region currently accounts for 8.2 % of total global FDI inflows, up from about 4.2 % before the global financial crisis (UNCTAD 2013).

Trade is mainly concentrated in three categories: 'Electronics' being the largest sector for both exports and imports, accounting for roughly 20 % of the region's total trade in 2010, followed by 'fuels and related chemical products' and 'machinery in manufacturing'. Other industrial categories feature less prominently in the region.

Concerning exports the region is quite diverse, with most developed countries specialising in sophisticated goods and the rest more focused on low technology industries. As a rule of thumb, the Southeast Asian countries with high gross domestic product (GDP) per capita also have correspondingly high levels of exports as well as high-quality technological trade.

Singapore has high-quality exports in all industry sectors, and, like Malaysia, low shares of low-quality exports. A diverse group of countries including Lao PDR, Malaysia and Myanmar have very high shares of medium-quality exports in medium-low technology industries.

Countries such as Vietnam and Cambodia have to a certain extent taken over the role of China as assembler of final goods. Other countries in the region, such as Thailand and Malaysia, have moved from labour-intensive manufacturing to higher levels in the value chain. In this upward move, large multinational enterprises play an important role.

| Country | Land area (km²) | Population (thous.) | GDP (US$ million) | GDP (per capita) | Total trade (US$ m.) | GDP growth rate |
|---|---|---|---|---|---|---|
| Brunei | 5,765 | 400 | 16,970 | 42,445 | 16,856 | 1.0 % |
| Cambodia | 181,035 | 14,741 | 14,411 | 978 | 18,664 | 7.0 % |
| Indonesia | 1,860,360 | 244,776 | 878,223 | 3,588 | 381,721 | 6.2 % |
| Laos | 236,800 | 6,514 | 9,083 | 1,394 | 6,159 | 7.9 % |
| Malaysia | 330,252 | 29,337 | 305,154 | 10,338 | 423,930 | 5.6 % |
| Myanmar | 676,577 | 60,976 | 52,525 | 861 | 18,503 | 5.6 % |
| Philippines | 300,000 | 97,691 | 250,543 | 2,565 | 117,382 | 6.8 % |
| Singapore | 710 | 5,312 | 276,610 | 52,069 | 788,117 | 1.3 % |
| Thailand | 513,120 | 67,912 | 366,127 | 5,391 | 477,302 | 6.5 % |
| Vietnam | 331,051 | 88,773 | 141,669 | 1,596 | 227,793 | 5.0 % |
| **ASEAN** | **4,435,670** | **616,614** | **2,311,315** | **3,748** | **2,476,427** | **5.7 %** |

**Table 1:** Key figures on ASEAN from: *ASEAN Cooperation in Science and Technology: Towards Building the ASEAN Community*, presentation by A. Lim, Tokyo, Japan, 2014

Within Southeast Asia, Singapore is the outstanding example of movement up the value chain, showing significantly higher median unit values of manufactured goods. Most of the countries in the region have raised their unit values compared to the world average, with the exception of Thailand, Lao PDR, and especially Brunei Darussalam, which have had lower product values in recent years.

It is important to note the role of investments in human capital for economic success, especially in Singapore and Malaysia, as suggested in a recent study by Ahmed and Krishnasamy (2013). This illustrates that the level of education and skills is crucial and contributes significantly to the effectiveness of national innovation systems and the participation as well as role in global innovation networks.

Innovation capabilities vary to a great extent across the region. However, in the future the sustainability of growth will largely depend on innovation. Increases of research and development (R&D) capacities will play an important role, especially when competing with other dynamic emerging countries such as China and India. The lesser developed countries in the region are more focused on incremental innovation. The amount of dedication to R&D content within their innovation activities is currently rather low.[4]

### 1.2 STI in ASEAN

In the past number of years, most countries within Southeast Asia have increased their spending on R&D. But, with increasing GDP, the share of these investments measured as gross expenditure on R&D (GERD) has not been kept up. On the whole, the intensity of R&D in Southeast Asia is mostly related to income levels, with the level of Singapore being around the OECD average of 2% and Malaysia at circa 1%. Other countries show ranges between 0.05–0.2%. In the more developed countries of Singapore, Malaysia and the Philippines, the business sector is the dominant performer of R&D activities. In other countries such as Indonesia, the government is the major funder of R&D. In most countries the public sector is also the major research performer. Typically the linkages between public sector research and the business sector are quite weak. Firms focus mainly on small innovation steps with low R&D content. The scientific community is sometimes also reluctant to take on an entrepreneurial role.

#### Publications

Along with increased spending on R&D, publication output has also risen in the past years. See table 2 for an overview on research output. Compared with other world regions, Southeast Asia has performed better in terms of quantity, both regarding overall and internationally co-authored papers. The impact in terms of citation rates of publications in the region has also increased.[5]

The increase in research output has been most prominent in Singapore and Malaysia. Along with this increase in volume and quality of publications, these countries have also implemented institutional reforms such as reorganisation and changes in the governance of public R&D institutions. Thailand and the Philippines have implemented some of these changes while other countries still have a long way to go in upgrading their R&D performing bodies.

#### Patents

The absolute number of international patents is rather low for most of the region but showing strong growth rates (see table 3). The levels of international patenting in these countries can typically be related to their income levels.

In Singapore, the level of intellectual property (IP) protection is well advanced, but in many countries of the region this is not the case. In these countries, simpler models of protection such as utility models[6] are more likely to be used instead of patents. This form of ownership protection is also more in line with the needs of the type of innovation that is prevalent in most countries, such as incremental or frugal innovation. Links and the level of trust between the research and business community in the less developed countries are weak, and research results are often bought from outside, from countries such as the USA and Japan or from the EU.

To conclude, multinational enterprises are the main R&D performing actors in the business sector throughout the region. However, in less developed countries this activity is mainly directed to adaptation of products to national markets. The confinement of R&D to multinational enterprises and the scarcity of high-end product development pose additional problems. There are few possibilities for continuous diffusion of advanced technological knowledge into the wider economy.

4 For a thorough discussion of the innovation systems in Southeast Asia please refer to the recent OECD publication *Innovation in Southeast Asia*, 2013.

5 A detailed discussion of bibliometrics in ASEAN will be conducted by SEA-EU-NET in 2014.

6 According to the World Intellectual Property Organization, a utility model is an exclusive right granted for an invention, which allows the right holder to prevent others from commercially using the protected invention, without his authorization, for a limited period of time. In its basic definition, which may vary from one country (where such protection is available) to another, a utility model is similar to a patent. In fact, utility models are sometimes referred to as 10 petty patents or 10 innovation patents . More infomation is available via the organisation's website at: http://www.wipo.int/sme/en/ip_business/utility_models/utility_models.htm.





| Country | Schimago Rank | Documents | Citable documents | Citations | Self-citations | Citations per document | H-index |
|---|---|---|---|---|---|---|---|
| Brunei | 134 | 1,345 | 1,188 | 8,967 | 874 | 9.52 | 40 |
| Cambodia | 125 | 1,556 | 1,462 | 15,891 | 1,739 | 12.76 | 49 |
| Indonesia | 61 | 20,166 | 19,740 | 146,670 | 16,149 | 10.94 | 112 |
| Malaysia | 40 | 99,187 | 97,018 | 356,918 | 93,479 | 7.85125 | 125 |
| Myanmar | 140 | 1,077 | 1,049 | 7,944 | 612 | 11.9 | 38 |
| Philippines | 70 | 13,163 | 12,796 | 141,070 | 15,727 | 13.38 | 116 |
| Singapore | 32 | 149,509 | 144,653 | 1,616,952 | 230,656 | 12.95 | 268 |
| Thailand | 43 | 82,209 | 79,537 | 621,817 | 109,600 | 10.96 | 167 |
| Vietnam | 67 | 16,474 | 16,116 | 125,927 | 18,500 | 11.79 | 107 |

**Table 2:** Publication output data for 1996–2012. Source: http://www.scimagojr.com/countryrank.php (accessed 10 January 2014)

| Office | 1992-2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2003-2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brunei | | | | | | | | | | | 2 | 2 |
| Indonesia | 14 | 1 | | 1 | 7 | 5 | 6 | 2 | 9 | 8 | 9 | 48 |
| Malaysia | | | | | 34 | 93 | 200 | 224 | 333 | 251 | 294 | 1,429 |
| Philippines | 28 | 15 | 11 | 25 | 19 | 17 | 12 | 21 | 9 | 20 | 15 | 164 |
| Singapore | 1,143 | 295 | 429 | 436 | 409 | 442 | 496 | 500 | 491 | 456 | 494 | 4,448 |
| Thailand | | | | | | | | 4 | 49 | 51 | 54 | 158 |
| Vietnam | 3 | 7 | 2 | | 9 | 3 | 4 | 4 | 5 | 11 | 8 | 53 |

**Table 3:** Patent Cooperation Treaty international applications, total count by filing office
Source: http://ipstatsdb.wipo.org/ipstatv2/ipstats/searchresultsTable/ (accessed 10 January 2014)

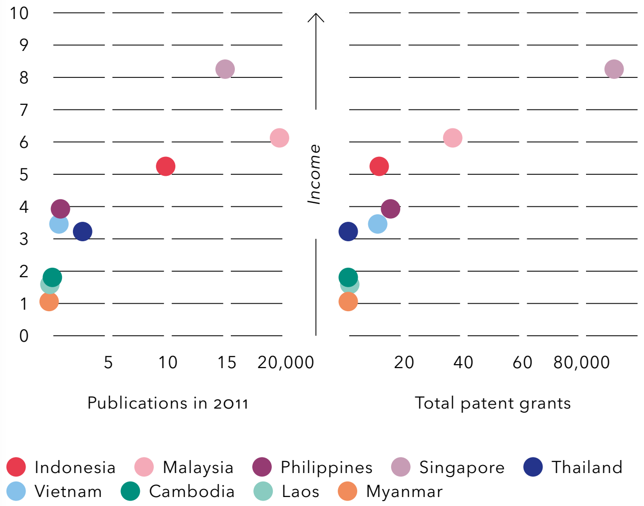


**Figure 1:** Publications, patents and the Knowledge Economy Index
Source: Ocon et al., 2013

#### Efficacy of the STI policy system

The Knowledge Economy Index (KEI), developed by the World Bank, is a composite indicator measuring a country's ability to generate, adopt and diffuse knowledge as well as its capacity to provide a business-friendly environment. This data can be correlated with the country's performance in publications and patents, thereby indicating the efficacy of the innovation policy system. The figure shows a strong correlation between a country's scientific and technological output and KEI scores in the context of Southeast Asia.

## 2 Innovation governance and policy strategies

### 2.1 Resource base and governance practices

A healthy, growing economy is generally both an incentive for and an outcome of innovative and entrepreneurial activities, and it stimulates foreign direct investments. However, in many ASEAN member states, a rapidly growing economy also creates a playing field with ever moving goalposts. Increasing the GERD as a share of GDP becomes more difficult to achieve if GDP increases substantially in a given period. The target has moved, and necessary adjustments are frequently called for.

Bearing this general caveat in mind, one of the striking features of the overall STI landscape in ASEAN is such that in most cases an appropriate amount of funding is lacking. Financial resources are simply too low to ensure viable innovation strategies. This is especially true for the lesser developed ASEAN member states, where the research infrastructure is often poorly developed even in terms of accessibility and logistics.

The large informal economy, which thrives in some ASEAN member states, represents a key challenge in ensuring that tax revenues are a source for sufficient public funding. The informality and lack of transparency of this type of economy constitutes a considerable barrier to efficiently targeting budgets to research and innovation, or raising the level of expenditure on STI. Most countries have active policies in place to help reduce the informal economy and create jobs in the formal economy.

Another related problem is that of covert corruption, usually facilitated or condoned by a top-down approach by high-level bodies. This of course makes budgetary management and foreign project financing more difficult. Some ASEAN member states have active anti-corruption councils combating this phenomenon with varying degrees of success.

Where a large part of the population is living below subsistence levels or is generally dependent on low incomes, tax revenues are scarce, and levels of demand in the economy are low; as such, political willingness or even the sheer feasibility of raising the level of funding for STI will be fraught with difficulties. And where financial framework conditions are relatively weak, this will in turn lead to low levels of FDIand technology transfer.

Currently, ASEAN member states recognize the need to align all relevant regulations and policies along the whole innovation chain in a well-coordinated and transparent way. This concerns coordination of STI policy with financial and fiscal incentives, human capital development, trade policy and social welfare. However, the vested interests of some of the stakeholders in the innovation system tend to work against this process of effective integration.

The responsibility for the relatively modest budgets for STI funding tends to be distributed over a complex set of ministries, agencies, and councils, as well as private sector stakeholders, all representing their own specific interests, targets, and priority areas. These actors sometimes work in close collaboration, adapting and aligning their activities towards the single goal of a healthy innovation landscape. In practice they often work either simply alongside if not against one another, or cater to overlapping research areas, devising and implementing basically similar policies. There seems to be an overall tendency to spread the scarce resources over too many priority areas through complex and introverted institutional systems, generating a substantial redundancy in bureaucracy.

As a solution for this ever growing problem, many ASEAN member states often resort to inserting new, additional layers of coordination between STI councils and bodies. All layers tend to remain in existence after changes in policy or government, with mandates that are perhaps less relevant than they were at the time the layers were established.

To give a few examples, in Indonesia, the National Planning Agency (BAPPENAS) has been in existence for a long time. Recently, a National Innovation Council (KIN) was established by a presidential regulation, whilst at the same time the National Economy Committee (KEN) was founded. There is some overlap in activities, and no clear coordinating mechanism between the two has been put into place. In Thailand, the National Science and Technology Development Agency (NSTDA) has a similar advisory role, and to some extent funding role, as the National Research Council of Thailand (NRCT), and works alongside recently created bodies like the National STI Policy Committee (NSTIC) and the National STI Policy Office (STI) which were created around the same time.

The effect of this scattered and relatively uncoordinated way of handling funding for STI is sometimes exacerbated by a weak implementation of governmental rules or presidential decrees into effective laws and regulations. On top of that, the enforcement of these laws is often not consistent or effective. In some countries there is a rapid turnover of governments, or within a single government ministers are replaced frequently. A rapidly changing political, institutional and funding environment is not conducive to coherent, consistent, and long-term innovation policies.

It appears that in most cases the ministries handling innovation issues are severely hampered by a lack of clear financial authority. Overall responsibility for budget allocation is usually firmly in the hands of either revenue departments in ministries of finance or budget bureaus of the board of investment (ministry of industry). This usually means that STI budget allocation is strictly tied to the annual budget and fiscal year. This annual budget allocation cycle puts severe constraints on the possibilities for long-term planning, and is out of line with the way R&D and applied research is normally conducted.

In cases where ministries have their own funding budgets for research and innovation, they tend to fight in their own corners by restricting their funding instruments to a predetermined set of topics, and to research institutes directly connected to them. Competition is then reduced, and scientific or innovative quality will not solely determine the outcome of the selection process. This government-driven approach, with key research institutions often directly governed by responsible ministries, with obvious conflicts of interest, sometimes results in decisions to fund less than the best projects in science, technology, or innovation.

One alternative to this closed-shop approach is an independent, unbiased research funding council, operating with transparent peer-review procedures in selecting proposals. In some ASEAN member states such councils in some form or other have been created, in other member states serious discussion and preparatory implementation of laws and regulations to establish such independent bodies are taking place. However, the prevalence of vested interests will for the time being counteract the emergence of overarching funding research councils, and will keep in place the compartmentalised funding mechanisms.





In some cases, funding is predominantly academia-focused and not demand-driven, leaving applied research and industry stakeholders in the lurch. In many of the lesser developed countries, support instruments for research commercialisation are scarce and extremely low on funds. In other countries the funding schemes are divides into brackets across the innovation chain, with different ministries and funding agencies catering to different stages in this chain. Exceptions to this general rule are some ministries and agencies which do cover the whole innovation chain from basic and applied research, proof-of-concept and prototyping early stage research to upscale support with subsidy programmes, like for example Indonesia's Ministry of State for Research and Technology (RISTEK), Malaysia's Ministry of Science, Technology and Innovation (MOSTI), and Thailand's National Science and Technology Development Agency (NSTDA). Typically however, ministries merely cover the early stages of basic and applied research, whereas separate organisations dedicated to specific products only cover the final stages of up-scaling and commercial exploitation, like the Malaysian Technology Development Corporation (MTDC) and the Malaysian Palm Oil Board (MPOB).

In some ASEAN member states the education system, although often extensive, is generally of low quality or with not readily accessible pockets of excellence. It frequently appears to be not able to comply with demands for a well-trained, highly educated workforce. In the area of higher education, there is often a considerable overlap and fragmentation of university curricula. A rapid quality increase of education systems is called for in order to boost the levels of education and to generate new creative and innovative generations with an entrepreneurial mindset. All ASEAN countries recognise the importance of having a highly educated and trained workforce, and measures are being implemented to shore up the quality of education.

**2.2 Key policy strategies**

Most of the ASEAN member states have some formally recognized national innovation system. Singapore was the first country in Southeast Asia to develop a coherent innovation policy. Innovation, in almost all ASEAN member states and across ministries and other stakeholders, has become a key concept for successful economic development.

Innovation policy is, as a rule, embedded in multi-annual development plans with names like STI Policy and Master Plan; National Research Policy and Strategy Plans; Research, Innovation and Enterprise Plan; National Science and Technology Policy Plan; and Engineering Research and Development for Technology Plan. Most of these STI and economic development plans are closely dovetailed both with higher education plans (such as national education plans, roadmaps for higher education quality development, long-term plans for higher education) and financial incentive plans (investment promotion strategy plans, etc.). Again, all these sub-plans are usually part and parcel of large-scale, long-term national master programmes, such as a medium-term national plan or national economic and social development plan. All these plans are developed by a series of different ministries, councils, governmental agencies, research councils, science academies and so forth. In Malaysia alone there are 14 agencies grouped under eight ministries involved in formulating and supporting STI initiatives and related activities.

The level of abstraction of both these plans and other innovation system documents is usually prohibitively high. The fact that these policy documents cannot be easily translated into well-coordinated actions or effective legislation makes it hard for relevant stakeholders in both academia and industry to commit themselves to these plans in any realistic way. The gap between policy documents, with their abstract rhetoric, and practical everyday research and innovation activities is very palpable.

Also, in most countries governments change rather frequently, and each new government tends to create its own key policy strategy papers, and implement new research priorities. Even within a single government, ministers tend to change quite frequently. Thailand, for example, has seen ten ministers of science and technology in the last ten years, resulting in frequent substantive changes in innovation policies.

To some extent, promoting a national innovation policy and publishing long-term development plans is called for by the simple fact that other neighbouring member states have these. This process of adapting and learning leads to a similarity between the various innovation systems and their concomitant documents. This often disregards country-specific or urgent societal needs like job creation, poverty alleviation and environmental protection. There is a generally voiced opinion that the innovation policy focus is on high technology development with insufficient direct funding for grassroots, incremental, demand-driven innovation in areas like social innovation, social entrepreneurship and inclusive development. However, there is in lesser developed countries a weak absorptive capacity for high-end innovation. The same mechanism of competing with neighbouring member states in having an innovation policy applies to some extent also to adopting advisory councils, planning agencies, research councils, overarching coordinating bodies, science and technology parks and incubator facilities. These sometimes do not have sufficient resources or are understaffed to do their work properly.

In quite a few cases collaborative research between public academia and private industry does not come off the ground. Commercialisation of research activities does not materialise, despite financial incentives like commercial loan schemes and the existence of incubator facilities, business innovation centres and other intermediary bodies. Although most government organisations, universities and research institutes are keen to foster private-public partnerships, both small to medium-sized entities and multinational companies do not sufficiently utilise research results from the universities and research institutes in the countries where they are active. Often a further obstacle is a lack of trust between the government and the private sector, in which innovation stakeholders are sometimes concentrated in large family-owned conglomerations.

Singapore is, of course, the outstanding exception. Excellent infrastructure for business in general, and R&D in particular, within its top-class science parks and research facilities are hallmarks of the Singaporean innovation climate; the National Research Foundation (NRF) effectively coordinates national R&D activities in the city-state. Singapore's Global Entrepreneurial Executive Programme and its cash pay-out option for tax deductions are also unique supporting programmes in the region for fostering entrepreneurship activities.

In most countries university lecturers and professors are expected to play key roles in innovation, as universities usually receive the bulk of science and technology funding. In some countries however, the teaching load for faculty is considered too high. In Indonesia teachers have to comply with a tripartite division of obligatory tasks in education, community services and research, and in Thailand most university staff consider their teaching load too extensive. But by and large there is currently increasing investment in higher education and entrepreneurship training to facilitate commercialisation of research results.

## 3 Regional integration and international linkages

### 3.1 ASEAN integration and innovation

The ten Southeast Asian countries of currently making up ASEAN embarked on their path of integration in 1967. Since then, the region has gradually become more integrated, building the integration processes on three 'community' pillars: The Political-Security Community, the Economic Community (AEC) and the Socio-Cultural Community. The recognition of the important role of STI in economic development has led to the inclusion of science and technology in the Economic Community. Hence, this area will be significantly influenced by the developments of this pillar. Without going into details of how this has developed, the ASEAN Vision adopted by the ASEAN Heads of State and Government during the summit in Kuala Lumpur in 1997 states that ASEAN will be, in 2020:

… a technologically competitive ASEAN, competent in strategic and enabling technologies, with an adequate pool of qualified and trained manpower, and strong networks of scientific and technological institutions and centres of excellence.

The ASEAN policy framework in which STI is being promoted is developed by the ASEAN Committee on Science and Technology (ASEAN COST). It was established in 1978 and is currently being organised into several thematic sub-committees. Several ministerial meetings, e.g. in 2003 and 2005, further reinforced science and technology cooperation within ASEAN, including better coordination of national plans and programmes. In 2006, the ASEAN Plan of Action on Science and Technology (APAST) was developed, initially implemented through to 2011 and extended until 2015. Currently, a new APASTI (including the aspect of innovation) is being developed, taking into account the so-called Krabi Initiative that was adopted at an informal ministerial meeting in 2010. It should also be noted that a blueprint for the ASEAN Socio-Cultural Community in 2009 included a significant chapter on science and technology, in particular on capacity building.

Key priorities in the current APAST include several strategic areas like networking, human resources and infrastructures. Flagship programmes have been a way to target certain well-defined thematic areas of key interest to the region. However, they do not receive substantive funding, not least because many of the ASEAN countries are under-funded as such in STI. Further, the flagship programmes are not managed by ASEAN, but by different member states with varying capacity to do so and varying degrees of success. In sum, even though thematic priorities are in place, resources to implement them across the region are still underdeveloped.

The most important process driving change in the ASEAN structure is currently taking place within the AEC. It represents the key component of the next phase of regional integration. ASEAN sets out to establish: "a) a single market and production base; b) a highly competitive economic region; c) a region of equitable economic development; and d) a region fully integrated into the global economy".[7] Similar to Europe's single market established by the EU, the AEC strives at an integrated ASEAN economy through characteristics such as free flows of goods, services, investments and capital, and skilled labour. The main areas of cooperation are:

- human resources and capacity building;
- joint and mutual recognition of professional qualifications;
- closer consultation on macro-economic policies;
- trade financing measures;
- development of electronic transactions through e-ASEAN;
- integrated industries across the region to promote regional sourcing;
- enhanced private sector involvement in building the AEC.

7 http://www.asean.org/communities/asean-economic-community/ (accessed 7 May 2014)



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Hence, AEC strives to deliver a more competitive regional economy, and a main vehicle to achieve this will be reduced or removed tariffs and non-tariff barriers to trade (not establishing a common tariff regime). The AEC highlights certain industrial sector of priority: Agro-based goods, air transport, automotive products, electronic goods, fisheries, health care products, rubber-based products, textiles and clothing, tourism, logistics and wood-based products. The freeing up of flows of investments, capital and labour will also have an impact on innovation in the region, and intellectual property rights have been highlighted with specific attention in this regard. Likewise, improved cooperation in several infrastructure areas like energy, information technology and transport is likely to have a positive impact on innovation.

The 'ASEAN way' of regional integration is difficult to compare with the one in Europe. In fact, the above reference to the EU's single market should not be taken literally, as the ASEAN way has been one of a process of consensus building without any will to pool competence and transfer sovereignty to supranational institutions. While the rhetoric of integration may have similarities, the substance of ASEAN economic integration seems to be one of slow-moving processes based on the mutual Southeast Asian approach of non-intervention in other countries' affairs (Goron 2011). However, two developments in the context of the AEC point to a shift in direction and more commitment. Firstly, the AEC Blueprint introduced the concept of 'connectivity', emphasising physical, institutional, and people-to-people linkages, fostering increased intensity in the integration process. This also includes a greater attention to the economic and social diversity between the member states, as well as focusing on the need to address the great gap in infrastructures. A *Master Plan of Connectivity* was adopted at the 2010 ASEAN summit in Hanoi, and includes a detailed list of actions. Secondly, the ASEAN scorecard system was introduced, thereby building up an indicator-based approach to implementation and benchmarking as a way to improve a joint compliance mechanism (Goron 2011).

EU integration is hence not to be seen as a model for ASEAN integration even if the rhetoric may have similarities. The diversity of the ASEAN member states is also considerable (e.g. in terms of political systems, historical developments and population sizes), and there were no up-front convergence criteria for ASEAN membership.

Southeast Asia is a region with low intra-ASEAN trade and high levels of competition. This is likely to continue with increasing economic integration. Opening up for flows of investments and capital as well as highly skilled people is likely to reinforce the advantages of the strong member states and regions, such as Singapore. In fact, as this study will illustrate, Singapore may develop into an even more obvious hub for deal flows and venture capital than already the case. Compensating mechanisms like the 'connectivity' approach discussed above will have to be seen by the various member states as a way to strengthen their capacity to take part in the integration process. The integration itself, however, represents an incentive for all to boost efforts and investments. Greater openness and connectivity should spur the joint interest to pool resources and embark upon joint programmes for research and development as well as infrastructures. The overall position of the ASEAN region in the global economic division of labour implies a need for significant upgrading of competence and capacity through innovation. But a bottleneck still remains: As mentioned above, allocating funds for STI remains a challenge as tax revenues are small and funds often distributed in 'sticky' national structures with corresponding difficulties in redistribution across borders.

### 3.2 International linkages

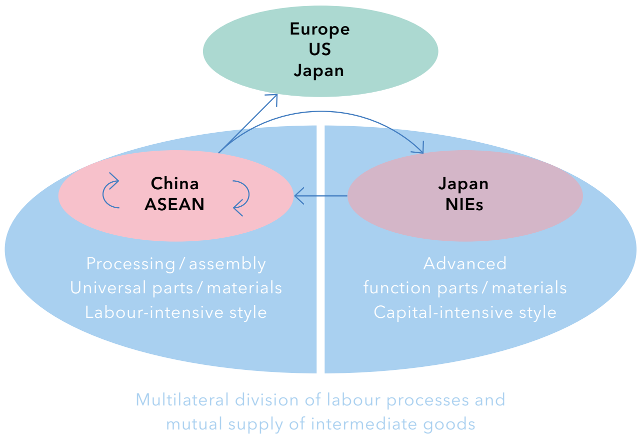
Trade can be seen as the single-most important indicator of international linkages between countries and regions. With the increasing liberalisation of trade since the 1980s, Asia has seen its role in the global trading system grow to become the most dynamic industrial region with growth rates far outpacing industrialised countries and most other emerging economies. Trade in East Asia was fuelled by the early growth of the 'new industrialised economies' (Taiwan, Singapore and Hong Kong), and later by Korea and China. In particular the growth of China has influenced not only trade patterns, but also investment flows and economic specialisation between countries in the region.

Hence, the economic integration of ASEAN needs to be assessed in the context of wider economic development in Asia and globally. Intra-ASEAN trade only comprises some 25 % of overall ASEAN trade (OECD 2012). For example, exports to ASEAN countries only make up 17 % of total exports from the Philippines, while other trading partners in East Asia such as China, Hong Kong, Japan, Korea and Taiwan make up more than 50 % in total. China is the Philippines' largest trading partner with some 12 % of exports, with the EU, USA and Japan slightly lower. Over the past few years the trading pattern in the region has changed to the benefit of Asian partners while Western industrialised countries have reduced their shares due to economic stagnation since the recent global financial crisis. The EU is ASEAN's second-largest trading partner after China, while ASEAN is the EU's third-largest trading partner after the USA and China[8].

Although this trading structure varies widely between the ASEAN member countries, it is a fact that intra-ASEAN trade is still small, and that ASEAN finds itself positioned as a supplier region to the 'assembly locations' in the bigger neighbouring countries. This has been taking place in the context of the increasing role of global value chains (GVCs), driving the export-oriented growth

8 http://ec.europa.eu/trade/policy/countries-and-regions/regions/asean/, European Commission, DG Trade (accessed 8 May 2014)

patterns of many ASEAN countries. Their position within GVCs has a significant impact on innovation in some sectors (see figure 2). Added to this, the geographical global landscape is changing, with Asia as a region becoming far more important in STI than only a few decades ago. The position of the ASEAN region in terms of GVCs should lead to great potential for future development if the ASEAN countries can link into the global innovation networks associated with GVCs, and ensure viable funding and investments.




**NIEs** – Newly Industrialising Economies

**Figure 2:** ASEAN in the global economy
Source: Ministry of Economy, Trade and Industry of Japan, 2007

Underpinning the trade pattern, there has been a tremendous growth of free trade agreements (FTAs). ASEAN as such is made up essentially of FTAs that again make up the ASEAN Free Trade Area (AFTA), which is a part of the AEC framework. Given the relatively low intra-ASEAN trade, AFTA has not been very successful up to now, as non-tariff barriers remain significant hurdles to free flows of goods and other trade categories. But other FTAs have flourished. By 2010, some 283 regional FTAs were operative and registered with the World Trade Organization, with East Asia having 45 FTAs and 84 under development (Goron 2011). The greater club of ASEAN+3[9] represents the most significant widening of the trade area, and China, Japan and Korea have engaged heavily in FTAs vis-à-vis the ASEAN region, not least for political reasons of influence and leadership in Asia (Goron 2011). This architecture also underpins the dynamic relationships of trade, competition and cooperation in Asia. Goron (2011) observes that with the complex system of cooperation and agreements (see figure 3), ASEAN resumes an increasing centrality and importance. This is also due to the apparent competition between the major powers in Asia, like Japan, India and China; ASEAN's increasingly important role may be seen as defusing some of the competitive tension (Goron 2011).

9 ASEAN plus China, Japan and South Korea (see figure below)

Another important area of international economic linkages (and, to a certain extent, competition) beyond trade is FDI. For different reasons, due to the activities of ASEAN countries like Singapore (production, industrial and research investments, finance), Indonesia and the Philippines (large internal markets), but also Cambodia, Myanmar and Vietnam (labour-intensive FDI), the region is receiving significant shares of global FDI. The FDI net inflows from countries in the region to other countries in the region (i.e. intra-ASEAN FDI) is still comparatively low: In 2012, 18.3 % of net inflows came from within ASEAN against 81.7 % of inward FDI coming from sources outside the region[10]. The EU (with 21.1 % of total net inflows in 2012) is the major FDI investor in ASEAN, followed by Japan (21 %) whose investments increased substantially in 2012. The FDI from ASEAN (the above-mentioned 18.3 %) is the third largest source, with the US (6.4 %) as the fourth largest source[11].

Figure 3 illustrates the fact that the regional architecture not only concerns economic and trade ties, but also linkages in fields such as cultural, political and scientific cooperation. These other layers of cooperation also support STI cooperation more broadly. This includes especially the dialogue partners to ASEAN, the most important being China, the USA, Japan, Korea, the EU, Russia and Australia. These connections also overlap with the legacy of colonial ties, e.g. between European countries and many of the ASEAN countries. Hence, foreign aid has been significant from many of the dialogue partners, including Japan. This aid typically includes investments in infrastructure and scientific cooperation like mobility programmes for highly skilled personnel. In fact, the STI-related cooperation with Japan, Taiwan and the EU, to name the most prominent, ensures both funding and networks highly valuable to the ASEAN countries.

The following, table 4, demonstrates the strength and relevance of international ties in research production of selected ASEAN member states.

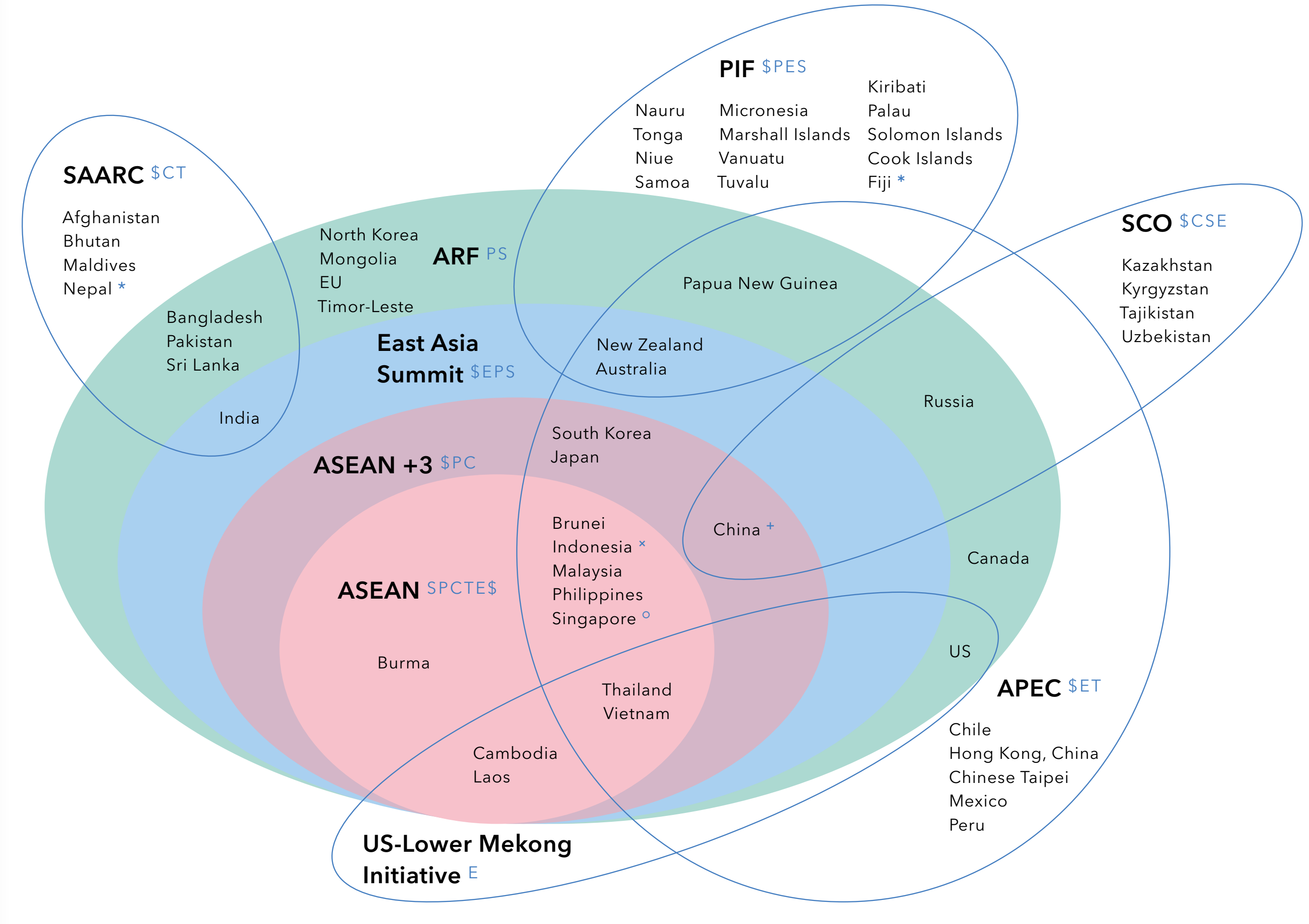
| Country | Publications 1996–2012 | Intern. co-authored (% of total) | Intern. co-authored within ASEAN (% of total) |
|---|---|---|---|
| Indonesia | 21,399 | 65.24 % | 13.20 % |
| Malaysia | 102,252 | 31.75 % | 4.69 % |
| Philippines | 13,882 | 59-94 % | 10.19 % |
| Singapore | 155,112 | 41.87 % | 1.89 % |
| Thailand | 84,886 | 40.69 % | 4.21 % |
| Vietnam | 17,116 | 71.97 % | 8.44 % |

**Table 4:** International co-authorship within ASEAN
Source: Scopus database, May 2014

10 http://www.asean.org/images/resources/2014/Jan/StatisticUpdate28Jan/Table%2025.pdf, ASEAN Statistics (accessed 8 May 2014)
11 http://www.asean.org/images/resources/2014/Jan/StatisticUpdate28Jan/Table%2026.pdf, ASEAN Statistics (accessed 8 May 2014)








E – energy and the environment T – technology P – political C – cultural $ – economic S – security
° – secretariat seat of APEC + – secretariat seat of SCO * – secretariat seat of ASEAN/+3/EAS/ARF * – secretariat seat of SAARC * – secretariat seat of PIF

**Figure 3:** ASEAN's regional architecture. Source: Bower, 2010; cited in Goron, 2011

It becomes visible, here, that international collaborative research is behind large parts, if not most (as in the case of the Philippines, Indonesia and Vietnam), of the scientific output of ASEAN countries. The collaborative ties within the region are still comparatively weak for most countries. Only between 2 % and 13 % of publications by researchers affiliated in ASEAN are co-authored with other ASEAN colleagues. This situation certainly has to do with both the maturity of the innovation systems and the strength of the research base, but might also indicate an outward orientation (researchers might prefer to cooperate with colleagues from Europe, Japan or the USA, perhaps because they received their postgraduate education there). The picture might change with the stronger integration of the ASEAN higher education and research landscapes fuelled by the ASEAN 'communities'.

While many western or industrialised countries have had individual cooperation linkages with individual countries in Southeast Asia, such as France with Vietnam and the Netherlands with Indonesia, in sum making up a complex web of linkages of cooperation, the discussion here will be limited to the most important. For example, the ASEAN USA dialogue relations were formally initiated in 1977 and now include a comprehensive set of areas like politics and security, economic and trade, social and cultural as well as development cooperation. Education has been key to socio-cultural cooperation. Development cooperation serves as an umbrella for cooperation related to addressing global challenges, and that typically includes STI.

Cooperation between ASEAN and the EU dates back to 1972, and covers a broadly based partnership on top of the cooperation and development agreements concluded with the individual ASEAN member states (these agreements typically include a special chapter on cooperation in STI). Among the many programmes and initiatives in this partnership, the EU has given dedicated support to the Socio-Cultural community in ASEAN, notably supporting mobility and exchange of students and scholars (through the EU Erasmus Mundus and the Marie Curie fellowships of the Framework Programme for Research and Innovation (in addition to participation in the Framework Programmes as such over many years).[12]

12 It should be noted that this report is funded by one of these cooperative mechanisms: INCO-net projects, from the 7th Framework Programme.

Japan has a long-standing relationship with the region, covering more than 40 years. These ties have become strong over the years, mostly driven by economic cooperation, but increasingly with comprehensive development cooperation, including in science and technology. Japan has developed a clear strategy for exchange of human resources in science and technology through its Ministry of Education, Culture, Sports, Science and Technology (MEXT), in which Japanese universities like Kyoto University play the key role (see box below).[13]

**The SEND programme of MEXT**

This programme is supported by the MEXT Re-Inventing Japan Project "Rediscovering Japan through Collaboration in the Open ASEAN+6 – International Human Resource Development Centring on the SEND Programme".

SEND (Student Exchange – Nippon Discovery) is a programme which aims to nurture the expert human resources who will be a bridge between Japan and other regions of the world, particularly the ASEAN region. The Japanese students who are sent to those regions study local languages and cultures while at the same time supporting Japanese language education and teaching local students about Japan.

**Box 1:** The SEND programme of MEXT

Japan, like all other international partners, channels much STI-related support and cooperation through development programmes with individual ASEAN countries. This is particularly the case with the Philippines. Cooperation in general is also being strengthened against the background of the looming role of China in the region, with the increasing tendency for territorial conflicts in the Asian region and waters. One particular example concerns the disputed South China Sea. It is one of the most disputed sea areas in the world, with four ASEAN states (Brunei Darussalam, Malaysia, Philippines and Vietnam) being involved in disputes with China and Taiwan. At stake are geopolitical security issues as well as natural resources of great economic value. For example, petroleum resources play a great role in the disputes, as well as access and rights to marine biomass. The latter is potentially of even more significance for innovation and development in the region, and is linked to how many countries can manage IP on marine resources for innovation.

On the other hand, the ASEAN China dialogue is also being strengthened. It dates back to 1991, and was reinforced in 2003. It builds upon the increasing economic ties between the two, but political and security related matters as well as socio-cultural issues are gaining a bigger role. Science and technology receives much attention, as well as environmental issues, notably through the China ASEAN Environmental Cooperation Centre (CAEC) inaugurated in 2011 in Beijing.

ASEAN and its member countries take much interest in international organisations. For example, ASEAN in 2013 signed a cooperation agreement with the United Nations Economic, Scientific and Cultural Organization (UNESCO) in Paris. It will span five years and includes areas such as education, science, technology and innovation, as well as social and human sciences. Malaysia in 2013 became an observer in the Organisation for Economic Co-operation and Development's (OECD) working party on technology and innovation policy (TIP). Both cases illustrate the growing interest in taking part in multilateral ties for learning and cooperation.

Further, financial inflows through foreign aid and FDI, necessary and useful as they are, have their own Janus faces: Illicit outflows of capital from the ASEAN countries are staggering. Many of the ASEAN countries are among the top 20 concerning illicit outflows of capital stemming from crime, corruption or tax evasion. These include Malaysia, the Philippines, Indonesia and Thailand (Kar, Freitas 2012). Much of these flows stem from tax evasion by multinational companies, but the total illustrates that international linkages are not always constructive to the respective countries ability to finance investments in infrastructure and STI.

The ongoing ASEAN and wider Asian economic integration, albeit through a patchwork of FTAs, provides a backdrop to the increasing need to invest in STI, development and capacity building. National efforts in innovation policy lie at the heart of this, and ASEAN and its member countries will need to learn and adapt their efforts so that they, on the one hand, become well integrated in the GVCs and global innovation networks, and on the other hand can ensure that the weaker member countries can improve their capacities for development and innovation. The chapters on national innovation policies and instruments in this book aim to cast light on these efforts.

13 http://www.kuasu.cpier.kyoto-u.ac.jp/english/overseas-program/ (accessed 7 May 2014)





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# Indonesia

Rudie Trienes[1], Tri Sundari[2], Herlina Hadisetiawati[2], Florian Gruber[3]

## 1 Key indicators and framework conditions

The economic growth of Indonesia, the only ASEAN country to be selected as member of the G20, still relies substantially on the comparatively low-technological exploitation of its natural resources (predominantly in the agricultural, mining and primary resource sectors). This largely resource-driven economy is reflected in the rise of the country's top ten export products between 2000 and 2010.

The average yearly GDP growth rate of over 6% from the mid-1960s to the mid-1990s was temporarily interrupted by the 1997–1998 Asian financial crisis. GDP growth improved again after this and was 6.5% in 2011, largely due to trade based on Indonesia's natural resources[4]. GDP per capita, however, is low, as are labour productivity levels[5], whilst unemployment, poverty, and child labour levels remain relatively high[6]. Total factor productivity has been lower than that of competing countries in the region, suggesting a sluggish technological change[7], although it should be noted that Indonesia has a number of pockets of excellence in S&T and R&D expertise, concentrated in a small number of well-known universities[8]. Indonesia ranked 46th on the global competitiveness scale in 2011–2012, again some distance behind regional competitors[9], and only 108th out of 146 countries in terms of the Knowledge Economy Index[10]. Foreign direct investment inflows into Indonesia have also been relatively modest but volatile since the Asian crisis, at 1.9% of GDP in 2010[11]. Inflation, a lack of consistent and transparent tax and foreign currency regulations and their weak implementation are also amongst the problematic factors for doing business in Indonesia.

By and large, the temporary drop in economic growth has had a detrimental impact on Indonesian S&T development. Indonesia does not as yet possess a technology-intensive industry, and the export balance is tipped to import more high-technology products, from 5% of the total in 2000 to 14% in 2010, rather than exporting high and medium-high technology products[12].

On top of this, a number of other thorny factors prove to be impediments to implementing new, innovative processes and establishing technology-based businesses. Amongst the main reasons for concern are corruption[13], inefficient government bureaucracy, inadequate infrastructure, policy instability, inadequate access to financing, an inadequately educated workforce, and restrictive labour regulations[14].

Sources of risk financing for technology-based companies such as those of venture capital are scarce in Indonesia. The main reason for this seems to be the lack of adequate IPR and patent protection[15], a weak ICT infrastructure, and a lack of qualified venture capital project evaluators capable of assessing the innovative potential of companies.

The Indonesian state government's budget for S&T as a share of the total state budget of Revenues and Expenditures (ABPN), which includes R&D and many other activities, has significantly decreased over the past 35 years. During the Soeharto administration in the 1970s, Indonesia's national GERD/GDP (gross expenditure on R&D as a share of GDP) stood at 6.11%, but by 1991 it was 2.34%, fell to 0.49% in 2006, and reached 0.08% in 2009 (in higher education the GERD/GDP is 0.03%). The rapid growth of GDP has to be taken into account whilst interpreting these rather worrying figures, however. In the decade after 1987 there were a mere 182 scientists and engineers per million inhabitants[16]. These findings are discomforting, and reflect both dwindling support for STI as a contributing factor to socio-economic welfare, and limited success in terms of upgrading overall innovation capacity, despite rhetoric to the contrary[17].

In sum, government policies were comparatively slow to develop adequate framework conditions to shore up S&T and innovation. However, fresh emphasis has been placed on implementing policies conducive to an innovation-led economic growth, as the Indonesian government recognises that a firm national science and technology policy will be instrumental to orienting the use of science and technology toward economic objectives.

Indonesia's government is keen to enter the era of innovation driven economies, and expand its competitive edge by involving science and technology in order to bolster innovation as a growth engine. To an increasing extent, Indonesia's policy makers are aware that STI and skilful human resources can substantially contribute to economic development.

Due to the limited resources for fostering S&T, Indonesia is realistic in that it realises that pioneering cutting-edge major scientific discoveries is not on the cards. Instead, it seeks to incrementally tighten the relationship between development and the application of S&T in the production of goods and services in key sectors of economic development. At the same time Indonesia's government recognises that tax, financial and economic incentives, the flexibility and adaptability of human resource mobility, and other incentives for R&D and innovation activities, should be provided.

## 2 Governance and public STI policy

Indonesia lacks an effective, single and coherent national innovation system[18]. There is a fairly densely crowded STI landscape when it comes to (non-)governmental bodies such as ministries, agencies, institutions, high-level advisory bodies, etc., responsible for S&T policy formulation, the launch and implementation of support programmes, and actual research institutes.

Government policies have, until fairly recently, failed to address the issue of an adequate scientific underpinning of, and framework conditions for, innovation. As noted above, Indonesia's economic growth has been predominantly trade- rather than science and technology-driven, and growth policies have not, as a rule, attempted to embrace innovative framework conditions.

Recently, improvements both to enhance policies designed to shore up innovation-led growth, as well as mechanisms to coordinate and inform this plethora of labyrinthine bodies, have been put in place to help formulate STI policies in a more coherent fashion[19]. A single, independent, authoritative body to ensure a coherent approach to policy development of innovation-related growth was conspicuously lacking, however, until the establishment of KIN in 2010 (see below).

Councils and advisory bodies such as the National Research Council (DRN, established in 1984), the Indonesian Academy of Sciences (AIPI, set up in 1991), and Local Research Councils (DRDs) try to pinpoint and streamline S&T development paths and priorities for the government in general and for RISTEK's national S&T policies in particular. DRN publishes National Research Agendas (NRAs), involving five year plans (2005–2009 and 2010–2014). The STI priorities of NRAs ideally fit into the National Long Term Development Plan covering the period 2005–2025 (the RPJPN), and the Medium-Term Five-year Plans (RPJMNs), each of which consists of annual plans (RKPs). The National Long Term Development Plan sets the R&D priorities for 2005–2025 in the areas of advanced materials, health and medicine, defence and security technology, information and communication technology, transportation technology and management, energy, and food security.

**1** Royal Netherlands Academy of Arts and Sciences (KNAW), Amsterdam, Netherlands
**2** Ministry of Research and Technology (RISTEK), Jakarta, Indonesia
**3** Centre for Social Innovation (ZSI), Vienna, Austria
**4** See *Indonesian National Income 1990–2010,* National Statistics Agency
**5** *APO Productivity Databook 2012*
**6** *World Development Indicators,* World Bank, 2012
**7** See *Human Capital Investment to Achieve a Knowledge-Based Economy in ASEAN5: DEA Applications,* E. M. Ahmed and G. Krishnasamy, Journal of the Knowledge Economy, 2013
**8** Such as, for example, Bandung Institute of Technology (ITB), The University of Indonesia (UI), Gadjah Mada University Yogyakarta, Bogor Institute of Agriculture
**9** World Economic Forum, 2012
**10** World Bank, 2012
**11** OECD, 2012
**12** OECD, STAN Bilateral Database (BTD)
**13** See *Illegal Financial Flows From Developing Countries: 2001–2010,* D. Kar and S. Freitas, Global Financial Integrity, 2012
**14** World Economic Forum, 2012
**15** See *Directorate General of Intellectual Property Rights,* Ministry of Justice and Human Rights
**16** See *Indikator Iptek Indonesia 2011,* Centre for Science and Technology Development Studies (PAPPIPTEK-LIPI). Note that in Higher Education researchers have to comply with the principles of Tridharma Perguruan Tinggi, i.e. they have three main duties: in Education, Research, and Community Service.
**17** See *OECD IP Review for Indonesia,* April 2013, and PAPPIPTEK, 1996–2007
**18** The implementation of national science and technology development is covered by a number of separate laws, such as no. 18/2002 on the National System of Research, Development and Application of Science, no. 17/2007 on the National Long Term Development Plan (RPJPN) 2005–2025, and Government Regulation no. 48/2009 on the Implementation of High Risk and Dangerous Research and Development and the Application of S&T activities; a number of Presidential Regulations and Instructions such as Instruction no. 4/2003 on Strategic Policy Formulation and the Implementation of National S&T Development and Regulation no. 5/2010 on the Mid-term Development Planning (NMDP) 2010–2014. Development is further stipulated by a number of government regulations on, for example, IPR issues (no. 20/2005), Technology Transfer (no. 20/2005), permits for Foreign Institutions (no. 41/2006), etc. At the moment novel legislation is being drafted to cater for a better embedding of innovation policies.
**19** E.g. National Coordination Meeting for Research and the Forum for Research and Technology Planning



INDONESIA

A number of government institutions play key roles in STI development.

