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Workshop Report on Domestic Innovation Systems and Network

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APEC Policy Partnership on Science, Technology and Innovation

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LIST OF ABBREVIATIONS

ABAC	APEC Business Advisory Council
APRU	Association of Pacific Rim Universities
BERD	Business Expenditure on Research and Development
CAS	Chinese Academy of Science
CONICYT	National Commission for Scientific and Technological Research
CONCYTEC	Consejo Nacional de Ciencia, Tecnologia e Innovacion Tecnologia
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GIST	Global Innovation through Science and Technology
IMF	International Monetary Fund
IP	Intellectual Property
MOST	Ministry of Science and Technology
MRI	Multi Research Institutions
NSTDA	National Science and Technology Development Agency
PNGSTS	Papua New Guinea Science and Technology Secretariat
PPSTI	Policy Partnership on Science, Technology and Innovation
PRI	Public Research Institutions
R&D	Research and Development
REI	Regional Economic Integration
SME	Small Medium Enterprise
SBIR	Small Business Innovation Research
STEM	Science. Technology, Engineering, Mathematics
STI	Science, Technology and Innovation
STTR	Small Business Technology Transfer
WTO	World Trade Organisation

EXECUTIVE SUMMARY

This report provides findings from the APEC PPSTI Workshop on Domestic Innovation Systems and Networks. The workshop was held on the 13th and 14th of August 2018, at the Lamana Hotel, Port Moresby, Papua New Guinea. Representatives from Australia, Chile, China, Korea, Malaysia, Papua New Guinea, Peru, Russia, Thailand and the United States attended the workshop and shared their experiences in establishing and managing innovation systems. ABAC and APRU representatives were also present to provide experiences in the industry and also regional network of research institutions. These shared experiences have led to the development of the Manual on Domestic Innovation Systems and Networks.

The workshop was proposed by PNG and was supported by China, Korea and China. The underpinning motivation that inspired the workshop was the persistent constraints that PNG faced in mainstreaming science and technology to be recognized as an important driver for economic and productivity growth. There have been barriers to effectively coordinate and integrate government, research institutions and industry into a system to advance a productive innovation landscape in PNG. Therefore, the PNG Science and Technology Secretariat felt that a workshop for economies to share their experiences in constructing innovation systems was a step in the right direction. This is particularly important for PNG to shift from a resource-based economy to a knowledge-based economy.

The workshop consisted of five sessions. The first session was an introductory session that provided an overview and definitions on innovation systems and networks. The second, third and fourth sessions were all experience sharing sessions that were provided by member economies. The final session was a review of the two-day workshop and also provided some recommendations on next steps forward. Each of the sharing sessions was guided by framing questions to ensure that discussions were contextually relevant to the motivations for hosting the workshop. This report provides in chronological order the outcomes of the workshop.

This report than concludes with some key recommendations that PNG as the host economy can take on. In particular, PNG's high biodiversity and potential for organic farming were highlighted as important comparative advantages for the economy. The important message is for increased STI collaboration both domestically and globally to enable investment in research to increase innovation products. All APEC member economies that were present expressed their support to PNG as it endeavors to build its domestic innovation system.

INTRODUCTION

The purpose of this report is to inform the APEC Secretariat and APEC member economies of the outcomes of the APEC PPSTI 06-2017A Workshop on "Domestic Innovation Systems and Networks." The report has a number of goals including;

- Sharing summaries of discussions that were presented during the workshop;
- Provide in chronological order the sharing of best practices by individual economies, and;
- Inform member economies on the potential next steps forward.

The workshop was held in Port Moresby, Papua New Guinea on the 13th and 14th of August 2018 and was attended by representatives from Australia, Chile, China, Korea, Malaysia, Papua New Guinea, Peru, Russia, Thailand and the United States. Representatives from ABAC and APRU were also present. There was a good mixture of developing, emerging and developed economies in the workshop and that created an environment for sharing and learning among these economies that were at different stages of development.

For developed economies, innovation systems and high levels of investment in research and technology development have been the cornerstone of productivity and economic growth. Their innovation systems are advanced and therefore they are competitive in all aspects of knowledge, technology innovation and industrialisation. These developed economies are in the forefront of digital innovation in areas such as Big Data, Cloud Computing, Quantum Technologies, Block-chain, Advanced Production Technologies, Internet of Things, Augmented Reality, Robotics, and Artificial Intelligence. These economies also have agile and adaptive network of innovation actors comprising of government, researchers, industry and consumers that ensure value is generated in all aspects of research, technology and business.

Developing economies on the other hand have fragmented systems of innovation. Many such economies are heavily reliant on natural resource capital and are often labour intensive. Under these economic circumstances, there is limited need for knowledge, innovation and technical skills for production and that severely undermines economic and productivity growth. Papua New Guinea for instance, is a heavy consumer of technology and digital products, and unfortunately it is at the lower end of the innovation supply chain. PNG relies on the export of minerals, natural gas and oil, and as well as forestry products and agricultural commodities for its socioeconomic development. However, there is limited value creation within these vast and existing economic activities.

This workshop was an opportunity to bring APEC member economies into a forum where experiences and practices on effective coordination of innovation actors, policies and regulatory instruments, can be shared for absorption and learning. Every economy has its own model of innovation system that is constructed based on individual economic needs and research priorities, and the political system. Therefore, what the workshop provides are shared experiences from which a developing economy such as PNG can learn from and tailor its own innovation system.

BACKGROUND

In August 2017, the Papua New Guinea Science and Technology Secretariat (PNGSTS) submitted a Concept Note titled "Workshop on Domestic Innovation Systems and Networks." The motivations for this concept note arose from the persisting constraints that were limiting to the development of STI within the economy. The PNGSTS saw an opportunity for learning through an APEC workshop that could enable economies to share their experiences to inform PNG's STI policies on regional innovation policy trends. The project proposal was supported by Korea, China and Indonesia.

The resulting workshop was held from the 12th to the 13th of August 2018 at the Lamana Hotel in Port Moresby, PNG. This manual is the final synthesis of the workshop presentations, desktop research and literature reviews on various innovation systems, and their role in promoting and supporting innovative growth within the Asia Pacific Region. The manual is intended for use by policy makers, researchers, NGOs, and SMEs in PNG, and other APEC member economies.

