PART ONE

REPORT ON THE CONSULTATIVE WORKSHOP ON THE PROMOTION OF NATIONAL INNOVATION SYSTEMS IN COUNTRIES WITH SPECIAL NEEDS OF THE ASIA-PACIFIC REGION

I ORGANIZATION OF THE WORKSHOP

A. Objective

A specific objective of the second phase of the "Promotion of National Innovation System (NIS) in Countries of the Asia-Pacific Region" project being implemented by the Asian and Pacific Centre for Transfer of Technology of the Economic and Social Commission for Asia and the Pacific (APCTT-ESCAP) is to enhance awareness and promote NIS in selected Countries with Special Needs (CSNs)[1] of the Asia-Pacific region. With this objective, a workshop was organized by APCTT-ESCAP in co-operation with the Ministry of Science and Technology (MOST), Government of Thailand, at Bangkok, Thailand, on 19 and 20 October 2010. The "Consultative Workshop on the Promotion of National Innovation Systems in Countries with Special Needs of the Asia-Pacific Region" was supported by the Department of Scientific and Industrial Research (DSIR) under the Ministry of Science and Technology, Government of India.

Besides the promotion of NIS and its organic linkages with sub-national and sectoral innovation systems among CSNs, this workshop was aimed at: (a) reviewing the current status of science and technology (S&T) infrastructure in participating least developed countries (LDCs); (b) examining current S&T policies that have been adopted by participating LDCs and assessing the extent of their contribution to the development of NIS; (c) sharing regional best practices of NIS; and (d) evolving possible policy prescriptions and institutional support mechanisms relevant to LDCs to promote innovation and techno-entrepreneurship.

B. Attendance

Senior policymakers from five APCTT-ESCAP member countries – Bangladesh, Bhutan, Lao People's Democratic Republic, Myanmar and Nepal – participated in the workshop. Afghanistan could not attend.

The following experts served the workshop as resource persons: Ms. Wang Yan, Director, Regulations and Intellectual Property Rights (IPR) Division, Department of Policy and Regulations, Office of Innovation System Construction, Ministry of Science and Technology, China; Mr. Shyamal Kumar Chakraborty, Scientist F, Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, India; and Mr. Jeong Hyop Lee, Director, Division of Research Planning and Administration, Science and Technology Policy Institute (STEPI), Republic of Korea. The workshop was also attended by 10 senior officials from Thailand's government departments and national agencies as resource speakers, and 26 other invitees from government offices, S&T institutions, non-governmental associations, trade associations and private sector in Thailand.

The list of participants is attached as Annex I.

[1] Countries with Special Needs (CSNs) are least developed countries, landlocked developing countries and small island developing states that face problems such as extreme poverty, limited human resources, an economy vulnerable to exogenous changes and remote geographical location.

C. Election of officers

The following experts were elected to chair each session and to serve as moderators:

Moderator, Session I – Introduction to National Innovation Systems (NIS) – Mr. K. Ramanathan (Head, APCTT-ESCAP).

Moderator, Session II – The NIS Experience in Selected Countries of the Asia-Pacific Region – Maj. Gen. Chainarong Cherdchu (Deputy Director General, National Institute of Metrology, Thailand).

Moderator, Session III – Country Presentations on S&T Infrastructure and National Innovation Policies: the CSN Experience – Mr. Jeong Hyop Lee (Director, Division of Research Planning & Administration, STEPI, Republic of Korea).

Moderator, Session IV – National Innovation System Policies and S&T Infrastructure in Thailand – Mr. Sonthi Vanasaeng (Director of Foreign Relation, Office of the Permanent Secretary, MOST, Thailand).

Moderator, Session V – Public-Private Partnership for Promotion of Technology and Innovation in Thailand – Mr. Edward Rubesch (Technology Licensing Office, Technology Management Centre, National Science and Technology Development Agency, Thailand).

D. Programme

The workshop proceeded as per the programme attached as Annex II.

II OPENING OF THE WORKSHOP

The workshop was inaugurated by Prof. Weerapong Pairsuwan, Deputy Permanent Secretary, MOST, Royal Thai Government. This was followed by the welcome address by Mr. K. Ramanathan, Head, APCTT-ESCAP, and an opening statement by Mr. Marc Proksch, Chief, Private Sector & Development, Trade and Investment Division, ESCAP. Prof. Weerapong Pairsuwan then delivered his opening address, which was followed by a vote of thanks by Maj. Gen. Chainarong Cherdchu, Deputy Director General, National Institute of Metrology, Ministry of Science and Technology, Royal Thai Government.

A. Welcome address

In his welcome address, Mr. K. Ramanathan, Head, APCTT-ESCAP, expressed his delight in welcoming the distinguished gathering to the Consultative Workshop. Explaining the rationale and background of the workshop, he said the event was being organized under the continuing work programme of APCTT-ESCAP on Promotion of National Innovation System, which has entered its second phase. During the first phase of the project, more than 1,150 participants from various ministries, industries, academia, and research and development institutes were trained in the concept of a policy framework for NIS and its linkages with the sectoral and sub-national innovation systems.

Mr. Ramanathan said one of the specific objectives of the programme in its current phase is to continue with awareness creation about NIS in the Asia-Pacific region, particularly among CSNs. Recognizing the unique needs of these CSNs and current global trends, emphasis would be on strengthening of S&T infrastructure and encouraging adoption of green growth as a strategy to leverage their natural resources, he said.

Mr. Ramanathan hoped that the workshop would enable CSN delegates to exchange views and seek expert inputs from the resource persons, and that more follow-up work would be carried out in CSNs participating in the workshop. He expressed his deep appreciation to Dr. Noeleen Heyzer, Under-Secretary-General of the United Nations and Executive Secretary of ESCAP for her strong support and guidance to APCTT's programme of work. He also thanked the Ministry of Science and Technology of Thailand for its invaluable support in organizing the workshop, Prof. Weerapong Pairsuwan and Mr. Proksch for participating in the inauguration, and Mr. Syed Nuruzzaman, Chief of the Special Unit on Countries with Special Needs of the Macroeconomic Policy and Development Division of ESCAP, and his team for providing guidance in organizing the workshop.

B. Opening statement

Delivering the opening statement, Mr. Marc Proksch, Chief, Private Sector & Development, Trade and Investment Division, ESCAP, said that in the present-day world a country's sustained competitiveness is defined by its ability to continuously improve and redesign its products and services to meet changing consumer demands and be a leader in the development of new and practical technologies. Innovation is the key word in this regard, and countries with the highest innovation rate are typically also the most wealthy and developed countries. To boost the capacities of countries to foster innovation, NIS needs to be established or strengthened, he said.