1. The Ministry of Research and Technology (RISTEK) is mandated both to formulate national research and technology strategic policies, and to coordinate and synchronise the policy implementation of R&D institutes and applications of technology;
2. The National Development Planning Agency (BAPPENAS) plays an important role in formulating S&T policy in the National Medium Term Development Plan (RPJMN) and is responsible for programme and budget allocation planning;
3. The Ministry of Finance is ultimately responsible for budget allocation;
4. The National Research Council of Indonesia assists the Ministry of Research and Technology in the formulation of research and technology policies;
5. The Indonesian Academy of Science (AIPI)[20] assesses, monitors, evaluates, organises the direction, and solves problems related to the acquisition, development, and utilization of science and technology;
6. The S&T landscape further comprises a number of non-departmental government R&D institutes[21] under the authority of the Ministry of Research and Technology[22];
7. On top of this there are some eighteen ministerial R&D institutes responsible for research and development to support the programme of the ministry, and sixty nine regional research and development agencies all over the country;
8. Each of the fifty four state universities and some private universities have university-based research institutes.

In Indonesia the bulk of R&D is performed by public research institutes (PRIs), and more specifically government research institutions (GRIs), sometimes associated with non-departmental agencies. There are also a large number of private non-profit institutions playing a substantial role in R&D[23], and a reasonably large amount of R&D is simply performed by large international companies themselves[24].

RISTEK developed a National Mid-term Development Plan (NMDP 2010–2014), a National Research Agenda 2010–2014 (NRA), and the National S&T Development Strategic Policy 2010–2014, in which it tried to indicate the way forward for science and technology development. It espouses the vision of national S&T development as *science for the welfare and progress of civilisation,* i.e. the idea that science and technology will lead to an innovation-driven economy and ultimately enhance the welfare and living standards of the nation as a whole (see figure 1).

The mandate of the Ministry of Research and Technology is rendered relatively ineffective because it is not directly coupled to any clear financial authority.

### 2.1 National Innovation Council (KIN)

One of the most prominent STI mechanisms put in place in 2010 was the National Innovation Council (KIN), based on a Presidential Regulation. Until the formation of KIN there was no single, independent high-level body with an overarching, steering and co-ordinating function across the innovation chain as a whole. The council can thus be considered a national effort to provide advice on an effective and productive innovation systems, well-aligned with both policy and financial regulatory measures in economic sectors.

The Council's thirty members are directly appointed by the president, and it has five working groups on innovation programme development, innovation in business and industry, innovation cluster development, innovation-related incentives and regulations, and the economic, social and cultural aspects of innovation. KIN is expected to boost innovation by providing recommendations for innovation policy directly to the president, enhancing inter-sectoral collaborations among innovation actors, and monitoring the implementation of government innovation policies. As KIN has been but recently established, and interaction with the other advisory bodies mentioned above is not yet not formalised, it is still early days in which to assess the full efficacy of this new coordination body.

Another important advisory body, the National Economy Committee (KEN), working closely with the Ministry of Economic Affairs, was established around the same time as KIN. One of the first tasks of KIN and KEN was the formulation of the Master Plan for the Acceleration and Enlargement of Indonesian Economic Development (MP3EI).

### 2.2 Master Plan Acceleration and Expansion of Indonesia Economic Development 2011–2025 (MP3EI)

Indonesia's government has recognised that investments in applied research in key priority areas are crucial for an innovation-driven economy. This is clearly reflected in the Master Plan Acceleration and Expansion

20 See law no. 8/1990
21 Lembaga Pemerintah Non Kementerian (LNPK)
22 Indonesian Institute of Science (LIPI), The Agency for the Assessment and Application of Technology (BPPT), National Institute of Aeronautics and Space (LAPAN), National Coordination Agency for Survey and Mapping (Bakosurtanal), National Nuclear Energy of Indonesia (BATAN), The National Standardisation Agency of Indonesia (BSN), The Nuclear Energy Regulatory Agency of Indonesia (Bapeten), Eijkman Institute for Molecular Biology and Biotechnology
23 E.g. the Institute for Social and Economic Research, Education and Information (LP3ES), the Centre for Strategic and International Studies (CSIS), the Laboratory of Development and Environment (Lablink), the Indonesian Centre for Biodiversity and Biotechnology (ICBB), the Centre for International Forestry Research (CIFOR), the Research Triangle Institute (RTI), the International Centre for Research in Agroforestry (ICRAF), the International Rice Research Institute (IRRI), the Bremen Overseas Research and Development Association (BORDA)
24 See *R&D Survey Industry Sector,* PAPPIPTEK-LIPI, 2010





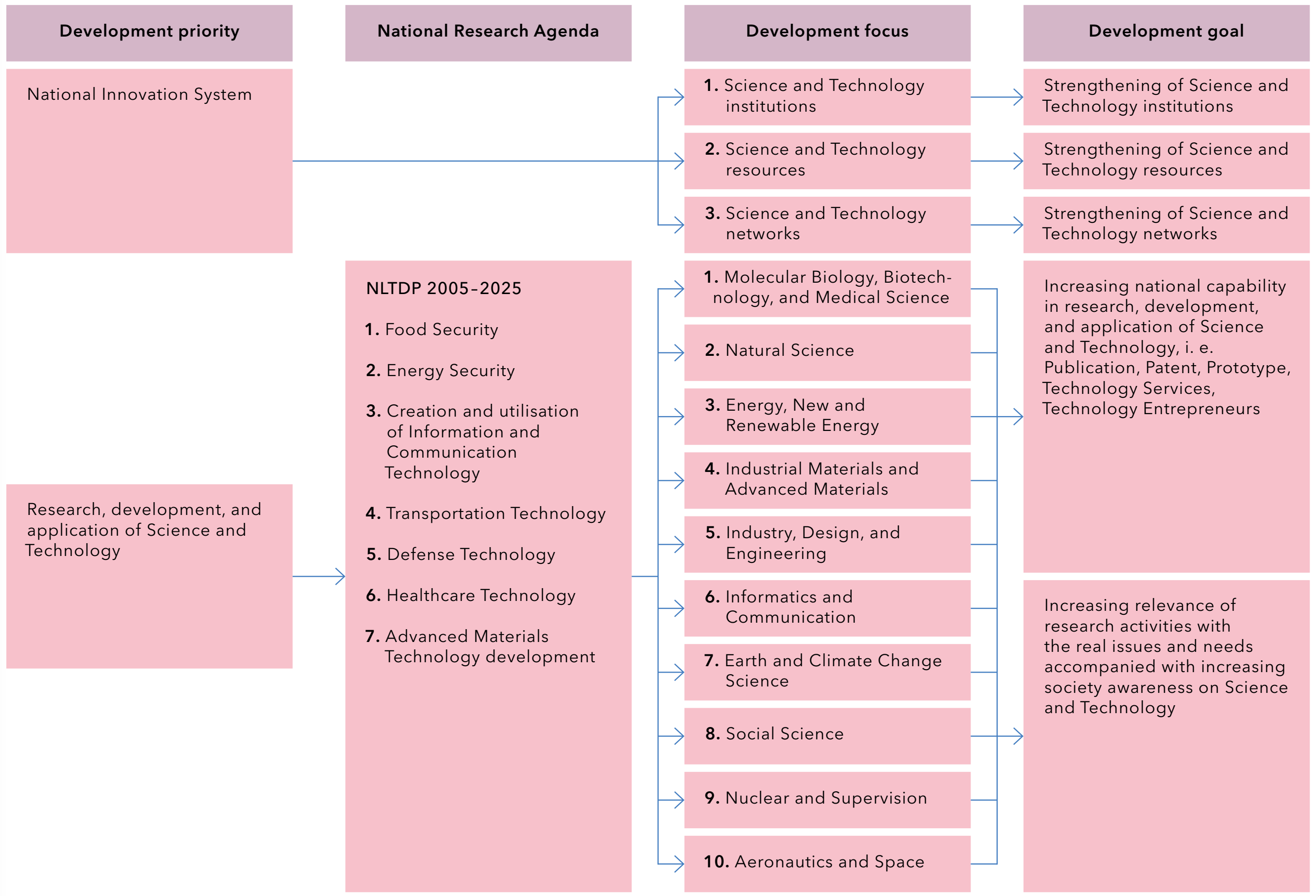


**Figure 1:** Indonesian S&T development framework[25]

of Indonesia Economic Development 2011–2025 (MP3EI), in which increasing the contribution of technology to meet the demand of domestic users has been acknowledged as a pivotal strategy for more mission-driven research. This plan, an addition to the existing National Long Term Development Plan (RPJPN), and tying in with the Ministry of Research and Technology's five-year Strategic Plan 2010–2014, aims for Indonesia to become a fully developed nation by 2025. Its ambition is to maintain a high annual economic growth of approximately 8 %, whilst at the same time transforming the economy from a natural resource and trade-driven economy, to one driven by innovation.

The three main pillars of the master plan are the development of six economic corridors throughout the archipelago, the development of robust links with the ASEAN member states and other countries in the world, and strengthening human resource, science and innovation capacity. It further elaborates eight strategic sectors and 22 economic activities[26].

Indonesia's government clearly recognises and encourages the continuous economic and social development of local communities, business entities, and local governments, and it therefore seeks to establish national as well as regional innovation clusters. The six economic corridors, as the centres of development, involve a regional innovation cluster for equitable growth, which is based on a centre of excellence and affiliated industrial clusters[27]. This regional approach is also conceived of as a way to redress the imbalance between well-developed Java and the less-developed outer regions of Indonesia (see figure 2).

The Presidential Working Unit for the Supervision and Management of Development (UKP4) has also been asked to keep track of the president's targets in the area of STI, as this is one the eleven national priorities of the United Indonesia Cabinet II (2010–2014) that are taken into account in the MP3EI. It is understood that the post-2015 development agenda will explicitly include policy measures on science, technology and innovation. According to UKP4 the focus has to be on gradual, incremental innovation to ensure that the local end-users will have access to appropriate innovations, such as local SMEs using existing technology and adapting this to local conditions.

25 Source: National Medium-term Development Planning 2010–2014
26 The eight strategic sectors are: the manufacturing industry, mining, agriculture, oceanography, tourism, telecommunication, energy, and strategic regional development.

27 The six clusters are: Sumatera, Java, Bali Nusa Tenggara, Kalimantan, Sulawesi, and Maluku-Papua.

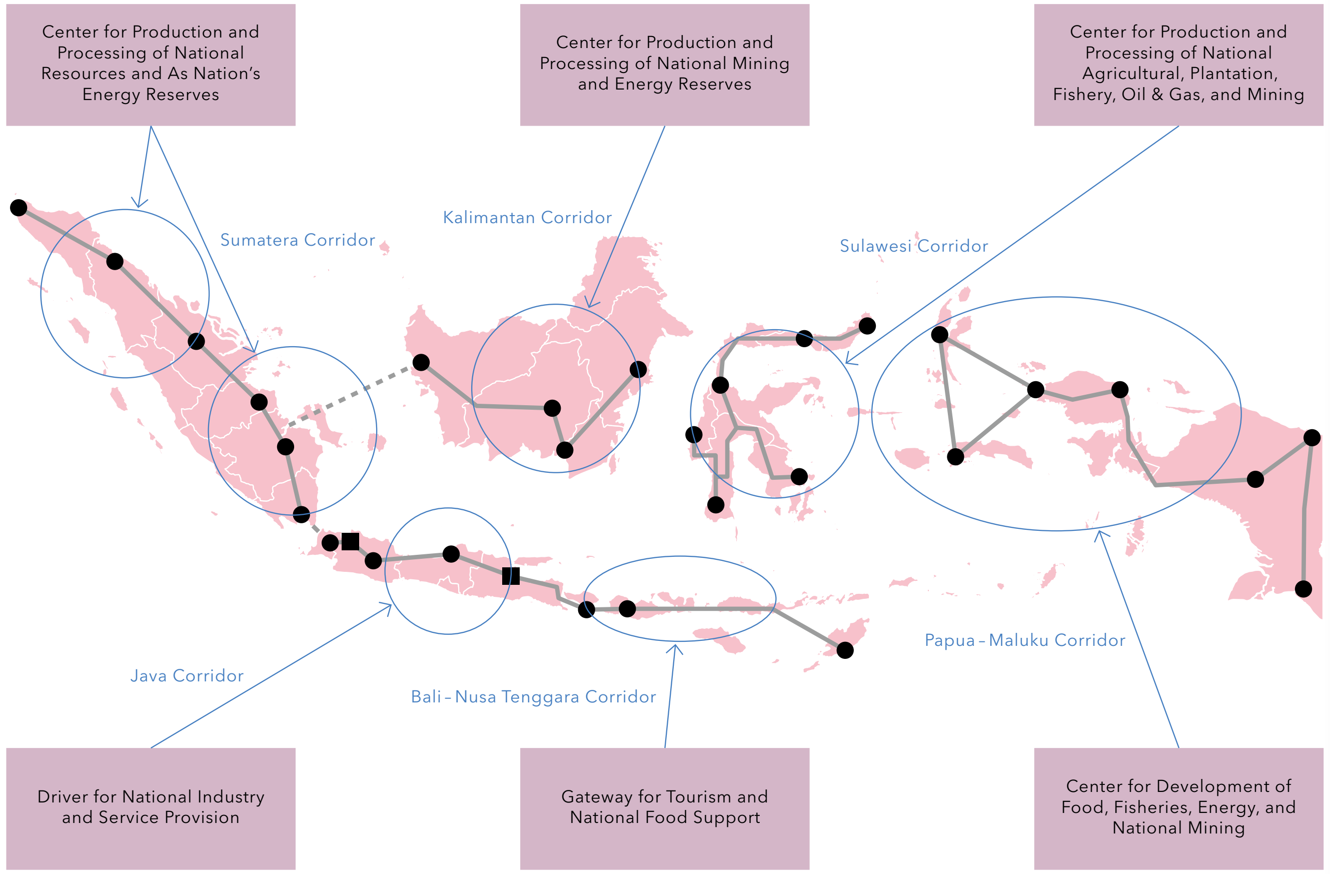


**Figure 2:** Regional innovation clusters in 6 economic growth centres[28]

### 2.3 Innovation Initiative 1-747

In the absence of a formal National Innovation System, KIN has provided a set of recommendations to the president in the form of the Innovation Initiative 1-747 (1% GDP for R&D in 2015, 7 steps to improve the innovation ecosystem, 4 models of innovation based industrialisation, 7 targets for the Indonesian vision for 2025) (see table 1).

## 3 Support instruments for innovation

The dominant mode of STI funding in Indonesia is institution rather than programme-based. Funding is usually provided in the form of direct institutional funding rather than funding allocated via competitive programmes.

### 3.1 State Ministry of Research and Technology

**National Innovation System Research Incentive**

The competitive incentive programme of National Innovation System Research (Insentif Riset SINas) is one of the policy instruments of the Ministry of Research and Technology that aims to support R&D performers optimising their resources as well as establishing innovative collaboration with industrial bodies. This research incentive is also intended for industrial entities so as to strengthen their S&T capacities.

The research incentive programme focuses on the following subjects: 1) Food, 2) Health and Medicine, 3) Energy, 4) Transportation, 5) ICT, 6) Defence and Security, 7) Material Sciences.

The schemes available within this National Innovation System Research Incentive are:

- Basic Research Incentive (Riset Dasar), particularly assisting state-of-the-art research activities to develop new high quality discoveries;
- Application Research Incentive (Riset Terapan), financing technology-production studies, including projects that aim to enhance technological integration. It specifically targets the development of basic research results to be turned into proven-technology applications;
- S&T Capacity Development in Production System Research Incentive (Rapasitas Sistem Produksi), funding technology development in the production sector through research partnerships with research bodies and the industrial sectors;
- S&T Diffusion and Utilisations Acceleration Incentive (Difusi dan Pemanfaatan), supporting the efforts of production sectors to enhance their S&T capacities, through collaboration with R&D bodies, particularly with the purpose of establishing technology based start-up companies.

28 *Innovation Capabilities in Indonesia: Challenges and Opportunities*, KIN, Jeddah, 18–19 February 2012





| Input | Process | | Output |
|---|---|---|---|
| 1% of GDP for R&D | 7 strategies to improve innovation ecosystem | 4 vehicles to accelerate economic growth | 7 goals of M.P 2025 |
| To increase R&D funding, 1% of GDP in the year 2015 | **1.** Remuneration for researchers and incentive to S&T programs<br>**2.** Revitalization of S&T infrastructure<br>**3.** Increasing applied research funding relevant to 4 vehicles<br>**4.** Creating center of innovation in SMEs<br>**5.** Creating regional cluster of innovation<br>**6.** Increasing synergy with global S&T centers<br>**7.** Creating appropriate atmosphere and culture, incentive and regulation to accelerate innovation | **1.** Basic Needs Industry (Food, Medicine, Energy, Clean Water)<br>**2.** Creative Industry<br>**3.** Regional-based Industry (S&T park & industrial park)<br>**4.** Strategic Industry (Defense, Transportation & ICT) | **1.** Increasing the number of patents and licenses of researchers and Industries related to economic growth<br>**2.** World class infrastructure of S&T<br>**3.** Sustainable and self supporting food, medicine, clean water, and energy<br>**4.** Increasing export of creative industry products by double figures<br>**5.** Increasing number of excellent regional products and value added industries<br>**6.** Self supporting defense, transportation and ICT systems and products<br>**7.** Well-distributed wealth and sustainable economic growth |

**Table 1:** Innovation Initiative 1-747. The recommendation by the Indonesian National Innovation Council (KIN)[29]

Both consortia and individual bodies can apply for these schemes. A consortium should consists of a triple helix of participants from government, higher education / university, and industrial bodies that share a functional cross-exchanging R&D agreement for executing a project, with a research topic that contributes to the national interest.

For each approved proposal, the upper limit of funding for non-consortium research is Rp 500 million (approximately US$ 50,000), and the lower limit for a consortium is Rp 500 million.

The targeted recipients of this programme are legally-recognised government agencies or non-departmental government R&D institutes, such as the Nuclear Energy Regulatory Agency, National Nuclear Energy Agency, Geospatial Information Body, the Agency for the Assessment and Application of Technology, the National Standardisation Agency, the National Space and Aviation Agency, the Indonesian Institute of Sciences, the research units of government ministerial bodies, industrial R&D entities, state / private universities, and the R&D units of NGO bodies.

### 3.2 Ministry of Education and Culture

**Capacity Building Programme (Postgraduate programme)**

This programme is dedicated to increasing the knowledge and skills of university lecturers by allowing them to take in post-graduate programmes (master's and doctoral degrees) both in Indonesia and overseas. In the long term, the programme is intended to increase competitiveness on a global level. The international part of this programme began in 2008. The total number of students participating in the programme has reached 1,104 people, spread across 27 countries.

**Research grants**

This multi-year programme[30] is undertaken by the Directorate for Higher Education (DIKTI). It covers various fields of research, such as economy, law, health, sport, science, mathematics, education, agriculture, engineering, literature, social and cultural studies. The research grant is subdivided into two programmes: (i) a decentralized research grant programme that allows the universities to organise research focus / research agendas based on their institutional constraints and challenges; and (ii) a competitive research grant programme that allows a synergetic approach to resources (people, funding, time) to find solutions to strategic problems in a more comprehensive, focussed and efficient manner, to counterbalance the sometimes unsystematic way some research is conducted in Indonesia.

The programme calls for the creation of consortia, and encourages the involvement of other government research agencies and stakeholders from the private sector. In the long-term, it is aimed at the development of centres of excellence that can improve innovation capacity in line with state of the art of technology and market-driven orientation.

29 *Innovation Capabilities in Indonesia: Challenges and Opportunities*, KIN, Jeddah, 18–19 February 2012
30 See http://www.dikti.go.id/files/Diktendik/Dosen/Panduan%20Pelaksanaan%20Penelitian%20di%20Perguruan%20Tinggi%20Edisi%20VIII.pdf

**Entrepreneurship Programme for Students in Universities**

This programme aims to provide a stock of scientific knowledge, skills and an attitude of science and technology-based entrepreneurship to students, and aims to change their mindset from being job seekers to being job creators, so as to become successful entrepreneurs.

**Co-operative Academic Education (Co-op) with SMEs**

This programme is developed in mind of the fact that SMEs were one of the national economic pillars that emerged from the economic crisis relatively unscathed. It fosters student abilities to create their own businesses by providing extended experience working with SMEs.

**IPR support programme**

The IPR programme[31] aims to increase the number of patents from universities. Applicants receive funding support for patent registration.

### 3.3 Ministry of Health

**IPR support**

The IPR support programme[32] aims to increase the quality of research within the Ministry of Health. The support is provided through a dedicated IPR centre. The centre is responsible for coordinating and assessing research that can potentially be registered for patent, copyright and other types of IPR.

**Research grants**

Research grants[33] are available to researchers in the National Institute of Health Research and Development (NIHRD) so as to conduct research in the area of biomedics and basic health technology, for clinical epidemiology and applied health technology, for public health intervention technology, for vector and disease reservoirs, and for herbal medicine. Some research activities are conducted in consortium-based groups, in tandem with other government research institutes, universities and private companies, in order to facilitate direct commercialisation of the research results.

**Capacity building programme**

This programme[34] is dedicated to increase the knowledge and skills of researchers, analysts and technicians.

**31** See http://www.dikti.go.id/files/Diktendik/Dosen/PANDUAN%20UBER%20HKI%202012.pdf
**32** See http://www.litbang.depkes.go.id/sites/download/LAPTAH/LAPTAH%20BADAN%20LITBANGKES%202012.pdf
**33** Ibid.
**34** Ibid.

Scholarships for degree programmes are open to those who want to pursue postgraduate courses. The Ministry of Health facilitates and coordinates candidates to obtain international scholarships, such as New Zealand-ASEAN Scholar Awards, DAAD scholarships from Germany, stipends from the Nuffic in the Netherlands, Fulbright awards from the USA, Australian Development Scholarships.

**Dissemination programme**

This programme[35] facilitates the publication of the results of research activities for the wider public through both national and international scientific journals, for other health communities, and for society at large.

### 3.4 Ministry of Agriculture

According to the vision espoused in the Ministry of Agriculture's Strategic Plan[36], research and development is an indispensable part of agricultural development in Indonesia. The strategic plan also articulates that the 2012–2014 National Budget (APBN) will be allocated in such a way as to revitalise the R&D sector in agriculture.

**Research grant**

This research grant is available to researchers in all working units in the Ministry of Agriculture and will cover the research topics of genetic engineering, plant breeding, plant cultivation, veterinary research, land mapping, application of satellite imaging and digital evaluation models and the like, policy analysis, agricultural mechanisation and precision farming, post-harvest technology, including processing and packaging, research on dissemination methods / strategies, research on standardisation, accreditation, monitoring and evaluation systems in agriculture, the establishment of robust research databases, market research, and other relevant topics. The scheme is also available to fund the activities of researchers and field instructors in empowering local farmers and local markets.

**Capacity building programme**

The Capacity Building Programme fund is available for all employees of the Ministry of Agriculture, which includes researchers, technicians, officials and field instructors. It is also available to young entrepreneurs. It supports both academic programmes and non-academic (i.e. non-degree) programmes.

**35** Ibid.
**36** *Rencana Strategis 2010–2014*, Kementerian Pertanian, 2011





**National Research and Development Partnership on Agriculture**

This funding scheme[37] is available to support collaborative research between the working units in the R&D Centre of the Ministry Agriculture with universities and/or other national research agencies. The expected output from the collaborative research funded by this scheme includes: 1) the establishment of a research network between the R&D Centre of the Ministry of Agriculture, universities and other national research agencies; 2) internationally / nationally published scientific papers; and 3) prototypes. The fund is available to support R&D activities covering agricultural-related themes in basic and applied research, which will result in publications in national / international scientific journals and/or registered patents.

### 3.5 Triple Helix examples of innovation clusters, incubators, centres of excellence

According to the triple helix model, three main stakeholders are to be involved in any national innovation system, viz. 1) the government as regulator and facilitator, 2) the industry and business sector, and 3) research institutions and universities. The smooth collaboration of these three main stakeholders is indispensable for an innovation-driven economy. Indonesia has recognised that facilitation for innovation can come in the form of establishing business innovation centres and S&T science parks. A few of these are listed below.

- The Centre of Science and Technology Research (PUSPIPTEK-Serpong), is an S&T park that supports innovation-based SMEs in relevant strategic areas, and facilitates interaction between universities, research and development institutions, and business resources. The main drawback of the Puspiptek centre is that it is unconnected to, and geographically at a great distance from, any university;
- The Bandung Raya Innovation Valley (BRIV). This university-driven innovation park, is a science-industry-innovation park located in West Java launched by the President in August 2012, where stakeholders like inventors, entrepreneur, suppliers, government agencies, can benefit directly from the incentives provided by the government;
- Cibinong Science Centre (CSC-LIPI);
- Bogor Botanical Garden (LIPI);
- The North Gresik Innovation-based industrial zone, launched by the President in August 2012. It serves as a best practice example in each of the corridors identified in MP3EI for an industrial innovation cluster, taking into account the specific regional resources;
- A number of Agro Techno Parks, e.g. in Palembang, Cianjur, Jimbaran, Minahasa, Bohorok, Limapuluh Kota;
- Innovation in Tropical Disease Vaccines, a centre of excellence for vaccine research and an industrial network led by Biofarma, a state-owned pharmaceutical company, including national and international universities and companies that collaborate in producing vaccines for various tropical diseases.

## 4 International cooperation

Indonesia's government realises that international cooperation is important for understanding and applying science and technology, and for providing best practices that have been developed in various countries. International partners increasingly tend to send their experts to Indonesia and transfer their skills to Indonesian scientists. International cooperation is to a large extent focussed not merely on producing patents, but on knowledge creation, education and the development of science policy[38].

One of the three pillars of the Master Plan Acceleration and Expansion of Indonesia Economic Development 2011–2025 (MP3EI), is explicitly to further enhance interaction not only with the ASEAN member states, but also with other countries in the world.

To improve its level of education Indonesia needs to focus its human resource development on competence through a combined curriculum of science and technology, social value, and humanities education. Indonesia tries to deploy and increase its existing educated workforce, particularly those with master's and doctoral degrees. The Ministry of Research and Technology has a number of schemes specifically targeted at human resource issues in innovative research programmes, such as an S&T capacity building programme for LPNK (a non-departmental government institution) researchers, and the RISET PRO Programme, supported by the World Bank. Research performed by the National Development Planning Agency (BAPPENAS) shows that Indonesia needs to strengthen human capacity building through vocational training and developing centres of excellence. The Ministry of Education has a large programme of sending Indonesian PhD students to Europe and America.

It is still a relatively common practice for large private companies to cooperate with international industries in the area of medicine and health when it comes to fundamental and applied science, rather than with national enterprises that tend to have a short-term view of research in terms of economic profit. However, Indonesia recognises that the adaptation of, for example, vaccines

**37** Kerjasama Kemitraan Penelitian dan Pengembangan Pertanian Nasional (KKP3N), Badan Penelitian dan Pengembangan Pertanian Kementerian Pertanian, 2012

**38** A good example of a consortium working along these lines is the Vaccine Consortium of the Ministry of Health, Biofarma, the Ministry of Research and Technology, and universities.

for local diseases, is important for the country, rather than trying to compete with large international companies. The vast natural resources Indonesia has at its disposal vouch for building a research infrastructure in Indonesia itself. The National Institute of Health Research and Development (NIHRD) has a consortia of Indonesian partners in the private sector (Biopharma, Kimiapharma, Indopharma) and international partners in the Netherlands, Belgium, Japan, and Thailand, and their training programmes receive assistance from overseas programmes, such as USAID.

The National Development Planning Agency notes that many large international companies do not base their R&D activities in Indonesia as the result of a lack of trust in Indonesia's S&T infrastructure. The agency strongly recommends that the relevant ministries bring into play stronger incentive measures to increase the number of international R&D industries in Indonesia with the aim of bringing the results of fundamental research to the market.

Indonesia's publication performance has improved steadily over the period 2000–2010, with an increase of publications in English language journals. Over 74 % of publications involved international cooperation, as co-publications with the EU-27 (with the Netherlands in first position), the USA, Australia and Japan[39]. Indonesia is particularly strong in international peer-reviewed publications on the agricultural and biological sciences and on medicine[40]. However, Indonesia is underperforming when it comes to USPTO patents[41].

## 5 Key strengths and weaknesses

Indonesia needs to address a number of major challenges in setting up a national innovation system on the route to an innovation-driven national economy.

Crucial amongst these challenges are to align regulations and policies conducive to the whole chain involved in innovation (S&T, finance and tax systems, higher education, trade, social welfare) in a coherent, transparent fashion[42]. The significant lack of coordination is reflected in the fact that R&D research is conducted in many ministries by their R&D agencies, in universities under the authority of the Ministry of Education, in non-departmental government institutes under the Ministry of Research and Technology, in provincial R&D agencies under the authority of the Ministry of Internal affairs, etc. Indonesia's government feels the need for a coherent, independent funding mechanism for basic and applied research, tailored to the needs and timetables of researchers, as in a National Research Council construction, rather than having research funds somewhat haphazardly distributed over a great many ministries, all with their own vested interests, and stringently tied to annual budget cycles.

It is also extremely important to address the faulty or abortive implementation of regulations and policy measures conducive to a smoothly working innovation system, mainly caused by the scattered landscape of governmental bodies sharing the responsibility for implementing these measures. In general, a more innovation-driven S&T culture for Indonesia would also entail reviewing existing S&T laws, regulations and fiscal incentive systems for business (private and state-owned), revitalising a National Research Council, refining and redesigning the scale, scope and accessibility of S&T parks, and facilitating the formation of R&D consortia through incentives provided by the central government.

One of the most striking features of Indonesia's innovation policy is that R&D activities fail to be regarded as commercially viable proposals. This is reflected in the fact that governmental research funds, according to the Annual National Budget (APBN), are almost exclusively allocated to universities, and in only much smaller proportions to R&D institutes. University-based academicians[43], and academia-focused research are expected to contribute directly to innovation. There is no other group of stakeholders in the innovation chain which receives direct financial incentives in the way academia does. The Ministry of Education budget however, only allocates a small amount to fundamental research proper, and virtually none to applied research.

Only a few collaborative research projects between academia and R&D institutes on the one hand, and industry on the other, are established on a mutual benefit basis. Almost none of these utilise a commercial loan scheme, as an effective royalty sharing procedure is not yet in place. Although the Ministry of Research and Technology has a number of incentive schemes which demands that applicants form a consortium with industrial partners[44], the number of applicants is still relatively low. It is generally felt that not enough incentives are available for Indonesian researchers to engage in entrepreneurial activities, and that there is still quite some room for development when it comes to a good strong basis for fundamental research as the necessary prerequisite for applied research.

One of the consequences of this model is that research orientation is mainly focused on academic purposes and is demand-driven only to only a very limited degree. The research agendas do not sufficiently relate to the needs of the productive sectors, whereas the infrastructure to facilitate this (incubators, business innovation centres, and intermediary bodies) is not, as yet, well developed or very effective. Indonesia's current non-demand-driven innovation system is insufficiently able to provide solutions for the needs of a wide range of local end-users, such as small-scale farmers. The low of uptake of national research findings and development technologies by domestic users, due to the prevalent academic research orientation to the detriment of a demand-driven approach, is one of the crucial challenges. It would seem that both a more mission-driven R&D to create relevant technologies, and an increase in the absorptive capacity of domestic technology by identifying needs and problems at the grass-root level of domestic users, is needed.

Steps could be taken to redress the insufficient trust held by industry in Indonesia's university and domestic R&D institutions, for developing reliable technologies. This is exacerbated by Indonesia's tendency to acquire foreign technology, which is believed to be more reliable, cheaper and can be used instantly. There is little to be obtained from acquired technology if this cannot be adapted and optimised for domestic use, however.

In medicine, Indonesia's top institutes mostly take their best practice examples of how to establish good research institutes from Singapore. Singapore, with an environment and infrastructure hospitable to both fundamental and applied research in medicine, attracts many of the most brilliant Indonesian scientists, causing a certain amount of brain drain from Indonesia.

The rather low levels of expenditure on R&D in the university sector[45], and constraints on spending research budgets (e.g. the need to return all unspent budget allocations at the end of every fiscal year), act as disincentives for university staff to get involved in joint activities with industry, despite the fact that some government schemes do try to encourage public-private research partnerships. It seems pivotal to increase the inadequate funding for R&D activities. Industry is one of the driving forces of economy, and industrial research towards invention and innovation of new technologies is a significant component of Indonesian economic development strategy. On the part of the government, at least one per cent GDP is needed for supporting STI activities, and on the part of industries and non-departmental government institutes more research incentives to become directly involved or contribute to R&D and innovation activities seem in order.

Indonesia's government also acknowledges the need to both strengthen the private business sector and state-owned enterprises by implementing incentive systems that reflect industrial needs, and to strengthen small and medium innovative enterprises and start-ups by developing new products and providing customised innovated technologies. Most private sectors have very low-tech R&D activities, and too few effective incentives are available to bring high-tech inventions to the market.

More focus in terms of technology and entrepreneurship should be given on lead sectors, selected on comparative and competitive advantages, as well as to the lack of awareness of academics of the problems associated with economic development requiring the contribution of technology, and the lack of awareness of the broader public, including domestic technology users, of the significance of innovation-driven research.

Universities as actors of innovation can be strengthened by building R&D clusters and nurturing research activities leading to the development of core technologies relevant to Indonesian comparative and competitive advantages.

The rapid expansion of the higher education system is needed to develop Indonesia's human resources into a more daring entrepreneurial and innovation-driven force. It is very important for Indonesia to have a high quality educational system at various levels of education so as to strengthen the knowledge base of its society, and to generate a new Indonesian creative and innovative generation with an improved entrepreneurial mindset.

Indonesia's government fully acknowledges that amongst the key bottlenecks for a smoothly working national innovation system the most prominent ones include the poor level of education, especially higher education (particularly in the areas outside Java), the low level of infrastructure for science and technology, the low level of the extra-university R&D budget, the relative weakness in coordination, operational instruments and, generally speaking, a lack of support and appreciation for the crucial role of researchers in national development. A bottom-up approach is needed to encourage the public and private sectors to collaborate by providing appropriate incentives to all stakeholders of the Triple Helix (industry, academia and government).

KIN has therefore proposed the following five areas of innovation to be pushed forward:

1. Strengthening the innovation capability of industries, universities and research institutions;
2. Producing and commercialising the products from research activities;
3. Strengthening cooperation with research institutions and companies and synchronising policy, budget and programmes;
4. Securing R&D investment efficiently and preparing / developing high quality S&T-based human resources and human capital;
5. Creating innovation-driven S&T ecosystem and culture.

**39** Science Metrix analysis of Scopus database
**40** See Scopus, 2009
**41** See US Patent and Trademark Office, 2012
**42** See also *National Innovation System in Indonesia: Present Status and Challenges,* B. Lakitan, presented at the Annual Meeting of Science and Technology Studies, Tokyo Institute of Technology, 10–12 June 2011; *Innovation in Southeast Asia,* OECD, 2012
**43** Indonesia has 54 state universities and 418 private universities.
**44** Diffusion Research Incentives Scheme, and Enhancement Capacity of S&T for Production System Scheme
**45** See *Indikator Iptek Indonesia 2011,* Centre for Science and Technology Development Studies (PAPPIPTEK-LIPI)

# 6 Appendices

## Appendix I: Institutions visited

*National Innovation Council (KIN)*

*Serpong Science and Technology Research Centre / Puspiptek*

*SEAFAST Centre (Southeast Asian Food and Agricultural Science and Technology Centre)*

*Indonesia International Institute for Life-Sciences (I3L)*

*Ministry of Research and Technology (RISTEK)*

*National Development Planning Agency (BAPPENAS)*

*Centre for Science and Technology Development Studies, Indonesian Institute of Sciences (PAPPIPTEK-LIPI)*

*Business Innovation Centre (BIC), ITB Bandung*

*President's Delivery Unit for Development and Oversight (UKP4)*

*National Institute for Health Research and Development (NIHRD)*

*Eijkman Institute for Molecular Biology*

*Indonesian Academy of Sciences (AIPI)*

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World Economic Forum (2012).


## Appendix III: Policy cycles

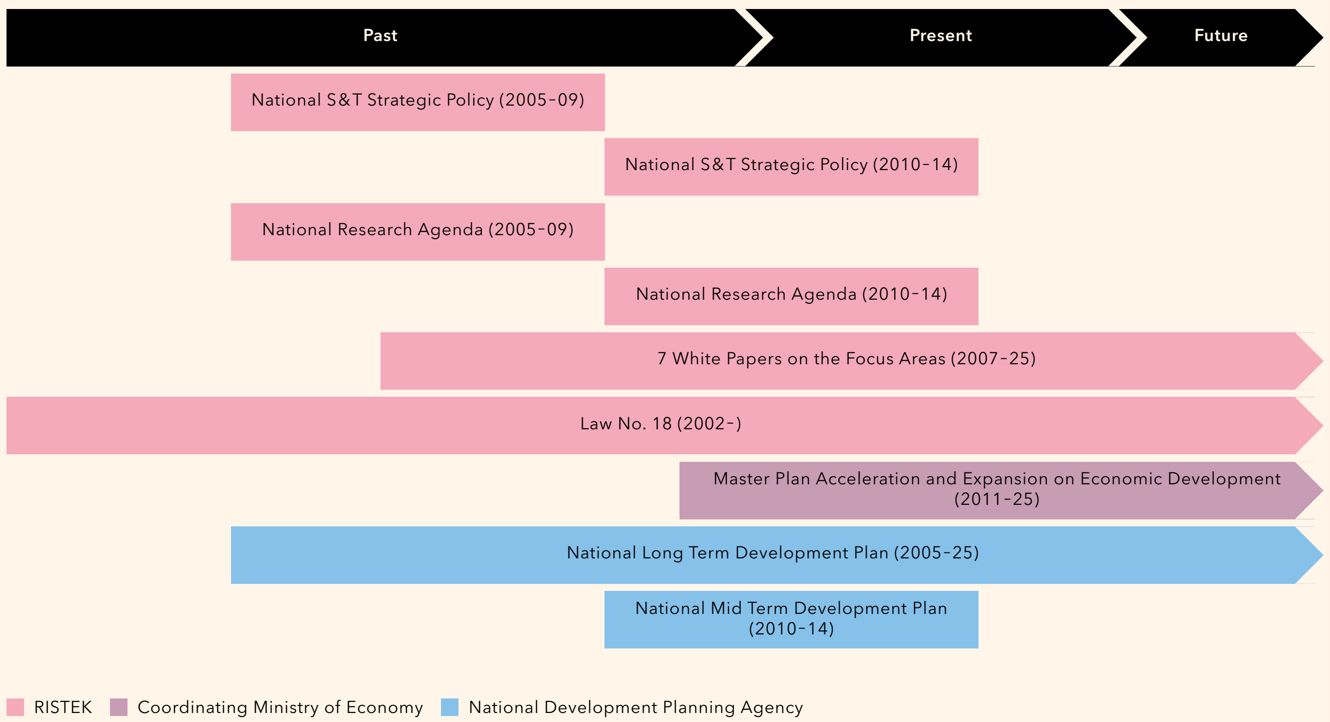


**Figure 4:** Policy cycles





## Appendix IV: Funding agencies and instruments[46]

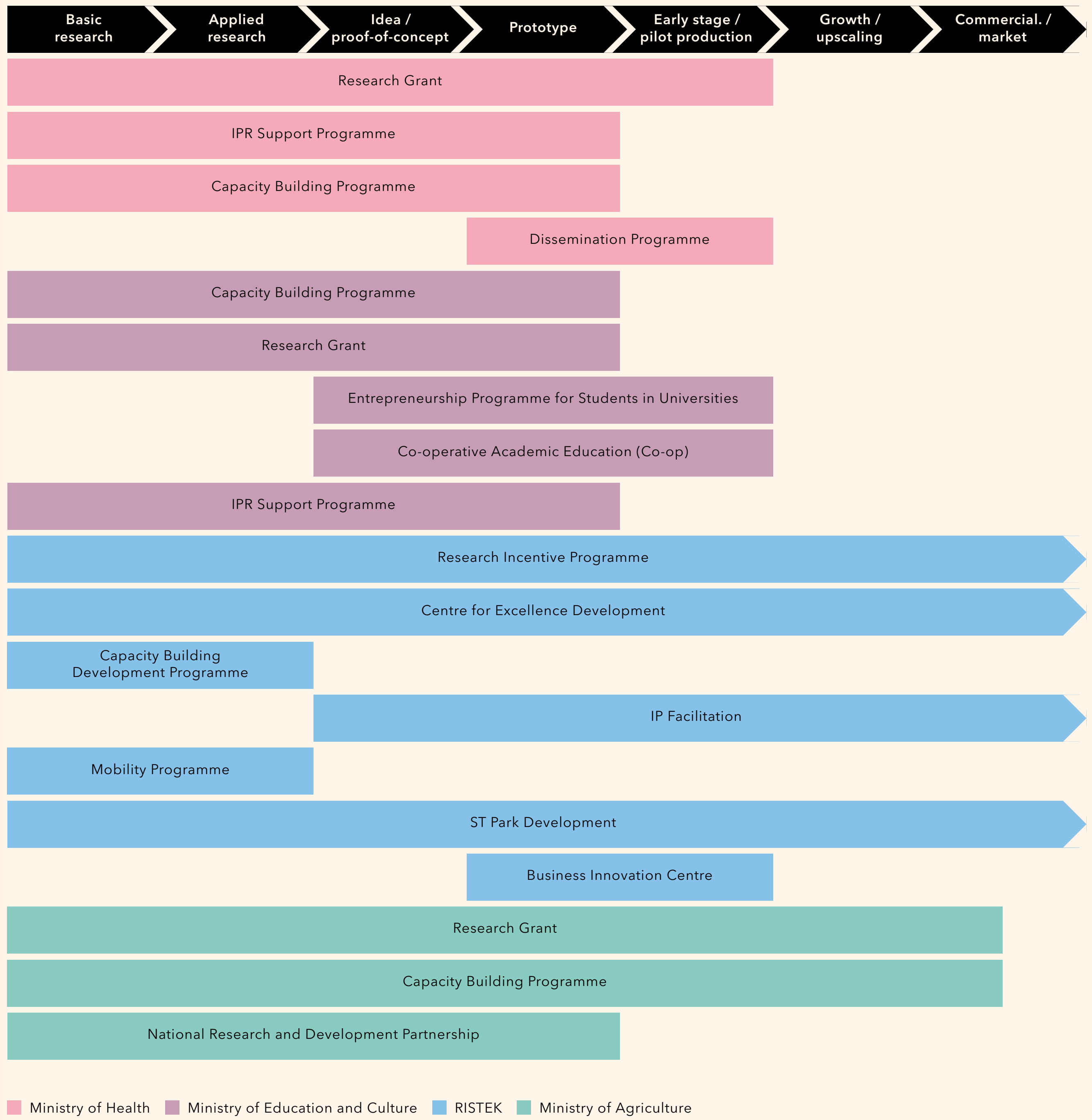


**Figure 5:** Funding agencies and instruments

**46** According to the stage in R&D / product development they focus on

# Malaysia[1,2]

Sara Medina[3], Kai Zhang[3], MOSTI[4]

## 1 Key indicators and framework conditions

Through its transition from a strong reliance on commodities to export-led manufacturing and foreign direct investment (FDI), and finally with the current emphasis on knowledge, and science, technology and innovation (STI), Malaysia is now ranked 15th in the International Institute for Management Development (IMD) World Competitiveness Ranking in 2013, and ranked 24th in the Global Competitiveness 2013–2014 Report written by the World Economic Forum.

Malaysia is second to Singapore in terms of Gross Domestic Product (GDP) per capita within the Association of Southeast Asian Nations (ASEAN) region[5]. A consistent government policy orientation has helped to rapidly strengthen Malaysia's position as a middle-income country, according to United Nations (UN) standards. This has been furthered by the focus on FDI and exports of technology-based products by multinational enterprises (MNE), for instance in the automotive and electronics industries, as well as improvements in the services sector, in particular tourism, and the impact of Islamic banking and finance.[6]

Malaysia now finds itself at a critical moment in the planned move towards a fast-growing economy with an emphasis on STI.

In 2012, Malaysia's GDP was mainly derived from industry and services – 38.5 % and 50.4 % respectively. In the same year, agriculture provided 10.1 % of GDP. Notably, manufacturing plays a leading role and contributes around 24.2 % of GDP.[7]

Gross domestic expenditure on research and development (GERD) has grown since 2000 and reached RM 9,422 million (€ 2,129.4 million) in 2011, three times the value in 2006. The GERD was 1.07 % of GDP in 2011. The private sector has been the main contributor to the GERD since 1996. In 2011, the private sector accounted for 56.7 % of GERD, although this represents a proportional decrease since the high point in 2006; while the public sector, namely government agencies and research institutes (GRI) and institutions of higher learning (IHLs) contributed 14.4 % and 28.9 % respectively.[8]

Malaysia ranks 32nd out of 142 countries in the Global Innovation Index[9], with relative strengths in GERD financed by business, ease of getting credit, high-tech exports, graduates in science, and engineering and cluster development. Relative weaknesses include GERD financed by foreign sources, employment in knowledge-intensive services, and education.

In terms of public awareness related to S&T issues, there seems to be a relevantly strong interest from the public in computer sciences and innovations in telecommunications, as well as in environmental pollution issues. This is in accordance with environmental sciences being listed as one of the national S&T priorities.[10]

1 This chapter is partly the result of a fact-finding mission (FFM) organised in June 2013 under the framework of the European Commission funded project "SEA-EU-NET 2: EU-ASEAN S&T Cooperation to Jointly Tackle Societal Challenges".
During the FFM, fourteen key organisations involved in science, technology and innovation (STI) in Malaysia were interviewed.
2 The authors also want to thank Osman Bin Zakaria from SIRiM Berhad (Malaysia) for his support in facilitating interviews.
3 Sociedade Portuguesa de Inovação (SPI), Porto, Portugal
4 Ministry of Science, Technology and Innovation, Putrajaya, Malaysia
5 http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?order=wbapi_data_value_2012+wbapi_data_value+wbapi_data_value-last&sort=desc, GDP per capita 2012 ranking (accessed October 2013)
6 *Malaysia – The Atlas of Islamic-World Science and Innovation*, Country Case Study no. 1, San Francisco, 2011

7 Department of Statistic Malaysia, Annual Gross Domestic Product 2005–2012
8 *National Research and Development (R&D) Survey*, MASTIC
9 http://www.globalinnovationindex.org/content.aspx?page=data-analysis, Global Innovation Index (accessed December 2013)
10 *S&T Indicators Report*, MASTIC, 2010





| Indicator | Number | Year |
|---|---|---|
| GERD | RM 9,422 million (€ 2,129.4 million) | 2011 |
| GERD as a percentage of GDP – GERD/GDP | 1.07 %[11] | 2011 |
| Private sector proportion of R&D expenditure (%) | 56.7 %[12] | 2011 |
| Full-time equivalent (FTE) of R&D personnel (person-year) | 47,242.1[13] | 2011 |
| Head count of researchers | 73,752[14] | 2011 |
| Researchers per 10,000 labour force | 58.2[15] | 2011 |
| Publication output | 28,330[16] | 2010 |
| Number of patents granted | 50,391[17] | 1988–2013 |
| Foreign direct investment | RM 34.8 billion[18] (€ 7.9 billion[19]) | 2012 |
| Number of research universities | 5 | 2011 |
| Total early-stage entrepreneurial activity (TEA) rate | 7[20] | 2012 |

**Table 1:** Important STI related indicators

Malaysia still has a relatively low but increasing rate of total early-stage entrepreneurial activity (TEA). The TEA was 7 % in 2012, increasing from 4.96 % in 2010. Among the TEA conducted by adults (between 18 and 64 year-olds) in 2010, the 25–34 age group accounted for the most (34 %) followed by the 35–44 age group. Experts from the Global Entrepreneurship Monitor (GEM) Global Report indicated that entrepreneurial activities in Malaysia have benefited from a good presence of programmes / initiatives and financing measures to support new and growing firms, as well as supportive national policies.[21] Table 1 demonstrates a selection of STI related data in Malaysia.

## 2 Governance and public STI policy

### 2.1 Key institutions

The key actors in Malaysia's National Innovation System (NIS) include: government agencies and bodies; R&D sector organisations such as universities, GRIs, and research companies; innovation support centres; institutions in the financing sector; education and training institutions; and commercial enterprises. These actors are linked through formal and informal networks, and contribute in various ways to the generation and diffusion of knowledge. They are illustrated in figure 1 below, together with the key aspects to which they contribute.