The PNGSTS had already developed several key STI policies when the Concept Note was drafted. These policies included the STI Policy, STI Plan, the National Research Agenda, and Research Guidelines for Papua New Guinea. The central theme across these policy documents is 'Knowledge and Innovation' as imperative cornerstones to achieving sustainable, equitable, and inclusive economic growth for PNG. The Secretariat also realised early in the policy development process that major policy, institutional, research, and investment gaps were contributing to low levels of STI and outputs in its economy. With such limitations, it is a challenge for PNG to effectively participate in APEC's REI process when most of the economies are focused on innovation for their economic growth. Therefore, it became apparent that broader regional conversations were needed on *innovation systems* to generate understanding about its role in economic development, productivity growth, and international trade.

The PNGSTS joined the APEC's Policy Partnership on Science, Technology and Innovation (PPSTI) fora in 2015. Subsequently, the Secretariat has actively been involved in numerous policy dialogues through the PPSTI fora and its strategic plan. Fundamentally, the PPSTI Strategic Plan 2016-2025 envisions that the APEC region will achieve innovative economic growth through PPSTI efforts by the year 2025, and to achieve the APEC leaders' initiative on

"*Towards Innovation-Driven Development*", PPSTI aims to "strengthen the synergy of government, academia and industry, including SMEs, and engage actors involved in joint scientific research and in the technology inception, dissemination and commercialization cycle, with both its competitive commercial sectors and non-profit elements".

The most critical policy issues of the 21st century include the crosscutting nature and the impact of innovation on the development of new technologies, the digital economy, society, and the environment. PPSTI foresees that innovative economic growth will be achieved "through enabling eco-systems, regional cooperation, human resource exchange, and infrastructure development". In essence, it is the level of integration of these actors, the enabling policy mixtures, and response to market demands that determines the form and structure of each economy's innovation system.

Representatives from ABAC, APRU, Australia, Chile, China, Republic of Korea, Malaysia, Papua New Guinea, Peru, Russia, Thailand and the USA attended the workshop. The mixture of representation from developing, emerging and developed economies was critical in obtaining a balanced perspective on the levels of innovation in the member economies. This report provides summaries of key-points that were presented during the workshop by the different speakers.

The workshop program is provided in ANNEX 1 at the end of this report. Also the workshop presentations can be accessed through this link.
https://www.dropbox.com/sh/4ge95mjsuzh1xh0/AABOzzLqJ13aj3rfIgN-A6tCa?dl=0

WORKSHOP PRESENTATIONS

The workshop was organised into four sessions. The first session was an introductory session, in which two keynote addresses were provided to give an overview on innovation systems and networks. The rest of the sessions are all sharing of best practices by member economies. Each of the sharing sessions was guided by a framing question to ensure that all presentations and discussions were focused so that best workshop outcomes could be achieved.

INTRODUCTORY SESSION: INNOVATION SYSTEMS AND NETWORKS OVERVIEW

In session one, an overview of innovation systems and networks was provided. Representatives from ABAC and a PNG-based company gave keynote addresses on the theme.

Keynote address One: Innovation Systems and Networks

Presenter: Mr. Nicholas Brooks, ABAC Principle Advisor

In delivering his keynote address, Mr Nicholas Brooks stated that the major objective of innovation systems to create an enabling environment that stimulates innovation to promote growth drives the economy and elevates innovation and technology policies as critical pillars in economic planning. There are a number of key actions that are needed to promote innovation and this includes;

- Establishment of an innovation system
- Fostering both public and private investment in R&D
- Policy emphasis on STEM education as a critical component of human development and innovation capacity building
- Financially assist those universities, which embark on applied research with a view to commercialization

Invest in appropriate infrastructure initiatives to champion innovation and technology including dedicated research institutions, science parks, incubators and accelerators

Using Hong Kong, which is in a unique position as the Innovation Hub for Guangdong-Hong Kong-Macau Bay area, Mr Brooks emphasised the importance of having ecosystem approaches to innovation and technology. The ecosystem approach within the hub comprises Investment, Human Capital, Innovation Culture, Infrastructure, Market and Industry Adoption, and Policy Support. Mr. Brooks also stated that the future of HK was

focused firstly on, ensuring social and economic sustainability through job creation and export growth. Secondly, it supported re-industrialisation to revitalise, modernise and grow new industries based on technology-led and design-led innovations for both technology and business development. Scalability is also a critical consideration in their innovation approach.

The following are some key messages that were presented by Mr. Brooks

- HKSTP focus on facilitating the growth of (vertical) technology clusters that are of Hong Kong's research strength; and (horizontal) integrated application platforms that answer social and business needs.
- Innovation is key to sustainable economic growth. Given Hong Kong's knowledge-based economy, our future lies on how much value we can capture and commercialise from knowledge and creativity (instead of extensive labour force).
- Creativity alone is not enough to generate any economic value. Execution is of critical importance in the whole innovation and technology industry. Hence, having an "idea" is not innovation – innovation is a very long process of making something happen and benefit society.
- Not all great technology ideas can be successfully commercialised and generate sustainable values. New technology applications need extensive research, new business models, and much effort to enter mainstream market. Hong Kong is strong in many aspects from university basic research, markets (including transforming traditional industries and exploring emerging markets in China and SE Asia), finance and professional business services (banking, legal, insurance, accounting), abundance of investors etc. They all give HK advantage in developing innovation and technology.
- However, we also see many unfilled gaps along the development process, e.g. lack of downstream product development workforce, regulatory restrictions, and lack of early industry adoptions. These are challenges that we have to tackle in order to facilitate knowledge translation into commercially viable products.

Keynote address 2: Reducing Poverty through Technology and an inclusive agribusiness model

Presenter: Mr Brad Jackson, Director i2i Development

In the second keynote address, Mr Brad Jackson gave a presentation on the work that PNG Agriculture Company is doing in PNG. The project is led by the PNG Cocoa Board and facilitated by an inventive Australian Indigenous owned company i2i Development. And it seeks to transform the cocoa industry for smallholder farmers by establishing a new

commercial operating environment that incentivises farmers to increase their incomes and attain greater value from the industry.

It is increasingly becoming critical for PNG and other developing economies that rely on agriculture to develop new systems of innovation to sustain rural farming communities and in doing so contribute to national development. There has to be more supportive policies, laws, and public spending on infrastructure in order to create a favorable climate for agriculture. Some of the organizational and business innovations that the PNGAC is conducting include the following;

- Inclusive and sustainable growth for rural farming families through a business model that incentivizes increased production and participation in the value chain
- Using technology to improve results, reduce risks and provide transparent information to farmers and financiers
- Facilitate effective change through trustful and culturally based relationships

As a developing economy, PNG has a young population that is a significant labor force to take advantage of the opportunities in the agriculture sector by employing technology, information, research and innovation to improve productivity. The development of an Agircultural Innovation System that builds relationships between government policies, research, industry and civil society organisations is essential to making transformational changes to agriculture particularly in the rural areas.

