United Nations
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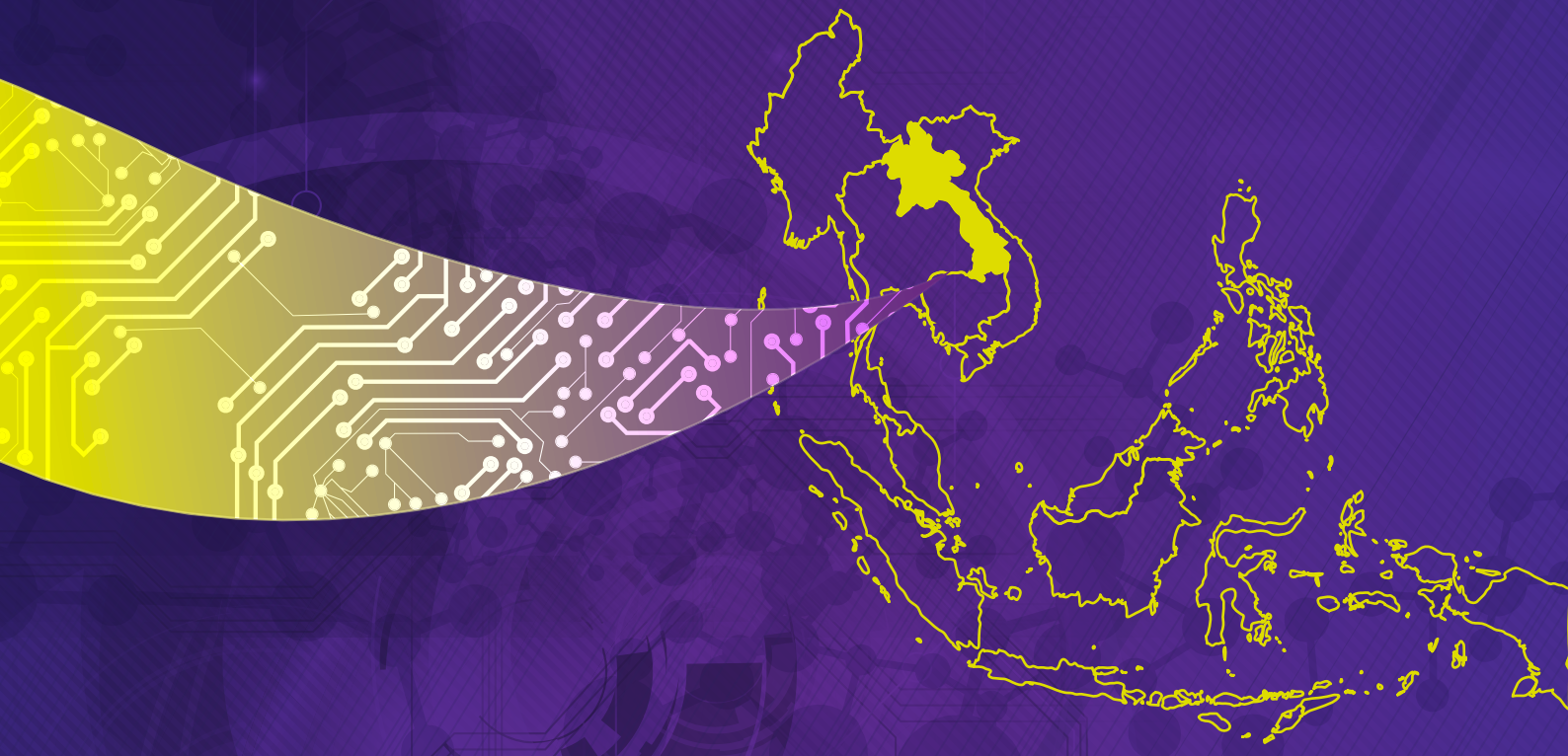
GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY
AND INNOVATION POLICY INSTRUMENTS