Main entities with responsibility for innovation-related policies include the Ministry of Science, Technology and Innovation (MOSTI), the Malaysian Innovation Agency (AIM), and the Ministry of Education (MOE) – formerly known as the Ministry of Higher Education (MOHE).

Major funding bodies include MOSTI, MOE and the Malaysian Technology Development Corporation (MTDC). Overall, a total of 14 agencies under 8 ministries provide grants for R&D activities. MOSTI acts as a coordinator for STI related policies and instruments. A wide range of funding instruments exist in the country to support STI related activities, covering R&D stages from basic research to commercialisation activities.

MOSTI (originally formed as the Ministry of Technology, Research and Local Government in 1973) supervises over 20 departments and agencies that are essential in defining Malaysia's scientific landscape, especially in the five key areas of biotechnology, industry, sea to space, and science and technology core services. MOSTI provides and manages funding including pre-seed, and research, development and commercialisation (R&D&C) grants. The distribution of this funding allocates approximately 30 % to applied R&D initiatives and 30 %–35 % to support pre-commercialisation initiatives, and the remaining amount is dedicated to commercialisation grants.

MOSTI's funding of R&D&C grants reached a total of RM 2,955.33 million (€ 667.9 million) during the Ninth Malaysia Plan (9MP, 2006–2010). Under the Tenth Malaysia Plan (10MP, 2011–2015), 86 national initiatives have been launched to support STI related projects, together with a range of incentives under MOSTI.

MOSTI set up the Clusters in 2007 to coordinate programmes and activities under various industry clusters, including the Malaysian Nuclear Agency (Nuclear Malaysia), the Department of Standards Malaysia (Standards Malaysia), SIRIM Berhad (SIRIM), MTDC, the Malaysian Design Council (MRM) and the Atomic Energy Licensing Board (AELB).

11 *National R&D Survey*, MASTIC, 2012
12 Ibid.
13 Ibid.
14 Ibid.
15 Ibid.
16 *Innovation in Southeast Asia*, OECD, 2013
17 http://www.myipo.gov.my/paten-statistik/, Intellectual Property Corporation of Malaysia (accessed January 2014)
18 http://www.mida.gov.my/env3/uploads/PerformanceReport/2012/MIPR2012_Slides2.pdf, *Performance Report 2012*, MIDA (accessed December 2013)
19 All amounts in € in this document are calculated based on the RM:€ exchange rate 0.226. Source: http://www.oanda.com/lang/pt/currency/converter/, Oanda (accessed August 2013)
20 *Global Report 2012*, Global Entrepreneurship Monitor (GEM)
21 Ibid.;
*Malaysia Report 2010*, GEM

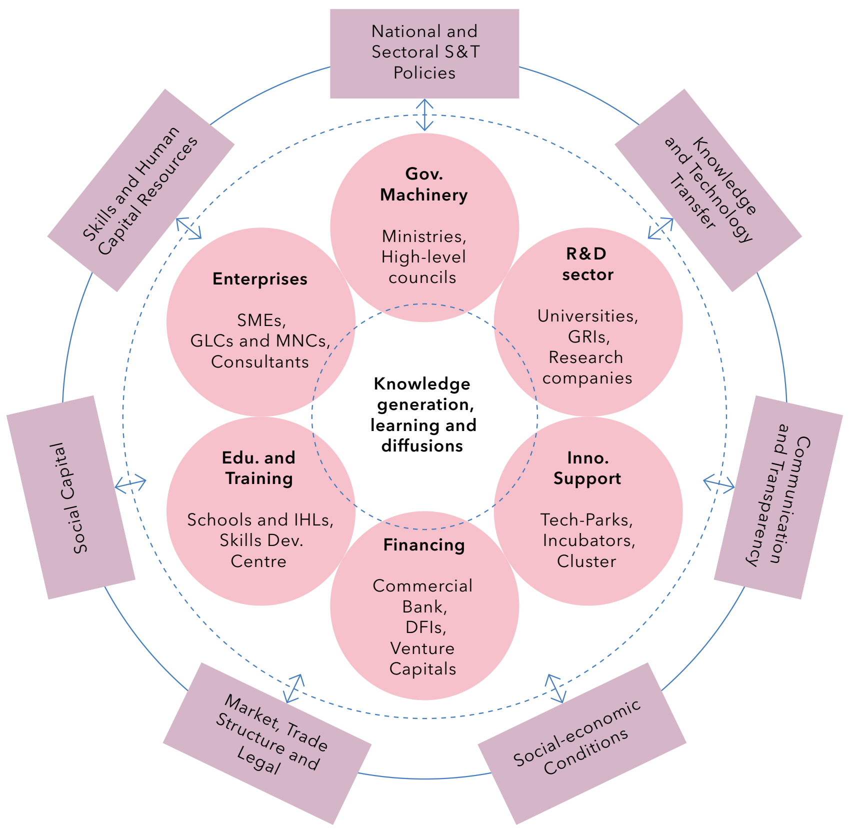


**Figure 1:** Institutional structures supporting innovation and R&D[22]

Major policy advice bodies include the Malaysia-Industry High Technology Group (MIGHT) and the Academy of Sciences Malaysia (ASM), which actively support national STI policies and work to promote science to a broader range of stakeholders. The Malaysian Science and Technology Information Centre (MASTIC) is the official reference centre for STI statistics and indicators. It is responsible for the National Research and Development Survey, held every year since 2008 (prior to 2008 this survey had been conducted biennially since 1992) and the National Innovation Survey which is held every 2–4 years. MASTIC is internationally regarded as a reliable source for STI information in Malaysia. MASTIC has also been responsible for publishing the Science and Technology Indicators Reports on a biennial basis since 1994, summarising the country's STI indicators.

The National Science and Research Council (NSRC) has further set up R&D priority areas to drive STI development in Malaysia – including ICT, biodiversity, cyber security, energy security, environment and climate change, food security, medical and healthcare, plantation crops and commodities, transportation and urbanisation, and water security.

Several ministries and organisations provide funding for human capacity development, including the MOE and the Ministry of Agriculture (MOA). MOA provides grants for agriculture-related research activities as well as training programmes that engage youth and entrepreneurs in agriculture production with the use of high-technology.[23]

There are a total of 20 public universities (excluding colleges and academies) and 18 private universities in Malaysia. Over the past 15 years MOE has become increasingly open to private and foreign universities, including the University of Nottingham in the United Kingdom (UK) and Monash University of Australia. Box 1 describes the research universities (RU) in Malaysia:

> Five research universities – Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Sains Malaysia (USM) and Universiti Teknologi Malaysia (UTM) have been appointed by MOE based on their performance on the RU Assessment Instrument. They feature research-focused fields of study, competitive entry and overall aim to have a 50:50 ratio of graduate and postgraduate students. These universities receive special allocation based on their status as research universities. In 2012, MOE announced, after an audit assessment, that these five public universities had been given autonomy in areas such as administration, human resources, and academic management. However they were only given some financial autonomy. MOE is also enhancing internationalisation in the higher education sector by setting goals to increase the number of international students in Malaysian universities, creating Malaysian chairs in foreign universities, and fostering R&D collaboration with international universities and research institutions.

**Box 1:** Research universities in Malaysia[24]

22 *Innovation in Southeast Asia,* OECD, 2013

23 http://www.moa.gov.my/web/guest/program-latihan-kemahiran-pertanian-kebangsaan/, MOA official website, programme details (accessed July 2013)





In addition to investment in human capital development and research activities, MOE strives to promote academia-industry collaboration. The Academia-Industry Consultative Council (AICC) under MOE was founded to create and foster links between stakeholders, providing funding and support under the National Higher Education Strategic Plan to research universities through the establishment of industry and community partnership offices. Several initiatives have been undertaken to improve academia-industry connections. For example, UPM set up a Deputy Vice Chancellor of Industry and Community Partnership to promote networking and relationships with industries in order to improve the quality of educational and R&D activities.[25]

SIRIM is a wholly-government-owned institution under the Ministry of Finance. As a premier total solutions provider, SIRIM drives quality and technology innovations that help institutions and companies to better compete through every step of the business value chain. SIRIM's technology focus areas are aligned with national strategic initiatives in energy and environmental technologies, plant and machinery expertise and medical technologies. SIRIM is able to provide total solutions for the industry and end users through its core businesses in research and technology innovation, technical services and conformity assessment. Together with industry partners, SIRIM has enabled Malaysian products and services to receive due recognition for quality and innovativeness worldwide.

MIMOS is the national R&D centre for ICT in Malaysia, focusing on R&D for national competitiveness and generating new technology ventures. MIMOS' mission is to pioneer innovative information and communication technologies (including microelectronics) towards growing a globally competitive indigenous ICT industry. Most local ICT companies focus more on product and solution development activities as opposed to research activities. To address this challenge, MIMOS is focusing more on research than product development.

The technologies and technology platforms developed by MIMOS will be transferred to industry recipients as the basis for product innovation. This reduction in 'technology risk' will enable more local industries to move faster into the market place. It must be emphasised that the 'technology platform' strategy not only helps to reduce the 'technology risk' for the local industry players but also enables the rapid development of 'verticals', innovative applications. Industry recipients will be able to patent novel products and solutions based on technologies or technology platforms to create competitive products and solutions. In addition, MIMOS also supports the local E&E companies by providing wafer fabrication and failure analysis services.

As stated, the private sector in Malaysia plays a significant role in Malaysia's R&D, being the largest contributor to GERD since 1996. The high point was in 2006, when 84.9 % of GERD was business funded. However, very few – 5.5 % – of the companies, mainly MNEs, participate in R&D activities.[26]

Technology Park Malaysia (TPM) is the leading and premier technology park in the country with development clusters in ICT, Engineering and Biotechnology. Since its establishment, it has provided support services, technology and R&D capability to stimulate the growth of science, technology and innovation. This includes the rental of incubator premises to scientists, researchers, technopreneurs (entrepreneurs involved with high technology) and SMEs, and the lease of land parcels for technology knowledge-based companies. TPM also provides a technology and business incubation programme, including business mentoring and coaching services, marketing and financial consulting, technology and business forums, workshops and business matching.

Among its renowned co-incubation and international partners are Shanghai Technology Innovation Centre, the Hong Kong Science and Technology Park and Novosibirsk State Technical University. TPM is also a member of the National Business Incubation Association, National Incubator Network Association, Asian Science Park Association, Asia Pacific Incubation Network and Association of University Research Parks.

Other service elements at TPM are technology commercialisation assistance and support for the commercialisation of technology, including advisory and consulting services in technology transfer, project management, strategic management advice, market research and opportunity analysis, and professional development programmes.

Senai Hi-Tech Park is a fully integrated technology park that is located in the southern state of Johor, sited immediately to the south of Senai International Airport. It is part of the integrated and comprehensive development of Senai Airport City (SAC). The Senai HTP is part of the flagship development under Iskandar Malaysia known as Flagship E, which is accessible to other

24 *Study on the State of S&T Development in ASEAN,* UNESCO Institute for Statistics, 2011

25 Ibid.

26 *Innovation in Southeast Asia,* OECD, 2013

regions via air through Senai International Airport. It is also well-connected via the Second Link Expressway and North-South Expressway.

The Senai HTP will be developed into a third generation science and technology park offering an ideal location, superb infrastructure with a service rich environment that strives to realise an international vibrant knowledge community of innovative organisations, driving research and development to successful global businesses and attracting logistics and high value manufacturing companies.

The list of hi-tech manufacturing activities that the park promotes is as follows:

- Semiconductor and related activities
- Alternative energy sources
- Advanced electronic industries
- Medical and scientific instruments
- Process control and automation equipment
- Optical and electro-optical application
- Optoelectronics
- Advanced materials
- Contract R&D services
- New emerging technologies

In the small and medium scale sectors, the targeted industries are supportive of the hi-tech industry.

### 2.2 Public STI policy

Throughout the 1940s and 1950s, Science and Technology (S&T) policies were mainly used to improve the efficiency of agricultural related activities. From Malaysia's independence in 1957 until the mid-1980s, STI policies were neither emphasised nor organically connected to the country's economic development. It was only in 1986 that the First National Science and Technology Policy (NSTP) was launched as a distinctive strand within the Fifth Malaysia Plan (5MP, 1986–1990).[27] Since the implementation of the first NSTP, Malaysia has prioritised S&T as a key strategy to achieve economic growth, sustainable wealth, employment generation and improve the well-being of the country. A historic view of the economic development, STI, macroeconomic and education policies can be found in table 2 below, which shows the evolution of Malaysia's economic, STI and education-related policies from 1960s to 2010s.

Dr Mahathir bin Mohamad introduced Vision 2020 in 1991.[28] The vision was to turn Malaysia into a self-sufficient industrialised country by 2020. To this ambitious end, Dr Mohamad stated that the nation required annual growth of 7% over the thirty-year period (1990–2020), so that the economy would increase eight-fold to a GDP of RM 920 billion (€ 208 billion), in 1990 Ringgit terms, by 2020. Improving STI capacity was highlighted as one of the priority strategies to achieve the goals. Box 2 provides an overview of the four supporting pillars.

> Within the scope of Vision 2020, the government has drafted a framework comprising four pillars to drive changes:
> - An Economic Transformation Programme (ETP), driven by eight Strategic Reform Initiatives (SRIs), which forms the basis of the relevant policy measures resulting in the New Economic Model (NEM);
> - "1 Malaysia, People First, Performance Now" concept, aiming to involve and encourage all Malaysians to jointly tackle challenges;
> - The Government Transformation Programme (GTP) with a goal to improve public services in the National Key Result Areas (NKRAs);and
> - The Tenth Malaysia Plan (10MP, 2011–2015), representing the implementation of policies through government and economic transformation programmes.

**Box 2:** Four pillars of Vision 2020[29]

The 10MP published by the Economic Planning Unit under the Prime Minister's office and the New Economic Model (NEM) launched by the National Economic Advisory Council, emphasises the importance of STI activities and strategies to provide necessary support and investment in STI initiatives. The current period is referred to as the "innovation decade", and there are dedicated attempts to turn innovation into inclusive growth.

Under the 10MP, a range of types of funding schemes and supporting mechanisms are being implemented to encourage R&D activities, focusing on identified key sectors. A strong emphasis on the commercialisation of R&D results, knowledge transfer from academia to industry, and attracting multinational companies by building capacity in S&T is also advocated, as well as supporting home-grown businesses to be competitive in local and global markets.

The emphasis on innovation can be demonstrated in three aspects: supporting innovation-led growth (focusing on building R&D capacity, strong scientific human resources and academic-industry partnership), creating innovation opportunities (focusing on creating framework conditions for the promotion of innovation activities) and funding innovation (focusing on a large increase in venture / risk capital as well as the commercialisation of R&D results).[30]

The launch and implementation of the 10MP appears to have been well received as a guideline towards social and economic development, with a strong emphasis

27 *Malaysia – The Atlas of Islamic-World Science and Innovation,* Country Case Study no. 1, San Francisco, 2011
28 *New Economic Model for Malaysia, Part 1,* National Economic Advisory Council, 2009
29 Ibid.
30 Adapted from the summary of the 10th Malaysia Plan





| Items | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s |
|---|---|---|---|---|---|---|
| Development stage of economy | Primary commodities; agriculture | | Investment driven stage; shift to manufacturing | | Focused towards knowledge-based innovation economy | |
| Macroeconomic policy framework / conditions | 1st Malaysia Plan (1966–1970) launched (to be followed by plans every five years); substantial increases in public sector expenditure | New economic policy – focused on national unity, restructuring society for greater Malay urbanisation and employment | Large investments in heavy industries; significant growth in Foreign Direct Investment; major recession in mid-1980s | Vision 2020 announced; Asian economic crisis | National Innovation Model; second phase of 2020, focused on key strategic thrusts for sustainable growth | New Economic Model; 10th Malaysian Plan (2011–2015) launched. Global economic crisis; New Economic Programme |
| STI policy and role of government | Limited focus | Dedicated Ministry for Science established as well as the National Council for Scientific Research and Development (NCSRD) | First national STI policy; first chapter on STI in Malaysia Plans; intensification of Research in Priority Areas (IRPA) grants Established; double deduction incentives for R&D | Multimedia Super Corridor established; National IT Council | Second national STI policy; National Innovation Council; IRPAs streamlined | Year of Innovation; Third National STI policy; National Biomass Strategy 2020; UNIK AIM |
| Education policy | Becomes federal responsibility; focus on basic education for all | Focus on improving quality; system begins adjusting to economic needs | Continued focus on improving quality and access, National Vocational Training Council | Rapid transformation; opening of private sector / institutions; Human Resource Development Fund | MOHE established; National Higher Education Strategic Plan; creation of research universities; APEX university | Science and maths to be taught in Bahasa Malaysia from 2012 |

**Table 2:** Historic development path of economy and STI in Malaysia[31]

on STI and private sector involvement. The 10MP, a "new coherent vision"[32] of the government, defines detailed targets. It also emphasises the development of key sectors in tackling identified major obstacles, including falling private investment and productivity rates, inefficient use of resources, outflow of talent, lack of skilled labour, heavy bureaucracy and out-of-date action plans.[33]

As a more economically focused strategic plan, the 10MP tackles issues such as how to increase the value of the economy and how to reduce inequalities. In particular, it highlights the importance of promoting a knowledge economy and innovation to achieve its economic goals. The 10MP supports the service sector, foreseeing that GDP growth should be led by the private sector and underpinned by the services sector. It estimates that the service sector should grow at 7.2% annually until 2015, raising its contribution to GDP to 61% (from 58% in 2010), while GERD/GDP is targeted at 1.0% by 2015 (in 2011 the rate of GERD/GDP already exceeded this target and reached 1.07%). The 10MP also intends that by 2015 a total of 75% of academics in public research universities should have PhDs and 75% of households should have broadband.

It is clear that there is excellent awareness of the importance of developing STI in Malaysia. However, experts have pointed out that the Malaysian NIS can be characterised by relatively weak links between key STI players from the public and private sectors, the low R&D capacity of Malaysian businesses, insufficient collaboration with foreign partners, and weak implementation of policies and strategies.[34]

To address these challenges, MOSTI launched a new STI policy framework known as the "National Policy for Science, Technology and Innovation (NPSTI) 2013–2020". NPSTI is a new STI national policy that cuts across all sectors of the economy. Its ultimate goal is to transform Malaysia into a scientifically advanced nation. The new STI policy adopts an integrated and holistic approach to enable Malaysia to innovate based on strong STI fundamentals. It addresses the increasingly challenging landscape, not only in government but also in industries, universities, research institutes, and the entire NIS. In this context, NPSTI endeavours to strengthen and mainstream STI in all sectors and levels of national socio-economic development and transformational agendas such as the GTP, ETP, and Social Transformation Programme (STP). Further, Malaysia has an overarching goal of becoming a high income and advanced nation that is inclusive and sustainable by 2020.

NPSTI also aims to enhance commercialisation and increase the uptake of home grown R&D innovative products, to maintain a beneficial R&D expenditure ratio between the private and public sectors, and to initiate an extensive review of fiscal and financial incentives to promote industry innovation, particularly among SMEs. In addition, there is a keen interest in enhancing international collaborations, and to intensifying domestic and

31 Adapted from *Malaysia – The Atlas of Islamic-World Science and Innovation,* Country Case Study no. 1, San Francisco, 2011; and *Innovation in Southeast Asia,* OECD, 2013
32 *Innovation in Southeast Asia,* OECD, 2013
33 Adapted from the summary of the 10th Malaysia Plan
34 http://www.nst.com.my/opinion/letters-to-the-editor/national-science-technology-and-innovation-policy-making-innovation-work-for-us-1.167041, K. Thiruchelvam, November 2012

international networks for research collaboration, strategic partnerships and business relationships.

Meeting the need to train students with market skills, MOE is endeavouring to turn Malaysia into a centre of higher educational excellence by 2020. The objective is to increase total enrolment in public higher education institutes, with over 50 % in the STI related disciplines. Private educational institutions are also being implemented, supplementing the government's efforts to generate a larger pool of skilled professionals.[35]

The National Higher Education Strategic Plan (NHESP 2007–2020)[36] launched by MOE reflects this commitment. By 2020, it is planned that 50 % of 18–23 years old will have access to tertiary education and 33 % of the workforce will have tertiary qualifications.

Malaysia also aims to advance its level of innovation through sector specific strategies, such as the Multimedia Super Corridor (MSC) in the ICT sector, managed by the Multimedia Development Corporation (MDeC) under MOSTI. MSC was established in 1996 and aims to become a global hub for ICT and multimedia innovation. Similarly, in 2011 Malaysia announced the Digital Malaysia (DM) initiative, which aimed to build an ICT ecosystem.

The first edition of the National Biomass Strategy (NBS) 2020 was published by AIM in November 2011, with the objective of supporting public-private partnership (PPP). It aims to facilitate Malaysia in developing new industries and high-value opportunities, mainly by utilising agricultural biomass for high value products, focusing on oil palm biomass, and creating high value-added economic activities.[37] AIM launched NBS 2.0 in June 2013.

## 3 Support instruments for innovation

This section provides an overview of public and private support instruments in Malaysia, categorised by funding instrument cycle.

### 3.1 Basic and applied research

MOE has been a key provider and manager of funding basic / fundamental research in the country. Following the NHESP, which has defined systematic guidelines on how to manage the various funding schemes and research outcomes, MOE is monitoring different types of basic / fundamental research funding. In 2006, the ministry launched the Fundamental Research Grant Scheme (FRGS) to fund fundamental research in public higher education institutions. Since then the FRGS has also been made available to private higher education institutions. Three research grants, the Long Term Research Grant Scheme (LRGS), the Prototype Development Research Grant Scheme (PRGS) and the Exploratory Research Grant Scheme (ERGS), were recently introduced in order to enhance research activities in Malaysia.

In addition to producing policy studies and advisory reports, ASM provides high-level awards to applied researchers, such as the Mahathir Science Award. This is an annual prize of US$ 100,000 to researchers who made contributions of international recognition in topics such as medicine, agriculture, architecture, engineering, and natural resources in the tropical context.[38]

MOSTI provides a key scheme for applied research, ScienceFund (maximum RM 500,000 per project, € 113,000), to support applied sciences in universities and other research institutes.

### 3.2 Idea / Proof of concept up to commercialisation

Under the framework of Vision 2020, the government has invested substantially in R&D as well as STI related activities that can have a positive impact on social economic development. Examples include the Business Growth Fund of RM 150 million (€ 33.9 million) which provides grants for a period of five years to support the commercialisation of public sector research. Tax deductions are also provided for R&D activities, and matching grants are available to the private sector for R&D and commercialisation.

Under MOSTI, idea and product development can be supported by two pre-commercialisation funds: the TechnoFund and InnoFund. The TechnoFund (up to RM 3 million per project, € 678,000) is designed to support small medium-sized enterprises (SMEs) from research provision to commercialising prototypes (i.e. pre-commercialisation). The InnoFund (RM 500,000 per project; € 113,000) focuses on providing funding for Malaysian individuals, sole proprietors, micro or small enterprises and registered / government recognised Malaysian community groups.

MOSTI also offers a flagship programme (RM 4 million per project, € 904,000). Assisted projects usually involve three parties – research institutes, universities and private companies. Support is given up to the pre-commercialisation stage.

The Ministry of Finance (MOF) operates a Cradle Investment Programme (CIP) to support R&D&C activities. Box 3 below provides brief information regarding this initiative.[39] [40]

35 http://www.mida.gov.my/env3/index.php?page=educated-workforce, Malaysian Investment Development Authority (MIDA), 2013
36 http://www.moe.gov.my/v/pelan-strategik-pengajian-tinggi-negara; http://www.mohe.gov.my/portal/en/info-kementerian-pengajian-tinggi/pelan-strategik.html, MOE website, the Malaysian Higher Education Strategic Plan (accessed October 2013)
37 *National Biomass Strategy 2020*, AIM, 2013

38 http://www.akademisains.gov.my/index.php?option=com_content&task=view&id=38&Itemid=214, ASM website, programme details (accessed July 2013)
39 http://www.cradle.com.my/about/cradle-investment-programme/, Cradle investment programme (accessed October 2013)
40 http://www.d-code.co/about_us.php?page=partners (accessed December 2013)





The Cradle Investment Programme (CIP) programme, first set up in 2003, was initially allocated a total of RM 100 million (€ 22.6 million). It aims to provide commercialisation support and pre-seed and seed funding. For the 2011–2012 period, an additional of RM 50 million (€ 11.3 million) was added under the 10MP.

Cradle has two types of support:

1. Prototype Development: Cradle can provide pre-seed conditional grants with funding up to RM 150,000 (€ 33,900). This can be provided to groups of innovative individuals and commercialisation units with technology based ideas.
2. Product Commercialisation: Cradle provides the CIP 500 fund (maximum of RM 500,000, € 113,000). This was the first pure technology seed-fund for Malaysian start-ups with technology-based products or services to commercialise.

**Box 3:** Cradle Investment Programme (CIP)

Researchers often still experience difficulties when working with the private sector. Cradle aims to help this by working closely with universities, especially through training programmes in entrepreneurship. Students also have the opportunity to work on projects with entrepreneurs.

AIM further offers and manages a range of initiatives in order to stimulate and develop the innovation ecosystem. These include the Innovation Business Opportunity (IBO), which is a major programme to encourage the commercialisation of Intellectual Property (IP) and to "Turn Malaysian inventions into Malaysian innovations".[41] AIM attempts to gather and promote inventive ideas provided by researchers and inventors, aiming to attract companies to help them commercialise. It provides information on markets, potential financial returns and business / cooperation models.[42]

In total, more than 200 IBOs have been launched (including 58 in June 2013[43]), over a wide range of traditional and emerging sectors, including agriculture, business services, education, electronics, healthcare, financial services, palm oil and rubber.

Established 22 years ago, MTDC is a leading entity focused on commercialisation. MTDC manages two types of funds for companies – the Technology Acquisition Fund (TAF) and the Commercialisation of R&D Fund (CRDF). TAF is designed to help companies acquire new technologies from foreign sources. CRDF provides support for companies commercializing local R&D projects. After selecting companies based on the level of innovation and commercial viability, MTDC then provides partial funding in the form of grants.

In addition, MTDC has a programme called Symbiosis for university students who want to become "technopreneurs" with up to RM 2 million (€ 452,000) of funding available per company. The programme is a combination of training, incubation and commercialisation. In this case, students create spin-off companies to commercialise technologies from universities or research institutes.

MTDC provides two other funds – the Business Start-Up Fund (BSF) and the Business Growth Fund (BGF). These target entrepreneurs by providing soft loans and hybrid grant-equity funding respectively. BSF provides up to RM 5.0 million (€ 1.1 million) or 90 % of the recognised project cost, whichever is the smaller.

The CRDF and TAF have achieved influential results. In the 9MP, CRDF funded 154 companies with a total of RM 294 million (€ 66.4 million). TAF funded 32 companies with RM 45 million (€ 10.2 million). A more detailed illustration of the results of the two grants is shown in table 3.

| | CRDF | TAF |
|---|---|---|
| Projects commercialised | 82 % | 62 % |
| Sales revenue | RM 1.22 billion (€ 0.3 billion) | RM 366.6 million (€ 82.9 million) |
| Private sector investment | RM 418 million (€ 94.5 million) | RM 131 million (€ 29.6 million) |
| IP registered | 356 | 55 |
| Number of new jobs created | 3,703 | 665 |

**Table 3:** Impact of TAF / CRDF during the 9MP

Another prominent example of pre-seed and seed funding is the Star Accelerator Fund, established by STAR Publication BHD in cooperation with the Malaysian government, and comprising a total of RM 20 million (€ 4.5 million) in funding.[44] The goal of the grant is to involve technology-focused individuals and enterprises in developing commercialisation solutions. The funding programme consists of two types of grants: pre-seed (maximum of RM 300,000; € 67,800 for innovative ICT-based ideas) and seed (for ICT-based products or services that are ready for commercialisation, maximum of RM 1 million, € 0.2 million).[45]

41 http://innovation.my/ibo/, AIM official website, Innovation Business Opportunities (accessed July 2013)
42 Ibid.
43 http://www.theborneopost.com/2013/06/08/aim-launches-58-innovation-business-opportunities-worth-rm1-9-billion/#ixzz2ZVWPP5wM/, Borneo Post News Online (accessed July 2013)

44 http://e27.co/cradle-there-isnt-a-lack-of-funding-in-malaysia/
45 http://www.accelerator.my/#!types-of-programs/c59a/

### 3.3 Venture capital

The VC industry in Malaysia, which experienced growth from RM 2.1 billion (€ 0.5 billion) in 2003 to RM 5.7 billion (€ 1.3 billion) in 2012, has had a positive impact on the evolution of high technology SMEs.[46] By 2007, there were around 50 VC firms in Malaysia, of which 42 were national. Some of these firms invest mostly in Malaysia-based companies, but the majority also invest internationally. The most popular industries for VC investment in Malaysia include ICT, consumer services, manufacturing, and life sciences.[47]

The government provides tax incentives and direct funding for VC firms. The Securities Commission of Malaysia introduced new tax incentive guidelines that make VC companies eligible for a five-year tax exemption if at least 30 % of their funds are invested in seed capital, start-up and/or early-stage financing. Funds have been allocated to various government-linked venture companies. For example, the Mudharabah Innovation Fund was formed to provide risk capital to government-backed enterprises.[48]

The majority of companies receive capital only after they pass the seed and early stages. Capital is available from both domestic and international VC firms. The majority of investments from international firms are from the neighbouring countries in Southeast and East Asia such as Singapore, Hong Kong, Japan, and mainland China. Firms in the US, the UK and South Korea have also invested.[49]

MTDC is a leading commercialisation and technopreneur funder. Its support includes provision of equity funding as well as consulting services at various stages. MTDC has funded over RM 1.5 billion (€ 339 million) in national and foreign high-tech firms since its inception in 1992 through various funding programmes.

MTDC has expanded its role as an intermediary that connects companies, especially SMEs, with private and public VC and investors (including banks or individual investors). Thus, MTDC's role has moved beyond funding and now includes supporting companies for expansion within Malaysia as well as internationally.

The Malaysia Venture Capital Management Berhad (MAVCAP) was established in 2001 by MOF. It is the largest individual VC company in Malaysia in ICT industry. MAVCAP has invested directly and through seed ventures into around 90 companies, 70 % of the investment goes to locally incorporated companies.[50]

Box 4 below indicates an initiative operated by MAVCAP and the investment model that MAVCAP follows:

46 http://www.thestar.com.my/Business/Business-News/2013/07/04/Malaysias-capital-market-at-RM25tril.aspx, Malaysia's capital market triples to RM 2.5 trillion (accessed December 2013)
47 *Report to the World Bank on the Malaysian Venture Capital Industry*, K. Lyons et al., 2007
48 *Innovation in Southeast Asia*, OECD, 2013
49 Ibid.
50 http://www.mavcap.com/index.aspx, MAVCAP (accessed December 2013)

MAVCAP has played a significant role in shaping the national VC ecosystem and encouraging the growth of the private VC companies through offering a one year Graduate Internship Programme with intensive practical training and mentorship to outstanding Malaysian graduates to prepare them to be venture capitalists. This is a strategy to nurture the VC industry and to build a pool of qualified venture capitalists for the country.

Typically, MAVCAP invests, on its own or in partnership with other private VC firms / financial investors, in technology-based firms for a period of 3 to 8 years in seed, start-ups and early-stage ventures with funding ranging from RM 1 million (€ 0.2 million) to RM 20 million (€ 4.5 million) according to stage of development and target sectors. MAVCAP ensures it is both a strategic and professional partner to the supported firms.

**Box 4:** MAVCAP initiative and investment[51]

### 3.4 Foreign Direct Investment

Since the 1970s, Malaysia has achieved notable results in FDI, mostly focused on new and emerging technologies such as aerospace, semiconductors, solar, machinery and equipment, biotechnology, petroleum and petrochemical products.

From 2011, the Malaysian Investment Development Authority (MIDA), an agency under the Ministry of International Trade and Industry (MITI) has highlighted the importance of the services sector, as well as of the high value-added and knowledge-based activities in new and emerging industries such as biotechnology, aerospace and advanced electronics.

Foreign companies which are undertaking activities listed in the promoted list are eligible for Pioneer Status and the Investment Tax Allowance (ITA). Pioneer Status offers an income tax exemption of 70 % on statutory income for a period of five years. ITA provides an allowance of 60 % on qualifying capital expenditure incurred within five years.[52] MIDA also provides support to match-making foreign and national companies and R&D grants for foreign companies that conduct R&D activities in Malaysia.

In addition, the Malaysian International Chamber of Commerce and Industry (MICCI) provides a series of services to support the growth of foreign companies, including export documentation services, business briefings and networking.

51 *Venture Capital in Malaysia: A Case Study of Malaysian Venture Capital Berhad (MAVCAP),* M. Ajagbe and K. Ismail, Australian Journal of Basic and Applied Sciences, 2013
52 http://www.mida.gov.my/env3/index.php?page=manufacturing-related-services, MIDA official website, Incentives for Investment (accessed July 2013)





### 3.5 IPR support

Malaysia, as the second largest ASEAN trading partner to the EU after Singapore, is attempting to agree a Free Trade Agreement with the EU that aims to further open the market for overseas companies and protect IPR. It is notable that Malaysia was removed from the lower level IPR US watch list of US Trade Representative (USTR) on intellectual property violations in 2012 (it had been on the list since 1989).[53]

The corporatisation of the Intellectual Property Corporation of Malaysia (MyIPO) under the Ministry of Domestic Trade, Cooperation and Consumerism aims to increase the number of patents granted to Malaysians.[54]

Data from MyIPO shows that the number of domestic patents granted to Malaysians, including local scientists, grew from less than 50 in 2005 to almost 350 in 2011. The number of international papers published by Malaysian scientists has also experienced significant growth from 1,608 in 2005 to 6,673 in 2011.[55]

## 4 International cooperation

There is a focus in Malaysia on achieving STI growth through international cooperation. This is illustrated by the emphasis on supporting innovation and research activities through international collaboration within the NPSTI and higher education policy. Further, the Economic Planning Unit, a governmental agency, has a dedicated department for promoting international cooperation and coordinating multilateral and bilateral programmes.

MASTIC, the official S&T data provider in the country, has published a wide range of S&T indicator reports since 1994. The latest MASTIC report on Malaysia's Science and Technology Indicators (2010) emphasises that there is a need to expand the biotechnology industry by venturing into the international market. One of the strategic ways to be competitive internationally is to form collaborations with foreign firms, RIs and IHLs.

The number of S&T related papers developed in cooperation with foreign countries shows that Malaysian universities and research institutes cooperate mostly with counterparts in the UK, India, China, Japan and the US. Within the ASEAN region, Malaysian researchers collaborate more with Thailand, Singapore and Indonesia researchers.

In terms of establishing STI international cooperation initiatives, Malaysia has a primarily focus on programmes with Europe, the rest of Asia (Japan, South Korea, Thailand, Singapore and Indonesia), Commonwealth countries, and the US.

53 http://www.thestar.com.my/News/Nation/2012/05/03/Ismail-Sabri-Malaysia-off-US-watch-list-on-intellectual-property.aspx (accessed December 2013)
54 http://www.myipo.gov.my/government-about-iptc/, MyIPO official website (accessed July 2013)
55 MASTIC data

Malaysia is among the top three ASEAN countries in terms of both number of the Seventh Framework Programme of the European Commission (FP7) projects awarded (almost 30 projects) as well as the amount of funding received (more than 5 million Euros). ICT and the KBBE (Knowledge Based Bio-Economy) are the FP7 themes with the most projects for Malaysian entities.

At the university level, there is a desire to attract top foreign universities to set up branch campuses in Malaysia. Currently, branches of six universities from Australia and the UK have been established. The GENOVASI programme, under AIM and in partnership with the Hasso Plattner Institute (HPI) School of Design Thinking at Potsdam University, Germany, was set up to promote design thinking skills. Other institutional partners of GENOVASI are Stanford University, Pearson, the Singularity University, the Millennium Project, the Institute for the Future and RSA.

The palm oil industry attempts to provide a prominent example of international industry collaboration. More details can be found in box 5 below:

The Malaysian Palm Oil Board (MPOB), as the leading government organisation in Malaysia in the industry, has led major research collaborations with institutes and organisations in Japan, the US and Europe. Aware of the need of attracting investment for R&D in the palm oil industry and to facilitate collaboration between in biomass, new research projects can now enjoy tax exemptions for statutory income for the first ten years from commercial production, as well as exemption of import duties.

**Box 5:** International cooperation of R&D in the palm oil industry

In regard to private sector international collaboration, it has been noted that there is insufficient technology transfer from multinational companies located in Malaysia. Although important companies are located in Malaysia, many of their activities in the country remain focused on assembly. Even for high-profile initiatives like MSC, whilst some large ICT companies have been attracted to Malaysia, few of them provide R&D activities in the country, and competition from neighbours such as Singapore, Hong Kong and China is fierce.

## 5 Key strengths and weaknesses

The Malaysian government emphasises the importance of STI in driving economic growth and elevating Malaysia from being a mid-income country. Innovation has become a keyword across ministries and various stakeholders in the country. The challenge is to maximise the effect of investment, through efficient coordination of all the stakeholders in the STI system to ensure successful outcomes and achievement of goals – thus allowing that "the right organisation does the right job".

There are a wide range of support measures incorporating a large number of STI stakeholders, which are undoubtedly beneficial to STI development. Further synergies among the fourteen agencies under the eight ministries which are involved in funding, initiatives and other STI related activities would be beneficial. The need for a secure funding base for STI remains, although it is thought that overly complex funding schemes can reduce the efficiency of their implementation. A commonly stated opinion is that the innovation policies focus on high technology development with insufficient direct funding for grass root innovation in the rural areas, social innovation and social entrepreneurship.

The current systems of funding and governmental structures are somewhat complex. A more simplified STI funding structure could be encouraged to prioritise strategic areas and also help applicants to navigate the targeted funding systems.

Indeed, the meaning of innovation in Malaysia is quite multi-layered. As well as being a key driver of sustainable economic growth, several organisations are considering how to incorporate innovation into social development. Some organisations emphasise that innovation should not be a privilege only for metropolitan areas, and should be further supported at rural and grass-root levels. For example, funding opportunities for commercialisation do not yet seem to be equally distributed between urban and rural areas.

One ongoing development is the change of government focus from being both a policy maker and programme implementer, towards being less involved in implementation. The idea is that the government policy creates the framework for the involvement of the private sector in the operation and implementation of programmes. Willingness and effective company leadership are essential elements for such a research and innovation development, and for activities such as international technology transfer. In order to strengthen the competitiveness of the private sector in leading STI development, the government is considering privatising public organisations such as the public research institutes and higher education institutes. However, the first experiences are regarded as being mixed, as demand for innovation remains relatively weak. The government is in the process of establishing stronger instruments and supportive environment/rules on competition to stimulate private R&D development.

It is clear that government organisations, universities and research institutes, as well as science parks and clusters, are eager to implement STI strategies that foster strong PPP. Universities, such as UPM, have established business centres in order to support the commercialisation of university innovations. Such centres also provide training services and international technology transfer support. The University of Nottingham Malaysia Campus, for example, has established close collaborations in research with Malaysian universities in aerospace, environmental related disciplines, the palm oil industry and agriculture sector with the government and various industry partners.

Clusters such as MSC are also working with universities to support innovative ideas. The government is attempting to strengthen its support for cluster development and adjust policies in order to tackle the existing issues. The perceived weakness of low demand for innovation is important and seen as a sign of the need to further improve private and public sector links. It is believed that both small business and multinational companies do not sufficiently procure innovation from universities and research institutes. Further support from the government for such cooperation to guide such relationships would also be beneficial. The publically supported industry clusters seem to be a positive step for PPP. Support for the STI capacities of industries can lead to positive returns, as well as build trust between the private sector and the government.

Improved ways to increase international collaboration in the development of Malaysia's industry and clusters are being explored. There are good opportunities to increase technology transfer from multinational companies. Although large international companies are located in Malaysia, many of their activities in the country focus on manufacturing and assembly.

Finally, the government has correctly focused on increasing the quality of higher education. Further improvement, as defined under the objectives for 2020, is required. Alongside the investment to improve international collaborative research programmes and instruments, this emphasis on higher education is likely to lead to the desired increase in skilled labour.





# 6 Appendices

### Appendix I: Institutions visited

*Academy of Sciences Malaysia (ASM)*

*Agensi Inovasi Malaysia (AIM)*

*Malaysian Industry-Government Group for High Technology (MIGHT)*

*Malaysian Investment Development Authority (MIDA)*

*Malaysian Technology Development Corporation (MTDC)*

*MIMOS Berhad*

*Ministry of Science, Technology and Innovation (MOSTI)*

*University of Nottingham Malaysia Campus*

*SIRIM Berhad*

*Senai Hi-Tech Park*

*Technology Park Malaysia*

*Universiti Tun Abdul Razak*

*Universiti Putra Malaysia (UPM)*

*Malaysian Foundation for Innovation (YIM)*

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## Appendix III: Policy cycles

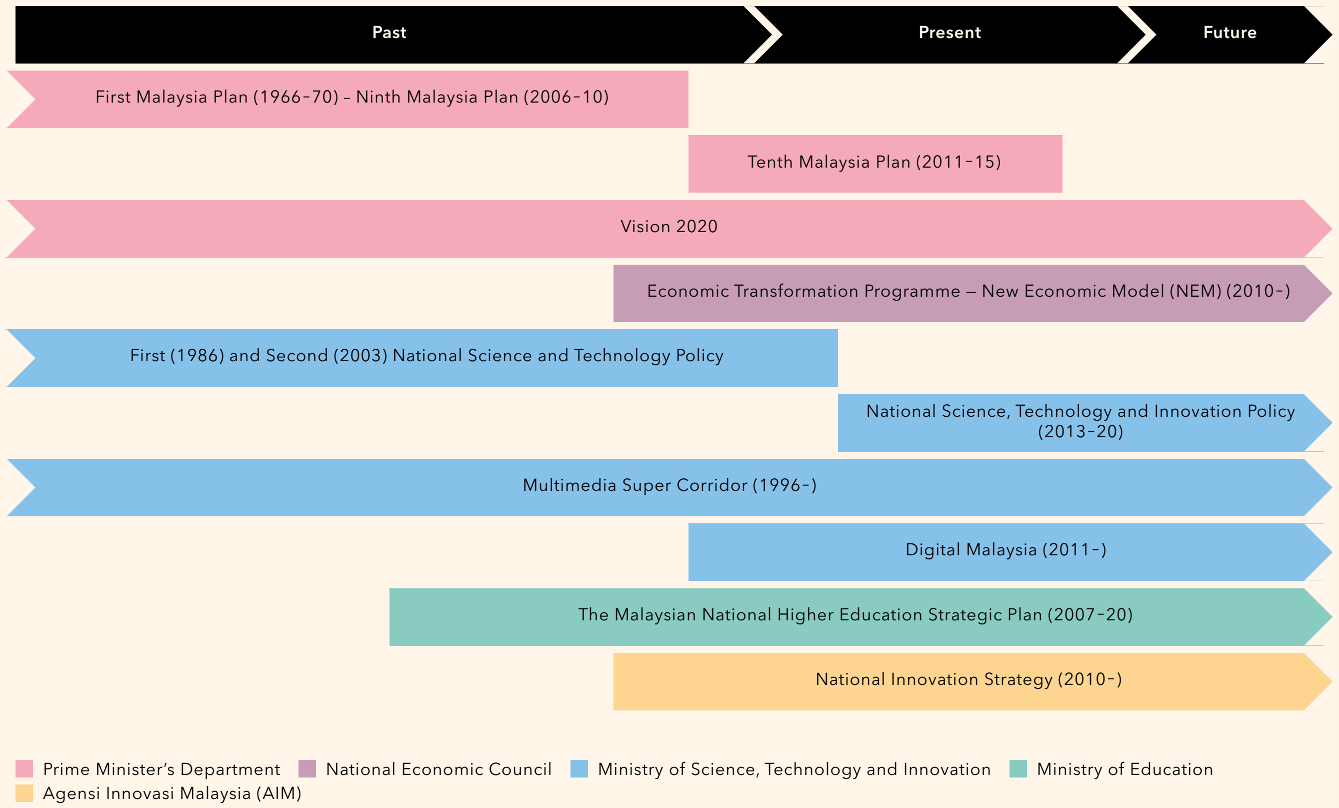


**Figure 2:** Policy cycles





## Appendix IV: Funding agencies and instruments[56]

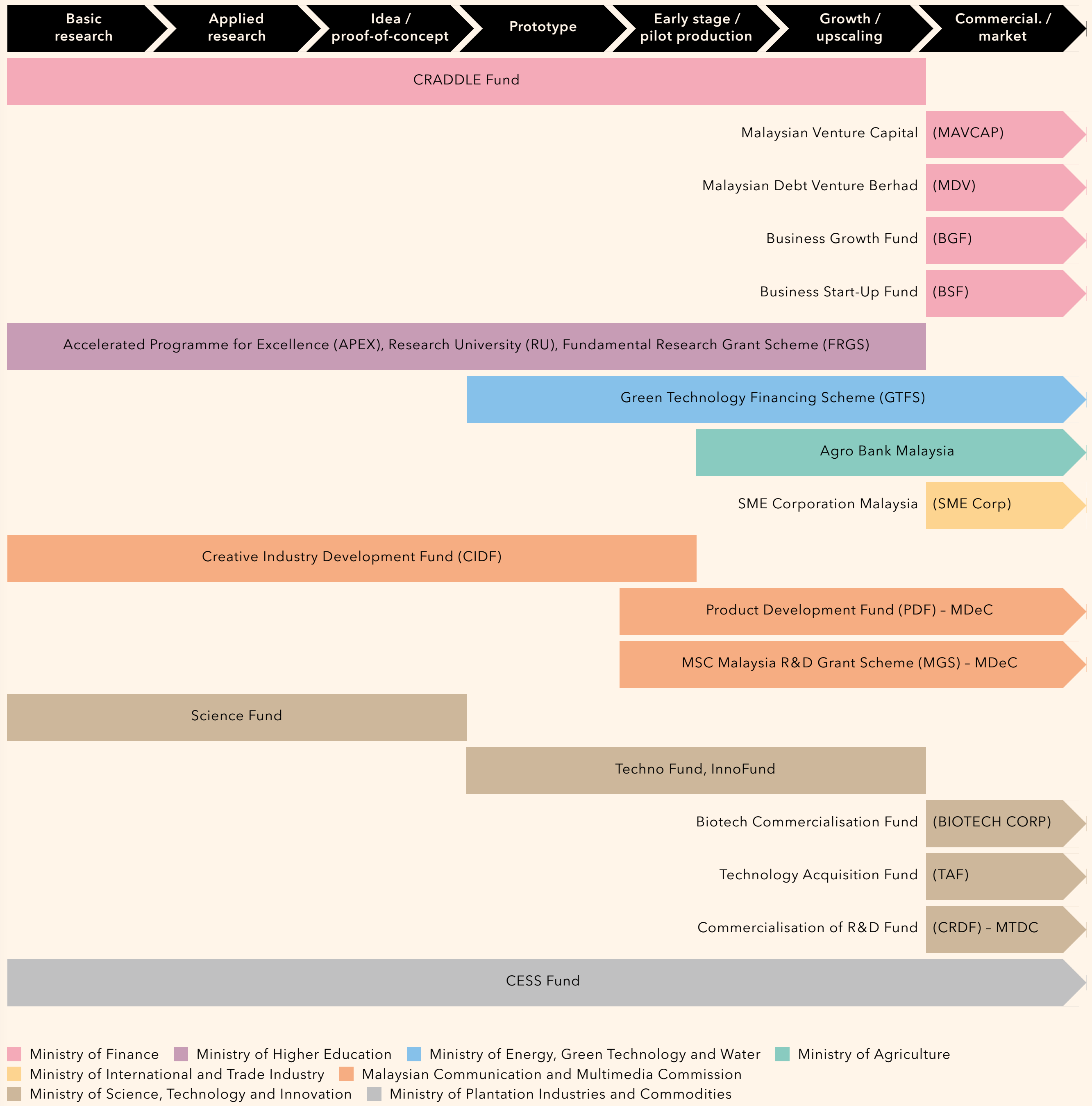


**Figure 3:** Funding agencies and instruments

56 According to the stage in R&D / product development they focus on

# Philippines

Svend Otto Remøe[1]

## 1 Key indicators and framework conditions

The basic message from the set of key indicators of science, technology, innovation and framework conditions for research and innovation is that the Philippines still has a long way to go to become an innovation-led economy, but that the country also has a number of important resources and conditions in place that will support the on-going efforts to turn the country in that direction. Table 1 brings the key indicators and framework conditions together, presenting a picture that is both encouraging and discouraging.

The table shows that the main feature of development in the Philippines is steady population growth combined with even stronger growth in GDP (6.6 % for 2012). This means that even with some increase in R&D expenditures, the GERD (gross expenditures in R&D as a share of GDP) is falling. The most recent figure shows a GERD of only 0.11, which is a level that is among the lowest globally as well as within ASEAN. While public investments in R&D are growing, business expenditures in R&D are still weak, leaving the government with an increasing share of the overall R&D expenditures. This pattern is likely to continue. However, there is an overall improvement in R&D personnel in the economy. In fact, the growth of researchers in the system is significant, and contributes to improving the ratio of researchers per capita. The distribution of R&D personnel is changing, with the share of R&D personnel in the business sector growing from 20 % in 2002 to 35 % in 2007.