SESSION I THEME: GOVERNMENT RESEARCH AND DEVELOPMENT STRUCTURES

Ms Christin Kjelland moderated this session.

The framing Question: What structural and policy elements are essential for the effective governance of innovation?

Keynote Presentation: Government Structures and Frameworks for Innovation Ecosystem.

By: Dr. Jungwon Lee, Senior Research Fellow, STEPI, Republic of Korea.

Dr Jungwon Lee used Korea's R&D system in introducing the theme on Government Research and Development Structures. Korea's R&D system involves 12 government ministries and 19 agencies that are coordinated to deliver on a common development goal, which is to produce creative knowledge. Korea recognises that innovation system is an "organic whole" that is operating within an ever-changing system that consists of interactive

and collaborative networks and linkages. Lee further reiterates that Korea's innovation system must be part of a global equilibrium of innovation ecosystems.

Due to the increasing costs and difficulties in managing DIS, it is important for Korea to make innovation systems more effective through developing connections between Universities, Public Research Institutions and Industry, which includes large firms, SMEs and Start-Ups.

Therefore, Korea is continuously increasing R&D investment, educating qualified human resources, increasing R&D performance (in quantity) and ensuring that government plays a key role in leadership and governance of innovation. At the same time, the economy (Korea) recognises that there is room for improvement in terms of strengthening the link amongst STI actors and with global resources, reform in the education system, increasing capacity for basic research and encouraging SMEs innovation.

Lee further stated that some of the Korea's domestic competitiveness is weakening and economic growth rate is decreasing. According to Lee, this is partly caused by lack of new technology development needed to maintain and strengthen global competitiveness of current major industries and the lack of new growth engines based on technology breakthroughs. This is propagated by a number of socio-economic factors that include entrepreneurship, technology financing, and the education system among others. Therefore, having dynamic innovation systems that encourages flow of knowledge, increasing investment or funding, and ensuring availability of researchers among innovating actors and government is critical for sustaining growth.

Korea's structure for R&D (**Figure 1**) currently supports more than 50,000 projects in more than 500 R&D programs.

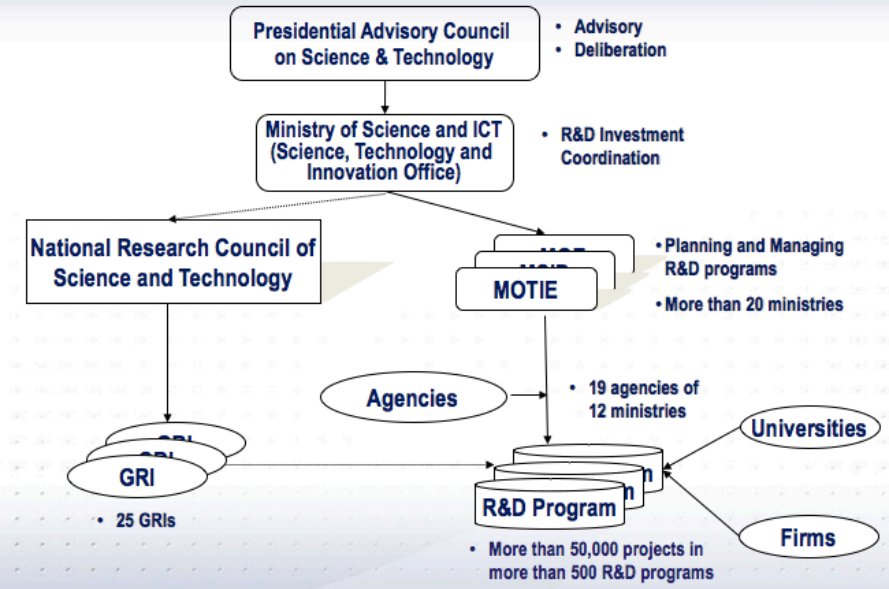

Figure 1: Korea's government structure for R&D

A copy of Dr. Jungwon Lee's presentation is located in the following file.
https://www.dropbox.com/sh/4ge95mjsuzh1xh0/AABOzzLqJ13aj3rfIgN-A6tCa?dl=0

Sharing Session for Theme I:

Presentation 1. Australian Innovation System

By: Mr. James Pitman, Acting Manager for International Negotiations, Science and Innovation Section, Australia

Australia conducts 73 percent of its trade within the APEC region. Therefore it is critical for the economy to remain competitive and agile. In the last couple of years, Australia's Innovation Framework has developed key science initiatives including the following;

- National Innovation and Science Agenda
- Global Innovation Strategy
- Review of the Australian Innovation, Science and Research System
- 2030 Strategic Plan
- 2016 National Research Infrastructure Roadmap
- Australian Medical Research and Innovation Strategy 2016-2021
- Australian Medical Research and Innovation Priorities 2016-2018
- National STEM School Education Strategy 2016-2026

These government policy initiatives are together supporting Start-Ups by providing access to expertise and finance; building and strengthening regional research linkages; providing

grants to SMEs; and funding Australian businesses and research organisations to collaborate with other economies on leading-edge R&D projects. The present research priorities are on;

- Health
- Food
- Soil and Water
- Transport
- Cyber Security
- Energy
- Resources
- Advanced Manufacturing
- Environmental Change

By focusing on these research priorities, Australia aims to move into the top tier of innovation nations. In pursuing this goal, Innovation and Science Australia developed an ambitious plan; "*Australia 2030: Prosperity through Innovation*" to advise the government on how to generate and capture the benefits of innovation. As such Australia's investment in science, research and innovation totalled $10.1 billion in 2016-2017. Out of this investment basic research was allocated 26 percent and applied research, 74 percent.

The higher expenditure in applied research is underpinned by industry collaboration across industry growth centres specialising in Advanced Manufacturing; Cyber Security; Food and Agribusiness; Medical Technologies and Pharmaceuticals; Mining Equipment, Technology and Services; and Oil, Gas and Energy Resources. The industry-focused strategy also includes collaboration and participation by key science and research stakeholders including universities and Research and Development Corporations; and other programs that such as Industry Skills Fund and R&D Tax Incentives to provide the conditions for industrial growth. This has led to regulatory reforms, improved access to global supply chains, improved engagement between research and business, and improved management and workforce skills.

Pittman concluded with a number of key messages;

- Innovation Frameworks must be fit for purpose and be scalable to help economies target areas of strength;
- For developing economies, R&D and innovation activity can more effectively target specific industries and sectors to demonstrate value;
- In the private sector firms, HGFs are both difficult to predict, and don't remain HGFs for long – so improving the framework conditions can improve all firms prospects

- Prioritising science interests ensures a stronger framework to support collaborations.