Pointing out that NIS links various stakeholders to foster innovation widely through S&T development at the national level, Mr. Proksch said that the NIS approach stresses on people, knowledge and resources – the main elements of interaction in any innovative process. He cited several examples to support the point that innovation is the result of a complex set of relationships and linkages among NIS actors such as enterprises, research institutes, universities and governments and financial institutions. The private sector is a key driver in NIS and high levels of technical collaboration, technology diffusion and personnel mobility contribute to the improved innovative capacity of enterprises in terms of products, patents and productivity, he said.

Many developing countries in the region, in particular CSNs, face problems in mobilizing and utilizing resources fully to realize innovations due to the lack of an effective NIS and an innovation-oriented private sector. The present workshop is timely and important to address the gap in those countries, he said. A better understanding of NIS can help policy-makers identify leverage points for enhancing innovative performance and overall competitiveness. It can assist in pinpointing mismatches within the system, both among institutions and in relation to government policies, which can thwart technology development and innovation. Mr. Proksch enumerated several factors affecting the successful development of NIS.

Highlighting ESCAP's strong support to APCTT in the promotion of NIS and similar initiatives, Mr. Proksch invited the delegates' active participation and inputs to ensure that the workshop produces realistic and well-prioritized recommendations to enhance the capacity of all the participating countries.

C. Opening address

In his opening address, Prof. Weerapong Pairsuwan, Deputy Permanent Secretary, MOST, Royal Thai Government, briefed the gathering on the efforts of MOST in improving and developing science, technology and innovation (STI) in Thailand, through its 15 organizations. He said the vision of MOST is to become the key agency in developing STI for enhancing a knowledge-based society, supporting higher incomes and better quality of life, and building capacities for sustainable competition. He identified the four missions that MOST has adopted to realize that vision: research & development (R&D); technology transfer; human resource development; and infrastructure development.

Prof. Weerapong Pairsuwan said STI could help solve the challenges thrown up by climate change, resources utilization, energy crisis, and environment and waste-associated issues. Focusing on innovations in strategic sectors such as biotechnology, nanotechnology, new materials, information and communication technologies (ICT), etc. could offer solutions to issues related to competition, globalization and regionalization. He said science, technology and innovation are the most needed tools to enhance skill-intensive, technology-intensive and R&D-intensive products and services in Thailand.

Public-private partnership (PPP) is one mechanism to develop STI, Prof. Weerapong Pairsuwan said. Under PPP, MOST supports licensing, contract research, joint research, joint investment and networking clusters. He listed some of the notable achievements under PPP for the promotion of technology and innovation in Thailand.

STI activities in all organizations under MOST are oriented towards energy, food and agriculture, railways and high-value added industries, Prof. Weerapong Pairsuwan said. Projects and activities are in line with physical infrastructure support, to help increase private R&D investments, private innovation districts, community science parks, etc. Other outputs from STI development are increasing number of patents and publications, higher employment for S&T personnel and knowledge workers, and more R&D centres. Improved technology and innovation capabilities also drive quality of education, industrial creativity and higher productivity, with positive impacts on gross domestic product (GDP) growth, employment, wealth distribution, per capita income, and green and sustainable living.

D. Vote of thanks

Maj. Gen. Chainarong Cherdchu, on behalf of MOST, Royal Thai Government, expressed thanks to APCTT-ESCAP and its team for organizing the workshop in co-operation with MOST, and the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, India, for its budgetary support and cooperation. He also thanked Mr. Marc Proksch, Mr. K. Ramanathan and Prof. Weerapong Pairsuwan for

their addresses to the gathering. After expressing gratitude to Mrs. Nitaya Patanarat, Director, Office of Technology Promotion and Transfer, MOST, for her guidance on the organization of the workshop, Maj. Gen. Chainarong concluded the inaugural session by greeting and thanking the delegates and resource persons.

III CONSIDERATION OF ISSUES

A. Background

The concept of innovation – transformation of ideas into products or services – is gathering greater attention throughout the world, especially in the Asia-Pacific region among the policymakers and small and medium enterprises (SMEs). There has been wider recognition that innovation enables countries to successfully participate in and benefit from the process of globalization (market, technology, economy, etc.) and the emerging era of knowledge-based economy. National systems that facilitate, nurture and promote innovation also contribute to sustainable economic growth and entrepreneurship. Asia-Pacific countries are at various stages of conceptualization, development and deployment of NIS, with most of the member countries facing certain difficulties to appreciate, develop and adopt NIS.

During 2005-2007, APCTT-ESCAP had implemented a project on the "Promotion of National Innovation System in Countries of the Asia-Pacific Region". The first phase of this project had the overall objective to impress upon policymakers from selected ESCAP member countries the importance of the concept, design and implementation of an NIS to facilitate, nurture and promote innovation. At the national workshops, participants were introduced to the key components of a normative NIS policy framework and presented with various approaches to the development and implementation of an NIS. They were also familiarized with good practices on how to develop an effective NIS policy framework. At each national workshop, group discussions were organized to identify generic and country-specific components for strengthening the development and management of an optimal NIS in the host developing country.

The project is currently in its second phase, and one of the specific objectives of this phase is to organize awareness creation activities and promote NIS in selected CSNs of the Asia-Pacific region. The programme of work is, as in the first phase, aimed at policymakers. In view of the unique needs of these CSNs and in line with current global trends, emphasis is on strengthening of S&T infrastructure and encouraging adoption of green, sustainable growth as a strategy to leverage natural resources.

This "Consultative Workshop on the Promotion of National Innovation Systems in Countries with Special Needs of the Asia-Pacific Region" is the first such workshop under the second phase.

B. Session I: Introduction to National Innovation Systems

Mr. K. Ramanathan (Head, APCTT-ESCAP) set the context of the workshop through his keynote address in the first session, by explaining the concept and role of NIS in national development. He cited a simple definition for NIS developed by United Nations

ESCAP – “A nation’s institutions and policies governing or inducing the innovative activity of research, invention, development and adoption of new technologies.” He, however, reminded the gathering that there is no “single best” NIS model that a country can imitate because NIS has to be in tune with national characteristics and it keeps evolving in response to global changes.