1 The Research Council of Norway (RCN), Oslo, Norway

In general, the higher education system is an inhibiting factor in not being able to produce a sufficient number of high-skilled workers as required by the advanced sections of the economy. A specific feature of the Philippine population structure is that approximately 10 % of all Filipinos live abroad, thereby also leading to a significant inflow of remittance payments. This is also an illustration of the economic and innovation system's inability to create sufficient jobs of a suitable quality.

According to the World Economic Forum, the Philippines scores low on the international competitiveness ranking, although there has been a steady improvement from being ranked 85 in 2010 to 65 in 2012 (of 144 countries, see Global Competitiveness Report 2012–2013). The factors pulling the score down for the Philippines are the quality of institutions and infrastructure as well as health and primary education, commodity and labour market efficiency. On the other hand, the Philippines scores well on macro-economic stability, overall technological readiness, business sophistication, market size and aspects of innovation such as business expenditure on R&D in some sectors.

The American Chamber of Commerce and Asian Development Bank (2006, 2009) report of the general framework conditions that the availability of low cost labour and trained personnel, as well as housing and office costs, are seen as strengths, while unstable laws and regulations, macroeconomic policy, corruption, taxation, infrastructure and the availability of raw materials are seen as constraints (see Tan 2010). For example, the low level of tax revenues seriously hinders the ability to invest in infrastructure and innovation for the long term benefit of the economy.





| Indicator | 2002 | 2003 | 2005 | 2007 | 2009 | 2011 |
|---|---|---|---|---|---|---|
| Population (million) | 80 | 82 | 85 | 89 | 92 | 95 |
| GDP* | 3,963,873 | 4,316,402 | 5,444,038 | 6,648,619 | 7,678,917 | 9,735,000 |
| Total R&D exp.* | 5,769 | 5,909 | 6,362 | 7,556 | 8,779 | 12,046 |
| GERD | 0.15 | 0.14 | 0.12 | 0.11 | 0.11 | 0.124 |
| Public R&D exp.* | 1,615 | 1,584 | 2,268 | 2,660 | 3,138 | 4,146 |
| Business R&D exp.* | 4,154 | 4,325 | 4,058 | 4,895 | 5,641 | 7,899 |
| Total R&D pers.** | 9,325 | 13,488 | 14,087 | 14,649 | 16,673 | 19,151 |
| No. of researchers** | 7,203 | 8,866 | 10,690 | 11,490 | 13,091 | 14,867 |
| Researchers (per million pop.) | 90 | 108 | 125 | 130 | 142 | 156 |

**Table 1:** Key indicators. Source: DOST * Current prices, in million pesos ** Headcount

## 2 Governance and public STI policy

### 2.1 Governance and institutional structure

The key player in the Philippine system of policy and governance is the Department of Science and Technology (DOST), created by law in 1987 to continue its various predecessors. Its main roles are to provide the central direction, leadership and coordination of all scientific and technological developments in the country, as well as to formulate S&T policies, programmes and projects in line with national development policies. The DOST institutional structure is thus comprehensive: it includes 3 sectorial councils that help shape priorities in given sectors, 2 collegial bodies (NAST and NRCP), 7 R&D institutes, 8 S&T service institutions, 16 regional offices throughout Philippines, and 79 provincial S&T centres. DOST is therefore not only a policy ministry as such, but also directly responsible for R&D activities and implementing agencies (see figure 1 below). The coordinating role of DOST is important, as its budgetary size is not overwhelming. Rather, the Philippine system is one of jointly co-funding innovation related activities, so that other key departments, such as the Department of Trade and Industry, which is jointly responsible with DOST for many of the industry-focussed policies, co-fund programmes with DOST as the coordinating agent. This has both advantages and disadvantages: the system is then characterised by institutional negotiations and trade-offs, but also consensus on policy efforts that need to bridge institutional barriers, such as inclusive development.

An integral part in policy formulation in S&T is played by the National Academy of Science and Technology (NAST). It was originally set up in 1976, and given an advisory function in 1982. NAST advises the whole policy landscape, not only DOST. NAST is made up of scientists, and has organised its activities into a strategic plan which includes the "Incorporation of S&T in Legislation and National Policies". It issues policy statements on S&T and innovation, and engages in round table discussions with the private sector to better include industry views in promoting programmes and initiatives.

A key policy advisory body is the COMSTE (Congressional Commission on Science, Technology and Engineering). It was created jointly by the Senate and the House of Representatives of the Parliament to generate high level recommendations and advice. It undertakes national reviews and assessments of the science, technology and engineering system of the country with a view to enhancing the system's internal capability to implement policies, providing the necessary funding resources and other infrastructural support, strengthening the links with all sectors concerning STI, and assisting the S&T sector in achieving objectives in line with overall policies.

All sectorial ministries in the Philippines have their own mandate and responsibility in STI. To balance this system of widespread responsibilities, the National Economic and Development Authority (NEDA) was set up. NEDA is the coordinating agency and national planning body and is headed by the President as the chairman. The board is made up of key persons from government agencies, including several cabinet members, and the governor of the Central Bank.

NEDA conducts its work through policy committees, such as those for budget coordination, infrastructure, investment coordination, social development, and regional development. Included in the NEDA's focus are several issues related to S&T and innovation. A key objective is rapid industrial growth, and NEDA attempts to coordinate S&T expenditure to support this, such as by promoting human capital programmes and innovative capacity. Industrial cluster programmes were advocated in the 1980s but are not included in the cross-ministerial coordination agenda today. A National Industrial Clustering Enhancement Program (NICEP) is supported by the Japanese government, however, being a replicate of the Japanese regional cluster approach.

NEDA relates to key policy frameworks such as Filipinnovation (see next section), and attempts to identify projects in line with these policies. Line ministries are then mandated to implement these projects or programmes, such as DOST in the case of S&T programmes.

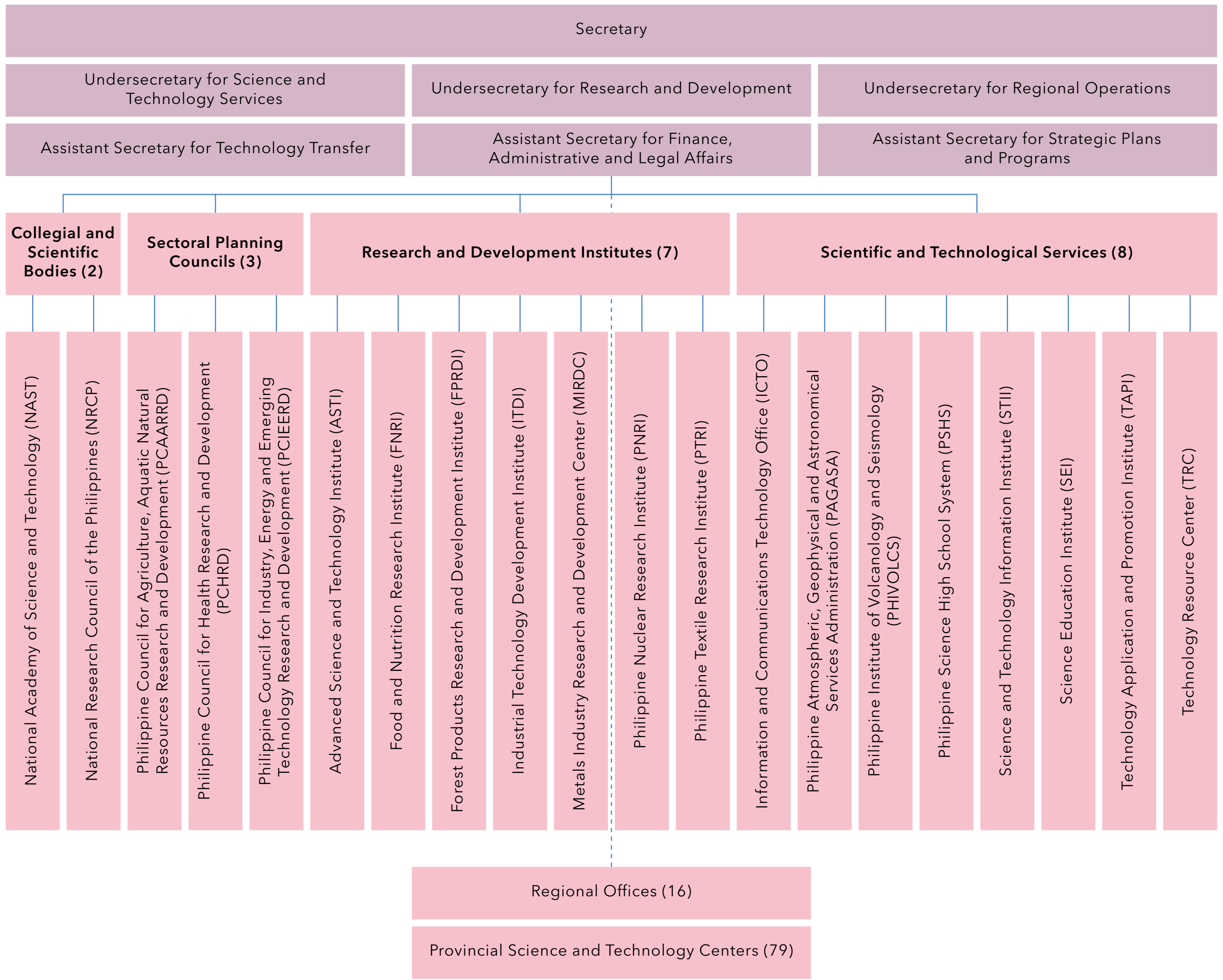


**Figure 1:** Department of Science and Technology. Source: DOST

### 2.2 Key research performers

There is widespread awareness of the importance of human capital in the innovation system, and that this needs to be significantly upgraded. While the Philippine innovation system suffers from many resource gaps and shortcomings, human capital is critical. This was addressed in the Filipinnovation strategy, and also by COMSTE in 2007. Part of the problem is linked with the vast system of low quality state universities and regional colleges.

There are currently more than 1,400 universities and colleges in the Philippines (Tan 2010). The proliferation of state universities and colleges has led to an increase in resources to this sector over the years, without any associated quality impact. More than 95 % of the expenditure on higher education have been allocated to this sector. Recent developments of establishing centres of excellence and centres of development are intended to rebalance this situation, but resources flowing to the major institutions are still small.

Only three of the many universities in the Philippines were included in the top 500 universities in the world in 2010 (University of the Philippines, Ateneo de Manila University, and De La Salle University), and these are ranked below 300. The University of Philippines particularly plays a national role with its seven universities and one college across 15 campuses, and has been granted special status through Republic Act no. 9500[2] (see also a more thorough discussion on its innovation efforts below). The role and quality of these key universities notwithstanding, Tan (2009) describes the situation as such: *"…the innovation system (is) underdeveloped as it has a small number of scientists with doctoral degrees who produce a relatively small research output, and a small number of graduates with advanced degrees. There is no critical mass of scientists and other highly skilled S&T workers"* (cited in Tan undated).

The top five universities produce most of the graduates in the Philippines, but Tan (undated) notes that their faculty and researchers with PhDs are made up of

2 http://www.gov.ph/2008/04/19/republic-act-no-9500/





| | 2000 | | 2004 | | 2009 | |
|---|---|---|---|---|---|---|
| | CE | CD | CE | CD | CE | CD |
| Science and Mathematics | | | | | | |
| Biology | 5 | 10 | 5 | 9 | 4 | 9 |
| Chemistry | 6 | 5 | 6 | 5 | 6 | 5 |
| Physics | 4 | 4 | 4 | 4 | 4 | 4 |
| Mathematics | 5 | 4 | 5 | 4 | 5 | 4 |
| Marine Science | 1 | 5 | 1 | 6 | 1 | 6 |
| Agriculture, Fisheries and Forestry | 4 | 0 | 6 | 4 | 17 | 3 |
| Geology | 1 | 2 | 1 | 2 | 1 | 2 |
| Information Technology | 0 | 21 | 0 | 23 | 9 | 24 |
| | *26* | *51* | *28* | *57* | *47* | *57* |
| Engineering | | | | | | |
| Chemical | | | | | 1 | 9 |
| Industrial / Mechanical | 1 | 13 | 1 | 12 | 1 | 18 |
| Electrical | 1 | 15 | 1 | 14 | 1 | 15 |
| Civil | 0 | 19 | 0 | 18 | 0 | 19 |
| Geodetic | 1 | 3 | 1 | 3 | 1 | 3 |
| Electronics and Communication | 2 | 7 | 2 | 7 | 1 | 7 |
| Metallurgical | 1 | 2 | 1 | 2 | 1 | 2 |
| Ceramics | 0 | 4 | 0 | 2 | 0 | 2 |
| Mining | 0 | 2 | 0 | 2 | 0 | 2 |
| Sanitary | 0 | 2 | 0 | 2 | 0 | 2 |
| Agriculture | 0 | 0 | 3 | 1 | 3 | 1 |
| Computer | 0 | 1 | 0 | 5 | 2 | 5 |
| | *6* | *68* | *9* | *68* | *11* | *85* |
| | | | | | | |
| Architecture | 2 | 3 | 2 | 3 | 2 | 2 |
| Social Sciences | 9 | 0 | 9 | 21 | 9 | 0 |
| Teacher Training | 18 | 3 | 18 | 3 | 18 | 3 |
| Health Fields | | | | | | |
| Medicine | 0 | 0 | 3 | 1 | 3 | 1 |
| Nursing | 0 | 0 | 8 | 0 | 8 | 0 |
| Linguistics and Philosophy | | | | | 13 | 0 |
| Business | | | | | 0 | 14 |
| Communication Arts | 2 | 0 | 2 | 0 | 3 | 0 |
| Distance Education | 0 | 0 | 1 | 0 | 1 | 0 |
| Information Technology Education | 0 | 21 | 0 | 23 | 0 | 24 |
| Music | 2 | 0 | 2 | 0 | 2 | 0 |
| | | | | | | |
| Total | 101 | 162 | 110 | 159 | 117 | 186 |

**Table 2:** Centres of Excellence and Centres of Development

a small group of around 500, and the output of PhDs was only some 30 per year.

The initiative to boost quality through centres of excellence (COE) and centres of development (COD) (which may qualify as centres of excellence) is important. The awards have been heavily concentrated on the top five universities, which also illustrates how poorly the wider system of universities and colleges are able to compete. A key requirement has been that a COE programme should at least have seven regular faculty staff with PhDs. Table 2 presents the overview of awarded COEs and CODs as of 2009, with a total of 117 COEs. The top five universities captured 61 of these. The remaining COEs are spread across the 1,400 institutions of higher education in the Philippines. While information technology and biology are dominant among the natural sciences, industrial / mechanical, electrical and civil engineering are prioritised in the applied areas. Further it is noticeable that information technology education is given a high number of COEs every year, underlining the perceived importance of the electronics sector in the Philippines.

DOST has created some twenty research councils, research institutes and administrative units. The main research institutes are thus subsumed under the ministry. Some other research institutes are subsumed under other ministries, for example those in key industrial sectors. The DOST councils play a major role in ongoing priority setting and planning. They engage in allocating funds to discrete projects in their area of responsibility, and private sector representatives are included in the process to ensure the relevance of the priority setting results. In fact, the four councils in question (see table 3 below) constitute a collaborative system of the legitimate distribution of funds to various research institutions and universities, although the funds in questions are small. For example, the Council for Health R&D (PCHRD) has a budget for 2013 of 220 million pesos (US$ 25 million). Recipients of the research grants from the councils are mostly the research institutes in Philippines.

While research and innovation in the business sector is still dismal, some innovation is taking place. A survey conducted in 2009 showed that the ICT firms in particular were innovating, with larger firms more likely to innovate than smaller. The same pattern was found in food manufacturing and electronics, although on a lower activity level. Firms in special economic zones (PEZA) had a significantly higher innovation level than others. A key finding was the lack of effective science-industry relationships. Government support in general had little effect on innovation (Albert et al. undated).

## 3 Support instruments for innovation

### 3.1 Key policy initiatives and frameworks

The Philippines has several long term socio-economic challenges, and allocates significant resources to alleviate problems such as poverty and exclusion. To better get an overall strategic grip on these issues, some major policy frameworks have been launched. This concerns first of all the National Science and Technology Plan (NSTD) 2002–2020 which provides a broad outlook and priorities for this policy area. The *Philippine Development Plan* (PDP) 2011–2016 includes a chapter which addresses science, technology and innovation, and their role in enhancing productivity and welfare. The plan identified a number of economic sectors for prioritisation. Further, the government has created a broad policy framework for *local economic development (LED)*, in which several cross-sectoral policies and initiatives are subsumed (see the Canadian International Development Agency 2010). This means that governmental ministries have a specific role to play in enhancing local economic development, and encouraging inclusive development to alleviate poverty and unemployment. The initiatives discussed below are also to be seen within these frameworks.

| Council | R&D Areas | Period | Number of Projects |
|---|---|---|---|
| National Research Council of the Philippines (NRCP)[3] | Veterinary Medicine, Space, Human and Social Sciences, Math etc. | 2010–2013 | 55 |
| Philippine Council of Aquatic and Natural Resources (PCAARRD) | Competitiveness, Agriculture, Food, Environment etc. | 2010–2013 | 455 |
| Philippine Council for Health R&D (PCHRD) | Drugs, Genomics, ICT for Health etc. | 2010–2013 | 187 |
| Philippine Council for Industry, Energy and Emerging Technology R&D (PCIEERD) | Industry, Renewable Energy, Materials, ICT etc. | 2010–2013 | 571 |

**Table 3:** DOST Councils

DOST was responsible for drafting the Philippine Innovation Strategy, known as *Filipinnovation*. It was developed as a broad, national initiative to boost innovation in the country. It had specific support from President Arroyo to lend it legitimacy and momentum, and was built upon a public-private partnership, a number of round table discussions with key stakeholders, and created a vision of the Philippines as a competitive, innovative nation. Filipinnovation called for action in four strategic areas assessed as the main challenges for the country: strengthening human capital, supporting business incubation and acceleration, regenerating the innovation environment, and upgrading the Philippine mindset, the latter a confirmation of "cultural capital" to be an Achilles heel for the strategy. The strategy was developed for the innovation summit in 2007, led by DOST and IBM as well as the IP office. The committee developing the strategy was then reorganised into the Filipinnovation Network.

In fact, the R&D prioritisation efforts had been undertaken by the Presidential Coordinating Council on R&D (PCCRD)[4]. This body was created by then President G. M. Arroyo on 16 February 2007 through Executive Order no. 604. It was presided over by the President with the DOST Secretary as vice chairperson and members composed of representatives from 13 government agencies involved in R&D, 5 from private business sector and 2 from organisations of scientists and engineers engaged in R&D. Among the primary tasks of PCCRD is to review and build a consensus on national R&D priorities to which government R&D budget allocation would be directed, to institute measures to improve the monitoring and evaluation of results of government-funded R&D and the performance of government R&D institutions, and to review and recommend policies on R&D with the aim of increasing national R&D spending to at least 0.5% of the country's gross domestic product by 2010.

The PCCRD recognised that there has been an urgent need to unify and coordinate all R&D efforts of government agencies as problems arise from the fact that public R&D funds are lodged in different government agencies, each having its own system of R&D fund management and R&D priority-setting. In this regard, the President instructed DOST to spearhead the preparation of a National Research and Development Priorities Plan (NRDPP) in collaboration with all concerned government agencies. The NRDPP would be used as a decision making guide for the allocation and utilisation of government R&D funds as well as a coordination tool to synchronise all R&D efforts of various government agencies. Ten sectors were identified as of priority in the Filipinnovation strategy, and the subsequent process through PCCRD came up with more than 100 priority initiatives, later reduced to 87 and then to 28.

The PCCRD also directed that: 1) a comprehensive database of all publicly funded R&D projects be developed for monitoring and evaluation use; 2) measures be adopted to overcome barriers constraining the importation of R&D equipment and materials; 3) an in-depth study be conducted on the possibility of maximising the Philippines' potential as an attractive location for international R&D; and 4) local and foreign scholarships be rationalised to maximise R&D links as well as to strengthen the colleges of engineering of state universities.

Under the administration of President Aquino, the PCCRD was reconvened in 2011 but the approval of the R&D priorities was deferred to take into account emerging needs and priorities.

Several of the programmes discussed later in this paper are related to the Filipinnovation strategy, however. The strategy is still relevant in the Philippines policy system, but needs commitment and better integration in national policies.

To improve horizontal governance, the cabinet has been organised thematically into cabinet clusters corresponding to key policy areas of the administration. DOST was designated as member in the two policy clusters of "Rapid, inclusive and sustained economic growth" and the "Integrity of the environment and climate change adaptation and mitigation".

3 NRCP is a collegial body attached to DOST, while the other three are sectorial councils.

4 The author wishes to express appreciation to Bernie Justimbaste, Director of the Planning and Evaluation Service of the Department of Science and Technology (DOST), for this information.





To better focus programmes and other initiatives, DOST launched a five-point action agenda, much in line with Filipinnovation and the LED. This includes: 1) using S&T to address national concerns and problems; 2) developing appropriate technologies to create growth in the countryside and alleviate poverty; 3) harnessing technology to improve industrial competitiveness; 4) using S&T to enhance the delivery of government and social services; and 5) developing emerging technologies to boost competitiveness.

### 3.2 ERDT

To better stimulate the human capital situation, the Engineering Research and Development for Technology (ERDT) plan, for a consortium of the eight top universities in Philippines was developed on an initiative from the College of Engineering at the University of Philippines the largest university in the country. The consortium is spearheaded by the University of Philippines in the context of ERDT, and has a set of specific objectives:

- Deliver high-impact research aligned with the country's National Science and Technology Plan (NSTO) and the Medium-Term Development Programme (MTDP);
- Attain a critical mass of Master's and Doctoral graduates;
- Upgrade the qualifications of practicing engineers;
- Develop a culture of research and development.

ERDT offers scholarships to students, and represents a dedicated effort to boost science and engineering capacity through the training of graduates for undertaking research in the science and engineering fields. Entry to the programme is based on a competitive process to ensure that the best students are recruited. The students have to remain in the country for a specified time to avoid immediate brain drain, but through cooperation with universities in Japan and USA, some are sent abroad as faculty to upgrade further.

ERDT is seen as promising, and has secured long-term funding through integration in Philippine law. However, observers argue that the funding is too small, and that the programme should be boosted financially to create a much higher impact on the situation of human capital in science and engineering in the country (Tan undated).

### 3.3 Technology transfer and intellectual property

A key component of the Filipinnovation strategy was the need to enhance the transfer of technology and stimulate commercialisation to boost innovation activities in the Philippines. It was well recognised that technology transfer activity was very low, implying little commercial impact from government funded research. During first ten years of this century, only 3% of the 250 technologies developed from government funded research were covered by licensing agreements with the private sector (Mendoza undated). In 2005, only 210 patents were applied for by local researchers out of a total of 2,972 applications. Only 15 patents were granted and only one of these was for a research and development institute (RDI) (in this case the International Rice Research Institute). The same pattern was found for 2006: of the 1,215 patents granted, only 24 were local, with only one from an RDI, on the sambong herbs of DOST. In 2007 of 1,814 patents granted, 28 were made by local researcher-applicants, again with only one from an RDI of DOST[5].

Against this background efforts were made to boost technology transfer, and the Philippine Technology Transfer Act was signed in 2009 and implemented in 2010. This initiative was seen as necessary because the system until then was characterised by a lack of well-defined and unifying policy, insufficient investments in technology transfer and commercialisation, weak public-private cooperation in R&D and a lack of well-defined IP regimes in RDIs.[6]

The new law, much appreciated within the RDIs, was built upon the US Bayh-Dole Act, and assigned the ownership rights of inventions from R&D to the RDIs themselves, rather than with the funding organisations. Further, through local agreements, scientists themselves may take a share in the revenues, and be free to found companies, engage in consultations etc. This was seen as imperative, as researchers had very little knowledge of how, or incentives, to engage in technology transfer and the commercialisation of their research results. The RDI ownership, however, is not absolute, as the law makes exemptions, such as in the case of national interests and challenges typical for developing countries. The new technology transfer law has been seen as one of the major and most important initiatives in innovation policy in the Philippines in recent years.

The Technology Transfer Act is a detailed set of legislation with some key concerns: 1) it gives priority to technology transfer and not income generation, including a right for the government to assume ownership in cases of national interest or emergency; 2) it provides for management of conflict of interest; and 3) it provides for a public or open access policy.

The act impacted directly on the key institutions in Philippines. For example, the University of Philippines, the largest and that with the largest IP volume, revised its already comprehensive system for IPR policy and upgraded its efforts for technology transfer through its technology transfer office, which since its reorganisation in 2011 has been called the Technology Transfer and Business Development office (TTBDO). Its focus is to ensure the protection and management of the university's intellectual property portfolio, spearheading technology transfer and the commercialisation of IP assets, leveraging the university brand in winning consultancy

5 http://www.bic.searca.org/news/2010/apr/phi/24.html

6 Ibid.

projects for knowledge transfer, as well as promoting entrepreneurship. More attention was geared to consultancy, access to theses and dissertations and a new focus on the formation of spin-off companies, licensing and the sell-out of IP as key routes to markets, to name a few of the revisions. The university diffused the policy throughout its seven campuses in the country with a view to strengthening the overall capacity to manage IP, and attempts to implement a university-wide IP and expertise audit to ensure that technology transfer and commercialisation were integrated in the normal set of activities.[7] The comprehensive set of activities organised through the TTBDO led to a number of accomplishments for the period 2012–13, such as 181 patent searches, 16 patent drafts, 11 of which have been filed, and 404 thesis assessments conducted for commercial potential.

The technology transfer law also serves as a guide for those institutional intermediaries assigned to promote technology transfer. For example, the Technology Application and Promotion Institute (TAPI) is subsumed under DOST to:

- Encourage the use of the intellectual property system and promote IP and IP-related services;
- Provide comprehensive assistance packages for inventions (innovations)
- Actively support activities geared towards the promotion of creativity and capacity-building within the innovation system;
- Facilitate business development of technologies, and;
- Promote and strengthen partnerships and linkages with and among stakeholders.[8]

The particular roles of TAPI are expansive[9]. TAPI is both an RDI, and the key service institution for the governmental RDIs to promote their technology transfer processes. TAPI also provides some venture financing with funds from DOST. Although TAPI is not a research institute but rather a S&T service institute, its role is related to the four steps of technological development:

- Research
- Development and pilot testing
- Field testing and validation
- Roll out to market.

TAPI tries to avoid projects that are individually based in RDIs, and works instead with projects that are included in R&D programmes to ensure quality and potential. It attempts to identify "low lying technologies" that are easier to commercialise. The identified technologies are then brought to the attention of end users, such as individuals or agencies, and the research councils including their private members. TAPI's investor forum is used to bring the technological projects in contact with possible private sector actors such as VC funds, and TAPI cooperates with lawyers at the Intellectual Property Office in Manila in addition to the certified lawyers in TAPI to help draft patent applications.

The venture fund run by TAPI offers financing for start-ups, which is facilitated through interest free loans rather than venture equity. TAPI also runs a programme called CAMPI (Consultancy for Agriculture and Manufacturing Productivity) that offers mentoring and consultancy.

In sum, TAPI is a core component of RDIs that are organised under DOST, and engages with other research institutions, universities and private sector actors. It is particularly active vis-à-vis the various DOST research councils that represent key networks in various scientific areas. However, it is also noted that TAPI represents a typical case of technology transfer through the linear model, or technology push, and despite the many efforts made, few technologies have yet been introduced successfully that have a market potential beyond Philippines.

TAPI also overlaps with the activities of the RDIs, such as the Advanced Science and Technology Institute (ASTI) that specialises in ICT-related research, and has its own technology transfer activities. Its technology transfer programme entails activities such as technology diffusion / commercialisation, collaborative R&D, training and seminars and industry studies. ASTI's technology transfer activities include, in principle, several noticeable features:

- There is an extensive cooperation with the electronics industry;
- This industry addresses and identifies their R&D needs;
- ASTI generates a proposal for funding from DOST and industry itself;
- IP is split according to the share of funding.

This model is seldom used, however: only one out of eighteen projects has been developed according to this model. The normal situation is one of "over-politisation": ASTI reports to the DOST responsible for R&D, but needs supportive decisions from the Philippine Senate for budgets. Budget proposals have to be defended in the House of Representatives, even on a detailed project level. Hence, prioritisation in R&D, with serious implications for technology transfer, is ineffective, as all RDIs under DOST and agencies in the public sector in general are required to comply with this process.

Two important programmes have been implemented to pursue technological innovation: the Small Enterprise Technology Programme (SETUP) and the Technology Incubation for Commercialisation Programme (TECHNICOM). These programmes serve as key initiatives to support capacity development and innovation in the private sector. Further, as ICT and electronics are seen as key to the innovative capacity of Philippines, with a visible position in the global value chain, initiatives to promote innovation in this sector have been given priority, such as the Advanced Device and Materials Testing laboratory (ADMATEL[10]). This is intended to provide a shorter turn-around time for analysis, less expensive services and to attract potential investors. The centre will support the increasing role of the semiconductor industry and further enhance the development capacity of the electronics sector which has a further growth potential if able to become more innovative and move up the value chain.

7 The author appreciates information from R. L. Garcia at the UP's Technology Transfer and Business Development Office, as well as the mid-term report from the same office for 2012–2013.

8 http://www.tapi.dost.gov.ph/index.php/about-tapi/

9 http://www.tapi.dost.gov.ph/index.php/programs-and-services/





Project NOAH (Nationwide Operational Assessment of Hazards) for disaster management is also a priority initiative for innovation. It leverages technologies and services through various DOST initiatives such as ASTI, with a partnership with the University of Philippines National Institute of Geological Sciences and the College of Engineering. It addresses a major challenge for the Philippines: to ensure a more accurate, integrated and responsive disaster and prevention and mitigation system especially in certain high risk areas. It includes themes such as geo-hazards mapping, hazards and storm assessment, and flood and landslide assessment.[11] (Project NOAH has built the country's capability to apply LiDAR mapping technology not only for disaster risk reduction but also for other areas such as land-use planning, resource assessment, smart agriculture and geo-tagging of government programmes and projects. In this regard, it is harnessing the help of fifty state colleges and universities offering geodetic engineering and computer sciences to address the growing human resource needs of the programme.)

### 3.4 Technology transfer: The case of agricultural R&D

Technology transfer and commercialisation may be illustrated by PCAARRD, the most important of the DOST research councils, which assumes responsibility for the area of agriculture and natural resources, and thus is key to the dominant economic sector in the Philippines. Members of the council come from the Department of Environment and Natural Resources, NEDA, DTI, the academic sector, and four companies, and the council is thus made up of a broad representation of interests and stakeholders. Its key operational tools are S&T plans (ISPs) that highlight objectives, benchmarks and STI interventions, and they are also used to communicate with other actors and interests with a view to invite them to align their activities to those of PCAARRD. The ISPs are funded according to perceived gaps in the sector. The council receives funding from the government which has been approved in Congress, by itself illustrating the high degree of central control of the system. The budget is long term, but the additional funding has to be defended in Congress every year. External funds are added, such as those from donor agencies and local partners, and they constitute 5 % of the overall budget.

The PCAARRD is, like all the other councils, evaluated regularly, with quarterly reports on key accomplishments, and the evaluation is conducted on an annual basis. The innovation-related indicators in this process are:

- Number of significant results
- Number of IP applications filed
- Publications
- Number of beneficiaries adopting outputs

As mentioned, the ISP is the key tool for managing innovation. For example, the rice industry strategic plan is value chain based, and is based on benchmarks in rice productivity indicators from other countries, such as Vietnam: yield in the Philippine rice production is compared with that of Vietnam, and gaps are identified with a view to lower the cost of production and increase productivity through dedicated S&T interventions. This includes R&D, but also additional training of farmers etc., and typically takes place through a national network of regional agencies. These agencies deal only with the RDIs of DOST, as these are also the only recipients of funds from PCAARRD. PCAARRD is conducting incremental innovation in a sector where the absorptive capacity of users is low (farmers). Within the PCAARRD technology transfer programme, the council attempts to promote innovation through an innovation cycle (see figure 2).

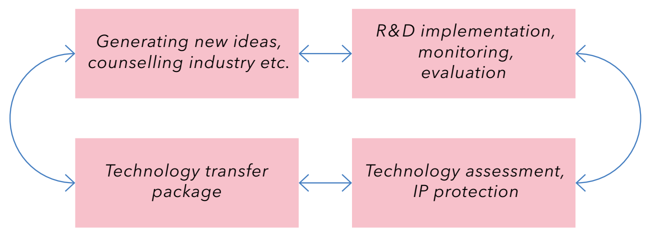


**Figure 2:** PCAARRD's Industry Strategic Plan innovation cycle[12]

Within this general model, PCAARRD exploits several instruments to promote innovation. These include training in commercialisation, the training of users, ICT and other service provision, consulting for new ventures, links to incubators and transfer agencies, joint research with the private sector, patenting and licensing. A major challenge is still to motivate researchers to engage in innovation in addition to publishing as the normal scientific activity. The new technology transfer law has had positive impacts on this work, as it has helped with the identification of relevant projects as well as the identification of IP issues in each case. While the Philippine R&D system is still not used to patenting and innovation, the new law stimulates contacts between the public and the private sector, and the recycling of funds to R&D. The Techno Gabay programme is an instrumental example. TGP is one of PCAARRD banner programmes. It aims to bring science-based information and technology services to end-users in the agricultural, forestry and natural

10 http://www.admatel.com

11 http://noah.dost.gov.ph

12 Illustration based on interviews at PCAARRD

resources (AFNR) sectors. TGP is characterised by networking with research and development (R&D institutions in the AFNR sectors, the Regional R&D Consortia and other members of the National Agricultural and Resources Research and Development Network (NARRDN), the private sector, local government units (LGUs), non-government organisations (NGOs) and other extension service providers, thereby enhancing technology utilisation, adoption and commercialisation. TGP addresses the government's medium-term development plan (MTPDP) for 2004–2010 through the capacity building of LGUs in terms of information and technology services.

PCAARRD sees IPR and IP management as critical issues, and the key to promoting innovation throughout the small-scale innovation activities typical of much of the Philippines' agriculture and forestry. There are four items of concern in particular:[13]

1. Promotion to make researchers and research managers aware of IPR and technology transfer policies and guidelines
2. Technical assistance in the development of agency IPR policy
3. Technical assistance on IPR concerns of DOST-PCAARRD funded projects
4. Capability building on specific subject matters such as patent search

PCAARRD's broad mandate and set of activities notwithstanding, the financial resources available are small. PCAARRD's annual budget is 800 million pesos (some 22 million US$), including all activities under PCAARRD, not only technology transfer and innovation. While foreign funding was previously more readily available, for example, from Japanese sources and aid programmes, the available funding today is mainly government funding. Foreign funding only makes up 5 % of PCAARRD's budget.

However, the Philippines is also endowed with other resources: the International Rice Research Institute (IRRI) is located in the Philippines. IRRI is part of a global network called the "Consultative Group of Agricultural Research" (CGAR). IRRI is also member of a Global Rice Science Partnership (GRISP), and thus is well networked and integrated in global partnerships. IRRI makes up key resources for R&D in the Philippines, and attracts foreign funding through the global network of donors attached to GGAR. IRRI is actively involved in technology transfer through its R&D activities, but normally only issues non-exclusive IP rights to allow the widest possible diffusion of innovations and to increase the speed of the adoption of new technologies. Although IRRI is subject to Philippine law, it is still governed by international treaties on IP and material transfer agreements.

13 http://www.pcaarrd.dost.gov.ph/home/ssentinel/index.php?option=com_content&view=article&id=952&Itemid=112

### 3.5 Investment support and venture capital

In any innovation system, the financial resources available for investment in innovation are crucial. In the Philippine case, these resources are generally scarce, with, for example less than 0.15 % of GDP being invested in R&D. A significant part of this, of course, is channelled to the public and private institutions for higher education and research institutes. Further, the Philippines has typically been a laggard in foreign direct investments (FDI), but saw a sharp increase in 2012, recording a growth rate of 185 % compared to the modest 2.11 % average expansion across the ASEAN-6 (Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam). Net FDI soared 61.6 % in April to US$ 202 million. The positive growth is currently explained by a shift in investor sentiment away from China, as well as benefitting from solid growth rates in Philippines and a booming work force.[14] Still, the Philippines is low on FDI, reflecting several structural and regulatory challenges in the economy, such as an industrial structure highly concentrated with key families and strict regulations on equity positions in Philippine companies.

To stimulate FDI and other investments in the Philippine economy, certain instruments have been implemented, aimed to give incentives / subsidies to various sectors or areas of priority. The key institution in this respect is the Board of Investments (BOI) (see box 1). Allocations of incentives, such as tax breaks, follow a detailed Investment Priority Plan (IPP) that is endorsed by the President on an annual basis. For FDI, BOI also follows a "negative list" that stipulates which projects / sectors cannot receive subsidies or meet limitations on foreign ownership (many key sectors have a ceiling 20, 25, 30, 40 or 60 % foreign ownership, which is, according to many observers, seen as inhibiting the investment climate in the Philippines).

Among the vast array of priorities laid down in the IPP, there are also provisions for support to R&D projects, as they are also stated as preferred projects. In the chapter on the specific guidelines of IPP, support can be given to R&D activities, the establishment of R&D labs and testing facilities, centres of excellence (COE) (see section on human capital), and technical vocational training (BOI 2012). However, the support or incentives given to R&D projects is modest: in the period from 1978 to 2012, 24 projects were approved and registered. Thus, BOI facilities provide incentives mainly to projects that represent investment in physical capital or industrial projects in line with adopted industrial policy. This includes tax breaks given to investments in Special Economic Zones endorsed by PEZA (Philippine Economic Zone Authority).

14 http://www.philstar.com/business/2013/07/05/961637/phl-catching-fdi-citi/, http://www.philstar.com/business/2013/07/11/963957/net-fdi-soars-61.6-april





The investment support activity managed by BOI can thus be said to be politically controlled at a detailed level, while also spread across a great number of preferred or priority areas. However, it should also be noted that the tax revenue in Philippines is not high, and any tax break or other incentive to investors is also a reduction in revenues that may be used for other immediate, not least social, purposes.

The Board of Investments (BOI) was established in 1967 to offer incentives to investors who invest in so-called preferred areas of investments. The institution was later adapted in response to several changes in the laws regulating the BOI. For example, the Investment Incentives Act, upon which the BOI was founded, was complemented in 1968 by the Foreign Investment Act, and in 1970 by the Export Incentives Act, and in 1987 by the Omnibus Investment Code. Today, BOI is responsible both for regulatory activities as well as investment promotion: BOI continually reviews the laws and regulations pertaining to investments and the granting of incentives, and recommends measures to give further liberalisation of foreign investments. The guidelines and priorities for incentives are adopted annually by the President. There is a cross-agency representation on the board to ensure coordination with the main sectorial policies. A reorganisation in 2012 led to the creation of Business One-Stop Action Centre (BOSSAC) to help improve counselling, reviving industry development and streamline investment activities with trade activities.

**Box 1:** Board of Investments. Source: *BOI at a Glance*

### 3.6 Venture capital, private initiatives and science-industry relations

Innovation and entrepreneurship are typically supported by risk capital, often venture capital understood as professionally managed equity capital to finance early stage growth in start-up and small companies. This is also the case in the Philippines, although on a small scale due to weak framework conditions for this industry. This section briefly highlights some characteristics of the VC industry in the Philippines based on Scheela and Chua (undated, circa 2003) and interviews and data collection conducted for this study in 2013.

With economic growth in Asia, VC has been flowing into many of the Asian countries, including the Philippines. The main characteristics of VC in the Philippines are, according to Scheela and Chua, and supported by our own research, the following:

- The VC funds are relatively small, and the deals are comparatively small
- Entrepreneurs are becoming less wary of venture capitalists, e.g. due to low levels of bank support
- Many of the VC investments take place in family-controlled businesses typical of the Philippine economy. This often leads to the need to engage directly with the recipients, e.g. to write business plans
- Entrepreneurs typically have limited understanding of technology
- There is often a lack of financial transparency in investee companies
- There is a high degree of networking and co-investing among the top VC firms

The institutional framework conditions for the industry are immature compared to more developed economies. A typical problem is the lack of exit options due to immature initial public offerings and stock markets. Another is the weak deal flow from R&D (see section on technology transfer and intellectual property). A key problem is that very few innovations address the global market with the corresponding growth potential, but are rather focused on regional or, at the most, the national market.

The Philippine VC industry is small and concentrated, and networks closely with each other. There have been some attempts to boost this industry, for example the Asian Development Bank was engaged in 1993 with the Walden International Investment Group to explore the possibility of establishing a venture capital fund for the Philippines with a view "to expanding the industry and promoting competition". The objectives of the joint effort were to provide long term risk capital for SMEs and contribute to capital market development. The performance of this investment was evaluated in 2012 with a dismal result, with an overall conclusion that the outcome was less than satisfactory on most accounts (ADB 2012), confirming the continuous weaknesses in the VC industry in Philippines.

Several private actors are engaged in investing in ventures, but following the above, these typically engage in a broader set of activities to compensate for the weaknesses in the institutional framework. For example, ARCDI is a company that was established from a semi-conductor association to engage in venture capital in the electronics industry, but later also expanded into other industries. The company engages with others, including R&D institutions to tap potential ideas for innovations, and thus takes up the role of a strategic partner for government agencies: ARCDI recently teamed up with ASTI (Advanced Science and Technology Institute, under DOST), while ASTI grants ARCDI a non-exclusive right to selected training materials. In fact ARCDI, as an investment company, engages strategically in training as this is seen as the key challenge in the Philippine system (see box 2).

ARCDI offers training modules on specific competency areas which are centred on industry requirements. The curriculum is developed and delivered by acknowledged subject matter experts in various fields of the industry. The theories and best practices learning are supported by laboratory equipment and instrumentation workshops. ARCDI began its operations in February 2004. For its first year, 15 technical courses were offered which gathered 778 participants from 60 companies. Setting the strategic direction, ARCDI is strongly supported by an 11-member Board of Trustees whose members are the leaders of the industry, government and academe.

**Box 2:** ARCDI[15]

In addition to training and technology sourcing, ARCDI is engaged in small scale R&D funding vis-à-vis researchers, networking and partnering as well as tapping into R&D resources in other Asian countries. A specific challenge for ARCDI as a venture company is the rigid organisation of government R&D institutes which are being further consolidated instead of being freed for more competition. This inhibits the potential flow of deals for the VC industry.

The VC industry is international, and with the continuing integration in ASEAN, the association of the 10 Southeast Asian countries, it is likely that Singapore will develop into a hub even more than it has today. This puts more pressure on reforms and liberalisation in the Philippines to avoid being unable to integrate and compete. ARCDI sees it as crucial to bring the Philippines into the international flow of R&D results and technology. With a lack of understanding in the Philippines about the need to achieve a global scale of innovations, reforms in the system will be desperately needed.

The Ateneo University and its Innovation Centre is another example of the Philippine system (see box 3). The centre is part of the School of Engineering of the Ateneo de Manila University, one of the major catholic universities in Philippines. The Ateneo Innovation Centre is not an instrument or part of the Philippine public policy, but rather an initiative from the university itself. It was established in 2008, and serves the broader "eco-system" for open innovation. It rests on a pool of faculty, but has only one full time employee. Students are recruited to the centre and join voluntarily to enhance their thesis and project ideas.

**The Ateneo Innovation Centre (AIC) promotes innovation through multi-disciplinary teaming and strategic long-term partnerships with industry.**

MISSION

To promote and facilitate collaborative research and problem solving, involving the academe, industry, government and international partners. To develop market smart, innovative Ateneans with demonstrated ability to innovate and a deep understanding of how technology creates new opportunities for the Philippines.

*"Our process of innovation, research and commercialization is really simple: we look for really good ideas from ourselves in Ateneo, from our partners and from around the world (through literature) for products, services and models. We would then spend a year of research and development time to create prototypes and proof of concepts, being an open innovation centre we show these to our close partners and get feedback, buy-in and investment. We work and work until something gels or vector into another direction that has more promise."*

The Ateneo Innovation Centre is first and foremost a research organisation but we have to go beyond just research and turn research into real products and services by commercialisation and training, empowering and providing for the next generation of innovators and technopreneurs.

**Box 3:** The Ateneo Innovation Centre[16]

Through broad cooperation with the School of Engineering and other schools at the university, the centre attempts to stimulate multi-disciplinarity in research and thus the basis for innovation activities. The centre does not have its own fund for investments in projects, but the President of the University allocates funds to the activities on a case-by-case basis. It also tries to access funds from abroad, such as from Japan, and sources ideas and technological projects from outside, being open to where the basis for innovation projects actually comes from. By the same token, the centre also attempts to access private funds in the Philippines, such as venture capital.

The AIC is currently seen as a model across the ASEAN network, indeed due to the model of open innovation, as this implies a break with the dominant linear, technology push typical of the government-based system of research institutes and technology transfer. It promotes open innovation, networks and a problem-oriented approach that is much needed in the Philippines.

15 http://www.arcdi.com

16 http://www.admu.edu.ph/ls/sose/ateneo-innovation-center/





To promote innovation in the Philippines, the government recently supported a private initiative to establish an incubation programme called IdeaSpace, a national competition to receive up to 5,000,000 pesos each for the most promising start-ups. The nation-wide competition received some 700 proposals, from which a shortlist of 20 projects was selected. This is being reduced to 10 projects for funding. While this initiative is targeted and appropriate for stimulating innovation, it also illustrates that the available funding does not allow for an effort with broad and significant impacts. Further, the DOST agency Technology Resource Centre (TRC) assists new companies through incubation, and may assist through the "inventors' guarantee fund". TRC manages the incubator affiliated to ASTI, with a space for 20 start-ups in the electronics sector. This incubator is currently 90 % full.

The wider issue of science-industry relations is, however, barely developed in the Philippines. The two examples above illustrate this, and the situation is similar in the public RDIs under DOST: the public RDIs are basically government driven, and the private sector typically complains about a system that is less open and too government dominated. However, DOST attempts to improve and strengthen science-industry relations and to induce a more demand-driven activity. For example the Advanced Materials Testing Lab (ADMATEL) was recently established by DOST close to the semiconductor cluster in Bicutan south of Manila.

As mentioned earlier, many of the Philippines Universities are private. This should, in principle, stimulate a more vibrant interface between science and industry, and in some cases it does. The Mapua Institute of Technology may serve as an example: this MIT was family-owned from 1925 to 1999, and was then bought by another private corporation in 2000. It is currently publicly listed on the stock exchange, and its main line of activity is higher education. After the takeover in 2000, the MIT has been more geared towards excellence and accreditation, and even if demand driven research is improving, it is still miniscule. The science-industry relationships are mainly linked to human capital. The range of activities includes on the job training and seminars, a few cases of "industrial PhD", where the student conducts much of the research in a company, although recently a company has suggested integrating 15 PhDs in their activities. The Office of Higher Education may finance this programme, which may also serve as an interesting model for other universities with a potential to develop relations with industry. A problem that is still to be tackled is the issue of confidentiality of student results when these are developed in cooperation with industry, leading to limitations as to what can be published. However, when this is solved, industrial PhDs should be an interesting way forward in the Philippines. The above mentioned ERDT programme also supports this approach.

MIT runs a dedicated office for innovation and technology support, responsible for activities such as patent searching and drafting, in line with other institutional efforts. The Mapua Technology Service takes care of licencing, much like a technology transfer office. Still, as industry itself is weak in terms of demanding innovation services, the overall output remains small.

The University of the Philippines manages a programme targeted to improve the links between academe, government and industry (IGLAP[17]). Its key objectives are:

- To serve as a venue for the industry and government to tap the talents of top-notch engineering graduates and faculty.
- To facilitate relevant research activities and joint projects across the three sectors and promote partnership in resource sharing and knowledge generation.
- To provide opportunities for students and faculty to be exposed to industry and government work environments in order to prepare them in the conduct of nation building.
- To make the internship programme an enjoyable experience for students so as to develop their self-esteem and confidence in facing the real world.

This has proved to be a useful interface with industry in setting internships, industry associate professors etc. While such initiatives are useful and necessary, the degree of research, innovation and transfer of technology is relatively small.

### 3.7 Innovation-related information and support systems for rural areas

A major challenge for the Philippines is to upgrade regional and local economic activities, many of which are in areas of poverty and scarce resources, often based on informal and subsistence level economic activities. Food and agriculture are critical sectors as the population is dependent on the output and productivity that can be boosted in these areas. Some 44 % of farmers and 50 % of fishermen are seen as being in poverty (Tan 2010). Some of the schemes put in place respond to this challenge. This includes, for example, the Small Enterprise technology Upgrading Programme (SET-UP) under the office for regional operations in DOST. The programme was launched to respond to the critical role of the small businesses in generating employment and development in rural areas. The SET-UP is an umbrella programme linking DOST activities and services to address the needs of these entities, and thus, the programme includes a number of possible instruments, such as the introduction of new technologies, upgrading, human resource training, database management and design.

The DOST council PCAARRD, responsible for agricultural and related research, implements the Techno Gabay Programme (TGP), providing delivery of information and technology services in agriculture and natural resources. It integrates a number of projects and

17 http://coe.upd.edu.ph/iglap/

services such as the Farmers Information and Technology Services (FITS), Farmers Scientist Bureau (FSB) and ICT-related initiatives. PCAARRD signed an agreement in 2008 with the Commission on Higher Education (CHED) to mandate state universities and colleges to adopt the TGP.

Other examples are the Technology Resource Centre (TRC) which is an autonomous institution under DOST, acting as a facilitator in the utilisation and exchange of ideas, information and technology to create new jobs, livelihood opportunities and SMEs. The Technology and Livelihood Development Centres (TLDC) mirrors the TRC in managing a "technology bank" and an electronic TRC service, providing materials and references on livelihood and entrepreneurship information. This system is based in 46 provinces throughout the Philippines.