Presentation 2. Chinese Academy of Sciences: Experience Sharing

By: Dr. Wang Junwei, Deputy Director General, Chinese Science and Technology Exchange Centre

In China, the Ministry of Science and Technology drives the innovation agenda through the Chinese Academy of Sciences (CAS). CAS is in charge of;

- Representing the highest standards in STI in China;
- Facilitating reforms in the R&D system;
- Driving domestic technology innovation;
- Advising government on major STI issues
- Training next generation scientists and engineers

CAS is currently supporting the higher education sector specifically the University of Chinese Academy of Sciences, the University of Science and Technology of China, and the Shanghai Tech University. Collectively, these universities cater for over 75,000 students including international students. The main goal of this approach is to provide access and opportunities to some of the best scientists and build domestic research and technology capabilities. CAS is also committed to ensuring that Chinese scientists and researchers are connected to global talent and delivering excellence in science. As a result CAS topped the global institution list of Nature Index 2017; that is maintained the number one spot as an institutional contributor to high-level science papers from 2012 to 2016.

In 2002, CAS established the Chinese Academy of Sciences Holdings Co. Ltd (CASH) as China's first asset management company engaged in the operation of operative assets of state-level public institutions. CASH has over 40 companies including China Sciences Group and the China Science Publishing Group.

CAS is also internationalising its programs through a number of key initiatives that include;

- President International Fellowship Initiative
- International Partnership Program
- International Outreach Initiative
- Special Engagement Program
- International Engagement Program
- Alliance for Non-Profit Scientific Organisation

Through these initiatives, CAS has an international outreach program that is well presented within the Asia-Pacific region and beyond. CAS welcomes new partnerships with other science and research institutions in APEC member economies.

Presentation 3. Russian Federation Innovation Ecosystem - Government Strategy and Support Measures

By: Mr. Maxim Romanov, Director, Department of International Cooperation, Skolkovo Foundation, Russia

The Russian Federation has developed three strategic plans to underpin innovation driven economic growth. These plans are *the Innovation Development Strategy*, *Strategy for Science and Technology Development*, and *Increase in Labour Productivity*. And these plans collectively govern Russia's Digital Economy Program in Big Data, Cloud Computing, Quantum Technologies, Block-chain, Advanced Production Technologies, Internet of Things, Augmented Reality, Robotics, Artificial Intelligence, and Regulations through a number of domestic technology initiatives. At the heart of these strategies are innovation development institutions including 55 state-owned enterprises that are under the auspices of the Ministry of Economic Development of the Russian Federation.

These initiatives have resulted in increases in R&D funding, output per employee, R&D non-budget funding and export of innovation products.

One of the major institutional developments has been the establishment of Skolkovo Innovation Centre, whose vision is to ensure "Russia is a technological power, a leader in the field of scientific research and education." Its mission is to create an innovation ecosystem that is favourable for entrepreneurial and research activities; through facilitating the creation of jobs in new companies that attract talent.

At present the Skolkovo Innovation Ecosystem comprises of StartUps, Investors, Industrial Companies and SKOLTECH. There are now over 1,800 StartUp ventures with over 1,200 patent ownerships spread across the ventures. Support services for the innovation ecosystem include innovation City and Physical Infrastructure program, Technopark Service Infrastructure program, and the Skolkovo Intellectual Property Center for IP Protection.

For more information, consult the powerpoint presentation on the link provided on Page 9.

Presentation 4. US Federal Government Policies and Structures to Support Innovation

By: Ms. Staci Rijal**,** Foreign Affairs Officer, U.S Department of State, USA

Research and Development has been the cornerstone of the US economy for a long time. In 2015, the Federal Government investment for R&D was approximately $40 billion. Corporate investment was more than $20 billion. Both university and philanthropic investment were around $10 billion each. That is a total of $80 billion in 2015 alone.

This level of support for R&D is a result of having a decentralised STI system that allows state; industry and other STI actors invest in local needs for research and innovation. That way, funding from the Federal Government is distributed to the citizens as well and not just to research institutions. This is in line with the SME Development Act that supports industry driven innovation.

The US decentralised STI system is working is by supporting innovation in small businesses through the SBIR-STTR seed capital. There are 11 federal agencies in these programs. This includes the Department of Defence, Department of Health and Human Services, Department of Energy, NASA, National Science Foundation, Department of Agriculture, Department of Education, Department of Transport, Environmental Protection Agency, Department of Homeland Security and Department of Commerce. This Federal and State Partnership have contributed to the growth of many innovative businesses. A study on the economic impact of this innovation seed capital can be found on this link: https://sbtc.org/wp-content/uploads/2018/02/Impacts-of-the-SBIR-program.pdf

The federal government also supports other programs including the Materials Genome Initiative, National Nanotechnology Initiative, National Robotics Initiative, and the State Department's GIST program. The government also encourages technology transfer through open data platforms in all federal funded innovation programs.

Intellectual Property Protection is another critical element in the US innovation system. Protection and enforcement of IP laws are essential to creating jobs and promoting economic prosperity; opening new markets for US goods and services; and fostering investment in innovation and development. IP intensive industries account for 38% of GDP, 52% of merchandise exports, 27.9 million jobs, and 49% wage premiums in the US.

The Federal government is further encouraging STEM education at all levels. This is in response to projected increases in STEM jobs that are requiring biomedical engineers, medical scientists, systems software developers, computer system analysts, and mathematicians. Agencies also have individual Women in STEM programs to ensure inclusivity and participatory growth.

Takeaways from Session I

1. Ms Christin Kjelland provided a summary of the session. The following key-points were shared.

- There has to be a holistic view on the innovation ecosystem.
- Flow of knowledge and innovation must be encouraged across government agencies, industries and users of knowledge.
- Gender and social Inclusivity is critical for innovation and broader economic development
- International collaboration is critical for regional growth within the APEC region. Open data platforms for technology transfer are essential.
- SMEs must be the drivers of innovation
- STEM Education at all levels must be encouraged and train students to become problem solvers. Paradigm shift in education systems is needed.
- Bring creativity into the policy discussions and make innovation become engaging for youth through creative industries.

2. Since PNG is at the starting point of innovation driven growth, the presenters were asked about their thoughts were on what should be PNG's priority for investment in innovation.