The basic objective of an NIS is to stimulate the use of technology to enhance competitiveness and for sustainable development, Mr. Ramanathan said. In conceptualizing an NIS, it would be useful to start at the firm level because companies compete on the basis of customer value creation. Customer value can be seen as a function of the core value determinants of performance, delivery, flexibility and convenience measured against cost. He explained each of these parameters in detail, and said that technology is used to achieve maximization of performance, delivery, flexibility and convenience, and minimization of cost. A competitive environment is key to create customer value through technological innovations and therefore, a government needs to adopt policies that will stimulate market competition.

Enterprises are at the core of NIS as the productive entities that use technological capabilities to create customer value and thereby, add value to the national economy and operate in a policy regime that stimulates competition. Based on this conceptualization, a major role of an NIS is to foster the technological capability development of productive entities so that they can generate surpluses through customer value creation not only locally but also globally. Thus, a key task for a nation is to develop an NIS infrastructure with policies and policy instruments that will enable the elements of an NIS to work together to foster the sustained technological capabilities of productive entities.

Mr. Ramanathan then described the common problems and challenges that countries could face in the formulation of an NIS policy. He concluded by listing the key steps that LDCs need to focus on for NIS development.

Mr. N. Srinivasan (In-Charge, Innovation Management Group, APCTT-ESCAP) made a presentation on the role of APCTT in the promotion of NIS in the Asia-Pacific region. He explained certain overarching characteristics of an NIS, while considering innovation systems at different levels and in different countries. Citing the basic definition of innovation as “transformation of an idea into a product or a process,” he pointed out that an innovation system should have the built-in processes to learn as much from failures as from successes. Thus, ‘innovation’ and ‘learning’ are both important to NIS.

Mr. Srinivasan explained some of the major components of an NIS framework that needed to be assessed carefully before establishing the NIS framework, and outlined the functioning of an NIS. He reminded the gathering that besides national government policy settings, certain international factors will also drive a major part of an NIS because an NIS functions in an international environment as well. The physical, facilitating and collaborating infrastructures also play a major role in the effectiveness of an NIS. He then listed the factors that can be measured to gauge the success of an NIS.

Speaking on the promotion of NIS by APCTT, Mr. Srinivasan outlined objectives and outcomes of the programme implemented by APCTT. He also explained the activities, such as national workshops and training programmes, planned under the current phase (2010-2013) of the programme.

C. Session II: The NIS Experience in Selected Countries of the Asia-Pacific Region

In Session II, three resource persons from China, India and the Republic of Korea – developing countries in the Asia-Pacific region that have relatively advanced NIS – presented key aspects of NIS in their respective countries.

The session started with a presentation from Ms. Wang Yan (Director, Regulations and IPR Division, Department of Policy and Regulations, Office of Innovation System Construction, Ministry of Science and Technology, China) on "China's National Innovation System and Innovation Policy". She said that China is in transition from a planning-oriented economy to a market-oriented economy. The associated reforms necessitated changes in the S&T system that included the reconstruction of the country's NIS, driven by the national R&D programme.

Ms. Wang then outlined the national and provincial S&T decision-making system in China and the country's Medium and Long-term S&T Development Plan (2006-2020). She said the Plan is guided by four elements: home-grown innovation; leapfrogging in priority fields; enabling development; and leading the future. She presented the overall deployment of resources under this S&T Development Plan.

Ms. Wang narrated the current S&T situation in the country and explained the effects of the S&T Development Plan that have begun to emerge, in terms of increased expenditure in the sector, larger S&T human resources pool, increase in the numbers of patents applied for and granted, and more number of papers presented in international journals by Chinese scientists. She also listed the major issues that remained in China's S&T sector and the reforms being undertaken for their resolution.

The presentation of Mr. Jeong Hyop Lee (Director, Division of Research Planning and Administration, STEPI, Republic of Korea) focused on the evolution of the Republic of Korea's R&D system in the global economy. He began by stating that the Republic of Korea had shown a very successful model of economic progress and social development through government intervention, and its R&D system contributed to the success through strategic acquisition of foreign technologies and domestic capacity building processes.

The presentation viewed the R&D system as evolving, reflecting the continuous change in the socio-economic demands of the global economy. Mr. Lee traced the historical growth of the R&D system of the country from the early 1960s to the recent times in terms of quantity and quality. The continuous increase in investments in R&D had helped the Republic of Korea survive economic crises and become one of the top 10 economies in the world. The R&D system had quantitatively and qualitatively evolved to adapt to the changes in global economy, he said.

Mr. Lee then made a statistical review and qualitative assessment of the Republic of Korea's R&D in its three evolutionary phases, highlighting their specific characteristics. He also explained the transition of S&T administrative framework during the period and outlined the direction that the national government had charted for the future of STI. The evolution of the Korean R&D system was a well-known successful model of S&T system for industrialization of developing countries. However, its future was not certain because of some systemic issues, which the country was trying to resolve, he added.

In his presentation on India's NIS, Mr. Shyamal Kumar Chakraborty (Scientist F, Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India) said innovation is emerging as a key driver in the rapid growth of the Indian economy. He detailed the programmes and mechanisms that various agencies of India's Ministry of Science and Technology launched to promote innovation.

Speaking of barriers on the path of India's NIS, Mr. Chakraborty said that each phase of innovation faced different and specific challenges: lack of screening, evaluation and support mechanisms in the birth phase; lack of awareness and less user friendliness in the survival phase; and intellectual property rights and lack of market information in the growth phase. He also listed the general issues faced by NIS and recounted some innovation-based success stories from both the public and the private sectors.

Mr. Chakraborty pointed out that innovation required synergistic efforts of industry, government, educational system, R&D environment and customers. For realizing the huge innovation potential, India needs to develop a strategy that focuses on competition and investment climate, supported by stronger skills, better information infrastructure and more finance from public and private sectors. India also needs to strengthen its efforts to create and commercialize knowledge, as well as better diffuse existing global and local knowledge and increase the capacity of smaller enterprise to absorb it.

D. Session III: Country Presentations on S&T Infrastructure and National Innovation Policies: the CSN Experience

1. Bangladesh[2]

The Ministry of Science and Information & Communication Technology (MOSICT) is the focal point for science and ICT in Bangladesh. The Ministry explores and executes socio-economic development of the country through research, development, extension and utilization of science and technology. It also formulates policies for promotion of science; participates in different international, regional and sub-regional forums; and signs collaborative agreements. There are several agencies that function under MOSICT.