Mapping Research and Innovation in Lao People's Democratic Republic



GO→SPIN Country Profiles in Science, Technology and Innovation Policy

Volume 7

Mapping Research and Innovation in Lao People´s Democratic Republic

GO→SPIN Country Profiles in Science, Technology and Innovation Policy

Volume 7

In co-operation with the Ministry of Science and Technology from Lao PDR

Sweden
Sverige

Sida
SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

With the financial support of the Government of Sweden to the GO→SPIN Country Profiles in Science, Technology and Innovation Policy Series

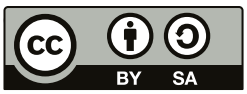
Published in 2018 by the United Nations Educational, Scientific and Cultural Organization (UNESCO)
7, place de Fontenoy, 75352 Paris 07 SP, France

ISBN 978-92-3-100271-7

Original title: Mapping Research and Innovation in Lao People's Democratic Republic

Suggested citation: UNESCO (2018) Mapping Research and Innovation in Lao People's Democratic Republic, G. A. Lemarchand and April Tash, eds. GO→SPIN Country Profiles in Science, Technology and Innovation Policy, vol. 7. United Nations Educational, Scientific and Cultural Organization: Paris.

The original text, figures and statistical analysis were prepared by Guillermo A. Lemarchand based on information provided by local authorities. The final edition was prepared by Guillermo A. Lemarchand and April Tash.



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Layout: Marie Moncet
Printed by UNESCO
Printed in Paris, France

Acronyms and Abbreviations

ASEAN	Association of Southeast Asian Nations
EPO	European Patent Office
FDI	Foreign Direct Investment
FTE	Full-time equivalent
GDP	Gross Domestic Product
GO→SPIN	Global Observatory of Science, Technology and Innovation Policy Instruments (UNESCO)
HDI	Human Development Index (UNDP)
IP	Intellectual Property
IPR	Intellectual property rights
ISCED	International Standard Classification of Education
Lao PDR	Lao People's Democratic Republic
LDC	Least Developed Country
LIRE	Lao Institute for Renewable Energy
LWU	Lao Women's Union
MDG	Millennium Development Goals
MEM	Ministry of Energy and Mines, Lao PDR
MOST	Ministry of Science and Technology, Lao PDR
NSEDP	National Socio-Economic Development Plan
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PPP	Purchasing Power Parity
SDG	Sustainable Development Goals
SETI	Science, Engineering, Technology and Innovation
SEZs	Special Economic Zones
SME	Small and Medium Enterprises
STI	Science, Technology and Innovation
S&T	Science and Technology
TVET	Technical and Vocational Education and Training
R&D	Research and Development
UIS	UNESCO Institute for Statistics (Montreal)
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UNPF	United Nations Partnership Framework

USPTO	United States Patents and Trademark Office
VC	Venture Capital
WIPO	World Intellectual Property Organization

Contents

List of Illustrations

FIGURES

TABLES

BOXES

Foreword by the Director General of UNESCO

Photo © UNESCO 2018

Science, technology and innovation are essential for working towards the achievement of the Sustainable Development Goals, by presenting new and innovative solutions to the challenges facing our world.

UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN) is an important tool to map research and innovation landscapes in different countries.

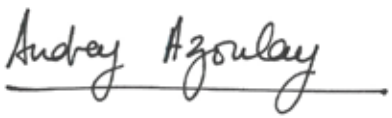
This tool provides key information on STI policies, instruments, and legal frameworks, in order to improve policy-making, implementation and evaluation. Such reliable information is also vital for integrating research and innovation into national development strategies.

International cooperation is vital for accelerating progress towards the SDGs, which is why the international community has strengthened its efforts to reinforce STI systems and the sharing of best practices. The Country Profile Series is designed precisely for this purpose.

This is the first volume of UNESCO's GO→SPIN Series for an Asian country. It reviews different dimensions of STI policy in Lao People's Democratic Republic since its independence in 1975 to the present time, covering aspects related to the key STI institutions, the legal framework and the operational instruments in place.