DOST also operates information services such as the Science and Technology Information Network of the Philippines (ScINET-PHIL), a consortium of the libraries and information centres of the 20 agencies under DOST. It is mandated to improve information sourcing and exchange in the DOST system. Further, the TECHICOM programme provides funds to fast track the transfer and commercialisation of research results. The One Stop Information Shop of Technologies intends to bring to the market technologies that were developed in the DOST R&D system.

Thus, the Philippines has developed a broad spectrum of services and programmes to support the regional and rural innovation processes. Naturally, the success of these initiatives rests on the adoptive capacity of the beneficiaries in question, and the programmes are also intended to increase this capacity. A major challenge will be to bring many of the informal economic activities into the formal economy and beyond subsistence-level business activities.

## 4 International cooperation

Although the Philippines' STI system may be said to be inward looking, there are several international dimensions in place that ensures links with outside resources. This concerns firstly ASEAN, the union of the 10 South-east Asian countries. ASEAN organises the region's STI cooperation through the ASEAN COST, the Committee for Science and Technology, and the Philippines is, through DOST, active in this cooperation and its strategic planning and programme development. ASEAN also provides a context for innovation and investment, as the union is currently taking a new step in its integration efforts, and will launch a single market by 2015. For the Philippines, this means new challenges, as the scarce financial resources in place for new ventures and innovation will relate to the expected changes in the deal flow: Singapore is expected to be the key hub in the ASEAN region, and a challenge for the Philippines will be to take advantage of this. However, this also challenges the Philippine system, as the research system in general is too focused on national potential and less on global. There are S&T agreements with more than 40 countries worldwide, many of which are donor countries providing foreign aid. Japan is, for example, active in financially supporting programmes related to innovation. However, donor priorities in S&T are the exception.

The Philippines give much attention to global competitiveness, and in that context attempts to exploit international cooperation to solve local problems and challenges. Thus DOST gives priority to international cooperation and relationships, and runs several programmes through its International Cooperation Unit (ICTU[18]) to stimulate greater international engagement. This includes in particular scholarships, such as the MECO-TECO programme with Taipei that grants scholarships in key scientific fields. Major cooperation in this context involves the e-Asia Joint Research programme (JRP) through which research cooperation with other East Asian countries is co-funded. It is a multilateral funding mechanism for projects selected through a call for proposals mechanism, and aims to enhance the overall scientific community in the region. It stimulates four forms of cooperation:

- Joint research by matching funds
- Research exchange by top-up funding
- Information exchange
- Promotion of exchange and networking among young researchers.

A striking feature of the Philippines innovation system is the fact that 10 % of the population lives and works abroad. A significant share of these are scientists, and thus valuable resources for the Philippines. To attempt to tap into this resource, a dedicated programme has been set up: the Transfer of Knowledge through Ex-pat Nationals (TOKTEN) provides funding for short term returns of Filipino scientists abroad. While this approach is commendable as it addresses the highly important human capital issue, the impacts of this programme on innovation and entrepreneurship is still miniscule. However, many of the larger universities have recruited foreign students, such as the University of Philippines and Mapua Institute of Technology. In the latter case, 200 out of 13,000 students at Mapua are from abroad.

DOST is also involved in the Balik Scientist Programme where foreign-based Filipino scientists and foreign scientists of Filipino descent are invited to return on short term stays to assist in priority R&D projects. It aims to benefit from the vast number of expat scientists, and aims to strengthen scientific and technological human resources to upgrade the R&D abilities of private and public institutions. As such it complements national initiatives to improve the human capital situation and helps expand networks and S&T linkages nationally and internationally. There have been good experiences with this initiative.

18 http://itcu.dost.gov.ph





The Philippines Congress approved the Philippine-California Advanced Research Institutes (PCARI) project in 2013, to be implemented by the Commission for Higher Education (CHED). This project aims to enhance the skills and expertise of the faculty and staff of Philippine universities and colleges through scholarships, training and research partnerships. It was agreed under the Philippines-US STI agreement signed in 2012, and is implemented through the creation of two dedicated institutes: the Institute for Information Infrastructure Development, and the Institute for Health Innovation and Translational Medicine. The key mission of the PCARI project is capacity-building with five partners on the Philippines side (Ateneo de Manila University, De La Salle University, Mapua Institute of Technology, Mindanao State University Lligan Institute of Technology, and University of Philippines) and two on the US side (University of California, Berkeley, and University of California, San Francisco).[19]

Another striking feature of the international dimension of the Philippines S&T system is the presence of international organisations. The World Bank, the Asian Development Bank, UN institutions such as the Food and Agriculture Organisation (FAO), and World Fish, make up useful resources for the Philippines, even though these operate on a regional basis. The most important in this context, the International Rice Research Institute (IRRI), discussed elsewhere, attracts significant resources and human capital, and thus makes a valuable addition to the Philippines system. IRRI is also member of the Global Rice Science Partnership (GRISP), an alliance of rice research institutes. IRRI in the Philippines has, for example, been able to attract resources to fund the C4 Rice Project, a long term fundamental research project with international cooperation funded by the Bill & Melinda Gates Foundation that uses cutting-edge science to discover the genes that will supercharge photosynthesis, boost food production, and improve the lives of billions of poor people.[20]

The main institutions of higher education are those that represent the bulk of international cooperation in STI. This may take place through national programmes such as ERDT. But individual universities are also active within their own strategies. For example, the Mapua Institute of Technology has developed strong ties with Taiwan universities with significant exchanges of faculty. It has signed an agreement with a key university in Indonesia, and has engaged in cooperation with US as well as European universities. The biggest university, University of Philippines, likewise has multiple international links. However, given the structure of the Philippines higher education system, the majority of these institutions do not have any significant outreach to international resources.

19 http://www.ched.gov.ph/index.php/projects-programs/projects/pcari-project/

20 IRRI, C4 leaflet

## 5 Key strengths and weaknesses

On balance, the STI situation in the Philippines remains relatively weak. On the strong side, the current momentum in economic growth provides a positive background for innovative activities. If this situation continues, it will stimulate further foreign direct investment and entrepreneurial activities. The abundance of natural resources in the Philippines also represents a potential on which to generate new economic ventures. The government has been increasingly more aware of the need to create better conditions for research and innovation, and has initiated several new programmes, incentives and support instruments to that effect. Several international organisations are present and work with the government, for example to create cooperative packages of initiatives with various levels of Philippines governance to ensure focus and critical mass. Thus, the Philippines has both potential and the political attention to innovation.

With the risk of over-simplifying, the governance of S&T and innovation in the Philippines can be said to be one of a complex and rather introvert institutional system managing meagre resources. There is a tendency to spread the scarce resources across too many priority areas, and the public R&D system has still a weak interface with the private industry. However, the Philippine leadership has a growing awareness that this needs to change, and has initiated several policies that intend to bring about a more innovation-led economic development. The key roles played by DOST, NAST and NEDA notwithstanding, the Philippines has yet to recognise the need for a "whole-of-government" approach to innovation. The Presidential Coordinating Council on R&D has yet to meet to finalise the government's strategic R&D agenda, and top-level attention, knowledge and understanding is key to the ability to engage strategically and ensure a long-term viability to STI governance. Strategic issues include balancing investments in new knowledge with acquiring existing technology, institutional improvements in the innovation system, pursuing horizontal policies to ensure strategic and coherent policy approaches and a more general consideration of the supply and demand side measures in the innovation policy mix.

The available financial resources for research and innovation are too small to ensure a viable innovation system, even though several innovation support schemes are in place. The innovation system is highly government-driven, with key research institutions directly subsumed under DOST and controlled by central government, with one implication being weak science-industry relations.

The low level of investment in R&D and innovation is linked to long-standing governance problems and the challenges of fiscal management. With generally low income levels and low levels of demand in the economy, the demand side that may otherwise spur innovation, is weak. Thus, framework conditions are weak, leading to low levels of foreign direct investment, technology transfer and integration in the global economy. There are exceptions, such as in the electronics sector, including the business process outsourcing industries (BPO), but this sector of the Philippine economy is mostly involved in the lower levels of the global value chains. Special economic zones provide another exception, as firms included in these are far more innovative than others. The foundations for long-term innovation performance, such as infrastructure and human capital, are seen as lagging significantly behind comparative countries, as well as the level needed to create momentum to innovation-led economic development. Still, the recent liberalisation policies have helped spur growth and development in the telecommunications sector, a key factor behind the growth of BPO.

The structure of the Philippine economy has certain features that seem to constrain innovation performance. It is significantly concentrated in large, family-owned conglomerations. These represent a conservative characteristic in an otherwise dualistic economy dominated by small business operations and even subsistence levels, including informal economic activities. Ownership in Filipino firms is highly regulated. Even though there are advance sections of the economy, it is recognised as lagging and not conducive to technology acquisition and innovation.

Further, only some 5 million of the 30 million Philippine labour force are included in the formal economy, the rest are in the informal economy, and a significant share of economic activities takes place in rural areas or is depressed due to a high degree of poverty. Lack of investment in infrastructure also provides poor framework conditions for innovation. There are high entry barriers in many sectors with restrictions on foreign ownership, and the labour market is highly regulated with disincentives for firms to hire. A key challenge for the Philippines is to mobilise sufficient resources in areas with the potential for growth and job creation to ensure momentum in innovation and technology development.

The educational system is extensive but of generally low quality. The strong population growth of 2 % annually has created a demand for a steady expansion of the system, but there is a continuous challenge to fill the faculty with highly qualified staff. Due to earlier policies, many of the higher education institutions are private (more than 1,200 of the more than 1,700 institutions), owned, for example, by religious organisations or private conglomerates. There has been a widespread proliferation of state universities and colleges, but they are very poorly funded and thus of low quality. The output from the tertiary level (Masters and PhDs) has been discouragingly low over the past years. Among the great number of colleges and universities there are five universities that are standing out, in particular the University of Philippines, suggesting a very dualistic system of higher education, with a gradual upgrading in recent years through accredited centres of excellence that mainly benefit the larger institutions. The Philippine government has initiated a dedicated programme to boost graduation in engineering and related areas through the Engineering Research and Development for Technology (ERDT) programme. Such initiatives are likely to play an important role, as they both help to boost human resources in science and technology as well as support relationships between science and industry. The strong population growth also has another implication: to boost the share of human resources in science and technology in the population, it is estimated that 2,000 candidates need to be produced annually, compared to the current 800 candidates from the higher education system.

Indeed, the issue of human capital is confirmed as a critical issue for the Philippines in a recent study by Ahmed and Krishnasamy (2013). They analysed the total factor productivity (TF) over many years (1993 to 2006) for ASEAN 5: Malaysia, Indonesia, Philippines, Thailand and Singapore). The Philippines experienced a decline in TFP over the years in question. Whereas Philippines has the by far highest expenditure on education, the decline in TFP is related to a loss in both technical efficiency and technological progress. Human capital, the inefficiency of education, stands out as the key issue.

Looking ahead, the weaknesses inherent in the Filipino system seems well addressed by the recent strategy of Filipinnovation. Investments in human capital remain the greatest concern. There is great potential in developing effective links between science and industry, however, this presupposes significant reforms in the university sector, while boosting the role and flexibility of research institutes is another much needed option. Dedicated innovation support schemes that explicitly stimulate cooperation between industry and research will be required. The recently implemented Technology Transfer Act has played a positive role in improving the propensity to patent and commercialise technology. Creative and flexible intermediary institutions such as the Ateneo Innovation Centre could play a key role in a more adaptive and responsive environment for innovation and technology transfer.

The overall situation in Philippines also leads to a need to continue, and even expand, the regional and local development profile of innovation policy. Social innovation and inclusive development remain a core challenge, and policies that stimulate a reduction of the informal economy, and job creation in the formal economy, have an important and necessary role to play. Innovation policies for technological development and key industries notwithstanding, the Philippine government's key challenge is to spur inclusion and job creation in an economy that still has significant growth stimuli from global value chains and networks.





# 6 Appendices

### Appendix I: Institutions visited

*Department of Science and Technology (DOST)*

*World Bank*

*Asian Institute of Management*

*National Economic and Development Authority*

*Mapua Institute of Technology*

*Food and Agriculture Organisation, UN*

*University of the Philippines*

*Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD)*

*World Fish*

*International Rice Research Institute*

*Advanced Research and Competency Development Institute (ARCDI)*

*Board of Investments (BOI)*

*United Nations Development Programme (UNDP)*

*Technology Application and Promotion Institute (TAPI)*

*Asian Development Bank (ADB)*

*Advanced Science and Technology Institute (ASTI)*

*Ateneo University Innovation Centre*

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## Appendix III: Policy cycles

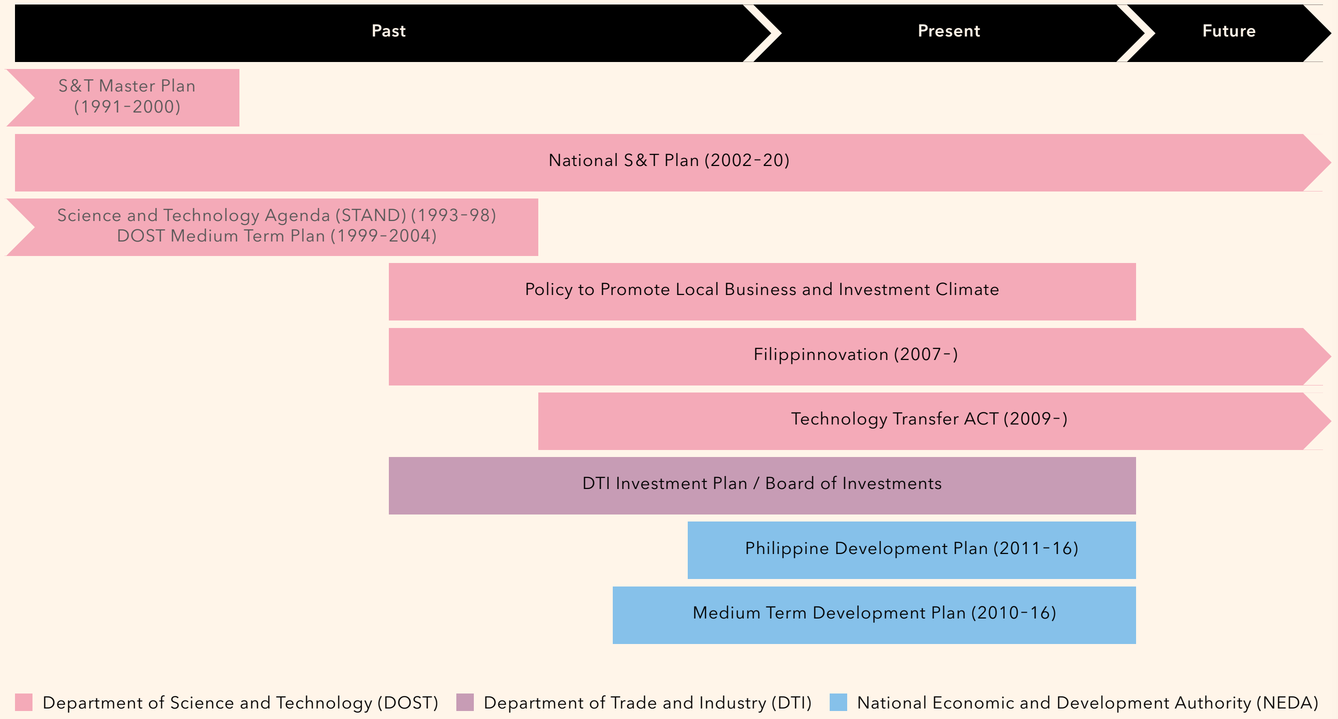



**Figure 3:** Policy cycles

## Appendix IV: Funding agencies and instruments[21]

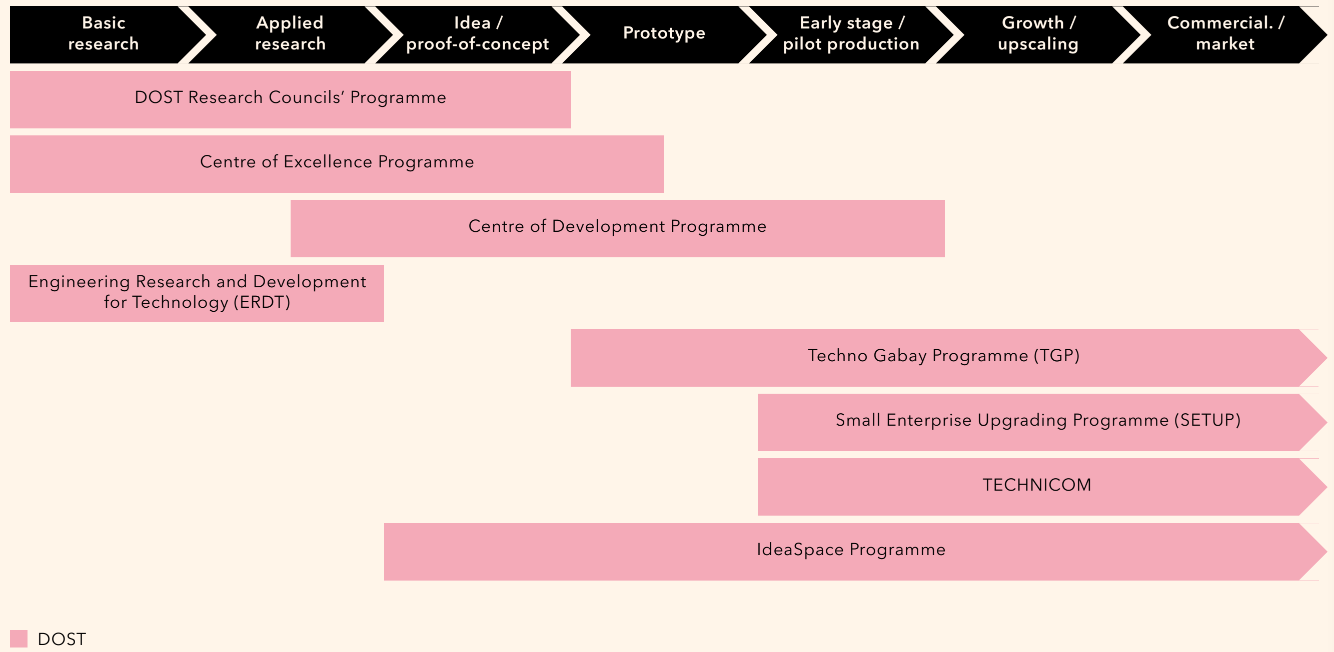



**Figure 4:** Funding agencies and instruments

21 According to the stage in R&D / product development they focus on





# Singapore

Alexander Degelsegger[1], Wanichar Sukprasertchai[2]

## 1 Key indicators and framework conditions

### 1.1 Socio-economic framework conditions for innovation

R&D investment in Singapore was low until the late 1980s, but has grown steadily since 1989 when policy decisions in favour of R&D were made. These decisions were institutionalised in a political environment, which is, for various reasons, uniquely stable. The results of these decisions and of a sustained public commitment to R&D investment and coordinated policies towards R&D performance are visible today. Singapore has established itself as a major player in the global research landscape in terms of the level of public and private investment in R&D, financial framework conditions and human resources.

Especially when comparing the commitment and achievements of Singapore with the situation in other countries in the region, as we do in this report, one basic and central framework condition has to be taken into account: Singapore is a city-state. Here, the agglomeration of different kinds of capital (financial, but also human resources and intellectual capital) can, in most cases, be achieved with fewer challenges than in the case of larger countries, where several centres usually exist and compete for scarce national resources. Bearing this in mind, the sustained commitment to R&D at the political level since the 1980s and Singapore's role as a hub for, among other things, R&D and higher education, are indeed particularly noteworthy features of its present innovation system.

In recent decades, supported by strong and sustained public investment, universities such as the National University of Singapore or the Nanyang Technological University have grown to be major research performers, as have the public research institutes of the Agency for Science, Technology and Research (A*STAR). The faculty in these institutions is highly internationalised and well networked globally. The major higher education institutions attract a large number of foreign students both at undergraduate and graduate levels; as well as young researchers. Other universities in Singapore also offer an excellent higher education portfolio, albeit in a more focused range of subjects (such as business and design) and with somewhat less focus on research.

Firms also invest heavily in research and development, mainly in the areas of electronics, information and communication technologies and media, precision and transport, biomedical sciences and chemicals. Public research investments follow similar patterns, but are strongest in the area of biomedical sciences (National Survey of R&D 2012).

R&D investment in 2012 (GERD) was S$ 7.24 billion (around € 4.54 billion) with an R&D intensity (GERD/GDP) of 2.1 % (against 2.2 % in 2011). Public investment in R&D was at 0.8 % of GDP in 2012 (S$ 2.8 billion), fuelling research activity in 59 public institutions. For the period 2011–2015, a total public budget of S$ 16.1 billion has been reserved to support research and innovation (Research, Innovation and Enterprise Plan) compared to S$ 13.55 billion between 2006 and 2010. 699 companies indicating R&D activity in 2012 have invested S$ 4.4 billion (€ 2.7 billion) or 1.3 % of GDP in research and development. Local private companies have spent S$ 1.3 billion (€ 0.8 billion).

With these investments, the following research output has been produced:

1 Centre for Social Innovation (ZSI), Vienna, Austria
2 National Science and Technology Development Agency (NSTDA), Pathum Thani, Thailand

- 1,722 patent applications (first filings) in 2012 as a result of R&D based in Singapore (10 % decrease from 2011; output comparable to 2010); of which 1,024 were from the private sector (a decrease of 21.5 %) and 698 from the public sector (plus 14.8 % compared to 2011); 820 patents have been awarded (a decrease of 4.1 % from 2011), 665 in the private sector
- 14,399 Web of Science indexed publications in 2012 (13,139 in 2011)

A growing number of researchers and engineers are behind the research output. In 2012, 30,109 research scientists and engineers (RSEs; head count; excluding graduate students) worked in Singapore (against 29,482 in 2011 and 28,296 in 2010), of which 8,729 (29 %) were foreign non-permanent resident RSEs. The full-time researcher equivalent (including all research personnel) was 34,141 in 2012, which equates to a researcher intensity of 10.2 researchers per 1,000 labour force.

| Indicator | Value | Year |
|---|---|---|
| R&D intensity: Gross domestic expenditure on R&D (GERD) as a percentage of GDP – GERD/GDP | 2.1 %[3] | 2012 |
| Full-time equivalent (FTE) personnel (man-year) | 34,141[4] | 2012 |
| Total labour force | 3.4 million[5] | 2012 |
| Number of patent applications | 1,722[6] | 2012 |
| Publication output | 14,399[7] | 2012 |
| Stock of inward foreign direct investment | S$ 672 billion[8] (€ 399.7 billion)[9] | 2011 |
| Flow of inward foreign direct investment | US$ 56.7 billion[10] (€ 42 billion) | 2012 |
| Flow of outward foreign direct investment | US$ 23.1 billion (€ 17.1 billion) | 2012 |
| Number of research universities | 4 | 2013 |

**Table 1:** Key indicators

Coordinating research policy with immigration, economic and fiscal policy, Singapore has become an attractive career destination for researchers from abroad. Particular emphasis has also been put on the ease of doing business and establishing companies. Singapore ranks first in the World Bank's "Ease of Doing Business Report 2012" with exceptional scores in trading infrastructure and networks, investor protection, insolvency resolution, construction permits and the procedure required to start a business.

3 *National Survey of R&D 2012,* A*STAR, December 2013
4 Ibid.
5 *Labour Force in Singapore, 2012,* Ministry of Manpower, January 2013
6 *National Survey of R&D 2012,* A*STAR, December 2013
7 Web of Science database, September 2013
8 Department of Statistics Singapore, May 2013
9 Amount converted at rates of 18 September 2013 with XE currency conversion, http://www.xe.com/currencyconverter/
10 *World Investment Report 2013,* UNCTAD

Singapore has ranked 2nd for three consecutive years in the World Economic Forum's Global Competitiveness Index (most recently in its 2013–2014 edition)[11]. Among the 12 indicators used to calculate the GCI, Singapore shows particular strengths in the financial market development, institutional framework, infrastructure, higher education and training, and private sector innovativeness pillars. It also ranks particularly high in the macroeconomic environment and fiscal management pillars; as well as in the goods and labour market efficiency pillars.

In the Global Innovation Index 2013[12], Singapore ranks 8th globally (2012: 3rd) with particular strengths in business sophistication (knowledge workers, innovation linkages and knowledge absorption) (1st), human capital and research (3rd), market sophistication (5th), infrastructure (6th), institutions (7th) and knowledge and technology output (11th). Interestingly, in the area of creative output (intangible assets, creative goods and services, online creativity) Singapore ranks only 40th globally.

Despite the high level of maturity of the Singaporean research system, challenges remain in the area of home-grown human resources (there is a highly competitive education system with little focus on, or space for, creativity; many youngsters prefer working in the finance and private management sector rather than in science and engineering) and research commercialisation (the economic value created out of intellectual capital is considered to be rather limited). The latter challenge results in a continuous, sophisticated discussion on how to fine-tune the existing public support instruments in order to get the most (commercially and socially) from the existing R&D capabilities.

Before presenting the major existing support instruments for innovation in Chapter 3, we will introduce Singapore's main research performers, its infrastructure for research and innovation as well as features of the Singaporean innovation policy (Chapter 2).

### 1.2 Research performers

In addition to approximately 700 national companies (Venture Corp, Osim International, Hyflux, TriTech, etc.) and multinational companies (Hewlett-Packard, Texas Instruments, Microsoft, Motorola, Dell, Cisco, Seagate, Hitachi, Asustek, Lite-On, Wistron, Rolls Royce, Trina Solar, Siemens, GlaxoSmithKline, Novartis, Takeda, Roche, Pfizer, Bayer, 3M, BASF, Nestlé, Kellogg, Procter&Gamble, LucasFilm, etc.) reporting R&D activity (investment) in 2012[13], the major public research performers can be roughly grouped in institutions of higher learning (IHLs), A*STAR institutes and other public research institutes.

11 http://www.weforum.org/issues/global-competitiveness/
12 http://www.globalinnovationindex.org
13 *National Survey of R&D 2011,* A*STAR, December 2012





The Singaporean university system features two prominent and globally recognised research universities, two more recent additions to the public university landscape, polytechnics and related institutions as well as private universities with little to no research activity.

- National University of Singapore (NUS; public): comprehensive research university founded in 1905; over 27,000 undergraduate students (around 37,000 students overall), over 2,000 academic staff; top positions in several international university rankings (e.g. QS World University Rankings 2013/2014 ranked it 1st in Asia; Times Higher Education World University Rankings placed it 25th globally); research activities focus on biomedical and life sciences, physical sciences, engineering, nanosciences, materials science, engineering, ICT, defence-related research, social sciences and humanities; 23 university-level research institutes and 3 Research Centres of Excellence (Cancer Science, Quantum Technologies, Mechanobiology Institute, and together with NTU: Singapore Centre on Environmental Life Sciences Engineering; see also below); strong partnership with Yale University and other institutions.
- Nanyang Technological University (NTU; public): established in 1991; 1,700 academic staff; 33,500 students, 22,500 of which are undergraduates; excellent and improving in rankings such as in the QS World University Ranking (47th globally in 2012, 58th in 2011), top 100 in the Times Higher Education ranking; research focuses on biomedical and pharmaceutical engineering, nanosciences, intelligent devices and systems, advanced computing and media, ICT; 2 Research Centres of Excellence: Earth Observatory of Singapore, and together with the NUS, the Singapore Centre on Environmental Life Sciences Engineering; many multi-national programmes with institutions from around the world (MIT, Stanford, Cornell, Caltech, Beijing University, Shanghai Jiaotong University, IIT India, Cambridge University, Imperial College, ETH, Karolinska Institutet, TU Munich, Hebrew University, etc.)
- Singapore Management University (SMU; public): established in 2000; around 8,000 students and 300 academic staff; offering degrees in business management, accountancy, economics, information systems management, law and social sciences; around 20 research institutes and centres
- Singapore University of Technology and Design (SUTD; public): the youngest among the public universities in Singapore (teaching started in 2012); focuses on training people to develop product and design solutions; collaborates with the Massachusetts Institute of Technology and Zhejiang University of China; interdisciplinary programmes in architecture, engineering and information systems; design is an integrated element in all curriculums
- Singapore Institute of Technology (public): provides polytechnic graduates with industry-focused bachelor degree programmes in engineering, health sciences, digital media, design, education and hospitality
- Polytechnics (public): currently, there are five public polytechnics offering education in the field of engineering.
- Singapore Institute of Management (national private university, originally a spin-off from the Economic Development Board of Singapore)
- other private universities

A series of international higher education institutions have established campuses in Singapore (TU Munich, James Cook University, University of Chicago [reported to be leaving Singapore for Hong Kong in 2013], etc.) or run partnerships and joint ventures with Singaporean institutions (partly in the framework of the CREATE campuses). Among the public research institutes, in addition to individual institutions such as the National Heart Centre and the National Cancer Centre, the research institutes of the Agency for Science, Technology and Research (A*STAR, formerly known as the National Science and Technology Board, one of the earliest players in Singapore's research system) certainly occupy a dominant and crucial role.

A*STAR has a mandate to foster world-class scientific research and talent for an innovative Singapore. It currently comprises 18 research institutes and consortia; 10 grouped and financed under the Biomedical Research Council (BMRC), and 8 under the Science and Engineering Council (SERC). The A*STAR Joint Council supports inter-disciplinary research spanning the fields of biomedical and physical sciences. Moreover, A*STAR's Graduate Academy invests in human capital through scholarships, fellowships, collaborations and outreach activities (to children and students, etc.).

A*STAR's budget allocated for the five year window 2011–2015 is S$ 6.39 billion, an average of over S$ 1 billion per year. A*STAR also plays a key role in Singapore's STI policy-making and priority setting.

In a way, A*STAR can be seen as the institutionalisation of past policy decisions. Between 2000 and 2008, a new A*STAR institute was created almost every year, responding to considerations regarding the scientific capabilities Singapore needed to develop to support existing and new industry sectors. Now, A*STAR has entered a consolidation phase with no recent additions to the family of institutes. This coincided with the government strategy to invest large parts of the additional public R&D resources into universities (and collaborations such as the CREATE campuses) to increase their research capacities and to improve their international standing, as well as to continue investments in infrastructure.

### 1.3 Infrastructure: The city-state Singapore as a cluster

After decades of continued investment, Singapore offers excellent infrastructure for business in general and

**A*STAR institutes and consortia**

**Biomedical Research Council**

- Bioinformatics Institute
- Bioprocessing Technology Institute
- Clinical Imaging Research Centre
- Experimental Therapeutics Centre
- Genome Institute of Singapore
- Institute of Bioengineering and Nanotechnology
- Institute of Medical Biology
- Institute of Molecular and Cell Biology
- Singapore Bioimaging Consortium
- Singapore Institute for Clinical Sciences
- Singapore Immunology Network

**Science & Engineering Research Council**

- Data Storage Institute
- Institute of Chemical and Engineering Sciences
- Institute of High Performance Computing
- Institute for Infocomm Research
- Institute of Materials Research and Engineering
- Institute of Microelectronics
- National Metrology Centre
- Singapore Institute of Manufacturing Technology

**Figure 1:** A*STAR institutes and consortia

R&D in particular. Mercer's "City Infrastructure Ranking 2012"[14] reports Singapore as having the best urban infrastructure in the world. The IT infrastructure, electricity grid, water availability, road and public transport system as well as airport effectiveness are considered excellent. Singapore is well connected online and offline: international trade and transport links are well established.

Property ownership for foreigners is restricted (with the exception of certain condominiums), meaning that vacant land and other property types can only be acquired by foreign persons or businesses with approval from the Singapore Land Authority. Approval is only granted if the interested buyer can demonstrate that economic benefits for Singapore can be expected from the investment. Within this regulated environment, however, Singapore still tries to provide space and facilities to be used by businesses and research institutes.

Regarding research and innovation in particular, Singapore offers a number of science parks and research facilities spread over its 710 km² surface.

The first science park in Singapore ("Singapore Science Park") was established in 1980 in the vicinity of the NUS Campus. It welcomed its first company tenant in 1982 and still has a focus on the IT industry. In 1993, further into the biomedical age, an additional park (Science Park II) was opened. Comprising 65 hectares, both parks together host around 350 organisations, of which an approximate 70 % are international companies, 30 % local companies and public research institutes. Singapore Science Park is managed by Ascendas, a government linked company owned by JTC Corporation (a Singapore statutory board responsible for industrial development and reporting to the Ministry of Trade and Industry). Ascendas is also developing science and business parks abroad. It has established and runs parks in, among other places, China and India. It is a good example of the indirect benefits of R&D infrastructure investments, making a successful business model out of public services provided in Singapore.

**14** An addendum to the Mercer *Quality of Living* Study

Another more recent addition to Singapore's research infrastructure around NUS is the Campus for Research Excellence and Technological Enterprise (CREATE). CREATE hosts the National Research Foundation (which funds CREATE) and a number of interdisciplinary research centres set up by top global universities together with Singaporean partners, corporate laboratories, technology incubators and start-ups. Currently, there are centres with ten different institutions such as Cambridge University, MIT (e.g. Singapore-MIT Alliance for Research and Technology), ETH, TU Munich (automotive research on electric mobility), Jiao Tong University Shanghai, Hebrew University, UC Berkeley, Peking University, Ben-Gurion University. CREATE aims to be a talent magnet and innovation hub, and it pushes towards technology transfer and commercialisation (using business students' expertise from INSEAD or SMU). CREATE houses around 1,200 researchers.

In 2001, construction of the "one-north" science and business park started. One-north has been envisioned since the 1991 National Technology Plan as an integrated and consolidated research and innovation hub in Singapore, and is being developed over a period of 30 years. It currently hosts Biopolis, the cluster for biomedical sciences, and Fusionopolis, the cluster for physical sciences and engineering. In Biopolis, public and private research performers (including A*STAR biomedical research institutes and over 40 corporate labs) are co-located for synergistic collaboration and public-private partnerships, within 13 buildings and over 340,000 m² of space. Fusionopolis, an R&D hub for information technology, media, physical sciences and engineering covering over 200,000 m² of space, co-locates A*STAR science and engineering research institutes and corporate / joint labs. Fusionopolis Phase 2A will be completed in 2015, by which all of A*STAR's science and engineering institutes will be integrated within the Fusionopolis region. Both Biopolis and Fusionopolis have shared R&D facilities for researchers of various entities, established to spur interaction and facilitate idea sharing. The entire one-north region aims to foster interdisciplinary





research and a culture of research collaboration and convergence, rooted in a diverse community of research talent.

Other cluster, incubation and science park facilities include the NTU Campus in the northwest of the island, Tuas Biomedical Park, Cleantech Park, Jurong Island and the new SUTD Campus, which is currently under construction and will be located close to Changi International Airport.

In the biomedical research area, in addition to Biopolis, the Academic Medical Centres with close links to the health care system have been established to facilitate trials, translational and clinical research.

Bringing together these various facilities in a small city-state area, Singapore as a whole could be described as a cluster or a cluster landscape with a special focus on biomedical, physical and chemical sciences, as well as IT research and innovation. In addition to the favourable infrastructure, a variety of direct and indirect public R&D support instruments are available for public and private players in research and innovation. The portfolio of these instruments is given in Section 3.

Singapore's geographical location adds to its features as a city-state, and its cluster-like character. It has been and still is a hub for trade and, more generally, international connections into and out of the Southeast Asian region. This comes with important advantages and certain challenges. In terms of the global manufacturing industry, one of its first stepping-stones in Southeast Asia was Singapore, which is part of the reason for the long tradition of foreign direct investment. However, with skyrocketing wages and limited land for production facilities, much foreign investment in manufacturing has moved from Singapore to other Southeast Asian countries. As we have seen, Singapore managed to upgrade its workforce and industry landscape to attract and create more upstream, higher value added industry, and there is little evidence to suggest that foreign R&D investments into Singapore will change course and move to other Southeast Asian countries in the near future. Conversely, it rather seems that Singapore is increasingly developing into a regional hub for, for instance, higher education, with international students from ASEAN countries gaining degrees in Singapore. However, Singapore needs and will continue to need efficient and intelligent policies to stay ahead of change. The following section introduces the relevant features of Singapore's STI policy before Chapter 3, which presents major STI programmes and support instruments.

## 2 Governance and public STI policy

As in most countries, responsibilities for research and innovation in Singapore are spread over a variety of players and agencies. The ministries concerned with STI policy implementation are: the Ministry of Trade and Industry; the Ministry of Education; the Ministry of Health; the Ministry of Defence; the Ministry of Environment and Water Resources; the Ministry of Information, Communication and the Arts and the Ministry of National Development.

Most public research performers and funding agencies are under the auspices of the Ministry of Education (universities; Academic Research Fund) or the Ministry of Trade and Industry. However, the Ministry of Defence (with the Defence Innovative Research Programme) and the Ministry of Health (via the National Medical Research Council) also fund research.

The degree to which R&D is considered a core policy area in Singapore's governance system becomes visible in the Research, Innovation and Enterprise Council (RIEC), which is chaired by the Prime Minister. It was established in 2006 to strengthen inter-agency coordination across the entire innovation system. Accordingly, the composition of RIEC aims to represent the entire Singaporean research and innovation community and to form an effective policy-making and advisory body. Interestingly, in addition to the prime minister, deputy prime ministers and all ministers of concerned line ministries, representatives from national and international universities, agencies, foundations, networks and companies are also among the members of RIEC.

According to its mandate, the RIEC shall "advise the Singapore Cabinet on national research and innovation policies and strategies to drive the transformation of Singapore into a knowledge-based economy, with strong capabilities in research and development (R&D), and … lead the national drive to promote research, innovation and enterprise, by encouraging new initiatives in knowledge creation in science and technology, and to catalyse new areas of economic growth" (www.nrf.gov.sg). Given Singapore's unique political system with a People's Action Party government in power since 1959 (and still with a comfortable majority in Parliament), the RIEC is essentially set up to design Singapore's research and innovation policy.

The RIEC decides on the overall strategy and national funding envelope and publishes it in the RIE Plan, the most recent of which covers the 2011–2015 period. While the plan introduces strategic focus areas, a global funding envelope and a rough distribution of the funds, a technical committee made up of the permanent secretaries of the concerned ministries decides how to distribute the allocated budget in detail.

In parallel with the establishment of the RIEC, the National Research Foundation (NRF) was also set up in 2006 under the PM's Office to support the Council. NRF implements policies approved by RIEC. It strategically oversees and coordinates national R&D activities in Singapore (cf. OECD 2012; Yeo 2006). According to the RIEC's priority setting, it also develops strategic sectors and supports research and innovation with a portfolio of top-down and bottom-up programmes.

Figure 2 shows all major actors in Singaporean research and innovation policy making.

# 3 Support instruments for innovation

Over the last two decades of strongly increasing R&D investments from both the private and the public sector, the Singapore government has made significant resources available in an increasingly complex and comprehensive portfolio of programmes. The Research, Innovation and Enterprise Plan 2015, covering the 2011–2015 period, foresees an overall public funding envelope of S$16.1 billion. This section introduces some of the major public R&D funding agency programmes and instruments, complementing information on the roles of the different actors as presented in the OECD Review of Innovation in Southeast Asia (OECD 2012).

While Singapore started its public R&D investments in the areas of applied and, to a lesser degree, basic research, nowadays, investments stretch from the basic research stage downstream to proof-of-concept, prototyping, technology transfer and commercialisation.

The Singapore innovation system features a distribution of tasks among the agencies that can be summarised as follows: public support to research and innovation is provided by:

- the Ministry of Education for basic funding of university research; the Ministry of Education also runs an Academic Research Fund
- the National Research Foundation (NRF) under the Prime Minister's Office
- the agencies under the Ministry of Trade and Industry:
    - the Agency for Science, Technology and Research (A*STAR) funds (and performs) basic and applied research in priority areas (cf. above)
    - SPRING Singapore is responsible for helping Singaporean enterprises grow; it helps enterprises in financing, capacity development, technology, innovation and market access; SPRING has a particular focus on SMEs
    - the Economic Development Board (EDB) aims to enhance Singapore's position as a global business centre; tries to attract inward FDI, grow industries vertically and enhance the business environment by, for example, conceiving and coordinating necessary infrastructure investments while also developing future strategies; in terms of R&D, focusing on raising the level of private sector R&D performed in Singapore by national but also multinational companies through information and investment support

### 3.1 Public support for public institutions

Since its establishment in 2006, the National Research Foundation has certainly evolved to be one of the core funding agencies for public R&D in Singapore. A five-year budget of S$5 billion has been allocated to NRF to achieve its mission. It is applied in a combination of top-down and bottom-up instruments supporting institutes of higher learning (IHLs) and public research institutes (PRIs) in their research and innovation endeavours.

NRF's top-down programmes:

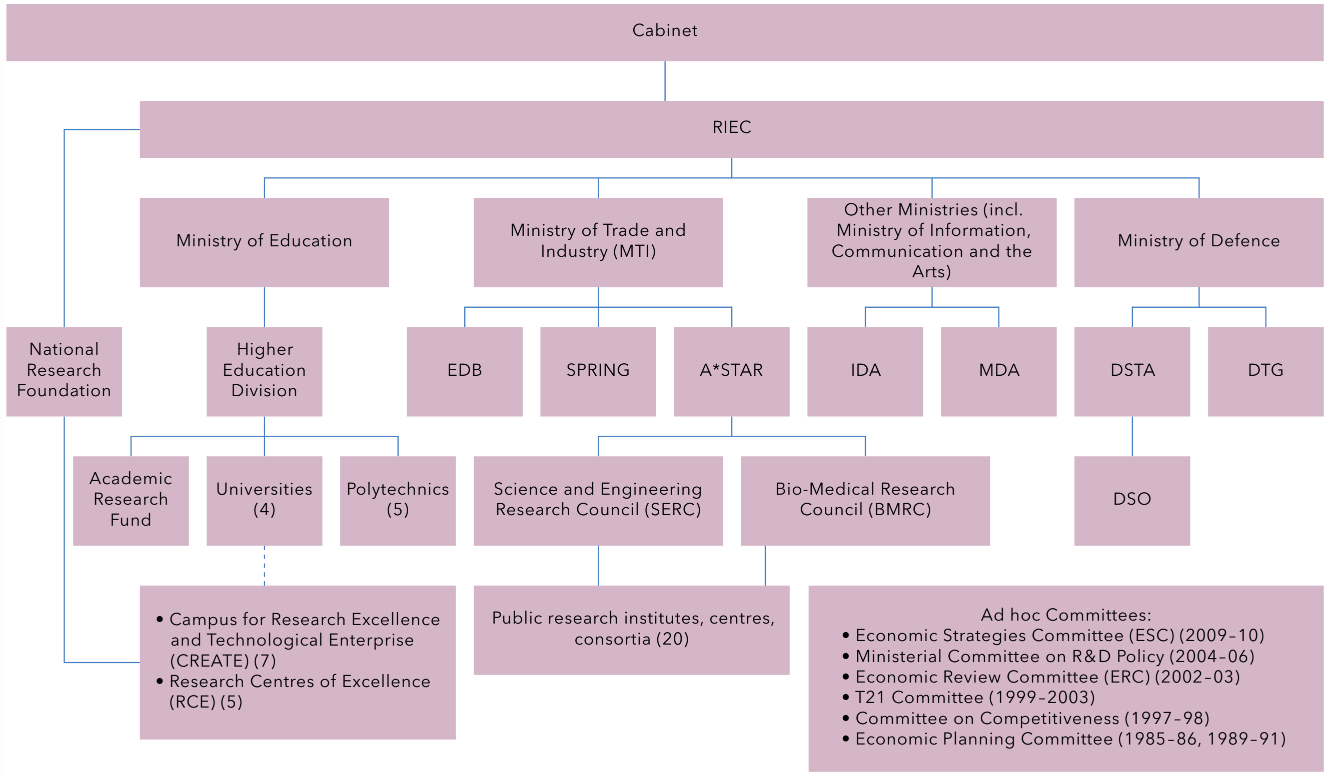
- Strategic Research Programmes in areas where Singapore considers itself as having a competitive edge; S$1.55 billion for five years in the following areas: biomedical sciences, environment and water technologies and interactive and digital media
- National Innovation Challenge focusing on complex national challenges whose solution helps Singapore in the establishment of new industries; first challenge Energy Resilience for Sustainable Growth; S$1 billion for 2011–2015

NRF's bottom-up programmes:

- Competitive Research Programme (CRP) funding scheme fostering the formation of multi-disciplinary cutting-edge research teams; funds use inspired basic research based on scientific excellence; since its start in 2007: 11 calls have been launched, 51 projects have been awarded; grants come in varying sizes and are allocated for a maximum of 5 years
- Campus for Research Excellence and Technological Enterprise (CREATE) located at NUS (see above); each centre has a budget of several S$10s of million
- Research Centres of Excellence (RCEs): long-term investments to create world-class research centres in Singaporean universities; currently five at campuses of Singaporean universities: the Centre for Quantum Technologies; Cancer Science Institute Singapore; Earth Observatory of Singapore; Mechanobiology Institute; Singapore Centre on Environmental Life Sciences Engineering; three of these are at NUS, one is a collaboration between NUS and NTU
- Singapore NRF Fellowship for young researchers around the world; five-year grants with free choice of research topic and host
- National Framework for Innovation and Enterprise (NFIE): a series of initiatives to facilitate the flow of knowledge created through earlier R&D investments into the marketplace. With a total budget of S$360 million for five years (2008–2012), the following initiatives are available:
    - Establishment of university enterprise boards (manages the university's Innovation Fund)
    - Innovation Funds for universities (supplements universities' own funding; funds entrepreneurship education, technology incubators, etc.)
    - Proof-of-concept grants (each grant a maximum of S$250,000); while this scheme provides funding for universities and public research lab, SPRING has a similar scheme for companies
    - Technology incubation scheme (85% co-funding for companies accepted into approved technology incubators; up to S$500,000 in exchange for equity stake in the company; co-investors have the option to buy out NRF's share at the next round of financing)








RIEC – Research, Innovation and Enterprise Council EDB – Economic Development Board SPRING – Standards, Productivity and Innovation Board
A*STAR – Agency for Science, Technology & Research IDA – Infocomm Development Authority MDA – Media Development Authority
DSTA – Defence Science & Technology Administration DTG – Defence Technology Group DSO – Defence Science Organisation

**Figure 2:** Singapore's institutional framework for STI policy (OECD 2013; updated and adapted by the authors and edited)

- Early-stage venture funding (seeding the development of early-stage venture capital (VC) funds; NRF matches funds raised by VCs 1:1; funds are managed by professional VCs, investing only in Singapore-based high-tech start-ups; currently, there are around 5 of these funds, each with around S$20 million, half of which comes from NRF)
- Disruptive innovation incubator (for companies that have the potential to disrupt a current industry; NRF co-funds 85%)
- Global Entrepreneurial Executives scheme to attract high-growth, high-tech, venture-backed companies with global entrepreneurial executives in ICT, medical technologies and clean technologies to Singapore
- Translational R&D grants for polytechnics: 500k grants for polytechnics which manage to translate university IP for the market; knowledge generated at the university adapted in the polytechnic
- National IP principles for publicly-funded R&D to promote the use of IP from publicly funded research
- Innovation voucher scheme encouraging SMEs to upgrade through R&D projects with IHLs and PRIs; the scheme is administered by SPRING

Within this comprehensive portfolio of instruments, the *Global Entrepreneurial Executive* programme is particularly noteworthy in that it introduces a rather uncommon approach to public innovation support: a narrow group of eligible executives who have been successful in their own business enterprise are taken as trustworthy business investment decision-making agents ("successful" is operationalised here as meaning that they have led their company from foundation to a minimum of S$100 million turnover). If these global entrepreneurial executives decide to invest in a start-up in relevant areas trying to attract it to Singapore, the government matches the investment with up to S$3 million.

Apart from the SPRING programmes, the RIE Plan 2015 also foresees an investment of S$1,35 billion in the Industry Alignment Fund, encouraging public researchers (e.g. in health research) to work more closely with industry.

In addition to funding research in A*STAR institutes, A*STAR's Research Councils, which are presented above, also provide competitive funding programmes for researchers in publicly funded institutions (within and outside A*STAR) in areas of national and A*STAR priority (biomedical science, physical sciences and engineering).

Support that is programmed and distributed by NRF, the Ministry of Education's Academic Research Fund, and A*STAR, goes exclusively to public research (both IHLs and PRIs). In the RIE Plan 2015, NRF is allocated around S$5 billion, the Ministry of Education slightly

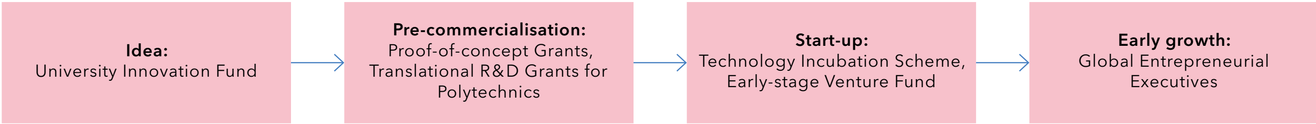



**Figure 3:** NFIE programmes along the innovation value chain

above S$ 1 billion and the agencies under the Ministry for Trade and Industry S$ 9.3 billion (S$ 6.4 billion for A*STAR). Around S$ 3 billion is reserved for directly supporting the private sector in its research and innovation endeavours.