Bangladesh has a National Science and Technology Policy (NSTP) since 1986 and recently, the government has updated it. The revised draft envisions the establishment of S&T as the main vehicle of socio-economic development through effective and innovative leadership in the development, promotion and application of S&T and to ensure that traditional and modern advances in all branches of S&T are effectively applied in all sectors of economy including agriculture, industry, environment and services for sustainable national development to build a happy, prosperous, S&T-led Bangladesh.

The core theme of the new NSTP is to ensure that it becomes an important and integral component of all development plans and activities in the country. To that end, the policy will implement 12 missions. The NSTP builds on the core strengths of the S&T system in Bangladesh – institutional and infrastructural facilities for research and

[2] Presented by Mr. Dilip Kumar Basak, Additional Secretary, Ministry of Science and Information & Communication Technology (MOSICT), Bangladesh.

innovation, and a good number of talented scientists. Fund constraint, however, is one of the major drawbacks for research work and the low efficiency in the commercialization of research results is another.

For the development of an NIS in Bangladesh, a national S&T need assessment should be conducted and research should be based on that assessment. There should be an effort to involve private sector in financing research works. Intensive efforts need to be taken for marketing innovative products or processes, while indigenous knowledge has to be accumulated and promoted.

2. Bhutan[3]

Research activity is weak in Bhutan. University lecturers conduct academic research, but research output from university is minimal. An Agriculture Research Centre operates under the Ministry of Agriculture and Forestry, conducting research on improving agriculture and forestry products. But such research takes a problem-solving approach rather than an innovation approach.

Bhutan does not have an S&T ministry: the closest to it that the country has are the Ministry of Education and the Ministry of Information and Communications. The Intellectual Property Division under the Ministry of Economic Affairs is engaged in creating awareness and promoting intellectual property. It also helps with the process of copyright registration and patenting.

An Entrepreneurship Development Programme operates under the Ministry of Labour and Human Resources, with the objective of employment generation and promoting self-employment. Bhutan's pro-innovation eco-system includes: Industrial Property Act, 2001; Copyright Act, 2001; Economic Development Policy of 2010; and Foreign Direct Investment Policy of 2010. A national ICT capacity building project has been undertaken and the first IT Park project is under way.

In Bhutan, expenditure on R&D competes with expenditure on immediate, basic requirements related to health, education, employment, poverty reduction, etc. The country realizes that innovation and R&D are critical, not just for economic development but also for the overall well-being of the country and for increasing gross national happiness.

3. Lao People's Democratic Republic[4]

There are two main actors involved in S&T development in Lao People's Democratic Republic: governmental institutions and the industry. At the apex of governmental institutions are the National Authority for Science and Technology (NAST) for the nation and the Provincial Department for Science and Technology (PDST) for the provinces.

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[3] Presented by Mr. Karma Wangdi, Chief ICT Officer, Infrastructure Division, Department of Information Technology and Telecommunications, Bhutan.

[4] Presented by Mr. Xayaveth Vixay, Director General, Department of Science and Technology, National Authority for Science and Technology (NAST), Vientiane, Lao People's Democratic Republic.

There is also a National Science Council (NSC), various ministries, universities and research institutes.

NAST functions under the Prime Minister's Office. It acts as a secretary to the government and manages science, technology, intellectual property, standardization and metrology at macro level throughout the country. PDST, a governmental institution at local level, acts as a secretary to the provincial governor and directly manages science, technology, intellectual property, standardization and metrology in the provinces. NSC, a technical institution under the Prime Minister's Office, provides advice on social and natural research activities, and certifies results of research carried out in the country.

Some sectoral ministries have established institutes, centres and councils to carry out R&D, application and management of S&T in their assigned domains. The country has three universities, but is yet to establish a national-level research institute.

There are four categories of industrial units in Lao People's Democratic Republic: state-run enterprises; private enterprises; joint enterprises; and collective enterprises. Most business units are involved with technology application, rather than S&T research and development.

The country has policies, regulations and laws concerning the management and promotion of STI. The government is focused on the improvement of organizational structure and development of capacity and skills of staff. However, institutions responsible for S&T management and promotion have limited experience, skills and resources to undertake their tasks. Further, government policies and regulations related to S&T are not properly implemented. There is also lack of coordination among the institutions, a disconnect between the research institutions and the industry, and a low level of S&T awareness among the public. Lack of funds is another critical issue.

4. Myanmar[5]

The Ministry of Science and Technology (MOST) is the premier agency mandated for S&T development in Myanmar. Its objectives are to: carry out research and development (R&D) programmes; strengthen the national economy; enhance production in industrial and agricultural sectors; produce and nurture human resources; and conduct applied research. Development of S&T human resources and conduct of R&D are MOST's two basic functions. There are two departments for S&T human resources development and six departments for R&D.

In 2002, the country started implementing its National Human Resources Development Plan that involved the setting up of 24 special development zones around the country. Each development zone has one technological college, one computer university, one arts and science university, one or more technical schools, and one 200-bed hospital. Currently, the country has 31 technical universities, 25 computer universities and an aerospace university, besides several technical colleges, institutes, high schools and training schools.

[5] Presented by Ms. Kay Thi Lwin, Pro-Rector, Pyay Technological University, Ministry of Science and Technology, Pyay City, Bago (West) Division, Myanmar.

R&D focus is on areas such as food science and technology, biotechnology, meteorology and geophysics, materials science and technology, information technology, non-conventional energy, marine science and technology, and space technology.

Myanmar has engaged in international-level collaborations with several Asia-Pacific countries and some European Union nations in terms of: exchange of scientists and researchers; exchange of news and documents on S&T; and conducting conferences, workshops and training programmes on S&T topics. It is also a member of several regional forums and international organizations.

While Myanmar has many of the required components of an NIS – such as a basic S&T framework, human resources and natural resources – the country lacks the linkages, policies and integration of components.

5. Nepal[6]

In Nepal, apart from different sectoral ministries, five governmental bodies formulate S&T policies as required: the Ministry of Science and Technology; National Planning Commission; Environment Protection Council; High-Level Commission on IT; and National Agriculture Research and Development Fund. There are a host of institutions that conduct R&D on S&T subjects.

S&T-related human resources have seen notable growth in the new millennium. To educate the country's S&T workforce, there are five universities, two health academies and the Council for Technical Education and Vocational Training. The allocation for education in the national budget is 16.5 per cent, out of which S&T education gets 1.2 per cent. R&D expenditure is only 0.3 per cent of the gross domestic product (GDP).

The Science and Technology Policy, formulated in 2005, has three basic objectives: enhance the national capacity through S&T; assist poverty reduction activities through the use of S&T; and elevate the country to a competitive position through optimum S&T development. The policy follows a four-pronged strategy of infrastructure development, human resources development, R&D and sectoral implementation. There are some other policies too that have a bearing on the S&T sector.