- **Dr Jungwon Lee**: Improve performance and connection in the innovation ecosystem by employing a collaborative approach, domestically and globally.
- **Mr. James Pittman**: Leveraging is key. Kickstart a few industries and build from there.
- **Dr. Wang Junwei:** Invest in education and build capacity for the digital economy.
- **Mr Maxim Romanov**: Focus on SMEs development and entrepreneurship.
- **Ms Staci Rijal**: Invest in wew industries that are connected to agriculture.

3. In PNG there is a need for reform in education to improve quality in STEM teachers and the curriculum. While the context in PNG is different, how are economies addressing this?

- **Dr. Wang Junwei**: International initiatives for scholarship are currently being provided by China to build teachers capacity. This is an opportunity that PNG can take.
- **Mr. James Pittman**: Tyranny of distance is a problem to teaching quality. Students must apply learning in their locality. STEM education can become meaningful when it is linked to what students know already. Rural research development corporations in which technologies are incorporated into agriculture are a great platform for STEM education. Farming is also about technologies
- There was a consensus that STEM education needs creativity, building partnerships and identifying how PNG can build a STEM Education strategy.

Figure 2: Takeaways from Session I

SESSION II THEME: INNOVATION FUNDING

Ms Staci Rijai (USA) moderated this session.

Framing Question: What are the principles of effective funding mechanisms and investment partnerships for innovation?

Keynote Presentation: Funding Mechanisms and Investment Partnerships for Innovation. A Case Report

By: Dr. Ma Leju, Senior Expert (International Industries), DiDi, China

Dr Ma Leju gave a keynote presentation on Innovation Funding as a representative for the industry and shared a case report based on Didi; a mobile transportation platform. The company offers over 31 million drivers opportunities for flexible work and income generation on the DiDi platform, whilst providing alternatives to innovative transport platforms such as Uber. Didi has also established global partnership network with *Grab, Lyft, Olam Uber, 99, Taxify* and *Careem*. It has recently launched its own branded mobility services in Mexico and Australia, and a joint venture to offer taxi-hailing services in Japan.

In the presentation, Ma provided three learning outcomes from Didi as an innovation company.

Learning I: Enabling Context is required to promote mass entrepreneurship and mass innovation. Promoting new education pathways that provide entrepreneurial skills development are critical for the 4th industrial revolution and the digital future.

Learning II: Technology Driven innovation that is centred on the availability of Skilled professional. Industry is focused on profits, and therefore R&D activities are theme-based requiring more investment in applied and development research. Protection of IP is critical for industry-focused innovation.

Learning III: It is vital to pursue Win-Win Cooperation. And this can be achieved by promoting open science, increasing global partnerships and encouraging public-private dialogue.

Two strategic actions have also been undertaken.

Action I: A project (PPSTI 01 2018A) titled "APEC Public-Private Dialogue on Sharing Economy and Digital Technology Connectivity for Inclusive Development" was proposed and approved. The project is currently being implemented.

Action II: Didi fostered strategic partnerships with APRU and Tecnologico de Monterrey.

Sharing Session for Theme II:

Presentation 1. National Commission for Scientific and Technological Research

By: Dr. Khaled Awad, Director for Fund for the Promotion of Scientific and Technological Development, CONICYT, Chile

Chile's Ministerial Committee for Innovation and the National Council of Innovation for Development together govern Chile's system of innovation. These two coordinating councils have political influence across the Ministry of Economy, Ministry of Education, Ministry of Agriculture and the Ministry of Environment. Through efforts by a conglomerate of institutions and under ministries, that include CONICYT, funding and government support are provided to firms, Research Centres, Universities, Foundation Chile and other international Centres of Excellence (see **Figure 3**).

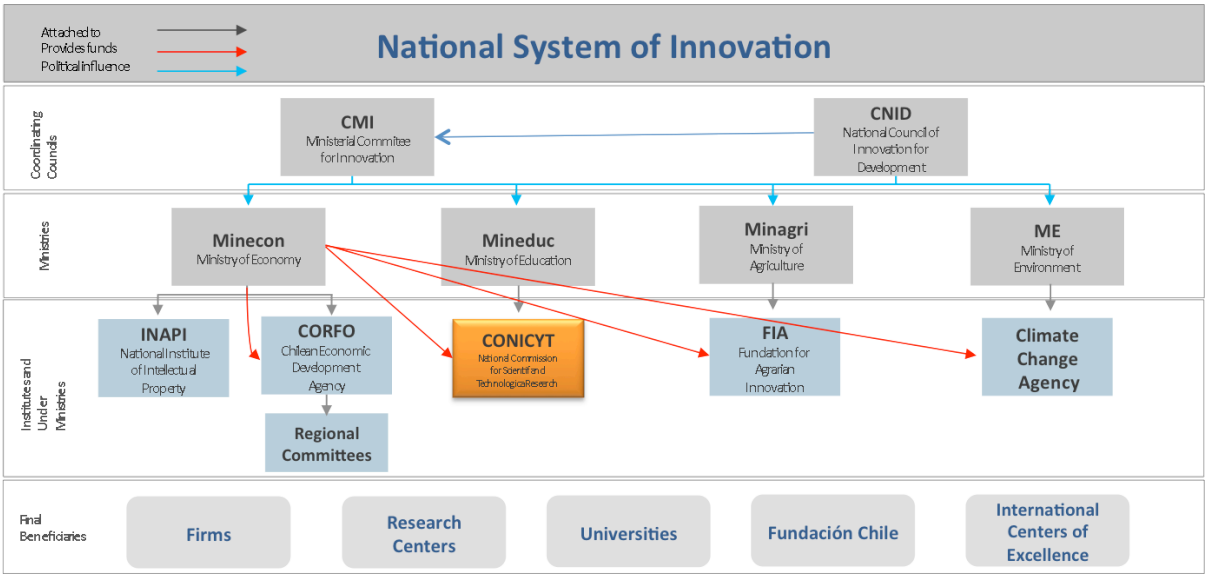

Figure 3: Chile's Innovation System

As a leading government institution supporting R&D in Chile, CONICYT has a number strategic of goals and programs. The five strategic goals are;

- Training of Advanced Human Capital
- Strengthening and Development of the Scientific and Technological Base
- Building Regional Capabilities
- Science and society
- International Relations

In 2014, OECD reported Chile's R&D spending to be 0.39% of its GDP. In the same year (2014) CONICYT spent $460 million into the STI system while total R&D expenditure in the economy was $744 million. In essence CONICYT supports more than half of Chile's R&D expenditure. At present CONICYT is funding over 3,800 research projects, 42 research

centres and are providing more than 10,000 PhD and Masters scholarships. The centres of excellence supported by CONICYT are;

- Early Human Development in Extreme Environments
- Antarctic and Sub Antarctic Science
- Conflict and cohesion in Chile today
- Water Resources
- Ageing processes and adult Health
- Medicine for 21st Century Chronic Diseases

Presentation 2. Effective funding mechanisms and investment partnerships for innovation

By: Ms. Katy Manrique, Analyst of Technological Innovation, CONCYTEC, Peru

CONCYTEC is Peru's implementing unit in charge of executing financial schemes that support the domestic science, technology and technological innovation system. It aims to form the human capital of Peru; increase and improve scientific research and technological development; promote more competitive businesses; and strengthen coordination between different stakeholders in academia, business and government.