### 3.2 Public support for the private sector

SPRING Singapore is the funding agency for business (especially SME) R&D efforts. Expressed in terms of levels of technological readiness, NRF provides support from basic technology research, feasibility studies, technology development and commercialisation down to the foundation of a company. SPRING, by comparison, focuses (more downstream on the innovation chain) on demonstration and proof-of-concept, development, test, launch, operations and commercialisation (venture capital stage).

There are four key ways in which SPRING supports SMEs. Firstly, it helps to catalyse technology projects, i.e. technology upgrading aimed at SME growth as well as overseas expansion. Secondly, it seeds technology start-ups with proof-of-concept and proof-of-value grants (spin-offs from public research institutions are also supported here). Thirdly, SPRING assists companies that wish to initiate projects but have no workforce to do so with expert provision schemes and secondment. Finally, SPRING invests in infrastructure, for instance in IHLs' innovation centres where companies can obtain services (e.g. in electronics, precision engineering, etc.).

A selection of SPRING's programmes and support instruments for research and innovation in detail:

SPRING Entrepreneurship support for start-ups

- Financing Schemes
  - Biomedical Sciences Accelerator (BSA) to identify, invest in and grow Singapore-based biomedical start-ups; SPRING SEEDS Capital to co-invest 1:1 in identified start-ups
  - Business Angel Scheme (BAS) to encourage angel investment; SPRING SEEDS Capital works with pre-approved private angel investors and invests 1:1 (up to S$ 1.5 million) in Singapore-based start-ups, taking equity stakes
  - SPRING Start-up Enterprise Development Scheme (SPRING SEEDS): equity-based co-financing option for Singapore-based start-ups with innovative products and processes with strong growth potential; matching third-party investment 1:1 up to S$ 1 million (first investment round usually limited to S$ 300,000); taking equity stakes
  - Technology Enterprise Commercialisation Scheme (TECS): competitive grant for companies for proof-of-concept (up to 100 % of qualifying costs up to S$ 250,000) and proof-of-value projects (up to 85 % of qualifying costs up to S$ 500,000); applicants can be companies or research scientists and engineers in a public laboratory (excluding IHLs), willing to show entrepreneurial commitment
- Work Pass for Foreign Entrepreneurs (EntrePass)
- Export Technical Assistance Centre (ETAC)

For start-up partners, SPRING offers an Incubator Development Programme (IDP) where incubators and venture accelerators can apply for 70 % grant co-funding for programmes to nurture start-ups, for mentoring and for operating expenses. In the Young Entrepreneurs Scheme for Schools (YES! Schools), grants up to S$ 100,000 are provided to schools putting in place entrepreneurship learning programmes. This is one of the initiatives to modify Singapore's education system to allow for more entrepreneurial and creative activity.

For existing enterprises, SPRING offers S$ 5,000 Innovation and Capability Vouchers allowing SMEs to engage approved consultants and service providers in innovation, productivity improvement, but also human resources and financial management. Relating to this, the Capability Development Grant supports up to 70 % of the cost of SME productivity improvement projects (in 10 supportable areas such as productivity improvement, technology innovation, IP and franchising). For upgrading production lines and related activities, there are also government-backed loans and loan insurance schemes available (for equipment acquisition, working capital, etc.) that can be applied for via SPRING.

Further areas of activity for SPRING are industry programmes and quality and standard setting. While most of the industry programmes focus on scaling up industry activities, MNE-SME collaboration, customer services, industry-business association partnerships, etc., there are activities for specific industries that relate to R&D. An example would be the Clinician Driven Innovation programme linking health care service providers with medical technology developers to accelerate product development and ensure solutions meet needs.

The third agency under the Ministry of Trade and Industry that is concerned with innovation-related funding is the Economic Development Board (EDB). Established in 1961 as a statutory board of the government, its main mission used to be to attract foreign direct investment to Singapore. This mission has evolved since and nowadays encompasses planning and executing strategies to





enhance Singapore's position as a global business centre in a broader sense. This particularly includes the goal of establishing and maintaining high added value activities of international companies in Singapore. EDB tries to vertically expand industries based in Singapore, to enhance the business environment and to prepare Singapore for the future.

EDB runs a series of incentive schemes for businesses to achieve its goals. Of particular relevance to our perspective is the Research Incentive Scheme for Companies (RISC) awarding grants to develop R&D capabilities in strategic areas as well as the Initiatives in New Technology (INTECH), awarding grants for capacity-building in applying new technologies, industrial R&D and professional know-how.

The Public-Private Co-Innovation Partnership programme (see also: coinnovation.gov.sg), offered by the Ministry of Trade and Industry, provides businesses with grants (co-financing) of up to S$ 250,000 for proof-of-concept projects, up to S$ 500,000 to demonstrate proof-of-value and up to S$ 1 million for test-bed prototypes.

### 3.3 Indirect public support for private R&D

Singapore has made some of the globally most ambitious tax and credit related indirect R&D support measures available.

Under the Productivity and Innovation Credit (PIC), administered by the Inland Revenue Authority of Singapore (IRAS), 400 % of qualifying investments to improve innovation and productivity (R&D, IP registration and acquisition, equipment, training, approved design projects) can be deducted (up to a cap of S$ 1.2 million) from taxable income. This measure is available for all businesses. For small and growing businesses with cash constraints, there is also the option to convert qualifying PIC expenditure into a cash pay-out (30 % of up to S$ 100,000). Moreover, there is a tax deferral option for companies with cash flow problems. There is a specific PIC for Investments in Design where 250 % of manpower costs on approved industrial and product design projects can be deducted (up to a cap of S$ 300,000) from income subject to taxation.

All Singapore-registered businesses, including sole proprietors, partnerships and companies can also claim 150 % of Singapore-based R&D expenditure (staff costs and consumables for in-house R&D; 60 % of R&D outsourced to a Singapore-based partner), even if the R&D does not relate to the existing business. A 100 % tax deduction can be claimed for R&D outside Singapore that does relate to the existing business.

For companies registered and based in Singapore, the EDB administered Investment Allowance (IA) encourages equipment acquisition.

SPRING also administers an indirect public support instrument for angel investors, the Angel Investors Tax Deduction Scheme (AITD). Approved angel investors get an income tax deduction of 50 % of the amount invested in Singapore-based start-ups.

Companies are informed about this kind of opportunities on a web portal dedicated to serving Singapore's business community (www.enterpriseone.gov.sg).

### 3.4 Awareness and information measures

In addition to the funding agencies and programmes, as well as indirect incentives Singapore has invested in information provision and soft support for innovators and entrepreneurs inside and outside the country. Dedicated web portals try to serve as one-stop shops for the needs of entrepreneurs, innovators, companies or researchers.

One of the most relevant of these sites is the previously mentioned EnterpriseOne.gov.sg, which is managed by SPRING for several agencies and combines relevant information for businesses and entrepreneurs.

EnterpriseOne.gov.sg is also linked with e-government web portals (ecitizen.gov.sg) serving citizens and providing information for non-residents (on visiting, relocating to, working, studying or doing business in Singapore). Information on the Singaporean tax system is provided, as is information on how to register a business as a foreigner.

Contact Singapore (contactsingapore.org.sg) is another initiative by EDB and the Ministry of Manpower that provides information for overseas Singaporeans, foreign job seekers, students, investors and employers (information on jobs in demand, cost of living calculators, information on the tax system, etc.).

Going beyond information provision, the Singapore IP Intermediary (IPI) supports Singapore SMEs to voice demand for technologies and technology-based problem solutions. IPI then assists in sourcing technology by identifying providers and matchmaking. IPI, so to speak, is a demand pull intermediary. It does not push technologies, trying to commercialise an institution's research output, but identifies demand for technologies in order to match it with suppliers regardless of their location or nature.

In practice, IPI runs a peer reviewed technology marketplace database where existing technologies are announced and described. The technology demands brought to IPI (or identified during company visits or events), by contrast, are not publicly displayed, as companies often prefer this information not to be disclosed.

IPI operates on a non-profit basis and is fully funded. According to its mandate, it focuses on servicing local SMEs rather than MNCs (which are most often referred to private sector intermediaries as they can afford to pay for these services). IPI only charges companies a nominal administrative fee. For companies using IPI services for the first time, this fee is often waived. Companies can also use the Innovation Voucher to pay for IPI services. If a licensing contract results from IPI mediated matchmaking, IPI takes 5 % of the contract value as a success fee.

If we now move from a demand pull to a technology push perspective, we can take a closer look at the Singapore PRI and IHL technology transfer support system.

### 3.5 Technology transfer

In addition to some of the NRF and SPRING programmes mentioned above and the support from intermediaries such as IPI, Singaporean public research institutes and research universities have in-house technology transfer services in place.

Some of Singapore's polytechnics have also been given a role in technology transfer although on a more adaption and technology diffusion oriented level. Thematic centres of innovation set up at several polytechnics together with SPRING help SMEs to enhance their technology innovation capabilities. These centres provide laboratory and testing facilities, consultancy and training.

In the case of A*STAR, a government owned company, Exploit Technologies Pte Ltd, was set up as its commercialisation arm focusing on transferring A*STAR research to industry and managing its intellectual property portfolio. Intellectual property creation processes for all A*STAR institutes are channelled through and managed by Exploit Technologies. Exploit Technologies officers cooperate with the research scientists, advising them on IP generation, clearing research results for publication, negotiating licensing agreements, etc. An important role is also played by the R&I industry development managers at the A*STAR research institutes themselves and Research Council level industry development groups. Working in the same laboratory or area, they often have better access to research scientists and can build on personal trust relationships. In their coordination, ETPL, the council and institute level commercialisation agents also have to take into account field specificities and agree when to start thinking about and deciding on a specific market (instead of continuing proofs and trials, remaining open to a variety of markets).

Of the major universities, both NUS and NTU have technology transfer and licensing offices (TTOs). NUS Enterprise's Industry Liaison Office protects and manages NUS' IP and is the entry point to NUS technology for external companies. NUS Enterprise (its Entrepreneurship Centre) manages a university incubator for NUS students, faculty and alumni as well as, in rare cases, non-NUS related entrepreneurs. The incubator is financed by NUS funds, with co-funding support from SPRING Singapore. The services offered are incubation space, seed funding, mentoring, customer and investor networking, reduced rent and support in applying for external seed and growth funding (from SPRING or the Technology Incubation Scheme) or pitching at angel investor events. The NUS Enterprise Industry Liaison Office works with intermediaries (such as IPI) to find demand, but also proactively tries to market its own technologies (through presentation at the NUS Enterprise website, events, use of networks, etc.) and benefits from NUS visibility in general. To develop an entrepreneurial mindset and increase the entrepreneurial skills of NUS students and staff, NUS Enterprise also offers company internships in start-ups around the world and entrepreneurship education.

If NUS Enterprise services and invests in a start-up, it usually takes equity in the company in lieu of IP licensing royalty, payment for services or seed investment. In case there are exits, the return from the sales of the equity returns to the NUS seed fund. On occasion, instead of investing and taking equity, NUS Enterprise gives a convertible loan, which makes the liquidation process easier in case the company fails. On rare occasions, external companies are admitted to the incubation space. They can either pay for the services, or give a small equity share to NUS Enterprise.

The Nanyang Innovation and Enterprise Office (NIEO) is NTU's technology licensing office, which, as in the case of NUS Enterprise, also acts as an incubator. NIEO manages NTU's existing IP portfolio and facilitates grant applications for promising novel technologies. It helps faculty members to assess the potential of new discoveries, protect IP, and to bring in industry experts to make the most out of the technologies. NIEO negotiates research collaboration agreements for contract research or license agreements (with the former being traditionally more important in Singapore).

A subsidiary company owned by NTU, NTU Ventures, helps faculty, students and alumni with their start-ups by assisting them in the application for start-up funding schemes from SPRING, NRF and others. NTU does not have an own seed investment fund, but invests in patents (around 300 a year are filed after internal examination for novelty). Current developments in NIEO are the establishment of a commercial arm as well as the decentralisation of the TTO services, reaching out to the institutes.

The university TTOs as well as Exploit Technologies hold increasing patent portfolios. In most cases, commercialisation still seems to be a challenge, but information on the number of licence agreements and commercialised patents is not available. One of the related challenges university TTOs face in their own start-up investment is that they cannot be too conservative and invest in a very low number of initiatives. At the same time, they neither can afford a particularly low success rate (in terms of start-ups supported to the stage that they get outside funding). The acquisition of additional investments coming from private sources is crucial for moving beyond the stage of public seed funding and incubation.

There are important changes in the Singapore IP environment in general. Singapore published an "IP Hub Master Plan" in April 2013[15] stating the goal of also becoming an IP hub in the region. The plan foresees, among other things, that a proper team of patent examiners should be established at the Intellectual Property Organisation of Singapore (IPOS) and that applications are no longer sent abroad for examination. There will also be a shift from a 'self-assessment' mode (where applicants can ask for a patent to be granted even if the examination indicates non-patentability) to a 'positive grant' system. This plan is among Singapore's efforts to increase research output commercialisation and private sector R&D; an important condition for tapping into and creating revenue from IP is risk capital.

15 http://www.ipos.gov.sg/Portals/0/Press%20Release/IP%20HUB%20MASTER%20%20PLAN%20REPORT%202%20APR%202013.pdf





### 3.6 Private equity financing and venture capital

While according to the OECD, the finance sector in Singapore is particularly strong, "the high-technology venture financing ecosystem … is still relatively under-developed" (2012, p. 228). The traditional institutional investors opt instead for classical investments such as construction projects, which are deemed less risky. Historically, risk capital was provided by MNCs for their own projects and industries. Venture capital funds managed outside Singapore only grew in number (and volume) since the late 1990s, a growth that was spurred by large public co-investments (e.g. through TIF Ventures, a former EDB subsidiary closed at the end of the 2000s with moderate returns). This pattern of public venture co-investment is still present today: regarding early stage investment rounds, we have seen the venture capital schemes offered by NRF and SPRING. For bigger, later-stage investments, publicly owned holding companies such as Temasek Holding and corporate investment arms such as EDB Investment traditionally play an important role.

In 1992, EDB also formed the Singapore Venture Capital and Private Equity Association (SVCA) to promote the development of the VC and private equity industry. SVCA has grown to encompass around 100 members, largely corporations engaged in VC and PE activities plus a few individual members. Thus, the venture capital scene is growing in Singapore, but most venture capital firms still prefer to focus on funding later-stage expansion and upscaling, rather than on early stages[16]. Typically, for the early venture capital stage and even more the seed capital stage, business angel investment would be relevant, but, according to the OECD, is also rather limited in Singapore. There is a "lack of available, sophisticated business angels investing at the seed stage, which is typically needed to fund early start-ups to grow to a stage at which they are fundable by venture capitalists" (OECD 2012, p. 229). Recognising this lack led SPRING to create its business angel co-investment and seed financing schemes.

The SPRING Business Angel Scheme works with approved business angel networks and funds such as BAF Spectrum Pte Ltd, Accel-X Pte Ltd, Jungle Ventures, Small World Group Angels, and Individual Angels. In addition to this small network, there are other angel groups such as Angels Den or the alumni societies of Hewlett-Packard and NTU.

In 2001, the Business Angel Network Southeast Asia (BANSEA) was established in Singapore by a group of Singapore-based angel investors with connections to investor groups in Thailand, Malaysia, Vietnam and Indonesia. BANSEA tries to foster the business angel community in Singapore. SPRING supported BANSEA within the Incubator Development Programme.

While BANSEA is a good example of ASEAN cooperation in innovation financing, Singapore's research performers and funding agencies also focus on and benefit from international cooperation.

## 4 International cooperation

As we have seen, Singapore has emerged as an attractive place for researchers from partner countries, providing excellent infrastructure and working environments. Singapore's major universities and public research institutes have a series of joint degree and exchange programmes with selected universities around the world. The closest ties exist with the US, UK, Japan, China and Australia, but links with Germany and other countries are growing stronger. Universities from these, and an increasing number of other countries, also have subsidiary campuses in Singapore.

Singapore funding agencies such as A*STAR have a track record of co-funding research (joint grant calls) with partners such as the UK Medical Research Council, the Department of Science and Technology of India, the Ministry of S&T of China, the National Health and Medical Research Council in Australia, South Korea's KHIDI (Korea Health Industry Development Institute), the JST (Japan Science and Technology Agency), and New Zealand's Ministry of Business, Innovation and Employment.

In addition to these kinds of joint programming activities, A*STAR has established and maintains relationships with numerous universities, other public research organisations and industry around the world. Singapore and the US have signed an S&T Cooperation Agreement, A*STAR and Japan's network of public research institutes (RIKEN) have signed an MoU fostering exchange, etc. Researcher mobility programmes, funding of joint symposiums and smaller co-funding for networking also exist (for example with the Institut Français).

The Campus for Research Excellence and Technological Enterprise (CREATE) explicitly foresees cooperation with leading research institutions around the world. Some institutions such as TU Munich have established joint institutes with Singaporean partners in Singapore, harnessing synergies with CREATE centres.

Two particularities of international cooperation in public research with Singapore might be worth noting. Firstly, Singaporean institutions can often choose

16 Cf. http://www.guidemesingapore.com/doing-business/finances/private-equity-financing-for-singapore-startups/

who they want to work with. There is currently a higher number of external partners interested in setting up links than Singapore institutions could or would want to handle. Secondly, cooperation agreements and programmes are, in most cases, set up independently with the major research performers, i.e. A*STAR, NUS and NTU.

As there is no single ministry concerned with research and innovation (but at least three), responsibilities and the mandate for external relations is shared. NRF as the agency providing public research funds to the broadest spectrum of the Singaporean public research landscape has worked on cooperating with leading international research institutes and universities (e.g. in funding the Singapore-ETH Future Cities Laboratory), but has not engaged in any co-funding activities so far.

In the area of private sector research, the Singapore-Israel Industrial R&D Foundation (SIIRD), a cooperation between EDB and the Office of the Chief Scientist (OCS) in Israel, promotes, facilitates and supports joint industrial R&D projects between companies from Israel and Singapore.

## 5 Key strengths and weaknesses

Singapore was one of the first countries in Southeast Asia to develop and implement innovation policies (using precisely this term). This can be explained by at least two factors. One is that, as we have seen, Singapore has been on the forefront of public R&D investment and related dialogue since the 1980s. Policy-making has thus closely followed the global dialogue on S&T policies, increasingly turning to innovation. Another factor is the political system itself where novel policies can be developed comparatively quickly by a government working on the basis of a clear majority in the legislative process. The top-down-like developmental state approach of government has also always rooted S&T policies (and now innovation) in economic policies and economic development goals (cf. OECD 2013). In comparison with other countries in the region, Singapore is thus characterised by a uniquely coordinated and sustained mode of policy and programme making.

It's this mode that makes the characteristic long-term planning and continued infrastructure investments and state-support infrastructure provision that we see in projects such as 'one-north', possible. This is crucial, particularly because rented space and property is such a limited asset in Singapore. If the publicly supported infrastructure provision did not work, the severe restrictions regarding non-Singaporean individuals and companies acquiring property would likely compromise Singapore's competitiveness and attractiveness for foreign direct investments and researcher mobility to Singapore.

Despite the strong engagement of the public sector in R&D investments, Singapore is one of the few countries in Southeast Asia where business expenditure in R&D is higher than public spending. The latter is bound to increase further in absolute numbers. Focus-wise, according to the current RIE Plan, more funding is intended for innovation and entrepreneurship activities until 2015, with more resources made available for businesses. The drafting of the next RIE Plan (2016–2020) will start soon (likely in 2014).

As we have seen, at the programme level, multiple instruments exist for basic and applied research, proof-of-concept and prototyping early-stage funding and growth support. Two of the most interesting (because of their uniqueness in the region) are the Global Entrepreneurial Executive programme and the cash pay-out option for tax deductions. Challenges and current funding agency discussions, as reported by interviewees, also circle around questions of programme design. For instance, an unresolved question regarding proof-of-concept and translational grants is who should drive prototype development. Researchers usually want to return to research and have little motivation to bring their results to a company. The current solution is to appoint Post-Doctoral researchers with an interest in entrepreneurship for this role (but they have no company experience). Another example of a subject of discussion in STI funding might be the size and granting process of proof-of-concept grants: a one-off larger grant or a multi-step iterative granting process with increasing volumes.

In this elaborate and internationally networked STI policy and programme discourse, the relevance of R&D for the country's economy and society (and, thus, the political agenda) is not discussed, but taken as a given by major stakeholders (including the public). However, critical voices point to the fact that too little is known about the actual impact of technology transfer offices and about the commercial returns on public R&D spending.

Interviewees confirmed that the upgrading of SMEs is still a somewhat unresolved issue with regard to the demand pull from industry and the development of private sector R&D. While Singapore has been extremely successful not only in attracting MNCs, but also in vertically integrating their activities, tapping into value chains, it has been difficult for local SMEs to grow and move upstream, for instance through R&D investments. It is a challenge to get SMEs out of the MNC supporting role they are used to and good at.

The strong role of MNCs in Singapore's economic development has also led to the country exporting to and investing in countries around the world, but not necessarily in the region. The economic integration of Singapore in the Southeast Asian context is not as dense as it could be. The country welcomes workers, students and researchers from the region, but many might not return or might not continue their links with Singapore after they return. Investment links from Singapore to neighbouring countries are also limited. Singapore is thus not necessarily well organised to invest and participate in the emerging markets in the region. It will be interesting to see how Singapore positions itself in the ASEAN





Economic Community, which will become a reality at the end of 2015.

There are a few other challenges remaining for Singapore's innovation system. An important one is related to human resources: the primary education system in Singapore is reported as being demanding and time consuming with little possibility for children (especially those in ambitious families) to develop creative potential through play and exploration. Many of the well-educated, ambitious young people who come out of Singapore's schools want to follow financial degrees and fast careers in the private sector and the finance industry in particular. Science and engineering degrees are not as sought after, despite the excellent conditions, support and quality of higher education.

An area that could potentially become a more severe challenge in the future is immigration and public opinion. Singapore has developed one of the most open immigration systems in the region, which was partly the reason for the country's success in attracting talent. In recent years, however, public opinion has shifted to a more critical stance toward immigration. Local Singaporeans fear that foreigners obtain the better jobs, property prices skyrocket and living costs increase. This debate could be a problem in view of the continuing lack of research scientists and engineers that is reported by some commentators (e.g. Wong, Singh 2008). It is closely linked to the issue of land ownership. Restrictions could be made even more severe as a result.

At the end of this chapter, we thus return to Singapore's city-state character, which has to be taken into account in analysing its system of innovation. As a state devoid of practically all natural resources, Singapore's innovativeness as well as its relationships with neighbouring countries will be crucial for its future development. Singapore will have to carefully select the industries on which to focus. They can and should be knowledge intensive, but cannot rely on land (for factories, etc.) or cheap labour. The products Singapore aims to develop out of its intellectual capital might need to be produced outside of Singapore with repercussions for production and value chains. Singapore's position within the AEC will be more important for the country itself than it might seem at first sight.

## 6 Appendices

### Appendix I: Institutions visited

*Ascendas Pte Ltd*

*Agency for Science, Technology and Research (A*STAR)*

- *Planning and Policy Department*
- *Exploit Technologies Pte Ltd*
- *Singapore Immunology Network (SIgN)*

*IP Intermediary (IPI)*

*Nanyang Technological University (NTU Innovation)*

*National Research Foundation (NRF)*

*National University of Singapore (NUS Enterprise)*

*Singapore Management University (SMU)*

*Singapore University of Technology and Design (SUTD)*

*Standards, Productivity and Innovation Board (SPRING Singapore)*

### Appendix II: References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## Appendix III: Policy cycles

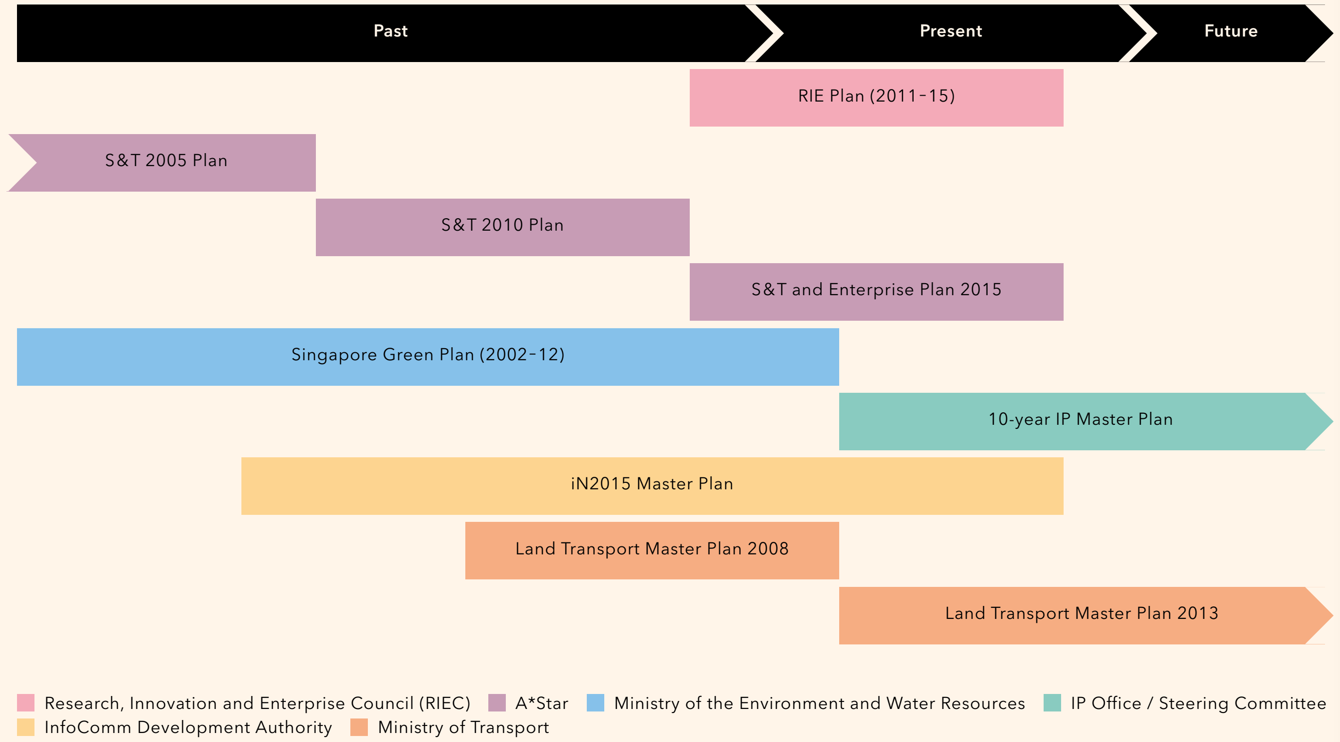


**Figure 4:** Policy cycles





## Appendix IV: Funding agencies and instruments[17]

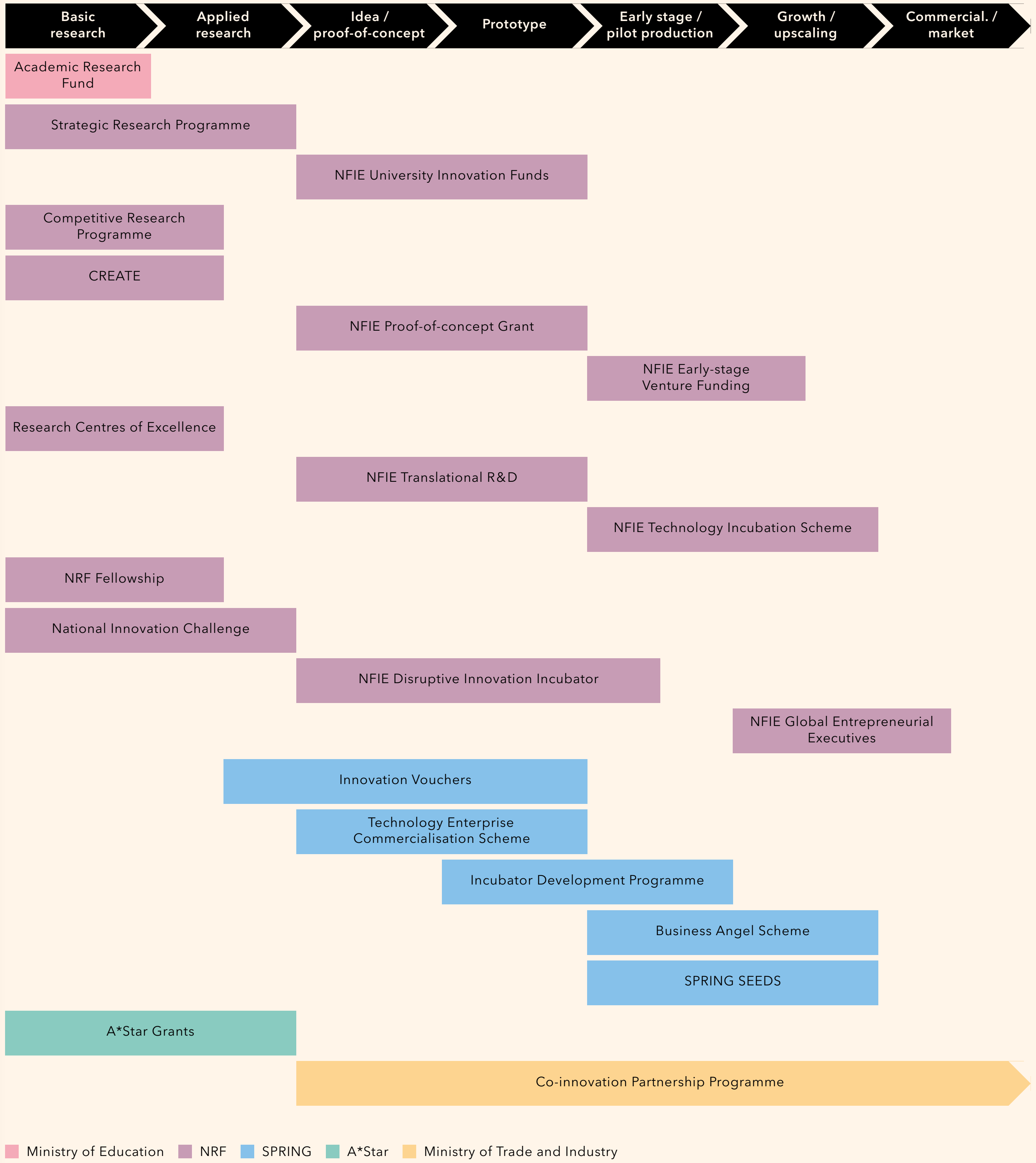


**Figure 5:** Funding agencies and instruments

17 According to the stage in R&D / product development they focus on

# Thailand

Alexander Degelsegger[1], Wanichar Sukprasertchai[2 3]

## 1 Key indicators and framework conditions

### 1.1 Economic context

Thailand's economy is the world's 32nd largest (24th largest according to purchasing power parities)[4] and has long been characterised by strong economic growth, particularly gaining speed at the end of the 1980s and beginning of the 1990s with annual growth rates of around 10 % before the Asian financial crisis in 1997. After the 1997 crisis, which hit Thailand, one of the 'Asian tigers', hard, the country's economy recovered relatively quickly to settle at a slightly lower level of around 5 % GDP growth per year. The impressive growth during the late 1980s was largely driven by foreign direct investments in manufacturing, the impact of which is still visible in Thailand's innovation system of today.

In the course of the decades of growth, Thailand's economy has been transformed from being agriculturally-based to being manufacturing-based (dominated by automotive and electronics manufacturing). While in 1970, only 4.7 % of exports were manufacturing-based (Intarakumnerd et al. 2002), in 1980 the share was 25.2 % and in 1990 had risen to 63.1 %. According to latest figures from the Bank of Thailand (2013), the share was 87.5 % in 2012. Exports have been growing strongly, especially after the Asian financial crisis (quadrupled at current prices from 1997 to 2012), driving Thailand's recovery. The trade balance from 1998 to 2010 has been positive, with the exception of two years: the last two years, 2011 and 2012, show negative balances, more pronounced in 2012 (ADB 2013).

Interestingly, Intarakumnerd et al. (2002) also show that science-based manufactured exports particularly grew, from 1.2 % to 26.4 % of total manufactured exports, between 1980 and 1999 (whereas the share of labour- and resource-intensive manufactured exports decreased). However, the authors note that this does not necessarily mean that Thailand's own scientific and technological capabilities contributed to its manufacturing industry. Rather, the manufacturing industry deals with technologically sophisticated products that are assembled in Thailand in highly automatised production lines, but with imported high-value-added components. There have been few technology spillovers through manufacturing and international trade. Productivity growth in the manufacturing industry has also been limited.

The technology-based and largely automated nature of the manufacturing industry (especially in the automotive sector) becomes visible in another key characteristic, with impacts on the country's innovation system: according to the Thailand Labour Force Survey, as per August 2013, 16.2 million employed persons (41.5 %) out of a total workforce of 39.0 million work in the agricultural sector. The other two major sectors in terms of employment are wholesale and retail trade and repair (5.6 million), followed by manufacturing (also 5.6 million). That is, 5.6 million workers employed in manufacturing are responsible for this sector's huge contribution to production and exports. Thailand has a very low unemployment rate, of currently around 0.8 %.

In terms of shares of GDP, manufacturing contributed 29.7 % and industry 38.2 % in 2011 (ADB 2013). In the same year, agriculture contributed 11.4 % to the overall GDP, which was at 11,121 billion Thai Baht (at current prices; roughly € 280 billion). The service sector was the largest sector, contributing 50.3 % to GDP.

One feature was missing in Thailand's development path: the decades of foreign direct investment and the growth of manufacturing and industry in the country were not accompanied by a sustained increase in public spending on research and development.

1 Centre for Social Innovation (ZSI), Vienna, Austria
2 National Science and Technology Development Agency (NSTDA), Pathum Thani, Thailand
3 The authors also want to thank colleagues from the Science, Technology and Innovation Policy Office (STI) for their support in facilitating interviews.
4 *World Economic Outlook Database*, IMF, October 2013





Despite moderate growth in absolute numbers, in terms of the share of GDP, Thailand's research expenditure since 2001 has been stable or has slightly declined. In 2001, it was reported as 0.26 % of the GDP, in 2008 at 0.21 %, in 2009 at 0.24 % and in 2010 at 0.22 % (STI Policy Office).

As a certain level of research activity has taken place in Thailand for decades, initially (in the 1960s) supported by development cooperation funds from the US, Germany and other countries, there is an institutional legacy that sometimes presents challenges today.

| Indicator | Value | Year |
|---|---|---|
| R&D intensity: Gross domestic expenditure on R&D (GERD) as a percentage of GDP – GERD/GDP | 0.24 %[5]<br>0.22 %[6] | 2009<br>2010 |
| Full-time equivalent (FTE) personnel (man-year) | 57,220[7] | 2009 |
| Total labour force | 39.3 million[8] | 2013 |
| Publication output | 11,146[9] | 2012 |
| Number of patent applications | 198 (international applications)[10]<br>4,548 applications (by Thai applicants and others) in Thailand[11] | 2011<br>2011 |
| Stock of inward foreign direct investment | US$ 159.1 billion[12] (€ 117.8 billion)[13] | 2011 |
| Flow of inward foreign direct investment | US$ 8.6 billion[14] (€ 6.4 billion) | 2012 |
| Flow of outward foreign direct investment | US$ 11.9 billion[15] (€ 8.8 billion) | 2012 |
| Number of research universities | 9 major research universities, overall around 80 public and 40 private universities | 2013 |

**Table 1:** Key indicators

### 1.2 Research performing actors

Even with the rather low and somewhat volatile levels of GERD/GDP, Thailand managed to build an innovation infrastructure with a series of excellent and well equipped research centres in a variety of fields (especially: agriculture, engineering, life sciences, electronics and ICT). Some of these are associated with the National Science and Technology Development Agency (NSTDA), the Thailand Institute of Scientific and Technological Research (TISTR) or are within one of the top research universities. Recently, nine universities have been identified and supported as the major 'research universities' of the country. These are: Mahidol University, Chulalongkorn University, King Mongkut's University of Technology, Kasetsart University, Thammasat University, Chiang Mai University, Prince of Songkla University, Khon Kaen University and Suranaree University. Overall, there are around 80 public universities (excluding colleges and academies) and approximately 40 private universities (e.g. Bangkok University) in Thailand.

Another major site for research excellence in Thailand is the Thailand Science Park, which hosts public research institutes of NSTDA such as BIOTEC (life sciences), MTEC (metals and materials), NECTEC (electronics) and NANOTEC (nanotechnology) as well as around 60 companies, most of which are Thai. While not attracting as many start-ups and external SMEs, Thailand Science Park's infrastructure is in demand and the Incubation Phase II of Thailand Science Park has recently been finished. It will officially open in March 2014 and offers space for around 600 companies in four buildings. The Thailand Science Park also inspired the so-called 'regional science parks' in the north, northeast and south of Thailand whose development is currently ongoing.

Related to the science park concept, but more focused on private companies, the cluster concept has inspired Thai industrial, economic and fiscal policies, especially since 2001, aiming at identifying potential clusters and supporting them in thematic areas of relevance to the Thai economy (such as the automotive sector or food production). Clusters of companies have been identified, and tailored incentives have been provided by the Board of Investment of Thailand (BOI). Private science parks such as the Software Park Phuket have been developed. Amata Science City is a currently ongoing development, something like a fusion of a science park and an industrial estate.

Of individual private sector research performers, a few large Thai conglomerates stand out: CP (food), PTT (petrochemicals) and the Siam Cement Group (SCG). These companies invest significantly in R&D, and increasingly internationalise and extend their share in global value chains. Most Thai SMEs, by contrast, do not have the capacity to invest in and benefit from R&D. SMEs, for instance in the food sector, only turn to R&D for problem-solving. For instance, if a problem in the rice or shrimp industry hampers the production of farmers and SMEs, university institutes are consulted for problem-solving. These short-term contract research relationships are often funded from extra-budgetary public resources requested from government. They seldom lead to longer term upgrading of technology or innovation oriented collaboration. Universities cannot plan long-term research agendas on the basis of these kinds of university-industry relationships.

5 2010 National Survey on R&D Expenditure and Personnel of Thailand
6 Estimate by the National Science, Technology and Innovation Policy Office
7 2010 National Survey on R&D Expenditure and Personnel of Thailand
8 *The Labour Force Survey*, National Statistical Office, August 2013
9 Scopus database, September 2013
10 EPO Espacenet (patent applicants from Thailand, application year 2011)
11 Department of Intellectual Property
12 *World Investment Report 2013*, UNCTAD
13 Amount converted at rates of 5 November 2013 with XE currency conversion, http://www.xe.com/currencyconverter/
14 *World Investment Report 2013*, UNCTAD
15 Ibid.

All major public and private Thai research players benefit from Thai researchers with an education from the world's best universities, returning to Thailand for research careers in their country. Interestingly, Thailand does not suffer issues of brain drain to the same degree as other countries in the region.

### 1.3 Business environment

Apart from the level of public investment in R&D, recent years have also seen increased efforts on the side of the government to facilitate business activities in general and in R&D. Tax incentives have been focused to support R&D and related industrial activities in specific research areas. There have been efforts to facilitate the mobility of foreign expertise to Thailand as well as the mobility of Thai researchers abroad.

In the World Bank's "Ease of Doing Business" report 2014, Thailand ranked 18th out of 189 (for regional comparison: Singapore ranked 1st and Malaysia 6th). Particularly good sub-rankings were reported for electricity supply (12th), investor protection (12th) and construction permits (14th). More problematic in doing business were, according to this report, the procedure of starting a business (91st), getting credit (73rd) and paying taxes (70th).

In the World Economic Forum's Global Competitiveness Index 2013–2014, Thailand ranked 37th out of 148 (compared to 38th out of 143 in the 2012–2013 edition) with relative strengths in financial market development, goods markets, business sophistication, macroeconomic environment and market size. Challenges are visible in institutions, health and primary education as well as technological readiness.

In the Global Innovation Index[16] 2013, Thailand ranked 57th out of 142 with relative strengths in market sophistication (37th), human capital and research (46th with a specifically high rank in the tertiary education indicator) and knowledge and technology outputs (53rd). The major weakness according to this report is in the institutional landscape (93rd, with political stability and the regulatory environment as major challenges).

## 2 Governance and public STI policy

### 2.1 Thailand's political system

Thailand's innovation efforts and policies are situated in the political system of a constitutional monarchy with a strong role for government and a limited number of legislative acts initiated by parliament. Policy making in innovation is also largely a matter of government, not of parliament. The Government obtains inputs for its science, technology and innovation policies from a number of advisory bodies, such as the National Economic and Social Development Board (NESDB), the National Research Council of Thailand (NRCT) or the Higher Education Commission. Figure 1 shows the main actors and agencies involved in STI policy making and implementation (including research funding and performance).

16 http://www.globalinnovationindex.org

### 2.2 Development plans and innovation policy

NESDB is responsible for broader, multi-annual development plans presented to government for its planning and budget allocation. The first National Economic and Social Development Plan to systematically take into account science and technology was the 5th plan, covering 1982–1986. In the 7th Plan, 1992–1997, the wish to increase the GERD/GDP rate was explicitly stated (the goal was then 0.75 %). NSTDA, established in 1991, was also taking shape during this period as were innovation policy instruments and innovation incentives. Intarakumnerd et al. (2002) consider these early innovation support measures narrow, with S&T still being largely seen as different from economic development. The 9th plan, in 2002–2006, called for a GERD/GDP of no less than 0.4 % and, among other things, suggested the promotion of innovation through encouragement of the use of new technologies, information networks, revision of the legal and IP system and the establishment of technology transfer centres. The latest of these plans is the 11th, running from 2012–2016. It sets the goal of a GERD/GDP ratio of 1 % with 70 % of the funds coming from the private sector. This means that the government wants to turn the balance of contributions to R&D from the public to the private sector. Currently, around 60 % of R&D funding comes from government sources. The plan focuses on creating a knowledge economy and sustainable society, prominently featuring research, innovation and creativity as drivers of the aspirational development path.

### 2.3 STI policies

One of the major recent strategy documents regarding science, technology and innovation policies, was the Science and Technology Action Plan 2004–2014, which was drafted with the support of, among others, the National Science and Technology Development Agency (NSTDA). For this plan, NSTDA, the biggest public research institution in Thailand and a major research funder, took over the role of a policy advisor similar to that of the NRCT. The plan itself introduced the National Innovation System concept to Thailand. Industrial clusters are considered the heart of Thailand's innovation system, especially in the targeted areas of food, automotive, textiles, software, microelectronics, tourism, life sciences and grass roots community products.

In 2008, however, with the National Science, Technology and Innovation Act, new policy orientations and a modified institutional setting for innovation policy were introduced: among other things, a National STI Policy Committee (NSTIC) was created. It is chaired by





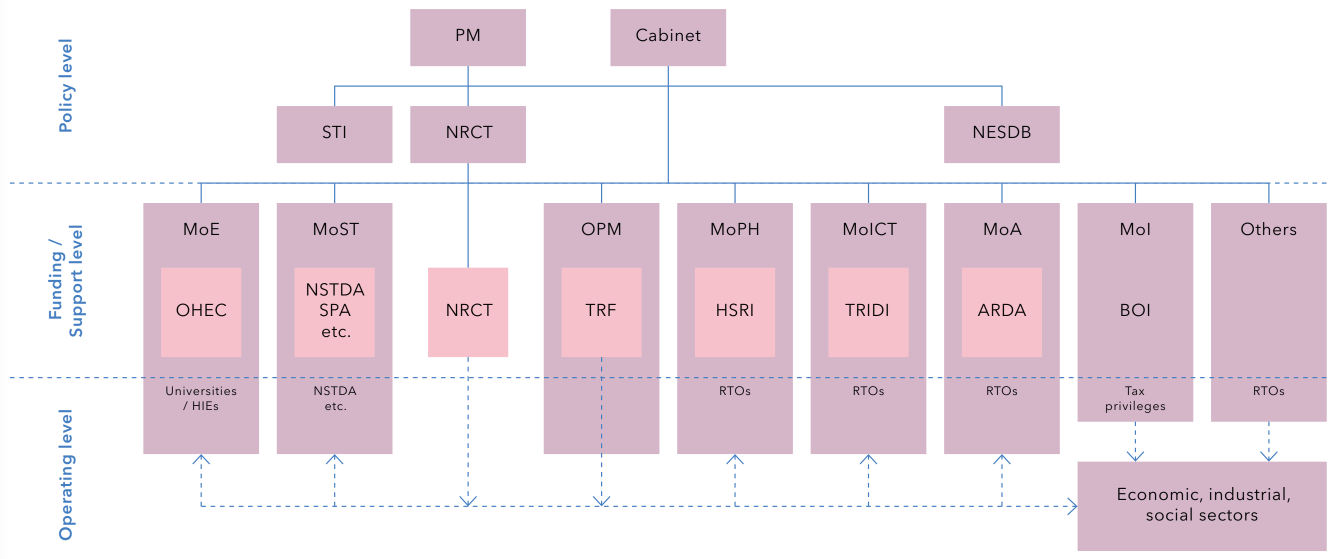


**Figure 1:** Thailand's STI policy, funding and operating landscape. Source: STI Policy Office, 2013

the Prime Minister and brings together all relevant executive agents for the purpose of coordination and policy making. The creation of NSTIC and its position in the political system signals that the research and innovation agenda has become more important for Thai decision-makers. However, it also means discontinuity in setting priorities. Before the end of the 2004–2014 Action Plan, a new overarching policy document had already been launched: the STI Policy and Master Plan 2012–2021. It was developed with the support of the STI Policy Office (STI), which was created together with NSTIC as an innovation policy advisory body. The Master Plan picks up the goals defined in the Economic and Social Development Plan and foresees, among other things, increasing the ratio of GERD to GDP to 1 % (by 2016) and, ultimately, 2 % (in 2021). In parallel, the number of R&D personnel (full-time equivalents) should be raised from currently 9:10,000 to 15:10,000 by 2016 and finally 25:10,000 by 2021.

Recently, in the process of carrying out the STI Policy and Master Plan, the STI Policy Office has also been made responsible for novel programmes and financing schemes, turning it partly into a funding agency. This seems to be a pattern in Thailand's innovation policy and related institutional landscape: institutions are built to advise government in relation to novel policies. As they gain experience and influence, they are trusted with the governance of funds and/or the implementation of research. After a modification of policies, they might lose influence, by, for example, being no longer responsible for the drafting of policy advice plans and documents.

Complementary to the 11th National Economic and Social Development Plan and the long-term perspective of the STI Policy and Master Plan, NRCT has developed a National Research Policy and Strategy Plan (2012–2016)[17]. This plan defines strategies and guidelines for publicly

17 Cf. http://www.kooperation-international.de

funded research. In addition to its specific advisory role on research policy and funding, the NRCT is itself also a major research funder.

In the area of higher education (and, relatedly, research at universities), two other long-term policy strategies have come into play: the National Education Plan (2002–2016) based on the National Education Act of 2002, the Roadmap for Higher Education Quality Development and the 2nd 15-Year Long Range Plan on Higher Education (2008–2022) by the Office of the Higher Education Commission. Current plans in higher education focus on the objectives of producing good quality graduates and researchers who are capable of lifelong work and learning and will contribute to Thailand's social and economic development. Taking into account a number of different scenarios for the future, nine relevant issues are formulated in the Long Range Plan, ranging from improving teacher education via university funding to the networking of universities for consolidating programmes and reducing duplication (OHEC 2013).

Beyond these broad research and higher education policies, there are sector-specific policies in certain areas. For the information and communication technologies, for instance, there are five-year ICT Master Plans (the latest is for 2009–2013, with a new plan currently being developed for 2014–2018) building on 10-year policy frameworks (e.g. IT2010 for the 2000–2010 time window). In the area of health, the respective agencies (NRCT, Ministry of Public Health, Health Systems Research Institute, Thai Health Research Institute and Ananthamahidol Foundation) work on the basis of the Thai National Health Plan (a sub-plan of the Economic and Social Development Plan).

In the area of private sector investment in R&D (and other areas), the Board of Investment recently announced its new Five-year Investment Promotion Strategy (2013–2017), which will focus on environmental friendly and sustainable growth, as well as on R&D and

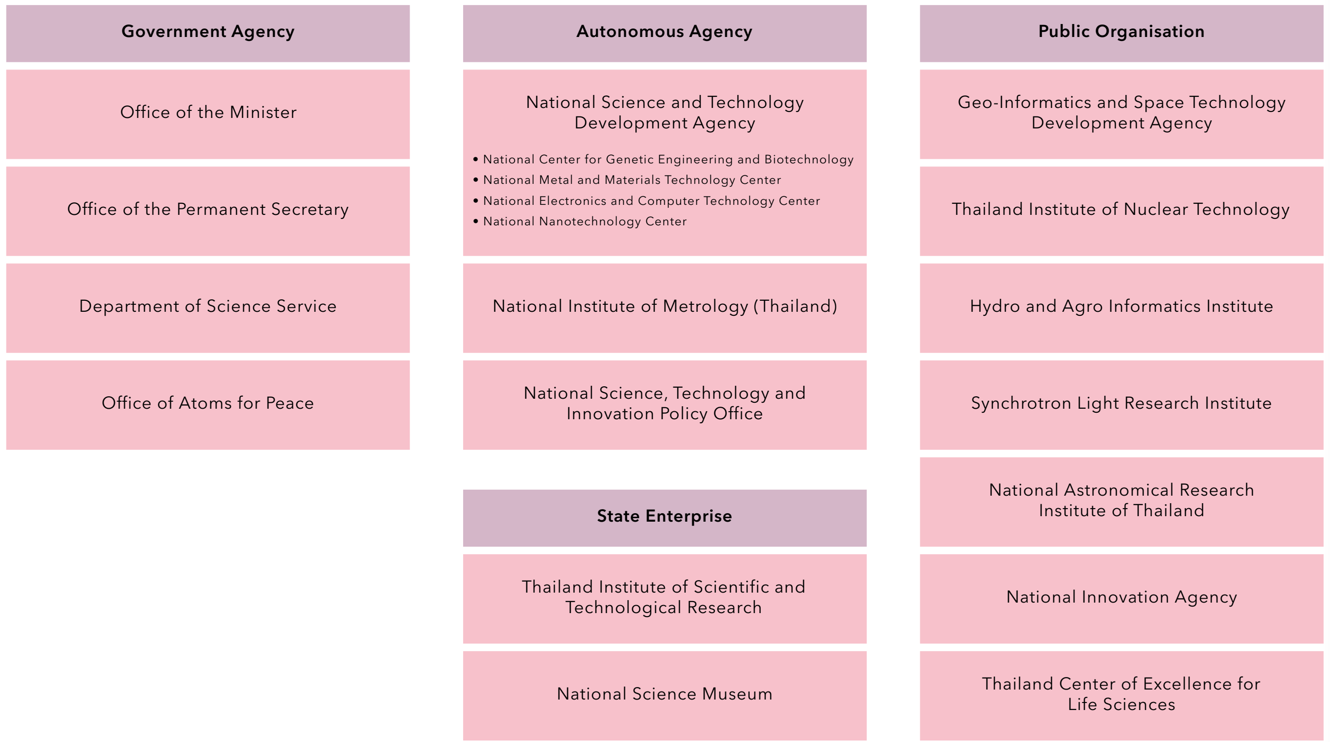


**Figure 2:** Organisational chart of MOST Thailand. Source: Office of International Cooperation, August 2011

"industries of the future" (such as the creative industry, alternative energy and green industries).