The country has good traditional technical know-how in sectors such as metallurgy, paper manufacture, plant-based medicines, architecture, textiles, food, handicrafts, agriculture and pottery.

The problems that Nepal faces in the S&T sector include: low priority for and investment in R&D; lack of high-quality S&T workforce; brain drain; lack of coordination among S&T institutions; lack of infrastructure; and lack of high-quality scientists.

[6] Presented by Mr. Sanu Kaji Desar, Under Secretary, Ministry of Science and Technology, Kathmandu, Nepal.

E. Session IV: National Innovation System Policies and S&T Infrastructure in Thailand

1. Direction of STI policy[7]

Thailand is assessing how it can exercise its S&T development policy in the coming 10 years. There are many issues and challenges, and the policy attempts to address those that have a major impact in the near future: demographic change; energy and environment; innovation; and globalization/regionalization.

As in many other countries, the ageing society is an issue in Thailand, with the aged people expected to form 20 per cent of the population in the coming 10 years. Ensuring good quality of life for them and retaining some of their productivity are issues of importance. An ageing society also means a declining labour force. Therefore, the available labour has to be made more productive, and the capabilities of the young people need to be increased.

Increasing agricultural productivity to feed the nation and reducing the dependency on fuel imports are two other key concerns. A related issue is the climate change associated with energy use. S&T development needs to seek alternatives to climate-changing technologies.

In the field of ICT, the key would be optimum resource utilization for better lifestyle and rewarding careers in the rapidly "globalizing" world. ICT could also help in the de-centralization of governance.

In the year 2015, member countries of the Association of Southeast Asian Nations (ASEAN) are coming together as a single economic, social and security community. The country needs to prepare for this, as there would be free flow of labour, goods, knowledge, technology and so on. This would test the country's competitiveness and productivity, and S&T policies need to help ready the country for it. S&T policies are focusing on three aspects to improve Thailand's competitiveness: raise the gross expenditure on R&D (GERD) to 1 per cent of the gross domestic product (GDP); double the number of researchers; and encourage the private sector to invest more in R&D.

To meet the challenges using S&T, Thailand would require tax incentive schemes for the private sector, more systematic organization of research framework for efficiency and effectiveness, technology transfer schemes, government procurement policies, national projects that would pool the research activities, and major S&T infrastructure such as science parks.

[7] Presentation by Mr. Pichet Durongkaveroj, Secretary General, National Science Technology and Innovation Policy Office, Thailand.

2. S&T infrastructure: Thailand Science Park[8]

Thailand Science Park (TSP) was established in 2002 as the country's first science park by the National Science and Technology Development Agency (NSTDA) in the northern outskirts of Bangkok. TSP was created as a key infrastructure to support the development of technology-intensive business and promote R&D and innovation development in the private sector. It provides its tenants advanced facilities and business space, and an environment conducive to R&D activities.

Flagship organizations like NSTDA and four of its national research centres are located at TSP, which is sited next to three leading universities and provides opportunities for the tenants to gain access to over 1,600 full-time researchers. The park is well-resourced with physical and knowledge infrastructures that encourage companies to innovate technological products and services.

The physical facilities to support R&D activities range from incubation area, wet/dry laboratory spaces, pilot plants, greenhouse facilities, design service centre and office space. TSP also offers conference, exhibition and training centres to its tenants. There are also a number of support services offered in TSP to facilitate innovation. These include: financial support (R&D grant, soft loan, joint investment in R&D project and tax incentive programme for R&D expenditure); business services (technology business incubation, and technological, business and management consultancy); R&D and technology support and services (contract and joint research, industrial consultancy, testing and analytical services, and information and technology acquisition); intellectual property (IP) services; and human resource development.

TSP facilitates linkages of its tenants with NSTDA, the four national research centres and universities. Specifically, it encourages the model of modern innovation process where knowledge creation takes place through collaboration among innovating firms, universities and research institutes. TSP has developed several means to network private companies with research institutes and universities through the use of formal and informal events.

Tenants at TSP benefit from the financial incentives provided by the government, the Board of Investment (BOI) and the Revenue Department, besides having preferential work permit and visa facilitation for foreign specialists and researchers.

There are three regional science parks in operation in Thailand. The Northern Science Park (started in 2004) is managed by the Thailand Institute of Scientific and Technological Research (TISTR), headquartered at Chiang Mai University. The Northern Science Park and the Southern Science Park (started in 2007) are being operated by several local universities – the Northern Science Park jointly by four universities and the Southern Science Park by six universities. The Software Park at Phuket is a private body.

[8] Presentation by Ms. Akeanong Plaeksakul, Industrial Technology Adviser, Industrial Technology Assistance Programme (ITAP), National Science and Technology Development Agency, Thailand.

3. Role of support services in promoting innovation[9]

The Department of Science Services (DSS), which functions under the Ministry of Science and Technology (MOST), is the oldest scientific organization in Thailand. It has several units that provide services for science, technology and innovation. Besides R&D, the services offered include: laboratory testing and analyses; calibration of scientific instruments; technical consultation and training for laboratory personnel; proficiency testing and accreditation for quality assurance laboratories; and S&T information dissemination.

4. Creating a market for technologies[10]

Creating a technology market for businesses is essential for a developing country like Thailand, which has the capability to develop game-changing products like iPod. Creating high-value products is important because in a creative economy, creation is more remunerative than manufacture.

For a product to have a high value, it is necessary to create a value market. In a technology market, there are three ways to create value: help reduce cost through using cheaper materials, more efficient processes, etc.; help sell at a higher price; or help sell products in more numbers. However, these three ways are not equal in potential. While there is unlimited scope for technologies that help realize higher price and sell more products, technologies that help reduce costs have theoretical limits.

Unfortunately, most of the technologies that Thai researchers work on are for producing at lower costs; the orientation is towards becoming a low-cost supplier. This needs to be changed, and Thailand should be looking at technologies that have unlimited scope and therefore more value. Companies should be willing to pay for such research and technologies; that would drive better research, which would ultimately help companies.

NSTDA is putting emphasis on “inventing for impact” so that researchers will look to commercialization of research as impact creation. It also runs a series of events to link researchers and businesses.

F. Session V: Public-Private Partnership for Promotion of Technology and Innovation in Thailand

Promotion of PPPs is an important aspect of Thailand’s STI activities, as evidenced by the programmes of National Metal and Materials Technology Centre, National Centre for Genetic Engineering and Biotechnology and the Thailand Institute of Scientific and Technological Research.