CONCYTEC's financial instrument support STI the entire research pipeline from basic research to applied research, and also funds centres of excellence. This is an incentive to attract talent and support postgraduate and PhD research both domestically and abroad. There are five categories of schemes under this financial instrument:

- Graduate Studies Scholarships – to fund Human Capital Formation
- Mobilisation (Travel Grants) – to encourage STI interchange
- Events and Publications – to support STI Diffusion
- Projects – to increase Generation, Application, Transference, and Commercialisation of STI
- Awards

Peru has also developed a tax incentive law to fund innovation. The law promotes private investment in projects of scientific research, technological development and technological innovation (R + D + i) through a tax benefit applied to Income Tax. This law seeks to encourage Peruvian companies to carry out (R + D + i) activities that impact the competitiveness and productivity of their organizations.

Companies that qualify their R + D + i projects will have access to the following benefits:

- Companies that develop a project directly or through a domiciled center will have access to a tax deduction of 175% on their expenses.

- Companies that develop a project through a non-domiciled center will have access to a tax deduction of 150% on their expenses.

The key challenge is to strengthen the System of Science, Technology and Innovation to improve the skills of research and innovation at the enterprise level.

Presentation 3. Funding Innovation

By: Dr. Ryan MacFarlane, C&M International, Australia.

The utilisation of blended financing to invest in waste management systems was presented during the PPSTI Workshop on Domestic Innovation Systems and Networks. With the Asia-Pacific region forecasting the generation of 1.4 billion metric tons/year of municipal solid waste by 2030, the APEC Virtual Working Group on Marine Debris recommended the need for innovative funding mechanisms to develop innovative solutions that address environmental problems associated with marine litter (2015/SOM3/CD/019). The volume of global waste is growing exponentially and poses high environmental and socio-economic costs to the Asia-Pacific region. To mitigate these negative impacts, solid waste management systems that will "increase economic growth, generate jobs, reinvigorate tourism, and reduce emissions of toxins and greenhouse gases" need to be developed through blended financing models.

Incidentally, there is a global revenue gap of $40 billion that is projected to finance the solid municipal waste sector. This is a significant financial undertaking that requires a whole of government approach to create the "political, economic, and legal/regulatory conditions to incentivize investment in waste management in APEC economies by private investors, multilateral development banks, and other sources of capital." A stacked or blended investment by various financial sources can be significant and would mitigate the human health, ecological, and economic costs that are associated with poor waste management infrastructure.

In the concluding Senior Official Meeting in Peru in 2018, some policy and practice recommendations were made on how to overcome barriers to financing waste management systems and reducing marine litter. Nine policy and practice recommendations were endorsed by the Oceans and Fisheries Working Group, the Chemical Dialogue, and the Committee on Trade and Investment. For instance, recommendation number 6 is to enable innovative, transparent funding approaches that include independent blended pooled funding entities from governments, private sector, donors, and DFIs. Such

pooled financial resources allow for a “manageable investment with no undue burden on any one party”.

In conclusion, Blended or Stacked financing is an innovative funding mechanism that developing APEC economies such PNG can apply to attract investments and finance innovations that promote the UN Sustainable Goals.

Takeaways from Session II

1. It is important to identify regulatory barriers especially for the private sector R&D funding. Key determinants could be:

- Identifying bankable projects for the private sector
- Ease of doing business in host economies
- Reducing risks for investment
- Developing different funding models for different innovation types

Figure 4: Takeaways from Session II

SESSION III THEME: INSTITUTIONAL FRAMEWORKS FOR INNOVATION NETWORKS

Mr. James Pittman moderated this session.

Framing Question: What are the principles for establishing and maintaining productive innovation networks?

Keynote Presentation: Productive Innovation Networks

By: Ms. Christina Schönleber, Director (Programs & Policy), APRU International Secretariat, Hong Kong, China.

APRU brings together thought leaders, researchers, and policy makers to exchange ideas and collaborate on effective solutions to the challenges of the 21st century. With a membership of a 50-member university, APRU recognises the importance of university networks in creating solutions to development challenges. Since domestic innovation systems are ecstatic and continually evolving, APRU has developed an adaptable network of universities since its inception in 1997.

APRU's strategic priority is to support productive innovation networks through a reliable platform for sharing of common goals, conducting focused research, securing adequate funding, and its ability to build strong partnerships. This is achieved through the creation of knowledge platforms that identify societal challenges, and investments are targeted to find appropriate solutions from an APEC perspective. By embedding networks under thematic areas, APRU takes an interdisciplinary approach that incorporates sciences, social sciences, and humanities.

These networks include both internal networks and external networks. The former is considered to be priority and targets higher education and research programs, Asia-Pacific and Global Leaders, and partnering on solutions to Asia-Pacific challenges. APRU's internal innovation networks offer Pacific Rim Challenges on a number of focus areas including Global Health, Multi Hazards, Population Aging, Gender Equity (Asia-Pacific Women in Leadership), Digital Economy and Artificial Intelligence, Pacific Ocean, and Sustainable Cities and Landscapes. Through collaborative research within the 50 members, APRU's internal innovation networks are generating impact and contributing to regional solutions.

The internal innovation networks impact APRU's external innovation networks, which are essential for global policy impact. The external networks promote advocacy across Asia-

Pacific and support engagement with policymakers, businesses, and community. Strong partnerships underpin APRU's external innovation networks.

Sharing Session for Theme III:

Presentation 1. Principles of International Technology Transfer Network

By: Mr. John Zhang**,** Secretary General, ITTN, China

Networks are critical to the efficient and effective functioning of any innovation system. In presenting on the principles for establishing and maintaining innovation systems, Dr. John Zhang shared experiences with the International Technology Transfer Network (ITTN) organisation. The ITTN organisation was established in China in 2011, and it carries out work in association with well-known technology transfer and innovation service organisations both domestically and internationally. ITTN has since fostered long-term partnerships with more than 200 international Technology Transfer organisations in 15 economies.