The chart in Appendix III shows the policy cycle and evolution of selected research and innovation related policies in Thailand.

### 2.4 The public actors involved

The executive body traditionally responsible for the core of Thailand's research policy, including some major research performing and funding organisations, is the Ministry of Science and Technology (MOST; see figure 2). Some of the most relevant public research institutions and funding agencies operate under the auspices of MOST. However, as in other countries in the region, the so-called line ministries (especially the Ministry of Health and the Ministry of Agriculture) have their own research budgets and use them to finance research in laboratories pertaining to the ministry, and to offer research funding programmes for universities and other public research laboratories.

On the research financing side, the Budget Bureau and the Ministry of Industry's Board of Investment also have an important role to play in policy making. The Budget Bureau is responsible for budget allocation, which in Thailand is traditionally negotiated annually. The Board of Investment (together with the Revenue Department) is responsible for granting tax incentives for strategic investments. It traditionally aimed at attracting foreign direct investment of all kinds. In the 2000s, these incentives were increasingly focusing on R&D related investments, with the aim of attracting FDI in R&D and to motivate Thai and foreign companies in the country to invest in R&D. In this function, the BOI has become an important player for indirect innovation support activities (granting general as well as R&D topic specific incentives, e.g. for the life sciences; facilitating access to work permits for foreign experts, etc.).

From such a broad innovation policy perspective, the Ministry of Industry, the Ministry of Information and Communication Technology, the Ministry of Commerce, the Ministry of Finance and the Ministry of Education can additionally be included.

The importance and usual practice of annual budget planning has consequences in the Thai innovation system and support instruments, especially taking into account another recurrent feature of Thai politics: even within the same government and legislature, changes in ministers are quite frequent. During the last 10 years, Thailand has seen almost as many different Ministers of Science and Technology. The result is that directions in innovation policy and funding not only change if there is a shift in government, but also within the same government. This sometimes results in initiatives and programmes being discontinued due to a combination of limited public resources for R&D and novel priorities to be implemented under the initiative of a newly appointed minister.

In the following section, we will sketch the main research and innovation support instruments, thus also providing an overview of major research funding agencies.





## 3 Support instruments for innovation

### 3.1 The public funding of research: an outline

Thailand has a long tradition of public sector engagement in R&D endeavours. In areas such as agricultural research, this tradition began as early as the 1960s with strong support from international donors such as Rockefeller or USAID (its predecessor). The largest proportion of R&D expenditure in Thailand still comes from public sources (around 60 %[18]).

Most public research is carried out by universities, the most important of which are mentioned above, as well as by public research organisations such as the National Science, Technology and Development Agency (NSTDA), the Thailand Institute of Scientific and Technological Research (TISTR) or line Ministries' research labs (e.g. within the Ministry of Health or Agriculture). Public funding for this research comes from several sources.

The Ministry of Education's university funding covers parts of professorial research activities as far as they are within their usual range of activities (teaching and administration).

Similarly, NSTDA's researchers benefit from the agency's basic funding for research activities that are in line with their institute's priorities (i.e. in areas relevant to the NSTDA research entities such as BIOTEC, NECTEC, etc.). The NSTDA budget (excluding the funding programmes) was around THB 3,500 million (around € 90 million) for 2012/2013, including for construction and building infrastructure. The funds for NSTDA activities come from MOST. For activities extending thematically or resource-wise beyond the regular research tasks, researchers at the universities and the other PROs apply for funding from a number of sources, of which the major ones are:

- the Thailand Research Fund (TRF; annual budget slightly over THB 1,000 million, i.e. around € 26 million, large parts of which go into the Royal Golden Jubilee PhD funding programme, as well as into research career development, research team support and basic research),
- the National Research Council of Thailand (NRCT; annual budget around THB 1,000 million / € 26 million; both research policy making body and funding agency),
- NSTDA's own sources within the Cluster and Programme Management Office (CPMO; budget 2012/2013 around THB 500 million, i.e. € 12.5 million; approximately 50 % of the funds in this programme are spent in-house at NSTDA, the other 50 % are available for researchers at other organisations);
- the Agricultural Research and Development Agency (ARDA; regular programme funds around THB 100–150 million per year); in addition extra-budgetary funds



- the Health Systems Research Institute, the Ministry of Health's funding agency.

The funding agencies annually negotiate extraordinary research funds with NRCT, which are made available for research topics of national relevance. In recent years, the amounts of these extraordinary funds have been increasing steadily (reaching THB 1 billion, roughly € 25 million, in the 2012/2013 fiscal year with the likelihood of a strong increase for the fiscal year 2013/2014). They have been used for "urgent projects" in research areas such as rice, rubber, potatoes, cassavas or tourism.

From two years ago, the major research funding agencies regularly meet in the National Research Management Network. It is within this forum, which significantly improved cross-agency coordination, that the proposals for extraordinary budgets are developed and where the responsibilities for implementing the topic-related programmes are distributed.

Extraordinary funds have also been made available within the 'National Research Universities' project by the Thai Higher Education Commission. The above-mentioned nine universities, which are the main beneficiaries of this scheme, were selected using the Times Higher Education Supplement's QS ranking and the impact factors from a major literature database. The Office of Higher Education (i.e. the Ministry of Education) has made special funding of THB 5 billion available over three years for research universities.

### 3.2 Public funding for private-public R&D cooperation

Several support programmes are offered by the agencies to *bring public and private research closer together* and support the private sector in acquiring relevant knowledge from public sector research performers. NSTDA, for instance, implements an Industrial Technology Assistance Programme (iTAP) where SMEs are provided with necessary technical and scientific expertise. iTAP funds 50 % of the costs of the expertise acquisition up to THB 500,000. NSTDA experts, as well as other Thai and foreign experts, can be consulted / invited. iTAP projects are usually very focussed and last for around six months.

The National Innovation Agency (NIA) has been testing a programme similar to iTAP, offering innovation coupons. SMEs can apply for funding of up to THB 400,000 (around € 10,000) for prototyping R&D activities implemented jointly with university partners. The NIA runs a database of registered service providers that can be consulted by SMEs within this scheme. In addition to the provision of expertise, the funds can also be used for acquiring machinery. Currently, the innovation coupon programme has been discontinued and the budget shifted to endeavours focusing on the "Thailand, kitchen of the world" concept, the bio-plastics industry and the substitution of imported medical devices.

Compared to NSTDA's iTAP, the innovation coupon focusses more on innovation in NIA's understanding (including the application of existing knowledge that is new to a region in Thailand) rather than S&T. One of our interlocutors also pointed out that only registered experts can be consulted, whereas in NSTDA's iTAP scheme, NSTDA looks for in-house expertise first, but can also alternatively bring in external and foreign expertise.

In the area of cooperation between private and public sector research, a novel scheme managed by TRF funds MSc and PhD projects that are defined together with industry actors. The programme provides THB 1.7 million for each PhD student and THB 300,000 for each MSc student. If the industry partner provides 50 % of the funding, any IP resulting from the project is shared equally and the industry partner reserves the right to buy off the IP at the value of the project (obtaining the IP within a PhD project thus costing 850,000 for the 50 % project contribution plus 1.7 million for the IP acquisition). The programme is endowed with an overall budget of around € 800 million to be spent over 15 years, an annual average budget of around € 50 million.

At the Science, Technology and Innovation Policy Office (STI), two novel and potentially relevant innovation support instruments have been created:

- the *Thailand Advanced Institute of Science and Technology* (THAIST) is a newly created national coordinating body that creates links between domestic research and institutions located overseas. Its mandate is to support research into human resource development (through the development of curricula, etc.), to promote joint R&D and degree programmes, to initiate knowledge and technology transfer, to support the establishment of centres of excellence, and to increase industrial R&D. THAIST is not supposed to perform research itself.
- the *Talent Mobility Programme* is related contentwise to TRF's programme for close-to-industry MSc and PhD theses. Its objective is to facilitate the mobility of researchers in government research and higher education institutions to the industrial sector so that government and university researchers can spend some time in private R&D, enhancing the country's competitiveness by applying their knowledge in large companies, SMEs and organisations. Upon their return to the public research laboratory, they bring networks, applied R&D knowledge, management skills etc., with them. For instance, the programme would support public laboratory researchers to move to SMEs as technology advisors, to be active as technology-based entrepreneurs in the their hometown or to spin off their own businesses. THB 7.5 billion (around € 180 million) is reserved for this programme for the five years from 2014 until 2018 (with increasing budget after a test run with THB 100 million in 2014).

In principle, there are thus a number of instruments available to Thai companies to get in touch with academic research and consult the expertise of university staff. While this will potentially increase the level of industrial R&D, the challenge at hand is providing sustained funding for these instruments.

If we now look beyond support for industry demand-based R&D to support instruments for the commercialisation of research results (from the private sector or public research actors), we will see that a small number of potentially effective programmes are available.

### 3.3 Instruments for research commercialisation

In this section, we would like to introduce public support that is available for commercialising research results, i.e. for getting over the "valley of death" in innovation where sustained and increasing funding levels are needed and the risk of the failure of a project or start-up is still high.

NIA supports private R&D in general with two instruments. It offers a Technology Capitalisation Scheme aimed at supporting companies in the prototyping and proof-of-concept stage. In this programme, NIA grants up to 75 % of the budget of a proposed project up to a maximum of THB 5 million over three years. The NIA contribution can be used for hiring technical experts, running tests and acquiring machinery and IP. Usually, NIA's share in the projects is around 50 %.

NIA also offers another programme, "Good innovation, zero interest", which targets R&D commercialisation further downstream. In this scheme, NIA pays the interest due in the first three years (maximum) of a 5–7 year bank loan for SMEs. Project proposals are developed in close collaboration with the loan-granting bank, which also sits on the decision-making board (25 % representation). Grantees of the Technology Capitalisation Scheme can apply for follow-up funding in the "Good innovation, zero interest" programme.

Currently, more than 70 % of the projects supported by NIA are within the Technology Capitalisation Scheme.

NIA employs around 30 staff (implementing the programmes, supporting SMEs in IP acquisition etc.) and its annual budget is between THB 500 and 600 million, around € 15 million. Given that there are 2.8 million SMEs registered in Thailand (around 99.7 % of all companies; BoI 2010), this is a very limited amount. The NIA lists a number of priority areas for which support is available: the bioplastics and organic agriculture industries within the so-called Strategic Innovation Programme; bio-business, eco-industry and design and solutions within the Industrial Innovation Programme. These areas are interpreted broadly to see whether requests for Tech Capitalisation Scheme or "Good innovation, zero interest" support can be granted. In addition to these core programmes, NIA also provides IP management services and innovation management courses.

In addition to NIA, there is also some support for the commercialisation of research coming out of NSTDA's activities. The agency offers a Company Directed Technology Development Programme, providing financial support in the form of 'low-interest loans' to R&D





performers to develop new products, set up laboratories, etc. The programme is thematically focused on NSTDA's priorities (genetic engineering and biotechnology, metals and materials, electronics and computers) as well as on particularly promising S&T advancements. The NSTDA Investment Centre co-invests in joint ventures or spin-off companies (nine joint ventures formed so far).

Finally, at the level of ex-post incentive schemes, the Ministry of Commerce, together with the Department of Intellectual Property, inspired by Google, has set up the "Innovation Thailand" programme and prize, where awards are presented to "Innovation Idols", that is individuals, businesses or organisations that started with an innovative idea and turned it into concrete action using the internet and other resources. Similarly, NIA organises annual National Innovation Awards, but with a broader and less IT-based view of innovation.

The flowchart in Appendix IV presents an overview of the innovation support programmes and their position in a simplified innovation value chain.

### 3.4 Investment support

The Thai Board of Investment (BOI) provides tax deductions and benefits for companies incorporated in Thailand for a defined set of activities. Among these are, currently, investments in research and development in general, investments in biotechnology and related R&D as well as investments in setting up scientific laboratories. The benefits include an exemption for import duties on machinery and raw or essential materials, corporate income tax exemption for 8 years, 50 % corporate income tax exemption for an additional 5 years and further deductions for costs related to facilities construction and maintenance.

Foreign and domestic firms can benefit from these deductions within the rules defined by BOI for foreign shareholding. No equity restrictions exist for manufacturing projects. The general rule is: the maximum shares held by a foreign company are decided on a project-to-project basis by BOI's board. Foreign companies and individuals, except for sensitive sectors (such as agriculture or fisheries) can also buy and own land. Firms within so called industrial estates (science parks are considered such estates) benefit from a wider range of deductions. With its new Investment Promotion Strategy (2013–2017), BOI will introduce a novel focus on environmental friendly and sustainable growth.

In addition to BOI, the Revenue Department can also grant tax incentives. Concretely, a 200 % deduction is available for costs of R&D provided by the Revenue Department approved Thai R&D provider companies or government entities (and carried out in Thailand). This also means that foreign-majority owned companies can claim the 200 % deductions when they engage approved Thai R&D service providers.

### 3.5 Venture capital

The Office of Small and Medium Sized Enterprise Promotion (OSMEP) offers a series of support activities aimed at SMEs, for instance encouraging college graduates to become home-based entrepreneurs. It also runs a facility to subsidise bank loans used for machinery acquisition. However, the support available is rather limited.

There are a number of government banks aiming to support the industrial landscape in Thailand and particularly helping start-ups and SMEs in obtaining loans for R&D or machinery investments (commercial banks might find it too risky to venture). The SME Bank of Thailand is one such example. However, complicated and time-consuming bureaucratic procedures have been reported to hamper the positive impact of these institutions (OECD 2013).

NIA, in its "Good Innovation, 0 Interest" scheme, has also worked with the SME Bank, but has recently shifted to working with private sector banks.

NIA also used to have a joint venture scheme, but the programme was discontinued after negative experiences and, for the moment, it is not considered a priority by the current government. The negative experiences concerned the role the public sector actors played in the scheme: NIA together with NSTDA and the Office of SME Promotion (OSMEP) acted directly as joint venture partners. This slowed down decision-making processes as public agencies have to follow procedures that are not compatible with the quick decisions needed by young companies. There are proposals and discussions for setting up a publicly supported and co-funded joint venture programme, which is publicly controlled and facilitated, but privately run (with government incentives used to attract private venture capitalists), however at the time of completion of this report, the discussions were still ongoing.

In private venture capital funding, corporate venture capital (from Microsoft and other multinationals or bigger national companies such as DTAC) has traditionally been strongest in investing in Thai start-ups. Development cooperation funds as well as, from the year 2000, government support, have also been essential for developing the VC industry in Thailand. Three VC funds were established with government support in 1999/2000: the Thailand Equity Fund (funded through government, local and foreign sources), the Thailand Recovery Fund (in cooperation with ADB), and the Fund for Venture Capital Investment in SMEs (cf. Harvie, Lee 2002, pp. 215 f.).

When it comes to 'traditional' venture capital, in 2007, the Thai Kasikorn Bank set up a venture capital company called Khao Khla to invest in high-potential SMEs via a 'K-SME Venture Capital Fund'. In 2012, for instance, K-SME invested in a honeycomb-paper producer and a logistics company. In the past, Khao Khla had also invested in food and software companies. Investments dedicated to individual companies range from around € 500,000 to € 1.5 million. A number of smaller private venture capital investor companies, as well as the Office for SME Promotion and the SME Bank, are united under the Thai Venture Capital Association, which goes back to a USAID initiated group of foreign VC companies trying to develop the VC industry in Thailand. Other VC initiatives failed, such as the Finn-Thai Technology Fund, which was established in 2005, but then dissolved in 2008 as neither side had injected the agreed amounts of money into the fund.

While the private equity financing landscape is still rather weak, new venture capital funds have been created in recent years (such as M8VC with an investment volume of around € 8 million for 2013).

### 3.6 Intellectual property

In terms of patent output, the European Patent Office's PATSTAT database, as per December 2012, has registered 2,463 patent applications with applicants from Thailand and 6,017 patent applications with inventors from Thailand. WIPO[19] reports annual patent filings by Thai residents in Thailand of around 1,000 per year since 2006 (data until 2011)[20]. It also registers around 200 patents filed annually by Thai residents abroad. The number of patents filed by non-Thai residents in Thailand is significantly higher: around 5,000 annually from 2005 to 2009. The number of non-resident filings in Thailand dropped from 4,832 patents in 2009 to 723 in 2010 and was at 2,997 in 2011.

Focusing on invention-related patents (no design patents), the Thai Department of Intellectual Property (DIP), the country's IP office, also reports that the number of filings by foreign residents is significantly higher than the number of filings by Thai residents, especially until 2010 when foreign filings drop.

In addition to the political situation in 2010, the lower number of international applications can be explained by the fact that Thailand acceded to the Patent Cooperation Treaty (PCT) in 2009, making it possible for Thai residents to file PCT patents via the DIP and for foreigners to file in other PCT member state offices applying for protection in Thailand.

Institutionally, interviewees reported resource problems at the side of DIP. The number of patent examination staff is very limited given the considerable number of applications they have to deal with. This is related to the fact that the DIP cannot keep and reinvest its own revenues (they are transferred to the Ministry of Finance's government accounts instead). In practice, for applicants, this means that there is a certain backlog at DIP in patent applications

It is noteworthy that many of the foreign applicants (which make up for the majority of patent filings) are foreign companies. In addition to these, some public research organisations such as NSTDA, funding agencies such as TRF (which partially act as applicants of IP coming out of research funded by TRF) and universities prominently figure among the (domestic) applicants.

The university's research results commercialisation as well as production and protection of IP are being standardised and professionalised. For instance, some fifteen universities operate Technology Licensing Offices (TLOs), which typically engage in raising internal awareness of IP and the usefulness of IP protection, university-internal training, support of university researchers in IP valuation and negotiation with licensees or contract research partners, support in patent drafting / filing, and draft contracts for IP commercialisation. The TLOs have an internal Thai network with irregular meetings and Thai TLO personnel are increasingly active in the international technology and innovation management associations.

Naturally, participation in global networks and standards in the commercialisation and production of research results is but one aspect of increasing international cooperation in the Thai innovation system.

## 4 International cooperation

Thailand's scientific community and innovation system are characterised by a long tradition of international networking. International partners were crucial in the development of Thailand's science base, such as through projects with USAID and its predecessor organisation on agricultural (especially seed) research or cooperation with Germany in the establishment of engineering colleges. Considerable foreign public investment in R&D, especially around the 1960s, was thus one of the cornerstones of the development of Thailand's strong scientific base. Another one was mobility: Thai students studying abroad who bring back relevant expertise. Some of these students benefitted from government scholarships for their PhDs abroad, which came with a condition: upon their return, beneficiaries had to serve twice the time of the scholarship in government research or other agencies.

One of the most relevant of Thailand's current innovation framework conditions is thus linked to international cooperation: while in the 1950s and 1960s, Thailand saw strong investment (foreign, backed with domestic funds) in R&D and had been able to educate researchers with international networks, careers and impact, this development could not be sustained through the decades of Thailand's economic growth. External aid funds were reduced and domestic public R&D investment remained rather low.

Nevertheless, a series of international collaborations could be maintained or developed, often linked to the personal networks of Thailand's most internationally active researchers. Global research institutions such as the

19 http://www.wipo.int/ipstats/en/statistics/country_profile/countries/th.html
20 According to the OECD (2013), this makes Thailand the country with the lowest patent per capita ratio in the region.





French Centre for International Cooperation in Agronomy Research for Development (CIRAD) have a strong presence in Thailand. Informal contacts between Thai universities and the University of Innsbruck in Austria in the 1970s laid the foundation for the ASEA UNINET ASEAN-European Academic University Network (www.asea-uninet.org) supporting ASEAN-EU mobility of students and young researchers. On other occasions, informal contacts developed into joint graduate programmes (e.g. between the University of Hohenheim in Germany and Chiang Mai University). A number of memoranda of understanding are in place between agencies such as NSTDA and partners in Germany, Israel, Japan, etc. (some translating into joint funding of research projects).

Major public funding agencies such as NSTDA, ARDA and others have jointly funded projects with international partner agencies. Joint bilateral programmes (going beyond a project-by-project approach to collaborative funding) have been scarcer, but exist, for instance, between NSTDA and the Japanese S&T Agency (JST) or the German Federal Ministry of Education and Research (BMBF). These bilateral programmes often focus on mobility and do not support personnel costs. Regarding the EU's funding system, there have been no coordinated calls or ERA-Net participations with Thai funding agencies. The latter is also true for all ASEAN countries, however.

As is also the case for most ASEAN countries, Thai researchers actively participate in the EU's Research Framework Programmes. As of June 2013, out of 212 projects with partners from ASEAN countries, Thai partners were participating in 33, bringing EU funding of THB 255 million (around € 6 million) to the Thai science system. This makes Thailand the most successful ASEAN FP7 participant in terms of budget share.

In addition to the EU, other important international cooperation and funding partners of Thailand (mostly supporting project-by-project co-funding) include Japan, Australia, the US as well as, more recently, India and China. Cooperation with Japan, for instance, is strong in the area of automotive research, linked to the sector with one of the most important foreign direct investment inflows in R&D. There is also a Japanese funded programme (SATREPS, supported by the JST and the Japan International Cooperation Agency [JICA]) that supports joint research projects addressing global issues. It aims at contributing to human resource development and the capacity building of researchers and research institutes by utilising Japanese technology and expertise.

None of the larger Thai public R&D funding programmes explicitly require international cooperation. However, in the Royal Golden Jubilee PhD programme, it is necessary to work with foreign co-supervisors. The programme also supports PhD students in gaining international research experience for 6–12 months at a foreign partner institute.

A programme called 'Reverse Brain Drain' has been implemented by the NSTDA since 1997, and offers planning, project initiation and small project grants to Thai universities working with Thai overseas researchers. There are also financial incentives for a return to government research organisations as well as support for short-term visits. Interestingly, Thailand is one of the countries least negatively affected by brain drain. Thai overseas students return more frequently than their peers in other Southeast Asian countries and fewer researchers leave the country permanently. Some commentators point out the potential positive effects of a certain degree of brain drain (Bhumiratana et al. 2009).

Around 40 % of the publications of Thailand-affiliated authors are international co-publications. The most important partner regions / countries are the US, followed by the EU and Japan (cf. Degelsegger et al. 2012). Subject area-wise, recent data from the Scopus database indicate medicine and engineering, followed by agriculture and biological sciences as well as biochemistry, genetics and molecular biology as the most important fields in Thailand-based research output in general (data for 2005–2012). When looking at collaborative output only, engineering research is less important, while the other above-mentioned areas remain the most important.

On the political level, Thailand's STI policy-making bodies are among the most active in the regional Southeast Asian context. For instance, the so called 'Krabi Initiative' (Science Technology and Innovation for a Competitive, Sustainable and Inclusive ASEAN), which is an ambitious strategy framework for regional STI development, goes back to the initiative of Thai Delegates in the ASEAN Committee on Science and Technology (COST). The Krabi initiative was negotiated and adopted at the 6th Informal ASEAN Ministerial Meeting on S&T in Krabi, Thailand. It introduces rationales, thematic tracks, necessary paradigm shifts and courses of action for STI development in ASEAN from a 2015 perspective. Topics of regional relevance such as water management, food security, green technology and biodiversity feature in this strategy, together with ideas of STI education and youth innovation, with a focus on the poorest members of society and public-private partnerships.

## 5 Key strengths and weaknesses[21]

We have seen in the previous section that the Thai innovation system can build on and benefit from a series of international links, especially on a strong tradition of academic cooperation. We have also indicated that there are strong government research agencies and research universities with a number of highly internationalised faculty members and a well-trained base of researchers.

21 The interpretations and analyses in this section and the entire chapter represent the author's views on the basis of our research and the interviews conducted. They do not represent any institutional perspective and cannot include all potential views.

As in the case of many countries, the teaching load for faculty is considered too high by some commentators. Faculty and students might benefit from more incoming mobility of visiting professors, etc. Both in the government research agencies and the universities, there are certain historical path dependencies. Some institutions have been established with a mandate that is not as relevant today as previously. They look for new areas of activity and expertise as well as for related funds and, thus, enter into potential competition with other public agencies. University curricula also include some duplication. There is an ongoing discussion about the question of how to better coordinate university curricula so that subjects are taught (and research is performed) at a sufficiently broad scale but without too much fragmentation.

The publication output of Thai research institutions is impressive and, in a regional comparison, second only to Singapore. As everywhere, the transformation of research output into economic benefits poses challenges. Addressing this, government research agencies, as well as research universities, operate with an increasingly professional organisation of research commercialisation (in the form of TLOs). Recent developments in university curricula and funding instruments show that there is an agreement on the necessity to invest in entrepreneurship education in order to maximise the benefits from Thailand's impressive human resources (given its young and increasingly well educated population).

The venture capital landscape is still comparably weak. However, taking into account current conceptual discussions, the recently increasing number of private equity financing initiatives and the favourable position of Bangkok as one of the region's most relevant and dynamic economic hubs, there is future potential that can be tapped into with suitable policy support.

It is the broader political landscape that poses significant challenges to the Thai innovation system. R&D policy is a long-term policy, which is hard to implement with unstable governments and with ministers serving only very short terms. In addition, the Ministry of Science and Technology is considered 'B-grade', meaning that it is among the ministries of second-level importance, less important than, for instance, the Ministry of Finance, but more important than, for instance, the Ministry of Culture. This grading of ministries also has effects on how the government assigns ministers and where the most ambitious staff want to work. The fluctuation in the political leadership forces innovation system actors such as funding agencies to present results to novel policies and instruments within a year, which is often impossible. Long-term planning is thus hampered.

These political challenges are also intricately linked with the other major challenge for the Thai innovation system: limited funding. On the public side, despite the goal of 1 % of GERD/GDP being proclaimed, it has not yet been reached. On the public funding side, the fiscal year and the fact that budgets have to be approved on a yearly basis, further complicates the situation and limits the possibilities for long-term planning according to R&D policy frameworks. Similarly, the fact that public R&D funding comes from a number of ministries makes coordination even more difficult. Recent initiatives such as the above-mentioned regular meetings of all funding agencies (in the National Research Management Network, are promising efforts to address this.

Part of the responsibility of reaching the 1 % goal lies with the private sector where only a few multinational and large national companies invest in R&D (with little authority from the public side to influence the direction of these investments). The vast majority of SMEs, which are the backbone of Thailand's economy, are not investing in R&D (due to lack of resources in time, finance and capacity). However, Thai stakeholders are increasing efforts to change this situation. Particularly in view of the ASEAN Economic Community becoming a reality at the end of 2015, they realise that the SMEs have to increase the profile of their added value in order to stay competitive even in the domestic market (and especially so if they want to internationalise).

At the level of support instruments for innovation, we have seen that there is a range of bottom-up and thematic grants for basic and applied research. Some recent instruments such as TRF's industry PhD / MSc scheme or STI's Talent Mobility Programme focus on industry-academia exchange with potential impact on the commercialisation of research results and the upgrading of companies' R&D efforts. Research commercialisation support instruments are scarce: there is only an innovation coupon scheme with NIA and a somewhat similar programme at NSTDA (iTAP). The problem currently is that both schemes are low on funds, the former because of a shift in focus required from NIA by the government, the latter because of an NSTDA-internal shift of focus to internal agency efforts that is in turn linked to limited funding for NSTDA. It seems to be an unfortunate recurring feature of the Thai innovation system that promising schemes such as iTAP are not, at the right moment, evaluated and, if considered successful, scaled up to a national scheme. Instead, as said above, the fate of such instruments depends very much on changing political, institutional and funding environments.

Two research commercialisation programmes are available at NIA that go beyond innovation coupons, counselling, technology matching and consultancy, namely: a technology capitalisation grant and an innovation related loan support scheme (subsidising interest payments). Experts agree, however, that more funds and/or programmes are necessary in close-to-market public R&D support. Another area where commentators have suggested that additional instruments would be helpful is the internationalisation of Thai businesses (which traditionally focus more on the domestic market). While this applies to SMEs in general, support would be particularly helpful and relevant for start-ups and R&D performers as they have greater potential for a competitive international performance.





The portfolio and amount of indirect support instruments available for R&D, for example through tax incentives via the Board of Investment, is comparable to the efforts of other Southeast Asian countries (although there is no R&D incentive cash-pay-out option such as, for instance, in Singapore). The portfolio mirrors the efforts of continuing to attract foreign direct investments while increasingly trying to steer them (as well as national private investments) towards R&D. Given their limited R&D investments, limited resources and willingness to deal with BOI application procedures as well as disclosure issues, SME usage of the indirect support instruments is reported to be limited. However, as we have seen, large infrastructure development efforts are currently underway, among them the second phase of the Thailand Science Park ('Innovation Cluster 2'), the regional science parks (although experiencing some delays) and the privately run AMATA science city.

Thailand thus seems dedicated to improving the innovation framework conditions further, especially for SMEs and start-ups coming out of academic research. Good practices of (and ideas for new) close-to-market public innovation support instruments are also available for implementation and up-scaling.

# 6 Appendices

## Appendix I: Institutions visited

*National Science, Technology and Innovation Policy Office (STI)*

*National Science and Technology Development Agency (NSTDA)*

*Thailand Institute of Scientific and Technological Research (TISTR)*

*Thailand Research Fund (TRF)*

*Agricultural Research and Development Agency (ARDA)*

*Thailand Board of Investment (BoI)*

*National Innovation Agency (NIA)*

*Thai Chamber of Commerce*

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## Appendix III: Policy cycles

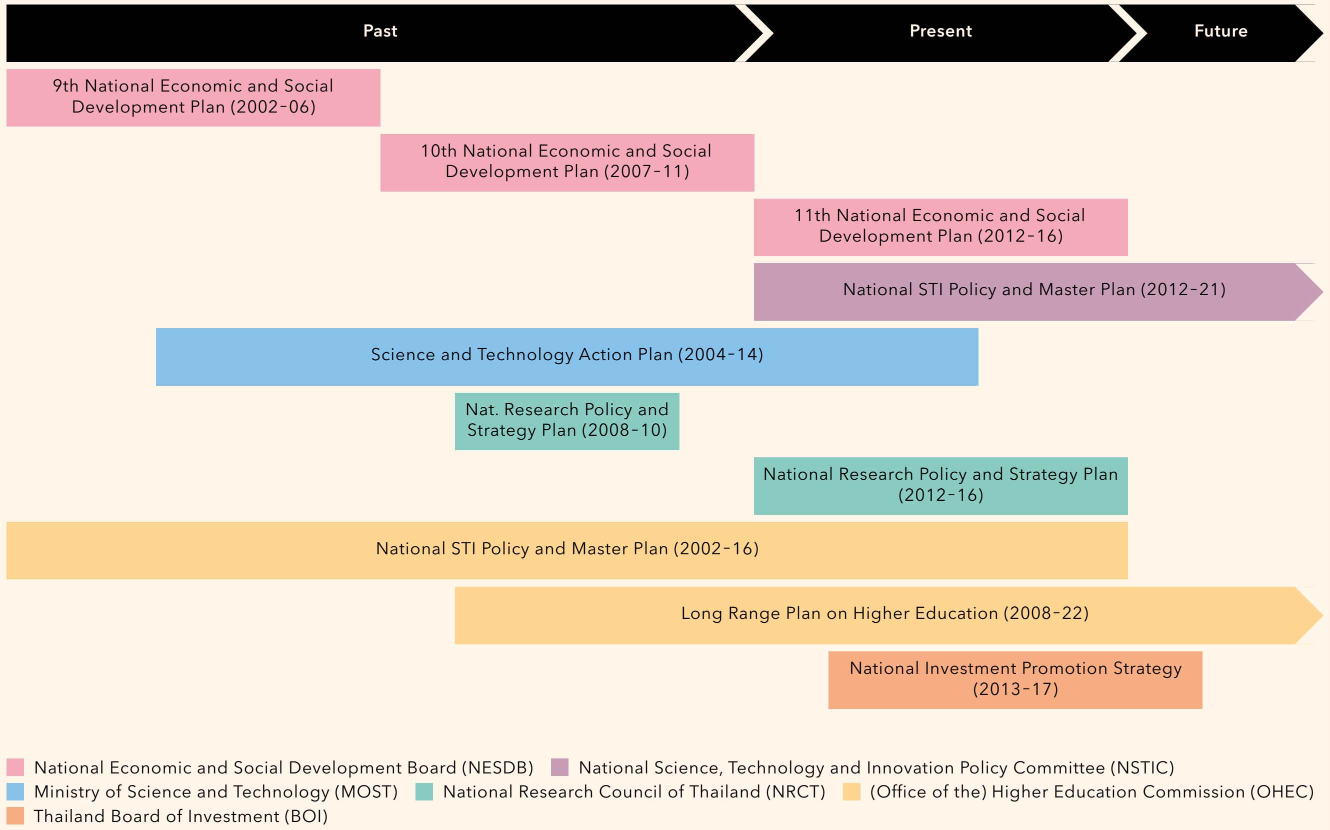


**Figure 3:** Policy cycles





## Appendix IV: Funding agencies and instruments[22]

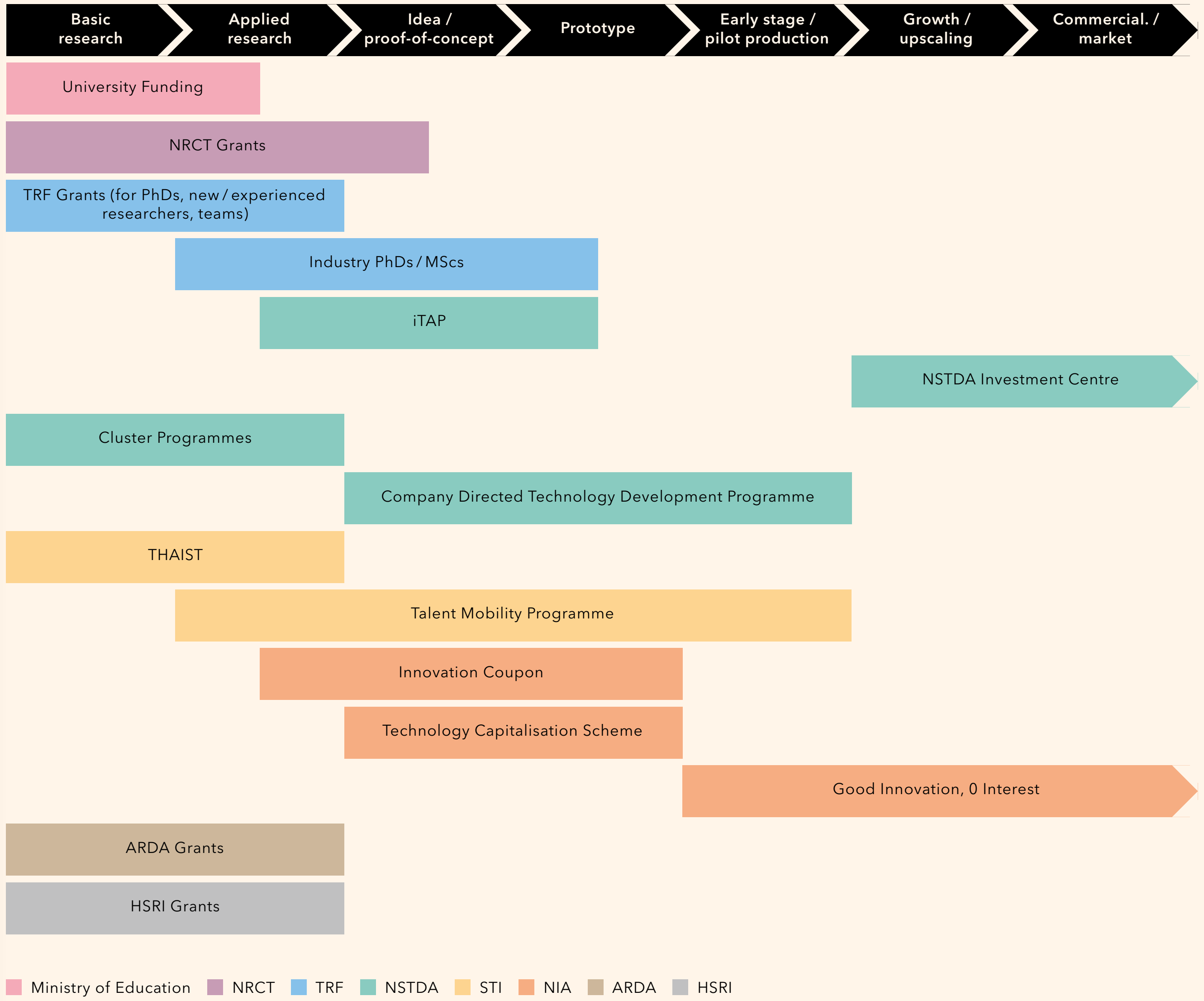


**Figure 4:** Funding agencies and instruments

**22** According to the stage in R&D / product development they focus on

# Vietnam

Thang Dao Manh[1], Florian Gruber[2], Wanichar Sukprasertchai[3]

## 1 Key indicators and framework conditions

### 1.1 Economic context

In the past three decades Vietnam has gradually undergone a radical shift, from a centrally planned economy isolated from the world to a more open, market-oriented economy. Vietnam has been, and is still to a certain extent, an agriculture-based economy. Among other things, this has allowed the country to weather the recent macroeconomic instability well in comparison with most of its neighbours. From 2007 to 2011 growth of the economy has been higher on average than in most other Southeast Asian countries, but at the cost of double-digit inflation over the same period.

In 2011 policy makers in Vietnam tried to counter the high inflation by tightening monetary and fiscal policies, but there are deeper structural weaknesses that need to be addressed in the near future if continuous growth is to be put on a sustainable basis. Policy makers have recognised this and put forward reform plans in 2012. In recent years Vietnam has put emphasis on integration with external economic networks and could reap the associated benefits to the economy. Exports have remained strong despite the difficult regional and global economic environment. These exports are, however, mostly in the area of less sophisticated products, with low added value, and embodying modest technology.

1 National Agency for Science and Technology Information (NASATI), Hanoi, Vietnam
2 Centre for Social Innovation (ZSI), Vienna, Austria
3 National Science and Technology Development Agency (NSTDA), Pathum Thani, Thailand

Within a quarter of a century Vietnam has achieved the status of a middle-income country with a per capita income by the end of 2010 of US$ 1,130. Supported by the growing economy, Vietnam was able to tackle and meet a number of Millennium Development Goals, with particular achievements in the area of reducing poverty at the national level: the number fell from 58 % of the population living under the poverty line in 1993 to 10 % in 2012. There is, however still a pronounced economic inequality between urban and rural areas, especially with regard to ethnic minorities living in the countryside[4].

As a side effect of economic success, Vietnam is now facing a transition process leading away from Official Development Assistance (ODA) financed schemes and support. This could pose a challenge to the country in the future, as rising budgetary pressures confront the government with hard fiscal policy decisions in order to balance the objective of economic expansion with that of macroeconomic stability.

Another large threat to the country's development is the enduring corruption within the system. The government has reacted by improving the anti-corruption legal framework with the adoption of the Anti-Corruption Law in 2005, the National Strategy on Anti-Corruption to 2020 (in 2009) and the ratification of the Convention Against Corruption from the United Nations in 2009. However, the implementation of these laws has been, to the current date, not totally successful due to a lack of enforcement of these regulations. The 2013 Corruption Perceptions Index places Vietnam as ranking 116 among 177 countries surveyed.[5]

4 http://www.worldbank.org/en/country/vietnam/overview/ (accessed 4 April 2014)
5 http://www.transparency.org/cpi2013/results/ (accessed 4 April 2014)





| Indicator | Value | Year |
|---|---|---|
| R&D intensity: Gross domestic expenditure on R&D (GERD) as a percentage of GDP – GERD/GDP | 0.21 %<br>0.21 %[6] | 2002<br>2011 |
| Total R&D personnel (head count) | 134,780[7] | 2011 |
| Total labour force | 52.6 million[8] | 2012 |
| Publication output | 2,836[9] | 2012 |
| Patent (resident + abroad and economy) | 424[10] | 2012 |
| Trademark (resident + abroad and economy) | 24,685[11] | 2012 |
| Industrial design (resident + abroad and economy) | 1,407[12] | 2012 |
| Foreign direct investment, net (BoP, current US$) | −7.168 billion | 2012 |
| Foreign direct investment, net outflows (% of GDP) | 0.770119359 | 2012 |
| Foreign direct investment, net inflows (BoP, current US$) | 8.368 billion[13] | 2012 |
| Number of universities | 419 | 2012 |

**Table 1:** Key indicators

### 1.2 Research performing actors

Actors directly related to, and dependent on, government undertake the majority of science and technology work. The innovation infrastructure within the country is relatively weak, with an emphasis on knowledge production rather than on policies to promote the adoption and diffusion of S&T knowledge. The system of STI in Vietnam encourages competition between actors in innovation, and there is little cooperation and coordination between them.

#### 1.2.1 Research and development organisations

a) National research and development organisations

The Vietnam Academy of Social Sciences (VASS) and the Vietnam Academy of Science and Technology (VAST) are the two major national research and development organisations in the country. In addition to their normal scientific work, VASS and VAST also perform the functions of implementing national S&T priority missions and key missions in order to provide scientific arguments to arrange the course of actions, policies, and laws on S&T. They perform R&D services to serve the cause of a developing national economy and society, and ensure national defence and security research. They train human resources and encourage talent in the field of S&T.

6 http://www.gso.gov.vn, General Statistics Office; NASATI; *R&D survey 2002*
7 First national R&D survey, carried out in 2012
8 *Key Indicators for Asia and the Pacific 2013*, ADB
9 http://www.scimagojr.com/countrysearch.php?country=VN, SCIMAGO country and journal rank (accessed 27 February 2014)
10 Statistical country profiles: Vietnam, WIPO
11 Ibid.
12 Ibid.
13 World Bank, January 2014

1) Vietnam Academy of Science and Technology (VAST):

VAST was founded in 1975. Pursuant to Decree No 108/2012/NĐ-CP, dated 25 December 2012, approved by the Prime Minister when defining the functions, tasks, powers and organisational structure of the Vietnam Academy of Science and Technology (VAST), VAST includes six supporting units for VAST's President as established by the Prime Minister; 34 research units (of which 27 were established by the Government and seven were established by VAST's President); four self-financing units and one state-owned company.

2) Vietnam Academy of Social Sciences (VASS):

Founded in 1953 during the French War, and pursuant now to Decree no. 109/2012/NĐ-CP dated 26 December 2012, VASS is a governmental agency which researches basic social science issues. Scientists are tasked by the state to provide scientific arguments for planning policy lines and strategies, with the aim of developing Vietnam quickly, sustainably, and with a socialist orientation. They provide consultancy on development policies, organise higher education programmes in the field of social sciences and generally develop national social science potential.

Currently, there are 42 units at VASS, including 6 supporting units for VASS's President; 7 units specialising in social sciences, 9 units specialising in the humanities; 8 units specialising in international research; 4 units specialising in regional analysis, 5 administrative units and 7 units specialising in other fields.

b) Other research and development organisations and agencies

These bodies were established in a variety of fields by ministries with a specific S&T portfolio (e.g. agriculture), commissions at the ministerial level, commissions under the government (referred to as research and development agencies at ministerial level), research and development agencies established by centrally-administered cities and provinces (referred to as research and development organisations at provincial level); research and development organisations of other commissions under the Government, political organisations, and socio-political organisations at central level.

c) Research and development organisations at grassroots level

These organisations perform S&T activities to achieve the objectives and missions of their founders. Many of those are funded by foreign sources, such as NGOs.

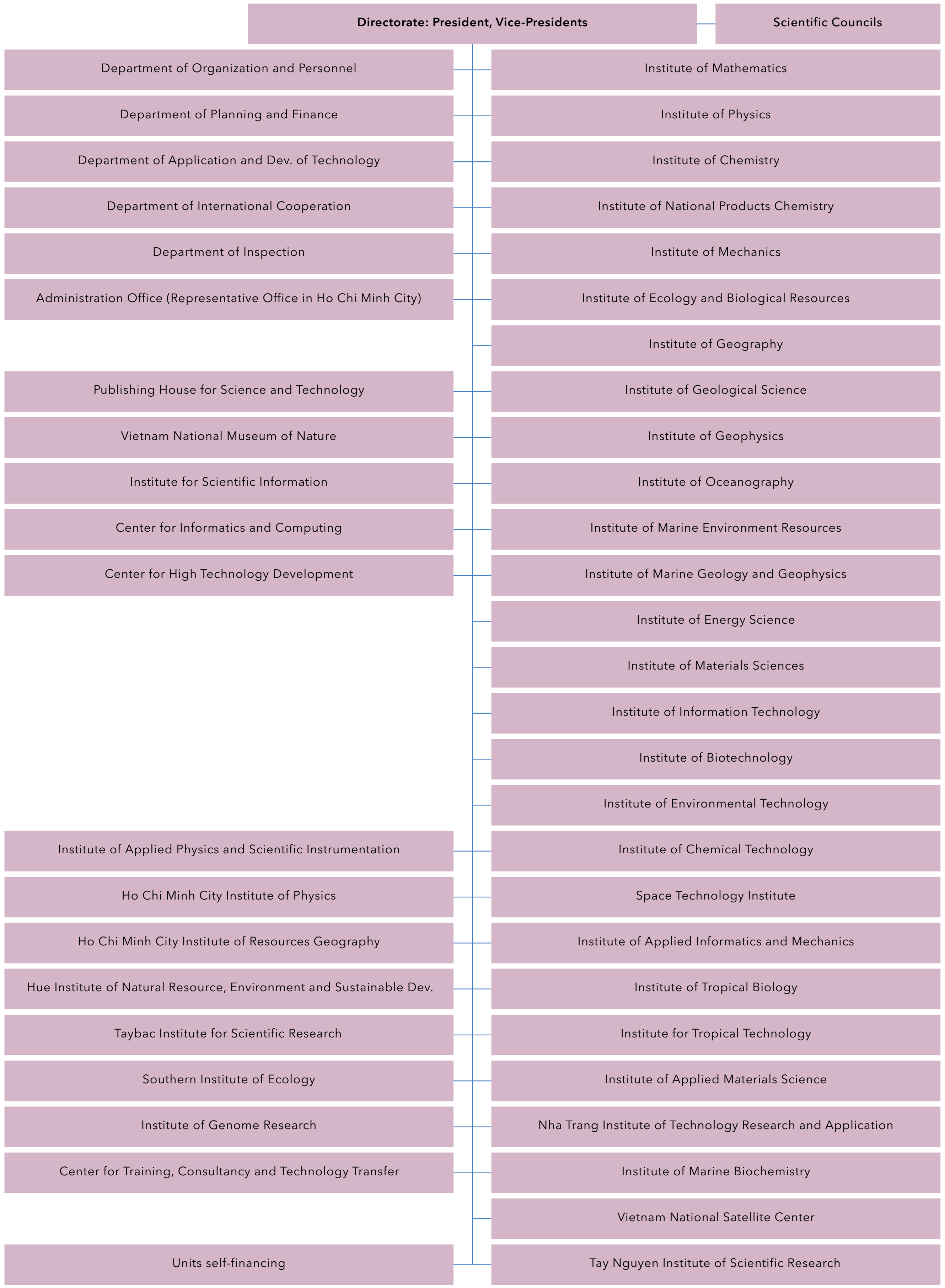


**Figure 1:** Organisational chart of VAST[14]





### 1.2.2 Universities and colleges

Universities perform basic research, including applied research, as well as offering education. They also implement priority S&T missions assigned by the government.

According to statistical data from the Ministry of Education and Training, there were 419 universities, institutes and colleges in 2011 and 2012 (table 2), with 84,109 lecturers, of whom 11 % had a PhD, 43 % a Master's degree, and 44 % were graduates and postgraduates.

| Types | 2009–2010 | 2010–2011 | 2011–2012 |
|---|---|---|---|
| Universities / institutes | 173 | 188 | 204 |
| State | 127 | 138 | 150 |
| Non-state | 46 | 50 | 54 |
| Colleges | 230 | 226 | 215 |
| State | 199 | 196 | 187 |
| Non-state | 31 | 30 | 28 |
| Total | 403 | 414 | 419 |

**Table 2:** Quantity of universities, institutes and colleges in Vietnam
Source: Ministry of Education and Training (http://www.moet.gov.vn)

### 1.2.3 Science and technology service organisations

S&T Service Organisations are intermediate organisations that are assigned to implement supporting activities for the development of science research and technology, such as activities related to intellectual property, technology transfer, and standards–metrology–quality. They also provide services related to information dissemination, consultation, training, and apply practical S&T knowledge and experiences.