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[9] Presentation by Ms. Pochaman Tagheen, Senior Scientist, Planning and Policy Analysis Section, Department of Science Services, Thailand.

[10] Presentation by Mr. Edward Rubesch, Technology Licensing Office, Technology Management Centre, National Science and Technology Development Agency, Thailand.

1. National Metal and Materials Technology Centre (MTEC)[11]

MTEC is one of the research centres under NSTDA. It has about 300 researchers in nine interlinked research units in the areas of design and engineering, computer-aided technology, polymers, ceramics, materials characterization, biomedical engineering, environment, materials for energy and materials reliability. Besides its own research, MTEC also undertakes contract research for the industry and other research organizations, as well as testing for characterization in accordance with international standards.

MTEC has developed and successfully transferred several industrial technologies to the Thai industry. These include: high-performance flocculant for natural rubber latex centrifuge machine wash water; leadless glaze for low-temperature glost firing; porous media derived from rice husk ash; energy saving in electric arc furnace; and bio-resins for the plastics industry.

2. National Centre for Genetic Engineering and Biotechnology (BIOTEC)[12]

BIOTEC is the premier government biotechnology research organization in Thailand. It is focused on four areas: biodiversity utilization; biomedical technology development; genome technology utilization; and food and feed industry development.

Thailand has a Bio-business Promotion Programme that provides investment incentives in six areas of the bio-industry: seed production and plant and animal improvement; biopharmaceutical agents such as vaccines and therapeutic proteins; diagnostic testing kits for medical, agricultural, food and environmental use; biomolecules and biologically active compounds from micro-organisms, plant cells and animal cells; raw materials and essential materials used in molecular biological experiments and tests; and biological analysis and synthesis services.

For biotechnology businesses, Thailand offers investment incentives such as: import duty exemption of machinery; eight-year corporate income tax holiday; and additional incentive (50 per cent reduction in corporate income tax) if located in a science park.

Thailand has issued a revised version of the “Biosafety Guidelines for Work Related to Modern Biotechnology or Genetic Engineering” and a new “Guideline for Risk Assessment of Plants Carrying Stacked Genes”. As a policy guideline for genetically modified (GM) organisms, the Thai government has readied a blueprint for conducting field trial and food safety assessment of GM papaya and GM tomato.

PPP involving BIOTEC takes the form of licensing, contract research, joint research, joint investment or cluster. BIOTEC has undertaken several such PPP activities and its experiences suggest that licensing helps create product differentiation, while contract research helps speed up the time for a product to hit the market. Joint research enhances

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[11] Presented by Mr. Somnuk Sirisoonthorn, Office of Executive Director, National Metal and Materials Technology Centre, Thailand.

[12] Presented by Ms. Nataporn Chanwarasuth, Policy Researcher, Policy Study and Bio-safety Division, National Centre for Genetic Engineering and Biotechnology, Thailand.

R&D capability to increase competitiveness and joint investment bestows the ability to conduct translational research. Cluster linkages have proved to strengthen the power of industry as a whole.

3. Thailand Institute of Scientific and Technological Research (TISTR)[13]

TISTR, a state enterprise under MOST, considers research and innovation in totality, with backward (raw materials) and forward (market needs such as food, shelter, clothing, energy, etc.) linkages. TISTR has facilities such as the Microbiological Resource Centre (MIRCEN), the Biosphere Reserve, a materials testing and calibration centre that is a certifying body for international standards, an Animal House for clinical tests and a Packaging Centre. It also has the services of teams of scientists dedicated to areas such as agriculture and food processing, materials science, renewable energy and environment.

TISTR collaborates with universities, international and national research institutes, local authorities, the industry, industry associations, communities and farmers in its activities. The overall goals of its activities are to improve Thailand's self-reliance and to contribute towards the country's sustainable development. Therefore, a good part of TISTR's research activities focuses on the basic necessities: food, energy and building materials.

TISTR pursues PPPs for problem solving (such as new type of packaging for longer shelf-life of food products or machine for removing water hyacinth from rivers to facilitate navigation), increasing production (such as of germinated brown rice drinks, skincare products from mushroom, etc.) or developing a new idea into a product (such as biodiesel from Jatropha and waste cooking oil, biofuel from algae and ultrasonic sewing machine).

G. Concluding Session: Challenges and Opportunities in Fostering National Innovation Systems

1. Summary of discussions

The Concluding Session that included Panel Discussion and Recommendations was opened by Mr. K. Ramanathan who said that the purpose of the discussions would be to find some steps that CSNs could adopt in terms of fostering NIS in their countries. This would help APCTT plan a sustainable programme of work on NIS in collaboration with CSNs. He stressed on the need for all delegates to understand and use the term "National Innovation System" to refer to the broad collection of policies and institutional infrastructure available to a country to utilize S&T for its development. In that context, NIS is present in all delegate countries, and strengthening the NIS and making it more effective are the tasks at hand.

While there are many notable differences among the delegate countries in terms of NIS, there are some commonalities also. All the delegate countries have certain policies

[13] Presentation by Mrs. Kasemsri Homchuen, Governor, Thailand Institute of Scientific and Technological Research, Thailand.

related to the usage of S&T for development. However, in many countries, these policies are not functional to a desirable degree. Similarly, there is a need to create awareness on the importance of S&T in national development, as that is not well understood in those countries.

Some countries have succeeded in creating large numbers of college graduates in S&T-related subjects, but quality in terms of skill levels is largely absent. Some other countries offer no opportunities for higher education in the field of S&T. Quantity needs to be accompanied by quality in research institutes, universities and human resources.

In terms of the current challenges that CSNs are facing on the use of S&T in development, Mr. Ramanathan listed the major issues: the creation of a critical mass of quality skills and its retention in the country; and the conduct of R&D by government institutes versus encouraging the private sector to carry out R&D, at least in certain key areas.

Speaking on the presentations made by various agencies from Thailand, Mr. Jeong Hyop Lee observed that the availability of facilities and access to services need not necessarily mean the success of an infrastructure, such as a science park. An infrastructure or an agency is successful only when its customers find the facilities/ services offered valuable enough to be worthy of payment.

Mr. Lee also raised a question about the appropriateness of placing laboratory services in the core business value chain. He felt that such services should be part of institutional infrastructure.