ITTN's overall goal is to foster international technology transfer and promote APEC STI APEC cooperation and connectivity. The ITTN aims to

> "achieve this by building a platform for science and research organisations, enterprises and government departments; offering and promoting two-way international technology transfer and international Innovation Cooperation of technology introduction and technology output; promote quick implementation of innovation cooperation programs; and realizing the conversion of commercial value and creating win-win solutions through cooperation." (ITTN, 2014)

According to Dr. John Zhang's presentation, ITTN now has an international committee that is present in more than 40 countries (including APEC economies), over 22 official work mechanisms, and over 400 Technology Transfer Organisations. The ITTN Global Think Tank group is divided into three Sub-committees based on various elements of technology transfer including; Professional Service Committee, Technical Cooperation Committee, and the National Cooperation Committee (John Zhang, unpublished). Therefore, ITTN is an excellent example of an innovation network that has an international focus science and technology cooperation focus within the APEC region, and also contributes to new technology development and productivity growth.

Presently, ITTN is focused on a number of innovation and technology frontiers. This includes ICT, bio-medical and healthcare, rail transit technologies, engineering of new materials, energy and environmental protection, high-end gear, modern agriculture, modern science and technology services, other cutting edge technology fields, and other emerging industries. These initiatives to develop advance technologies can be enabled through technical cooperation, which requires an open innovation approach to allow the movement of professionals and experts across APEC economies. The flow of knowledge and technology, particularly from developed to emerging and developing economies, can be viewed as a critical enabler in advancing APEC's Regional Economic Integration (Committe on Trade and Investment, 2018). It is vital that developing economies are supported so that they can develop their comparative advantages and further improve their research capacities. Therefore, there is increasing urgency to develop a regional strategy to support and promote technology transfer across APEC economies.

In 2017, ITTN and MaTRineX Academy of International Innovation and Strategy jointly filed an application for APEC funding for a project titled "Foster International Technology Transfer Professionals for the APEC STI Cooperation and Connectivity". The project aimed to propose relevant policy recommendation through research on industry standards and knowledge systems of international technology transfer. This is to progress regional cooperation in scientific and technological innovation for transformation to promote economic growth within the APEC region. The project execution team is now completing the Manual of APEC Cross Border Technology Transfer.

Presentation 2. Thailand Institutional Frameworks for Innovation Network

By: Dr Chalermpol Tuchinda, Director, National Science and Technology Development Agency of Thailand

Thailand's National Science and Technology Development Agency's experience was shared during the workshop. In January 2016, NSTDA established the National Startups Committee (NSC) to ease funding access for startups and to drive collaboration across agencies and organisations to support startups. The NSC committee initially developed a 6-month program for trial and evaluation to assess its impact on the growth and success of new start-ups. The outcomes of the program were provided to the Thailand government as policy recommendations.

Thailand's funding and entrepreneurship comprised of the following 5 modules:

Module 1: *Entrepreneurial Education* – innovation awareness and training in 30 universities and TVET colleges for approximately 30,000 students.
Module 2: *Startup District* – 17 Startup districts identified and developed.
Module 3: *Idea to Startup* – at least 550 business models and prototypes developed in 30 universities.
Module 4: *Research Commercialization* – at least 100 research projects encouraged for commercialisation in government universities and research organisations.
Module 5: *Business Brotherhood* – collaboration between large corporations and universities established in 5 universities.

The success of this exercise has been remarkable. Out of the 150 funded projects, at least 50 had been successful. Monetary wise, NSTDA, and NSC invested US$ 7 million, and after six months (2017) the return on investment from these startup ventures was US$ 4 million. The expected return on investment in 2018 was around US$ 18 million. Intellectual property and rights created from this investment accounted for 9 Patents, 10 Petty Patents, 3 Copyrights, 1 Trademark, and 1 Trade Secret.

Thailand's financing and entrepreneurship model has a broad coverage in their innovation ecosystem, which covers financial, technical, human resource development, and businesses as prerequisites to their innovation network. Their networks include Technology Business Aspirers who are beneficiaries of pre-incubation programs, New Startups who are supported through research gap grants and Startup Vouchers, SMEs who are funded through Industry Technology Assistant Programs and low interest rate loans, and large organisations who are financed through NSTDA Investment Center and are also incentivised by 300% Tax reduction on R&D expenses. Thailand has demonstrated that creating a platform for innovative funding mechanisms can support entrepreneurial activities and provide solutions to their development needs. These platforms can maximise knowledge and technology outputs.

Thailand's Software Park and Science Park are NSTDA's research and development institutions that are driving the economy's entrepreneurial financing program to reach their current level of innovation success. As state institutions, they were established to strengthen Thailand's capabilities in research and innovation under their specific research priorities. The entrepreneurship program is an initiative to popularise and diffuse research outcomes and to translate knowledge into products for commercialisation and consumption within the economy or abroad. This is a good example of the impact of government decisions and clear policy intent to financially support startups. From the experiences that

were shared, NSTDA's approach ensures there is adequate financial sustainability as start-ups progress into becoming SMEs.

Presentation 3. Experiences from Academy of Science Malaysia

By: Dr Hazami Habib, CEO, Academy of Sciences Malaysia

The Academy of Sciences Malaysia was established by an Act of Parliament (ASM Act 1994). It strives to

- Be the 'Think Tank' of the nation for matters related to science, engineering, technology and innovation
- Pursue excellence in the fields of science, engineering and technology for the benefit of all.

The ASM has bee at the forefront to build the scientific capacity of Malaysia. The key to making impact is to build collaboration and rebuild broken linkages between government, universities and the industry. Accordingly, it is imperative to create a shared economy on order to initiate a shift away from the resource and labour focused traditional economy into an agile and adaptive new knowledge economy. ASM remains focused on collaboration as opposed to competition.

In pursuit of excellence in research and innovation, ASM developed the Science Outlook 2015: Action Towards Vision. The report aims to provide an independent review and insights on STI landscape in Malaysia and forge a way forward. The Science Outlook covers six strategic thrusts that are founded on collaboration network building.

- Science Governance
- Research, Development & Commercialisation
- STI Talent
- Energising Industries
- STI Enculturation
- Strategic International Alliance

CONCLUSIONS AND RECOMMENDATIONS

Ms Christin Kjelland moderated the wrap-up and review session as the PPSTI Chair for 2017-2018.

The workshop was very informative and from the outset it became very clear that representatives from the APEC member economies were supportive and wanted to see PNG succeed in developing its domestic innovation system. In moving forward, Mr James Pittman asked, "How can PNG identify new opportunities for innovation?" This then led to a further three questions being asked.