The report is the fruit of the successful collaboration between the Ministry of Science and Technology of Lao PDR and UNESCO, with and the participation of key stakeholders in the country. Their in-kind contributions, together with the support of the Swedish International Development Cooperation Agency, made this volume possible for which I am deeply grateful.

I am confident that this publication will provide Lao PDR and the international community of experts with useful guidelines for inclusive, evidence-based science, technology and innovation policy.



Audrey Azoulay,
Director-General of UNESCO

Executive Summary

Mapping Research and Innovation in Lao People's Democratic Republic is the seventh of a series of country profiles prepared by UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN). The series is designed to expose – through the rigorous application of an assessment lens—usable insights about science, technology and innovation (STI) policies and their context. The GO→SPIN programme is helping Member States to reform and upgrade national innovation systems and governance. It promotes building capacity to monitor and evaluate the policy performance, through a structural analysis (covering the explicit policy, the STI national ecosystem, the legal framework and operational policy instruments), because such analysis points to implicit policies and gaps, and situates the performance of Lao PDR's policy. In this way, the scope of standard STI assessment can be widened, to consider country-specific contexts, as well as emerging knowledge of technological advances that contribute to sustainable development. While complementing efforts to promote evidence-based STI policy-making as well as efforts to evaluate policy performance, GO→SPIN offers a good baseline for the promotion of scientific and technological foresight studies.

The present country profile is the result of a collaboration process initiated by UNESCO through its field office at Bangkok and its Division of Science Policy and Capacity Building at Headquarters, joined by the Ministry of Science and Technology of the Government of Lao People's Democratic Republic. The publication was possible thanks to the financial support provided by the Government of Sweden and the Swedish International Development Cooperation Agency (Sida).

This study is an attempt to systematize the different dimensions of STI policy in Lao PDR from the late sixties to present. It compiles statistical information as well as presenting inventories of the fundamental instruments in order to create a reliable framework for policy analysis.

The volume is organized so as to present the following items: (a) a long-term description of the political, economic, social, cultural and educational contextual factors; (b) a description on the status of women in science and engineering; (c) a study of R&D and innovation indicators; (d) a long-term scientometric analysis of scientific publications, patents, trademarks and utility models; (e) a historical background to STI policies in Lao PDR, (f) a description of the STI policy cycle within the country; (g) a standard content analysis of the explicit STI policies, (h) a complete analysis of the STI organizational chart at five different levels (policy-making level; promotion level; research and innovation execution level; scientific and technological services level and evaluation level); (i) an inventory of all the STI government bodies and organizations related to research and innovation activities and to science and technology services; (j) an inventory of the STI legal framework, including acts, bills, regulations and international agreements; (k) a standard inventory with 18 different analytic dimensions of all the STI operational policy instruments and (l) an analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) of the country's research and innovation landscape.

Some key findings arising from this work of describing the Lao PDR STI system are summarized below:

- Life expectancy at birth has increased from 47.7 years in 1975 to 66.5 years in 2015. The Human Development Index has progressed in a parabolic fashion over decades increasing their value from 0.37

in 1985 to 0.586 in 2015. The under-5 mortality rate had fallen to 66.7 per 1 000 live births, improving the 2015 UN Millennium Developing Goals' target of 70. The gross domestic product (GDP) of Lao PDR, measured in constant 2015 US$ (1984–2016) and expressed in constant 2011 PPP international $ (1990–2016), has been growing exponentially at annual growth-rates of 6.4 and 6.7 respectively. On the other hand, the GDP per capita experienced a growth following a mathematical cubic curve, with annual growth-rates of 4.4 and 5 respectively.