As far as the direction of science, technology and innovation in Thailand was concerned, Mr. Lee felt that the three measures proposed – raising the gross expenditure on R&D (GERD) to 1 per cent of the gross domestic product (GDP), increasing the number of researchers to 15 per 10,000 population and encouraging the private sector to invest more in R&D – might not be adequate to increase the country's competitiveness, as they basically increase the inputs to the NIS.

While the PPP examples are impressive, those are a minor portion of the R&D that the S&T agencies in Thailand carry out. It is therefore necessary to examine the obstacles that are hindering the development of PPP as the main mode in the country's R&D system, he said.

Responding to the country presentations, Mr. Shyamal Kumar Chakraborty stressed on the need for the top leadership in the country to encourage innovation, as pointed out earlier by Mr. Ramanathan. In India, declaration of 2010-2020 as the "Decade of Innovation" has helped foster a series of innovation-related activities in the country. A dedicated mechanism to synergize the relationship between academic/institutional R&D and industry would help commercialize research results, he observed. An incentive/tax exemption regime to investors and industry is another policy measure that CSNs could try out. There could be an infrastructure development fund to finance development of the SME sector, and collaborative R&D would be a useful mechanism, he said.

Ms. Wang Yan listed lack of funds, lack of adequately trained S&T human resources, absence of coordination among the different actors involved and the low level of R&D institute-university-industry linkages as the problems common to CSNs. Citing China's

thinking, she said development is the most important thing; with development, more funds would come in to raise the level of the S&T sector and to make it more attractive to investors. The second is to have a coordinated development vision; development of the S&T sector needs to happen within the development of a knowledge-based society. The third is to weave S&T development strategy into the nation's development strategy and it has to be in tune with the national characteristics. The fourth is that coordination needs skills of negotiation.

Mr. N. Srinivasan, while recapitulating the two presentations from APCTT, emphasized that technology innovation has been a continuous and evolving human activity in the quest for socio-economic development. At present, in the era of modern science and technology, technology innovation has taken a centre stage in all the spheres of socio-economic development, wherein competition and globalization have become the major driving factors. In the national context, government is the main actor who can induce and regulate competition among industries to meet the national developmental goals. In the recent past, competition has led to globalization of technology development, manufacturing as well as the market itself. In addition, many countries are signatories to the World Trade Organization (WTO) and therefore are obliged to adhere to rules-based trade, which gradually eliminates or limits tariff-related advantages. International obligations to WTO and other global treaties have necessitated countries to develop national capabilities in the area of technology innovation by evolving or strengthening a national innovation system that is relevant and suitable to each of them.

He pointed out that all countries have, to different degrees, the various components of NIS. However, the important thing is to integrate all those components to function as one system. In this context, it is essential to identify the S&T areas of importance and build R&D capacities in those areas.

Mr. Lee then restated for discussion the important issues raised in the country presentations. Other resources persons joined him in suggesting steps to move forward, and the delegates responded.

(a) Bangladesh

While Bangladesh has the S&T institutional infrastructure, plans and scientists, it is not able to commercialize its research results because of inefficiencies and lack of funds. Hence, the issue is mainly that of an appropriate operational principle that could trigger the system to work efficiently.

Mr. Lee observed that as the autonomous nature of Bangladesh Atomic Energy Commission appeared to be facilitating research work, other research institutions might also be given more autonomy. This was a strategy that could be tried in other CSNs as well, he said.

Mr. Dilip Kumar Basak, the delegate from Bangladesh, said NIS would be incorporated into the National Science and Technology Policy that the country is currently formulating. The country would introduce need-based research by identifying the areas where focus is required, with special attention to utilizing the national resources and adding value to them. Mr. Basak said it would be necessary to create awareness among the public and policymakers about the need to raise the quality of Bangladeshi

products. Entrepreneurs needed to be motivated to innovate and improve the quality of their products. The indigenous knowledge of the country needed to be compiled and put to good use.

In response to Mr. Basak's statement about mobilizing R&D activities towards contributing to value addition to the country's natural resources, Mr. Lee said such a priority has to be reflected in the NIS policy. For that, two major policy tools are needed: one to provide adequate incentives in national programmes to induce research entities to focus more on value-adding R&D in natural resources; and the other to induce the research institutes and universities to have institutional schemes to mobilize researchers to engage in value-adding R&D activities. There is a need to create success stories of value-adding R&D activities and disseminate them among the research entities to motivate the researchers.

(b) Bhutan

Bhutan's educational system seems focused on developing human resources that would help sustain the nation's current industries – tourism and hydropower – and the graduates from universities are looking to become civil servants. In this situation, the government has adopted a strategy to boost SMEs. Bhutan measures its development very differently from the traditional means, and economic development is only one of the four priority areas that the country is pursuing. In this context, there is the question whether it would be feasible, or even advisable, for Bhutan to get into S&T innovation because of its small size.

Mr. Lee said that the issue is about the choice of appropriate strategic industries for a small-sized economy, and what might be the strategies and programmes that could support such industries. IT industry will not be an appropriate target industry because it requires domestic consumption to support it. With a small market and a small pool of human resources, countries like Bhutan might not be able to sustain such an industry. Hence, the key steps are to determine the industrial sectors ideal for SMEs in the Bhutanese context and to mobilize people to get into those industries.

Responding to the question that Mr. Karma Wangdi, Bhutan's delegate, raised – whether it would be possible for a small and resource-poor nation to not take up costly S&T development but still achieve reasonable level of economic development – Mr. Ramanathan said that S&T is already part of the daily life in Bhutan, an example being the fibre optic network used for telecommunications or medicines used in healthcare. The question could therefore be rephrased as: instead of attempting the S&T development adopted by larger countries, can't a small country develop its own unique approach in using S&T to achieve national aspirations? The response would be that such unique approaches can be adopted within the overall national vision.

Mr. Ramanathan added that it is very important to generate employment. With its focus on ICT, the country may strategically position itself as an offshore site of global IT companies. This could generate some employment in the country. Once employment generates wealth, the country needs to develop the next-generation industry, which would provide better quality employment for more people. Thoughts on the next-generation industry would also provide the answer to what could be the S&T policy.

Mr. Chakraborty expressed the view that the innovation policy of any country should be customer-driven and need-based, and the results must reach the masses. In Bhutan, food processing technologies could reach more common people easily, and more people would understand the usefulness of technology development. Another area that Bhutan could apply innovation was the use of biotechnology in agriculture. As tourism is a key revenue earner for the country, innovations could be tried out also in the tourism sector.