### 1.2.4 Science and technology enterprises

According to the incomplete statistic data for high technology and S&T enterprises from the Registry Office, there were 40 enterprises that received the Certificate of S&T enterprise until 2012, and more than 200 applications had been reviewed at Departments of S&T. The Ministry of Science and Technology (MOST) has implemented many policies to support these businesses, such as exemption or deduction of corporate income taxes, reduced land rents, and easy access to financial sources.

Most of the certified S&T enterprises operate in the form of limited companies or joint-stock companies, which is very common due to the limited responsibility and the high ability of fund raising. There are two conditions for the establishment of an S&T enterprise:

1. The enterprise undertakes research, and commercialises its S&T results; or
2. The enterprise is established based on the adoption of S&T results created by institutes, universities, private research organisations, individuals, or a group of scientists / inventors.

S&T enterprises are mostly located in Hanoi City (10 enterprises) and Ho Chi Minh City (8 enterprises) as these cities offer favourable conditions for implementing research and innovation.

S&T enterprises are mostly of small and medium scale. These enterprises, especially new ones, face difficulties in expanding and developing S&T products due to a shortage of available funds and high loan interest. As newly established enterprises are often inexperienced, it's difficult for them to raise the funds to further develop their products. Consequently, they are unable to produce significant results.

### 1.2.5 Hi-tech parks

The establishment of high technology (hi-tech) parks aims to improve the national technology capacity, and to fill the economic and scientific gap between Vietnam and other countries in the region and worldwide. They are believed to push the development of the Vietnamese economy and to support Vietnam in integrating effectively into the global economy. At present, there are three national hi-tech parks located in three regions across Vietnam: Hoa Lac Hi-Tech Park in the North, Sai Gon Hi-Tech Park in the South and Da Nang Hi-Tech Park in the Centre. Construction of Hoa Lac Hi-Tech Park and Sai Gon Hi-Tech Park has been completed and they have started to achieve results. After being established in 2010, Da Nang Hi-tech Park is now entering its initial construction phase. There are plans to relocate Hanoi University to Hoa Lac Hi-Tech Park, therefore boosting its scientific potential and making it a draw for investors. This will help to ameliorate the unfortunate location of this hi-Tech park on the margin of the city, with difficult infrastructure access.

## 1.3 Business environment

Currently the business environment in Vietnam is rather difficult. Although policies are being organised to change bureaucratic hurdles, it is a significant challenge for new firms to raise sufficient funds. Additionally there is a lack of venture capital companies to support startup enterprises.

"For Vietnam to become a mature, internationally competitive economy, the government needs to bring the business environment more in line with international benchmarks. This requires changing the administrative culture of regulators and public service delivery agencies, with an emphasis on introducing a user-centred approach (OECD 2011)."

In order to become more business-friendly, the government is currently implementing Project 30, originally developed by economist Ngo Hai Phan. This initiative

14 http://www.vast.ac.vn/en/about-vast/organization-chart/ (accessed 4 April 2014)

seeks to install a more user-centred approach that aims to reduce the costs of administrative procedures and compliance costs for businesses and citizens by 30%.

In the World Economic Forum's Global Competitiveness Index 2013–2014, Vietnam ranks 76, with relative strengths in gross capital formation, credit, national office resident trademark registrations, and creative goods exports, and relative weaknesses in press freedom, business environment, tertiary inbound mobility, ease of protecting investors, and market access for non-agricultural exports[15].

While Vietnam's overall "ease of doing business" ranking is in the top half of countries assessed, the ranking for dealing with taxes is considerably worse. Among the countries that have participated in the World Bank's Enterprise surveys in the past five years, the percentage of firms reporting paying bribes when dealing with taxes is relatively high. With a rank of 99, Vietnam is between China (96) and the Philippines (108), with the regional average being 88.

Vietnam ranks highly in the indicators for "Dealing with Construction Permits" (29), "Getting Credit" (42), "Enforcing Contracts" (46), and "Registering Property" (51), whereas the report shows difficulties for business in "Protecting Investors" (157), "Getting Electricity" (156), "Paying Taxes" (149), and "Resolving Insolvency" (149).[16]

## 2 Governance and public STI policy

### 2.1 Vietnam's political system

Vietnam is a socialist one-party system state that is ruled by the Communist Party of Vietnam. In parallel with opening its economy, the government has implemented tentative political reforms, such as strengthening the role of the National Assembly that in turn has become more assertive in exercising its authority over law-making processes. In the democracy index of 2011, Vietnam ranked 143rd out of the 167 countries surveyed, and it was described as a country with an authoritarian regime.[17]

In 1986, a programme was launched in Vietnam to kick-start political and economic renewal: *Doi Moi*. This programme contained reforms to facilitate the transition of the country from a centrally-led economy to a socialist-oriented market economy. Part of this programme included the integration of the country into global economic value chains. *Doi Moi* is considered as rather successful – since its inception it has led to steady economic growth and has significantly reduced poverty.

15 http://www.globalinnovationindex.org/content.aspx?page=interactive-SW (accessed 27 February 2014)
16 http://www.doingbusiness.org/data/exploreeconomies/vietnam/ (accessed 3 March 2014)
17 *Country Strategy for Development Cooperation with Vietnam 2013–2016*, Ministry for Foreign Affairs of Finland

### 2.2 Development plans and innovation policy

In response to the rising demand for a highly skilled workforce, Vietnam's political leadership at all levels is highly committed to enhancing the skills of the country's labour force. The 10 year *Strategy for Socio-Economic Development (SEDS;* from 2001–2010*)* places human resource development as one of the three main breakthroughs needed for Vietnam's economic growth. An action plan with concrete steps for the SEDS is outlined in the five year *Socio-Economic Development Plan (SEDP).*

These strategic documents were prepared in an open manner with the participation of a variety of stakeholder groups from the donor community, government agencies, and civil society organisations. The plans provide a framework for the different ministries and agencies in the country to aid and structure the development of their own sector plans of actions.

### 2.3 STI policies

#### 2.3.1 Background

The government of Vietnam acknowledges the important role of science and technology in the socio-economic development of the country. In ten years of implementing the *Socio-Economic Development Strategy,* Vietnam's economy has achieved relatively high and continuous growth rates, and people's lives have improved. However, the pattern of growth in the country is based on ever increasing investment, and exploiting the advantages of resources and labour. Vietnam's economy has not secured a basis for sustainable development in the context of rapid science and technology innovations. Globalisation is inevitable and international and regional competition is increasingly fierce.

The 11th National Congress of the Communist Party, organised 12–19 January 2011 at the My Dinh National Convention Centre, Hanoi, set the goal that "Vietnam strives to become a modernised, industrialised country by 2020". It was determined that S&T development would play an important role in achieving the proposed objectives. The 11th National Party Congress judged that in the past planning period, S&T had contributed widely to the development of society and the economy, but that "science and technology have not really become a motivation, not closely linked to the objectives and tasks of socio-economic development. The S&T market is still aboriginal, even though creating effective linkages between research, training and business. Investment in science and technology is low, and the technology level is generally obsolete, slow innovation". Therefore, science, technology, and especially innovation, had to become strong key factors for socio-economic development in the 2011–2020 period.

The *National Science and Technology Development Strategy to 2020* defined basic perspectives on science and technology development as follows:





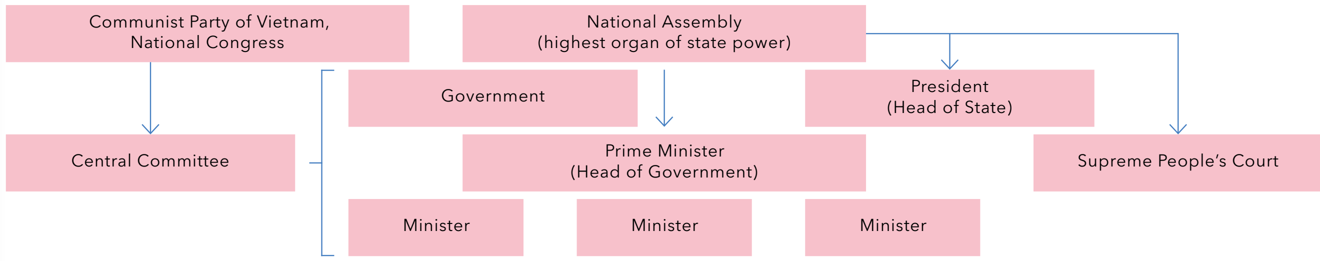


**Figure 2:** Political system of Vietnam[18]

- Development of science and technology together with education and training are the top national policies and key motivations for the country's fast and sustainable development. Science and technology must play a decisive role in order to make a development breakthrough in productive force, innovate growth models, to enhance the competitiveness of the economy and speed up the country's industrialisation and modernisation;
- Focusing on a synchronised fulfilment of three essential tasks: continuing to fundamentally, comprehensively and synchronously reform science and technology organisations, especially with regard to management mechanisms and operational mechanisms; strengthening the national science and technology potential and promoting research and development; and linking science and technology development tasks with socio-economic development tasks at all levels and branches.
- The state increases investment levels and prioritises investment for national science and technology tasks and national products. The socialisation and mobilisation of all resources are prioritised, especially from enterprises investing in science and technology development.
- The development of a science and technology market is linked with the enforcement of the law on intellectual property in order to boost technology research and development results and encourage science and technology innovation.
- International integration of science and technology is an objective and at the same time an important solution, which will contribute to Vietnam's science and technology quickly reaching international levels. International integration of science and technology must be implemented in an active, proactive and creative manner, ensuring the national independence, sovereignty and national security, as well as equality and mutual benefits.

#### 2.3.2 Science and technology development

The *National Science and Technology Development Strategy to 2020* proposed the overall objective "To develop in a synchronised manner social sciences and humanity, natural sciences, technical and technological science; make science and technology really become a key motivational force and meet basic requirements of a modern industrial country. By 2020, a number of Vietnam's science and technology fields will reach the advanced and modern level of the ASEAN region and that of the world."

With such an overall objective, the strategy defines specific targets:

- By 2020, science and technology will contribute a significant proportion to economic growth and the restructuring of the economy. The value of hi-tech products and hi-tech application products will account for approximately 45% of the GDP. The speed of technology and equipment innovation will reach 10–15%/year for the 2011–2015 period and over 20%/year for the period of 2016–2020. The transaction value of the science and technology market will increase 15–17%/year on average.
- The number of international publications from research themes funded by the state budget will increase 15–20%/year on average. The number of innovations registered for protection for the 2011–2015 period will increase to 1.5 times higher than those for the 2006–2010 period, and the number for the 2016–2020 period will be twice as high as that of the 2011–2015 period; the number of innovations resulting from state key science and technology programmes will be particularly quickly increased.
- Efforts will be made to increase the total social investment in science and technology to the level of 1.5% of the GDP by 2015 and over 2% of the GDP by 2020. Investments from the state budget in science and technology are ensured so as to reach at least 2% or more of the total annual state budget expenditure.
- By 2015, the number of R&D officers will reach 9–10 persons per ten thousand people; approximately 5,000 engineers will be trained and examined according to international standards and fully capable of managing and operating the hi-tech production lines of the country's branches and fields of development priorities. By 2020, the number of R&D officers will reach 11–12 persons per ten thousand people; approximately 10,000 engineers will be trained and examined according to international standards

18 Based on information at http://www.mofa.gov.vn/en/tt_vietnam/nr040810155159/ (accessed 3 March 2014)

and fully capable of managing and operating the hi-tech production lines of the country's branches and fields of development priority.
- By 2015, 30 basic and applied research organisations will reach the regional and international levels, and be fully capable of solving issues of national importance relating to science and technology. There will be 3,000 science and technology enterprises, and 30 hi-tech technology incubators and hi-tech enterprise incubators will have been formed. By 2020, 60 basic and applied research organisations will reach the regional and international levels, and be fully capable of solving issues of national importance relating to science and technology. There will be 5,000 science and technology enterprises, and 30 hi-tech technology incubators and hi-tech enterprise incubators will be formed.

#### 2.3.3 Directions of science and technology development tasks

To achieve the above objectives, the strategy proposed directions for the S&T development tasks, including:
1. To continue to reform fundamentally, comprehensively and synchronously science and technology organisations, management structures and operational mechanisms
2. To strengthen science and technology potentials
    - To focus investments on the development of key science and technology organisations; link science and technology organisations of the same nature, field or inter-sectors; establish strong research groups which are fully capable of fulfilling key national tasks. To improve basic research capacities of key national universities and establish potential young research groups in universities and research institutes.
    - To improve the operational capacities and efficiency of hi-tech zones, hi-tech application agricultural zones, centralised information technology zones, national key laboratories, and technology incubators as well as science and technology enterprises, science and technology information centres, centres for science and technology advancements, centres for standards, metrology and quality at the central and local levels.
    - To improve the capacities, qualifications and quality of science and technology managers in all sectors and at all levels.
    - To develop systems of technology transfer service organisations, markets for technology and equipment; to ensure enforcement of the law on intellectual property, efficiently exploit and use innovations; to organise exhibitions to introduce achievements in S&T innovation and creation.
3. To synchronously develop social sciences and humanities, natural sciences and prioritised technologies

### 2.4 The public actors involved

#### 2.4.1 Ministry of Science and Technology

This ministry is the nodal point for managing S&T organisations, and developing targeted S&T strategies and activities within the country. Political directives developed by the Ministry of Science and Technology have been strongly aimed at the separation of state management functions and public service activities. It clearly defined the tasks of state management units with public service organisations:
- To reorganise the management method of key S&T programmes at state level with the establishment of the Office of National S&T Research Programmes
- To deploy activities of the national S&T development funds for the funding of basic research activities and other scientific activities under the funding model.

The ministry is tasked with enhancing the management capacity of the application and development of technology, S&T information and statistics, and atomic energy and nuclear safety. It deals with the management and supervision of state-level key programmes, scientific and technological valuation, the scientific enterprises and technology market, study of scientific intellectual property, S&T communication, and strengthening of local S&T activities through the formation of newly developed organisations.

As a result, the organisation of the S&T state management apparatus of the Ministry of Science and Technology has been strengthened and described through Decree no. 20/2013/ND-CP dated 26 February 2013 issued by the government defining the functions, tasks, powers and organisational structure of the Ministry of Science and Technology. Under the Ministry of Science and Technology is a government agency, which performs the state management of science and technology including:
- Science and technology activities
- Development of science and technology potential
- Intellectual property;
- Standards, metrology and quality control;
- Atomic energy, radiation and nuclear safety;
- State management of public services in fields under the ministry's management as stipulated by law.

#### 2.4.2 S&T management in other ministries

Ministries with a specific portfolio such as agriculture and agencies under the Government are responsible for the management of science and technology in their respective fields. Most ministries established S&T departments to help perform the state regulatory functions of S&T in their sectors.

Some ministries established a state agency to fulfill the functions of management and to organise the implementation of S&T activities (such as the Ministry of Public Security, Ministry of Defence, and Ministry of Health), while others assigned the S&T management function to an S&T institution (as in the case of the Ministry of Labour, Ministry of the Interior, Ministry of Justice; State Bank; the Government Inspectorate).

There are also a handful of ministries that assigned the state management function of science and technology to another management department (such as an office or a department which is in charge of planning, finance, or other general matters).

Most ministries have established a scientific council to advise ministers and heads of ministerial-level agencies on S&T issues in their fields.

#### 2.4.3 S&T management in localities

At the provincial level, the separate departments of science and technology advise and assist the provincial People's Committee to manage S&T activities in the area.

The Science Councils of provinces and cities directly under the central government are advisory agencies for the state management agencies of the localities (such as the People's Council, People's Committee, the departments, commissions, and further branches)





| Economic sector | Total expenditure | Divided by implementing area | | | | |
|---|---|---|---|---|---|---|
| | | R&D institutes | University | Administrative agency / service unit | Business | NGO |
| State | 4,287,586 | 2,303,436 | 760,596 | 393,646 | 382,960 | 446,949 |
| Non-state | 690,982 | 7,580 | 165 | 0 | 0 | 614,684 |
| With foreign investment | 315,382 | 0 | 0 | 0 | 0 | 315,382 |
| Total | 5,293,950 | 2,311,016 | 760,761 | 393,646 | 382,960 | 1,377,014 |

**Table 3:** Expenditure intensity for R&D by stakeholder (billion VND)

## 3 Support instruments for innovation

### 3.1 Management of science and technology programmes and tasks

Currently there are 14 priority state level S&T programmes approved for 2011–2015 managed by the Ministry of Science and Technology. There are 10 programmes (from KC01 to KC10) in S&T and 4 programmes (KX01 to KX06) in social science and the humanities. The ministry supervises the S&T activities, and deploys various mechanisms for ordering S&T tasks, to meet the criteria of feasibility and socio-economic efficiency and to select the correctly qualified individuals and organisations. The ministry has also supported the registration and establishment of intellectual property rights for the S&T results generated from priority state-level S&T programmes and projects.

The Office of National S&T Research Programmes was recently established under MOST, in order to assist the Minister of the Ministry of Science and Technology in managing programme activities, being responsible for the management and use of expenditure from the state budget allocated for the programmes. The signing of research contracts was made in time for the 240 themes and projects which began in 2011, and the 125 themes and projects implemented in 2012.

From the very beginning of 2012, the Ministry of Science and Technology has supported ministries, sectors and economic groups and localities in planning and budgeting for 2013 with special regard to innovation in Decision no. 1244/QD-TTg, on which the requirements of raising state-level S&T tasks under the ordering mechanism have been focused (the ministries, branches and localities propose S&T tasks, the Ministry of Science and Technology on behalf of the state orders the implementation of S&T tasks).

### 3.2 Funding of research

The state is the biggest funder of research in Vietnam, with the majority of the budget going to government R&D institutes. Non-state actors, as well as foreign funders mainly support NGO research activities.

| | 2002 | 2011 |
|---|---|---|
| Gross Domestic Product (GDP) (billion VND) | 536,098 | 2,535,008 |
| National gross expenditure on R&D (GERD) (billion VND) | 1,142.39 | 5,293.95 |
| Percentage of GERD/GDP | 0.21 % | 0.21 % |

**Table 4:** GDP and R&D expenditure[19]

National gross expenditure on R&D (GERD) in 2011 was VND 5293.95 billion. With that GERD indicator, the expenditure rate of national R&D over gross domestic product (GERD/GDP) is close to 0.21 %. This is a low rate compared to that of developed countries and is one of the reasons for the low ranking of Vietnam's R&D and the higher education system in the Global Innovation Index 2013[20].

19 http://www.gso.gov.vn, General Statistics Office; NASATI; *R&D survey 2002*
20 http://www.globalinnovationindex.org/content.aspx?page=interactive-SW (accessed 4 March 2014)

In national gross expenditure on R&D (GERD) in 2011, the state sector spent VND 4287.58 billion, accounting for 80.99 %; the non-state sector spent 690.98 billion, accounting for 13.05 %; and 315.38 billion came from foreign investment (accounting for 5.96 %).

### 3.3 National programmes and projects in science and technology

In order to implement the national strategy of developing S&T from 2011 to 2020, MOST has established and submitted a number of national programmes and projects on S&T to the government for approval. In recent years, MOST initiated a series of national programmes and projects on developing S&T, such as: a national programme supporting public S&T enterprises and organisations to enhance accountability and administrative processes; a project on enhancing the capacity of the *Centre for Applying S&T Advances,* a project for centres to support technical standards and quality measurement at provincial and city levels; a technical support project to develop the safe and secure application of atomic energy, and a programme on developing S&T markets.

MOST has drafted the framework on finance, human resources, regulations and techniques for the three large, long–term, multi–objective programmes (Programme on Technology Innovation, Programme on Hi–Tech Development and Programme for National Products), so as to be able to synchronously and effectively implement these programmes from 2013 onwards. Two of the three programmes have received joint circulars on financial management. The joint circulars, which define the identification, selection or direct assignment to implement projects under the Programme on Hi-Tech Management and the Programme for National Products, are being rapidly completed for enforcement.

Regarding the Programme for developing national products, MOST has announced a list up to the year 2020 and actively coordinated with other ministries and the industry to complete the necessary procedures to implement projects on manufacturing six official groups of products (high quality and productive rice; ultra and super light facilities, network security products, engines for automobiles, vaccines for human, animals; defence and security products) and three groups of reserve products (mushrooms and medicinal mushrooms; catfish; microchips). In addition, the Prime Minister has approved two national products in need of development in the field of defence and security.

In the following, a selection of these programmes is described in more detail, particularly regarding their objectives.

#### 3.3.1 National Programme for Improving the productivity and product quality of Vietnamese enterprises until 2020

Objectives:
- Establishing and applying the system of Vietnamese standards, technical specifications, management systems, models and tools; developing necessary resources to improve productivity and product quality of enterprises;
- Transforming the productivity and quality of priority products and goods, as well as increasing the competitiveness of enterprises so as to develop the society and economy of Vietnam.

#### 3.3.2 Programme for supporting the application and transfer of S&T advances for social-economic development in rural and mountainous areas from 2011 to 2015

Objectives:
- Transferring and applying technology and advanced techniques in the production, preservation and processing processes of enterprises to improve the productivity, quality and competitiveness of products and agricultural products in domestic and foreign markets, to develop rural S&T markets, to contribute to poverty alleviation, to create jobs and increase income, to improve the livelihood of communities living in rural areas.
- Coordinating and joining other key national programmes, including social-economic programmes to select and apply suitable techniques to gain experience, and lay practical foundations for the dissemination of advanced technology in order to improve the efficiency of investments from the government and the public.
- Training farmers and grassroot officers to improve their professional skills, to support the provinces in searching for, selecting and implementing projects on applying advanced technologies suitable for the social-economic development of the provinces.

| | Decision, date | Name of the programme / project |
|---|---|---|
| 1 | No. 712/QĐ-TTg, 21 May 2010 | Programme for improving the productivity and quality of products made by Vietnamese enterprises until 2020 (see 3.3.1) |
| 2 | No. 144/2006/QĐ-TTg, 20 June 2006 and No. 118/2009/QĐ-TTg, 30 September 2009 | Regulations on applying the quality management system based on Vietnamese standards ISO 90001:2000/2008 into the operation of public administrative agencies |
| 3 | No. 682/QĐ-TTg, 10 May 2011 | Agreement on technical barriers in trade (Project TBT from 2011 to 2015) |
| 4 | No. 1831/QĐ-TTg, 1 October 2010 | Programme for supporting the application and transfer of S&T for the socio-economic development of rural and mountainous areas from 2011 to 2015 (see 3.3.2) |
| 5 | No. 2204/QĐ-TTg, 6 December 2010 | Programme for intellectual property development from 2011 to 2015 |
| 6 | No. 2441/QĐ-TTg, 31 December 2010 | Programme for developing national products until 2020 (see 3.3.3) |
| 7 | No. 2457/QĐ-TTg, 31 December 2010 | Programme for hi-tech development until 2020 |
| 8 | No. 677/QĐ-TTg, 10 May 2011 | Programme for National Technology Innovation until 2020 (see 3.3.4) |
| 9 | No. 735/QĐ-TTg, 22 May 2011 | Project on S&T International Integration |
| 10 | No. 592/QĐ-TTg, 22 May 2012 | Programme on promoting the implementation of autonomous and accountable mechanisms at public S&T enterprises and organisations (see 3.3.5). |

**Table 5:** List of national programmes / projects in science and technology approved by the Prime Minister





#### 3.3.3 Programme for developing national products until 2020

The Programme for developing national products was approved by the Prime Minister at Decision no. 2441/QĐ-TTg dated 31 December 2010. This programme contains the following main points:
- Developing national products based on applying new technology, high technology (referred to as advanced technology) is an important method to transform S&T achievements into commercial products; it is the foundation on which to establish new industries and products containing new features and high-added value; it is an efficient method to improve the development capacity of S&T enterprises and organisations.
- The government issues special policies to develop national products, expand their share in the domestic market and export them to regional and international markets.

The general objective of the programme is to establish and develop Vietnamese trademarked products, goods that are new, of a high standard, and competitive based on the exploitation of comparative advantages in human resources, natural resources and the natural conditions of Vietnam; to promote technology transfer, to master and apply technology into key economic-technical industries, and to improve the capacity of enterprises to innovate technology and develop national technology potentials.

National products are products with the following features: products from priority development sectors of the government, produced and made from the results of scientfic research and technological development based on new technology principles and design ideas; dramatically improving the productivity or function of the products. The general requirements of national products include:
- Products that are made from the results of scientific research and advanced technological development, are competitive, protected by intellectual property rights and play important roles in key economic-technological industries of Vietnam.
- Products that are produced on a large-scale, include high added value, and either partly substitute for imports or bring high export value.
- Products that bring into play the advantages of the human resources, natural resources and conditions of Vietnam, attract huge demand, play an important role in the development of society and contribute to the establishment of key economic-technical industries of Vietnam.

#### 3.3.4 Programme for National Technology Innovation until 2020

The Programme for National Technology Innovation until 2020 was specified in Decision no. 677/QĐ-TTg dated 10 May 2011 by the Prime Minister.
Objectives until 2015:
- The number of enterprises implementing technology innovation will increase 10 %/year on average.
- 100 % of the enterprises manufacturing flagship products, key products and national products master advanced manufacturing technologies.
- 30,000 engineers, technicians and managers of small and medium enterprises are trained in technology management, and new technology updates.
- Establishing at least one sustainable agricultural production model that applies advanced technology in each ecological area.

Objectives until 2020:
- The number of enterprises implementing technology innovation increases by 15 %/year on average, including 5 % hi-tech applied enterprises.
- 100 % of the enterprises manufacturing flagship products, key products and national products master and establish advanced manufacturing technologies.
- 80,000 engineers, technicians and managers of small and medium enterprises are trained in technology management and update.
- Establishing research groups that apply and develop suitable technologies for each area, setting up sustainable agricultural production models applying advanced technologies at each ecological area.

#### 3.3.5 Programme for supporting public S&T enterprises and organisations in implementing autonomous and accountable mechanisms:

The Programme for supporting public S&T enterprises and organisations in implementing autonomous and accountable mechanisms was approved by the Prime Minister through Decision no. 592/QĐ-TTg dated 22 May 2012. The main contents of the programme are:
- The government establishes mechanisms and policies to encourage the establishment and development of S&T enterprises, to mobilise social resources

to develop S&T enterprises; to create favourable conditions to apply the results of science research and technology development to production, business processes, to promote the commercialisation of products and goods that are the results of S&T activities, to develop the S&T market, to contribute to the socio-economic development of Vietnam.
- Promoting and supporting the arrangement and transformation of public S&T organisations toward autonomous and accountable mechanisms in accordance with the law in order to increase responsibility and improve the cost-effectiveness, activity, and creativity of S&T organisations, improving the operating efficiency of S&T organisations, contributing to the improvement of Vietnamese S&T potentials.

Objectives:
- Supporting the establishment and development of 3,000 S&T enterprises; establishing 100 units and focal points for incubating technology, and S&T enterprises at institutes, and universities.
- Supporting 1,000 individuals, organisations, enterprises, and strong research groups that are the results of technology incubation units, S&T enterprises units and focal points; organising training programmes, and courses for 5,000 individuals in establishing S&T enterprises and related objectives.
- Supporting public S&T organisations that have not implemented the autonomous and accountable mechanism in completing the transformation before 31 December 2013.

### 3.4 National Foundation for Science and Technology Development (NAFOSTED)

The Vietnam National Foundation for Science and Technology Development (NAFOSTED) is a scientific organisation founded in 2008 to fulfil following missions:
- Carrying out investigator-initiated research projects in all fields of science and humanities through competition
- Awarding fellowships to young researchers, postdoctoral students, and PhD students to study or undertake research abroad
- Undertaking research cooperation nationally and internationally
- Providing scientific contacts (for travel and conferences)
- Being a knowledge communication centre (publication of monographs and scientific papers, technology transfers)

In 2012, the number of applications for basic research grants was increased in comparison to the previous years, including 387 applications in the field of natural sciences, and 141 applications in the field of social sciences and humanities. The post-acceptance reviews of 165 basic research projects in the field of natural science in 2012 showed that most projects had achieved their targets (90 % of these projects). Extensions were granted to others by the science council based on the success of the project. The total number of scientific publications, which were considered by the Science Council to be the research results of projects funded by NAFOSTED, was 692 articles (4.4 articles/project). NAFOSTED has reviewed the cost and signed contracts for projects funded from 2012 in the field of social sciences and the humanities. According to the review of the science council, the ongoing projects are well on track and are of the required quality in the project abstracts.

Apart from funding scientific research projects, NAFOSTED continues to develop its grant schemes and programmes. In 2012, NAFOSTED started to implement the credit granting scheme by offering loans to those implementing S&T projects, and managed the Credit Grantee Institution supported by the Global Environment Fund in order to support grants for projects on economical and efficient energy use in small and medium enterprises. Since September 2012, NAFOSTED has developed its grant scheme by receiving applications for R&D projects for grants in 2013 according to Decree no. 119/1999/NĐ-CP dated 18 September 1999 by the government, on promoting scientific research and technology development in enterprises.

The results of the organisational assessment indicate that basic research projects funded by NAFOSTED gain good results and approach international standards. Statistics show that the number of applications increases sustainably and the quality of the applications is better synchronised. The statistics also reflects the increase in the number of scientists participating in basic research, particularly from southern organisations (from 5 % in 2009 to more than 20 % in 2012). The number of young scientists who are managers of projects funded by NAFOSTED is increasing significantly, accounting for more than 60 % of the total managers under 40 years old (in comparison with only 5 % in 2009). NAFOSTED also publicises its grant activities through information dissemination (on grant programmes, portfolio profiles of funded projects and the results of assessing S&T project outcomes).

In 2012, NAFOSTED aimed to improve its operation through planning, processing and computerising its management and administration process. NAFOSTED also continues to expand its granting schemes based on its assigned functions and missions as well as to attract more grants from extra-budgetary resources, increasing social investment and international support for the development of S&T. NAFOSTED has expanded its funding scheme through providing loans to S&T projects, and implementing a programme for promoting scientific research and technological development in enterprises. Apart from the state budget, NAFOSTED has achieved initial results in attracting grants from extra-budgetary resources, diversifying the investment funds for S&T activities.





### 3.5 Specific initiatives to foster innovation in Vietnam

#### 3.5.1 Supporting enterprises in technology application, innovation and development of the S&T market

Since 2002, under Decree no. 119/ND-CP dated 18 September 1999 by the government, on supporting enterprises in the research and innovation of technologies, enterprises in all economic sectors have been reviewed and were considered and selected for support for scientific research and technological innovation funds from the state budget with the following criteria:
- Research to create new products, new technologies in the priority areas of the state.
- Enterprises have to invest 70 % of funds to implement the topics. Expenditure by the state does not exceed 30 % of total project expenditure.
- 70 % of the price of the state-owned technology transfer, which is formed from the research results of themes using the budget, and 50 % additional profit in three years by applying new technologies, will be awarded for those who have created additional profit.

S&T application and technological innovation with the financial support of S&T tasks

These are enterprises which have invested in S&T applications and technological innovation with financial support from the state budget through S&T tasks: programmes at state-level, KC programmes, KT programmes, priority programmes, and others at ministerial and equivalent level. The current number of businesses supported by this measure is 253, with a total investment expenditure of VND 7,652,738 billion. On average, investment in the S&T application and technological innovation of each unit is VND 3 billion per year.

Application and innovation of S&T in the form of technology transfer linking research institutions, universities and enterprises

| | Forms of technological innovation | Number of enterprises | Rate (%) |
|---|---|---|---|
| 1 | To innovate lines, equipment and technology of manufacturing | 1,120 | 74.6 |
| 2 | To innovative technology through S&T research tasks | 253 | 16.8 |
| 3 | Enterprises master technology through affiliated institutes, universities, local technology transfer | 117 | 8.6 |
| | **Total** | **1,500** | **100** |

**Table 6:** The rate of S&T application and technological innovation

Current statistics: 117 enterprises have received technology transfers from the research institutions, universities or from other local enterprises. The total investment cost for this measure is VND 1,618,406 billion. On average, the investment cost for S&T applications and the technological innovation of enterprises is VND 4.5 billion per year.

#### 3.5.2 Technology and Innovation Fund

A new national Technology and Innovation Fund was approved in 2011 by the Prime Minister. The Technology Transfer Law states that the Technology and Innovation Fund is a national, financial non-profit institution under MOST. Its financial solvency is ensured by the state budget, with a charter capital of one trillion VND for the first three years. Support may be provided in the form of a loan, interest rate subsidy, guarantee, or grant. At least 50 % of the fund is for full grants. The fund may also be replenished with funding from the private sector, financial and credit institutions (including donors), bond issuance, and voluntary contributions. All actors supporting technology transfer are eligible to apply. The fund can support six types of projects: (a) technology transfer for SMEs; (b) technology transfer for national product programmes; (c) new technologies / high-tech R&D for SMEs; (d) incubators and entrepreneurship; (e) development, transfer and dissemination of technology to agriculture, forestry and fisheries in rural areas; and (f) training and capacity-building.

Details of the institutional aspects (such as hosting by existing or new agencies, and governance arrangements), overall procedures, size of grants and sub-projects, and the priority areas (other than the six project types) are currently undefined. The design of the fund must take account of the law and its stipulations, a review of international practices and examples, and the experience arising from the fund pilot. The temporary institutional arrangements under the fund pilot will be integrated into the final design of the fund agency (either the integrating pilot institution or handing over duties of the pilot institution).

### 3.6 Preferential tax schemes for S&T enterprises

The "2013 Asia-Pacific R&D incentives" report by Ernst & Young lists two main incentives for business in Vietnam:
- *"A tax exemption or reduced tax rate incentive is available for companies deriving income from performing R&D, the sale of products during test production, and products made from new technology.*
- *An import duty exemption is also available on qualifying R&D investment projects and goods imported for direct use for R&D."*

As regards income tax preferences for enterprises, the procedures to benefit from this are rather complicated; there are no clear guidelines on tax preferences for S&T enterprises in the current legal documents. Consequently many national tax agencies have not enforced this policy. Among the more than forty S&T enterprises, the number of enterprises that benefited from the tax preference is small, because many of them are facing procedural difficulties, not meeting the requirements (particularly the revenue rate requirement) or are not producing taxed income. In addition, some enterprises have already received preferences for particular S&T fields (such as information technology and biotechnology) with similar preferential levels and simpler procedures. As there is no mechanism to recognise S&T products made by the enterprises through private R&D investments, it's difficult for S&T enterprises to benefit from the tax preferences and preferential policies in order to develop their S&T achievements.

Apart from policies on exempting and reducing income tax for enterprises, many preferential policies haven't reached S&T enterprises, such those as policies on transferring state-budgeted research results to enterprises, on using research equipment in key national laboratories, or the land use preferential mechanism. As there is no official implementation guideline, these preferential policies are difficult to apply in reality.

### 3.7 Intellectual property

Patent filings in Vietnam, as recorded in the World Intellectual Property Organisation (WIPO) database, include around 300 annual filings by Vietnamese residents and around ten times this number for non-Vietnamese residents. The number of patents filed by Vietnamese residents abroad was 42 in 2012, which is rather low in comparison to other countries (rank 84). Most patents were filed in the field of the technology category "Engines, pumps, turbines", and "Textile and paper machines". In 2012 there were 11,524 patents in force[21].

The vast majority of patent applications are submitted by foreign enterprises, with the domestic sector not being very active in patenting.

A significant increase in the number of patents occurred in the field of trademark applications, as can be seen in figure 3.

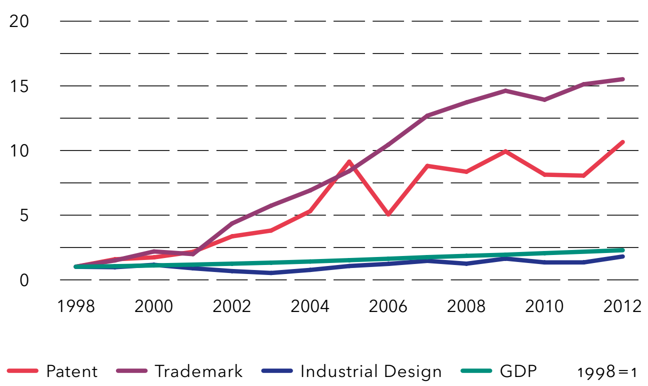


**Figure 3:** IP filings and economic growth. Source: WIPO statistics database

The legislative framework for IP protection in Vietnam is rather comprehensive. Even before the accession of the country to the World Trade Organisation (WTO) in 2007, Vietnam issued several laws and regulations to strengthen IP protection. However, the enforcement mechanisms for this legal framework have to be strengthened with an increase in fines and awareness raising of counterfeits among the populace. The administrative enforcement bodies dealing with patent infringements cases have a considerable backlog, and some trade counsellors advise taking civil action instead of administrative measures. However, as well as using the official channels it can be more effective to use private mediation through legal professionals.

Product piracy and counterfeiting is widespread in Vietnam, with an estimate of 90 % of all software used in Vietnam being pirated in 2011, compared with an average of 55 % in the Asia Pacific region as a whole.[22]

In addition to the WTO, Vietnam is member of the following international conventions regulating IP matters: the Madrid Agreement (Trademarks), Paris Convention (Protection of IP), Rome Convention (Protection of Performers, Broadcasting), the Patent Cooperation Treaty, the International Convention for the Protection of New Varieties of Plants, Agreement on Trade-Related Aspects of IP and the Berne Convention (Protection of Arts).

## 4 International cooperation

In recent years Vietnam has become an important stakeholder within the region, actively participating in the Association of Southeast Asian Nations (ASEAN). Together with the Philippines, Vietnam is leading the programme on climate change, one of the six priority programmes of the Krabi Initiative built upon the 2007–2011 ASEAN Plan of Action on Science and Technology (APAST).

On a global level Vietnam is increasingly active in multilateral organisations, such as through their accession to the World Trade Organisation (WTO) in 2007. In formulating its own S&T strategies, Vietnam is cooperating with other organisations and countries. For example, in 2002–2004 the Department for International Relations of the Ministry of S&T asked the Canadian IDRC to provide support for the initiative to design a strategy for developing international cooperation and integration in science and technology (ICST). This was preceded by another study in 2000–2001, under a UNIDO/UNDP project, for the formulation of a science, technology and industry strategy for Vietnam, as one component of the overall development strategy 2010–2015.

Vietnam participated actively in the OECD regional innovation study that was published in 2013. As one outcome the OECD is currently preparing a national innovation system review for Vietnam, to be published in 2014.

21 http://www.wipo.int/ipstats/en/statistics/country_profile/countries/vn.html (accessed 27 February 2014)

22 *ASEAN IPR SME Helpdesk – IP Country Factsheet: Vietnam,* European Commission, 2013





Vietnam is one of the largest Asian Development Fund recipients. The projected ADF allocation for 2013–2014 is US$ 732 million. However, due to weak project management, recruitment problems, and legal issues such as contract management, the full amount of a budget can often not be claimed. As a result of its lower middle-income country status, Vietnam's ODA profile is about to change. Some donors will phase out their traditional ODA or shift to concessional loans, which puts quite some strain on the economy. The effects on scientific institutions will not be pronounced, as most research is financed by the state.

Publications, as can be seen from the SCOPUS database, have increased from 368 in 2002 to 2,720 in 2012, and Vietnam's share in the region's publication output has also risen during this period (from 0.16 to 0.37 %), and also with regard to world publication output (from 0.03 to 0.12 %).

Regarding the output of cooperative research in the work of Vietnamese scientists, the percentage of co-publications is around 70 % of all publications. This number of international co-publications is quite high and has also been stable for the past twenty years. Recent data from the Scopus database indicates Agricultural and Biological Sciences, Mathematics, Engineering, Physics and Astronomy and Biochemistry, Genetics and Molecular Biology as the most important fields in Vietnam-based research output in general.[23]

Currently there are two significant international cooperation programmes in existence: the IPP (with Finland), and FIRST (with the World Bank).

#### Innovation Partnership Programme (IPP)

IPP is short for the Innovation Partnership Programme (IPP), which aims to strengthen the National Innovation System (NIS) of Vietnam. IPP is financed jointly by the governments of Vietnam and Finland. IPP is an Official Development Assistance (ODA) programme.

The first phase of IPP was implemented in 2009–2013. It worked with enterprises, public authorities and knowledge producers such as universities and research institutions in order to increase innovation activities in Vietnam. Partnerships between Vietnamese and Finnish institutions were also encouraged. The tools used included strategy work, capacity and capability building, knowledge brokerage, promoting and financing the use of experts and partnership building.

Vietnam plans to be a modern, middle-income and industrialised country by 2020. In order to reach the target, the rapid development of science and technology is needed. The government of Vietnam wants to strengthen the National Innovation System, especially with regard to S&T, in order to encourage enterprises to be more competitive. Vietnam has asked the government of Finland to join forces and to give support to the innovation promotion.

The IPP is intended most of all for enterprises (SMEs but also bigger enterprises), who are the main actors in keeping a competitive edge with the help of innovations. IPP is also intended for those authorities who promote S&T and innovations, because they have to learn to support good ideas. IPP is also intended for knowledge producers such as universities and research institutions, who have to learn how to work with innovation processes. Individuals can also learn to use their creativity to process innovations and to take them successfully to the competitive market. Finnish partners, such as enterprises, public sector actors and universities, obtain contacts to their Vietnamese counterparts and can build business and cooperation in Vietnam.

IPP1 was considered successful and achieved its set targets. Out of a total 60 sub-projects carried out in the programme, 29 (49 %) produced good outcomes; 20 sub-projects (34 %) were considered satisfactory and 10 sub-projects (17 %) were seen as problematic. Following the successful implementation of IPP1, the country's agreement to the second phase of the programme between Vietnam and Finland, IPP Phase 2, was signed in March 2014.

#### Fostering Innovation through Research, Science and Technology (FIRST)

The Fostering Innovation through Research, Science and Technology (FIRST) project is the biggest project in science, technology and innovation funded by an international donor in Vietnam. Recognising STI as a key factor for socio-economic development of Vietnam, the World Bank decided to provide the country with ODA to help foster STI activities in Vietnam.

The project focusses on two main priority areas: (i) improving the national policy framework for S&T (systemic intervention); and (ii) supporting specific reforms planned by the government, all with the objective of improving technology development and innovation. On this basis, and taking into account added value and feasibility, three main components of the project, beyond the component of project management, have emerged: (i) supporting a stronger national policy framework for S&T; (ii) supporting government research institute (GRI) reform; and (iii) building stronger linkages between supply and demand. It is expected that these components will address the critical challenges related to poor institutional and financing incentives, human capacity and information for S&T in Vietnam.

The first component aims to improve technology development and innovation by supporting a stronger policy framework for the Vietnamese National Innovation System through stronger institutional and finance incentives, and information and human resource capacity for effective and efficient S&T delivery. The component is composed of four sub-components: (A) institutional

23 http://www.scimagojr.com/countrysearch.php?country=VN&area=0 (accessed 3 March 2014)

incentives for GRI conversion; (B) new financing mechanisms for S&T; (C) monitoring and evaluation and S&T statistics, and (D) human resources for S&T.

The second component aims to improve technological development and innovation by supporting higher GRI effectiveness through the transition to autonomous status. Overall, some 292 applied research GRIs will make the transition to autonomy (Decree 115) by 2013 (with 144 at a more advanced stage). Approximately 100 GRIs have been selected to become scientific enterprises (Decree 80) by the same date. There are multiple challenges in implementing this reform. This component will support the transition via a three-fold strategy: support for a group of high potential GRIs in priority subsectors with needs for additional financial and technical assistance (Group 1); technical support for a broader set of "viable" GRIs with potential for strong links with the private sector (Group 2); and the "closure" of low potential and non-viable GRIs (Group 3). The first two groups are supported through two separate sub-components (further discussion is needed on how the third group will be dealt with).

This third component aims to improve technology development and innovation by further strengthening links between R&D institutions and firms through financial and institutional measures. Adopting a practical but also forward-looking approach, these measures fall into three categories: (i) financing mechanisms; (ii) incubators, and (iii) science parks. Each of these categories represents a separate sub-component described below.

The total budget of the FIRST project is estimated at US$ 110 million, including US$ 100 million from an ODA loan and US$ 10 million from the Vietnamese government. The project has been in effect from October 2013 and will be implemented over a period of 4 years.

#### Bilateral cooperation

One example of bilateral cooperation is the Vietnam-Belgium programme. All projects in Phase I (2009–2012) of the grant programme were completed with good results. Following the success of Phase I, NAFOSTED and the Flanders Foundation (FWO, Belgium) have signed the Memorandum of Bilateral Cooperation for Phase II (2012–2016). NAFOSTED also continues to implement joint activities with its former partners, establishes new relationships to develop the fund resources for Vietnamese scientists, and to improve the capacity of NAFOSTED.

## 5 Key strengths and weaknesses[24]

Currently there is continued economic growth in Vietnam, and with a young population and a diaspora that retains its links to the country there is good potential for further development. In recent years poverty has been significantly reduced, even though there is a widening gap in development between urban areas and minority areas in the rural sphere. With increased industrialisation, and also as a result of past wars in the country, there are significant pressures on the environment, which is one reason why the country is putting an emphasis on international cooperation, such as the Mekong regional cooperation. Environmental issues are of great importance for the tourism industry, a sector that has increased in the recent past, as well as with regard to the biodiversity potential of the country.

In the past, the agricultural sector and the possibility of using FDI to create cheaply manufactured products have greatly contributed to the country's growth, but with Vietnam now a middle-income country there is also a need to raise low productivity levels in other sectors. There are low levels of R&D in the enterprise sector, and few medium-to high-tech exports coming from the country. Developing a better-educated workforce and strengthening its technology and innovation system will be critical for this.

There are deep structural challenges within the country that need to be addressed in the near future: the dependence of the country on state-owned enterprises that are rather inefficient because of their structural rigidity, and a banking system that is dependent to a large extent on big state-owned banks. The restructuring of state-owned enterprises has been hindered by the elaborate national regulatory framework and by weak financial and operational analytical evidence as a basis for the planned divestures. Progress in these areas is, however, especially important, as due to its open economy, Vietnam is becoming more and more vulnerable to external economic and financial uncertainties, which in the worst case may stop Vietnam's development.

In comparison to other Southeast Asian countries, Vietnam has the benefit of a stable political environment that allows for targeted and strategic planning. This also facilitates cooperation with international donors and partners. However, a central weakness of planning has been the sparse inclusion of all stakeholders to the process, the reports having been made by a small group of officials assigned to the task. In recent years this has changed, but future plans would benefit to a great extent from the inclusion of other viewpoints, especially from the business stakeholder group. There is also a

**24** The interpretations and analyses in this section and the entire chapter represent the authors' views on the basis of our research and the interviews conducted. They do not represent any institutional perspective and cannot include all potential views.





significant lack of coordination between the different ministries in formulating the strategic action plans.

Vietnam has a rather weak innovation infrastructure, and the higher education system, as well as the research community, could benefit from a stronger political focus and enforcement of reforms. Funding organisations within the country often have no unique mandate that differentiates them from each other. This stems in part from historical reasons, but it is important for the workings of the entire system that the funding landscape be further streamlined.

There are heavy bureaucratic hurdles within the country, with a need to further focus on administrative and legal reforms, especially with regard to their concrete implementation. Corruption is still a major problem for development in the country, but the government seems to be dedicated to tackling this issue.

The scientific community has to dedicate a significant share of their working time to reporting, either on the progress and eventual success of research projects, or on monitoring and evaluating these reports.

Generally it can be stated that Vietnam is on a good basis to further develop its economy, if the country can accept the challenge of strengthening its innovation system. A greater emphasis on higher education, as well as on research and development, will open possibilities for the country to reach the advanced and modern level of ASEAN region and that of the world by 2020.

## 6 Appendices

### Appendix I: Institutions visited

*National Agency for Technology Entrepreneurship and Commercialization Development*

*National Foundation for Science and Technology Development (NAFOSTED)*

*National Office of Intellectual Property of Vietnam (NOIP)*

*State Agency for Technology Innovation (SATI)*

*Vietnam Chamber of Commerce and Industry (VCCI)*

*Hoa Lac Hi-Tech Park*

*Vietnam Academy of Science and Technology (VAST)*

*National Institute for Science and Technology Policy and Strategy Studies (NISTPASS)*

*National Agency for Science and Technology Information (NASATI)*

### Appendix II: References

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With this study, the **SEA-EU-NET** project presents an analysis of the variety of innovation support policies, programmes and instruments available in selected Southeast Asian countries. The report first offers a regional overview and then covers *Indonesia, Malaysia, the Philippines, Singapore, Thailand,* and *Vietnam* individually.

Public programmes and indirect public support schemes are explored. In addition, venture capital availability, intellectual property rights systems, and innovation-related international cooperation patterns are discussed.

The study aims at sharing information about innovation policy in Southeast Asia and supporting cooperation and joint innovation policy-making between the region and Europe. It can facilitate policy and programme makers' work by providing a state-of-the-art overview of innovation support systems in the region. Finally, it can also assist innovation performers from the public and private sectors in identifying available support for their research and commercialisation endeavours.

This report will be followed up and accompanied by a related study on innovation framework conditions (regarding intellectual property rights, material transfer agreements, and public procurement for innovation) to be published in autumn of 2014.

ISBN 978-3-200-03710-6