1. What is PNG benefiting from and have?
2. What are the strengths and weaknesses
3. What are the opportunities for technology and business?

In answering these questions, the following recommendations and conclusions were made.

- It is critical to build regional innovation networks to target development challenges within the Asia-Pacific region. However, it takes time to build networks. In the case of APRU, it took time to build trust between STI actors and the investors.
- Public sector policies can be limiting so needs improving and developing, particularly within domestic government agencies. This is because global or international collaborations are challenging because of different political systems across the APEC region. Therefore the urgency lies with strengthening domestic policy networks and alignments to avoid working in silos. This is essential before regional and global networks could be accessed.
- It is becoming increasingly important for universities to understand their roles in the impending knowledge based economy. Universities must also build bridges into the industries and SMEs and ensure that entrepreneurial thinking be built into the curriculum.
- Research is not the only way for innovation: it is about creating value on what you already have.
- Creating links, partnerships and exchange programs across borders in the higher education sector are vital for PNG to elevate its level of education and research capabilities.
- International cooperation is important for PNG to build its domestic innovation system. PNG's high biodiversity and agricultural background are key to promoting international innovation and research collaborations.

- Build and sustain talent. It is essential that people are not seen as capital but as creative talent with the potential to innovate.

ANNEX I: WORKSHOP PROGRAM

PPSTI 06 2017A - Workshop on Domestic Innovation Systems and Networks

Lamana Hotel, Port Moresby, Papua New Guinea

12th – 13th of August, 2018

AGENDA

Sunday, 12th August 2018 **(DAY ONE)**	
8:30 – 9:00 am (30mins)	**Arrival and Registration**
9:00 – 9:15 am (15mins)	**Opening Remarks** Prof. Teatulohi Matainaho, Chairman & CEO, PNG Science and Technology Council & Secretariat
Introductory Session	***INNOVATION SYSTEMS & NETWORKS OVERVIEW***
9:15 – 10:00 am (45mins)	**Moderator:** Ms. Christin Kjelland, PPSTI Chair **Keynote Address 1:** Mr. Nicholas Brooke, Chairman, Professional Property Services, Hong Kong, China (15min) **Keynote Address 2:** Mr. Brad Jackson, CEO, i2i Development and PNG Agriculture Company, Australia (15min)
10:00 – 10:30 am (30mins)	**Coffee Break and Photo Session**
Session 1	***THEME 1:*** ***GOVERNMENT STRUCTURES AND FRAMEWORKS FOR INNOVATION*** *Framing Question: What structural and policy elements are essential for the effective governance of innovation?*
10:30 – 11:30 pm (60mins)	**Keynote Address:** Dr. Jungwon Lee, Senior Research Fellow, STEPI, Republic of Korea (15min)
	Sharing Session: **Moderator:** Dr. Jeffrey Noro, Project Overseer 1. **AUSTRALIA:** Mr. James Pitman, Acting Manager for International Negotiations, Science and Innovation Section (10min) 2. **CHINA:** Dr. Wang Junwei, Deputy Director General, Chinese Science and Technology Exchange Centre (10min) 3. **RUSSIA:** Mr. Maxim Romanov, Director (Department of International Cooperation), Skolkovo Foundation (10min) 4. **USA:** Ms. Staci Rijal**,** Foreign Affairs Officer, U.S Department of State (10min)
11:30 – 12:30 pm (60mins)	**Break-Out Session:** Break-out into groups to delve into framing question and related topics.
12:30 – 1:30 pm (60mins)	**Lunch**

Session 2	***THEME 2:*** ***INNOVATION FUNDING*** *Framing Question: What are the principles of effective funding mechanisms and investment partnerships for innovation?*
1:30 – 2:30 pm (60mins)	**Keynote Address:** Dr. Ma Leju, Senior Expert (International Industries), DiDi, China (15min)
	Sharing Session: **Moderator:** Dr. Jeffrey Noro, Project Overseer 1. **CHILE:** Dr. Khaled Awad, Director for Fund for the Promotion of Scientific and Technological Development, CONICYT (10min) 2. **PERU:** Ms. Katy Manrique, Analyst of Technological Innovation, CONCYTEC (10min)
2:30 – 3:30 pm (60mins)	**Break-Out Session:** Break-out into groups to delve into the framing question and related topics.
3:30 – 4:00 pm (30mins)	**Coffee Break**
4:00 – 4:30 pm (30mins)	**Review of Day 1** Dr. Jeffrey Noro, Project Overseer

Monday, 13th August 2018 (DAY TWO)	
8:30 – 9:00 am (30mins)	**Arrival and Registration**
9:00 – 9:15 am (15mins)	**Brief Review of Day 1 & Overview of Day 2** Dr. Jeffrey Noro, Project Overseer
Session 3	***THEME 3:*** ***INSTITUTIONAL FRAMEWORKS FOR INNOVATION NETWORKS*** *Framing Question: What are the principles for establishing and maintaining productive innovation networks?*
9:15 – 10:15 am (60mins)	**Keynote Address:** Ms. Christina Schönleber, Director (Programs & Policy), APRU International Secretariat, Hong Kong, China (15min)
	Sharing Session: **Moderator:** Dr. Jeffrey Noro, Project Overseer 1. **CHINA:** Mr. John Zhang**,** Secretary General, International Technology Transfer Network (ITTN) (10min) 2. **INDONESIA:** Dr. Sasa Sofyan Munawar**,** Head of Division for Incubation and Technology Transfer, Center for Innovation, Indonesian Institute of Sciences (LIPI) (10min) 3. **THAILAND:** Mr. Chalermpol Tuchinda, Director, Software Park, National Science and Technology Development Agency (NSTDA) of Thailand (10min) 4. **MALAYSIA:** Mrs. Hazami Habib, CEO, Academy of Sciences Malaysia (10min)
10:15 – 10:30 am (15mins)	**Coffee Break**
10:30 – 11:30 pm (60mins)	**Break-Out Session:** Break-out into groups to delve into the framing question and related topics.
11:30 – 12:30 pm (60mins)	**Lunch**
Session 4	***FORMAT/OUTLINE*** ***"APEC Manual on Innovation Systems and Networks"***
12:30 – 1:30 pm (60mins+)	**Moderator:** Dr. Jeffrey Noro, Project Overseer The draft format/outline of the APEC Manual on Innovation Systems and Networks to be presented for comments and input.
1:30 – 1:45 pm (15mins)	**Coffee Break**
Closing Session	***WRAP-UP & REVIEW***
1:45 – 2:00 pm (15mins)	**Moderator:** Christin Kjelland, PPSTI Chair