Ms. Wang said for a small country with low population, the services industry would be a focal area. In this respect, tourism sector is a good candidate for innovation, as it offers a global market. Inviting foreign direct investment in the education sector is a good policy, as it would help the services industry. It is not necessary that every country should emphasize the manufacturing sector, she added.

Mr. Srinivasan said the key question is about the way each country deployed technology in its context. Referring to Bhutan's unique way of measuring development in terms of gross national happiness, he opined that such uniqueness itself has a marketable brand value. Application of S&T could add value to Bhutan's natural resources through eco-tourism and traditional medical services. It is essential that Bhutan leverages S&T to generate employment.

Mr. Karma said the creation of awareness in the country about the role of S&T in national development would be the starting point for promoting NIS in Bhutan. He expressed his agreement with Mr. Lee that Bhutan needed to find niche areas for the nation to focus its efforts on and then establish systems and facilities to support those areas. Once this is done, the move to promote NIS would gather its own momentum.

(c) Lao People's Democratic Republic

In the case of Lao People's Democratic Republic, the country has not yet developed a certain level of research activities and R&D capacities. While the government provided leadership in planning for S&T, those plans could not be executed by the national institutions.

In such context, Mr. Lee suggested, it would be advisable to have a strategy for capacity building process to help implement the S&T plan among the R&D institutions. While it is good to have a long-term plan, like a 2020 vision, it is also important to have plans for shorter periods such as one year and three years.

Mr. Xayaveth Vixay, the country delegate, said he would like to ensure at the onset that there is a clear understanding about the various components in the NIS in his country and how they could be integrated into an effectively functioning system. There are still some hazy areas in terms of science and technology, innovation and development that needed clarification. In this regard, he said, his country would look forward to hosting a national workshop, as mentioned by Mr. Ramanathan.

The current Science and Technology Policy of Lao People's Democratic Republic initiated in 2003 is drawing to a close in 2010, and the following policy period would be up to 2020. Drafting of the new policy would soon commence and that would be the time to consider innovation and its importance in S&T development for incorporation

as a strategy into the new policy. A coordination mechanism for S&T agencies and activities is very much required, and the existing S&T Council could be restructured to serve that role effectively.

(d) Myanmar

Myanmar has a good institutional framework for boosting R&D activities, and policies and plans to coordinate universities, research institutes and the industry to pursue certain national goals. The key issues are how to sustain and expand university-research institute-industry relationship, and what goals could be set to develop the critical mass of resources required to drive innovation.

Mr. Lee pointed out that setting general goals would not help create the critical mass of resources required to mobilize the innovation actors for sustained research activities. To achieve this, it was advisable to set specific national-level targets in university-industry research collaboration.

According to Myanmar delegate Ms. Kay Thi Lwin, while the country has all the key components required for an effective NIS, many of those components are weak. Hence, strengthening them would be one of the initial tasks. At the same time, it is essential for those connected with the NIS, particularly the top policymakers, to have a sound understanding of the issues involved. Therefore, a national workshop on NIS is needed.

Mr. Lee responded that to strengthen the various components of NIS, there is a need for a stimulus. However, this would not come without intentional public intervention. Myanmar could, for example, establish a national science park to mobilize the resources to create success stories, which could then be the stimulus for strengthening the NIS, he said.

(e) Nepal

The S&T human resources in Nepal have increased sharply in the past decade, which augured well for the country. However, the brain drain is negating that gain to a certain degree.

Therefore, Mr. Lee suggested, it is necessary to have a strategy to boost the country's industries to retain educated people in Nepal. Other key steps are to determine the industries suitable for SMEs in Nepal and to motivate the private sector to start those industries.

Mr. Ramanathan observed that the difficulty that Nepal faces – the migration of its talent, even gainfully employed people, to other countries – is due to the lack of economic opportunities and political instability.

Mr. Sanu Kaji Desar, the Nepal delegate, agreed with Mr. Ramanathan that political instability is one of the reasons for the citizens leaving the country. It also prevented the private sector from making meaningful investments in the industry or in research, thus reducing further the economic opportunities available to the educated Nepalis.

Mr. Desar expressed the necessity for a national workshop on NIS. He said he would strive to introduce the term “innovation” into the title of the recently drafted S&T policy to highlight the importance of that aspect. He said that he would urge the S&T Ministry to mobilize its different sections to draft an NIS policy at the earliest. Such a policy document would clearly identify the priority sectors. The creation of a national innovation centre would be a useful initiative, but the feasibility of such a centre needs to be assessed by the government.

Mr. Ramanathan clarified the issues associated with organizing national workshops in the CSNs and invited the countries to write to APCTT formally expressing interest in such workshops. He concluded the session by thanking the delegates, the resource persons and the invited speakers for their contributions towards making the workshop a fruitful one. He also thanked the Ministry of Science and Technology of Thailand for the warm hospitality and excellent support it extended to the conduct of the workshop.

IV CONCLUSIONS AND RECOMMENDATIONS

Participants of the workshop appreciated the efforts of APCTT to focus on the strengthening of national capacity for the development and utilization of NIS to improve the innovation capacity of firms to develop new and practical technologies. In this regard, sharing of experiences of other countries in the Asia-Pacific region would be useful for CSNs to develop an NIS relevant to each country.

Most of the participating CSNs found the concept of NIS to be new and stated that there is a need to convince policymakers and key actors of NIS about the outcomes of such an approach. In this regard, they requested APCTT to organize national workshops on the concept of NIS in their respective countries in cooperation with relevant national institutions.

The S&T infrastructure in CSNs is either relatively new or yet to be developed. Two major challenges faced by them are inadequate qualified human resources and the lack of appropriate policy and support mechanisms to develop an effective innovation ecosystem wherein linkages and partnerships among R&D institutions, academia and the industry could be facilitated, nurtured and strengthened.

While some of the components of NIS do exist in CSNs, there is a need to strengthen the NIS through developing a more in-depth understanding of best practices and adapting these to suit the specific needs of the nation. It was emphasized that all SMEs would not be able to carry out R&D, but all of them could focus on strengthening their production capability and quality standards.

The major challenge of inadequate human resources has to be addressed through creation of critical mass of quality skills in the medium and long term. To meet their immediate needs, CSNs could consider deployment of quality skills from other countries as well as through foreign direct investment.

It is important for CSNs to identify the role of government in R&D and the role of technology in customer value creation. Governments have to take a lead role in the

development of collaborating and facilitating infrastructure, such as technology and science parks, and in providing adequate support to science, technology and business services.

A list of recommendations can be found on pages 143-144.