- In order to maintain its growth and make the country more sustainable, Lao PDR must diversify its productive system and develop its industries to move towards higher-value production by improving its innovation system. At present, policies focus on developing STI management capacity without a comprehensive view of industry or R&D. Each line ministry has been pursuing its goals individually, which has created inconsistencies in overall planning. The main goal of this project is to increase the absorptive capacity of Lao PDR and its stakeholders using collective priority setting.
- The government has created specific and special legislation as a foundation to develop *Special Economic Zones* (SEZs), promote investment and a favourable environment. At present, there are 13 SEZs in Lao PDR, four of which are SEZs and nine of which are specific economic zones. Of the total 13 established SEZs, seven have been upgraded from general concession investments. By 2016, there were 249 companies that have invested in these zones, including: 180 foreign companies, 48 domestic companies and 21 joint venture domestic and foreign companies. These companies have invested 49.4% in the service sector, 34.6% in the commercial sector and 16% in the industrial sector.
- The creation of the ASEAN[1] Economic Community (AEC) in 2015 marked a milestone in regional economic integration in Southeast Asia. The AEC has since established a highly integrated market consisting of 625 million consumers with a combined purchasing power of US$ 2.3 trillion. For a small, landlocked country like Lao PDR, the ASEAN market and production base offers great economic potential by opening-up more opportunities to participate in regional value chains. Recent regional agreements within the framework of the ASEAN Plan of Action on Science, Technology and Innovation (APASTI) for the period 2016–2025 open opportunities for Lao PDR to enhance the quality of education through exchange and twinning arrangements with high-standard educational institutions in advanced ASEAN countries such as Singapore and Malaysia.
- Enrolment in tertiary education has been expanding exponentially at an annual rate of 13% from 26 students in 1955 to more than 130 000 in 2015. The total enrolment per 100 000 inhabitants remained very low (approx. 130 students per 100 000 inhabitants) from 1984 to 1996. After 1997 this number expanded exponentially to reach 2083 in 2013. These facts are consistent with the creation of the National University of Laos, in 1996, and the growing number of tertiary and higher education institutions in the country since then.
- The country requires the development of better skills, for example by providing training to the local workforce. Improving skills is a necessary condition for diversifying the economy, and for shifting the type of investment inflows to the country away from those that rely on unskilled labour and away from activities that make intensive use of natural resources, toward those that use skilled labour and capital-intensive production processes. Human resource development has been very little promoted by either the private and public sectors. Labour lacks necessary skills. Human resource development may be essential to the demand-driven socio-economic development, especially for SMEs that confront changing conditions due to Lao PDR's integrating into the ASEAN Economic Integration and joining WTO.
- The National Assembly has recently approved eight new public laws for the promotion of STI activities. With the creation of the Ministry of Science and Technology (MOST) in 2011, four new research institutes as well as the Office of National Science Council were founded under MOST.
- Research and innovation are dependent on having the requisite stock of human capital, defined as the knowledge, skills, competencies and attributes that facilitate the creation of personal, social and economic wellbeing. Per million inhabitants, Lao PDR has an estimated 76 headcounts (HC) or 19 full-time equivalent (FTE) researchers.

1 Association of Southeast Asian Nations (ASEAN). The Member States are: Brunei Darussalam; Cambodia; Indonesia; Lao PDR; Malaysia; Myanmar; Philippines; Singapore; Thailand and Viet Nam.

- The university system in Lao PDR does not have adequate PhD programmes on science and engineering or infrastructure to conduct research in the key national strategic areas. Evaluation and accreditation standards for postgraduate programmes and a system of full-time scholarships at PhD level are also lacking. In absence of these critical conditions, it will be very difficult to expand the number of FTE researchers in the country during the next decade. The design, implementation and substantial financing in series of new STI operational policy instruments is a necessary minimum requirement to expand the number of researchers. Policy measures can be designed to ensure a healthy supply of human resources to STI, for example incentives such as fellowships aiming to rapidly increase rates of student enrolment and completion of scientific, technological and engineering education and training at undergraduate and postgraduate levels.
- The small pool of researchers is the most serious weakness of the research and innovation system of Lao PDR. The 8th National Socio-Economic Development Plan (NSEDP) proposed to "reach 11 researchers per 10 000 of the population by 2020." Assuming the plan is referring to headcount numbers, this particular target is 14 times the number available in 2012. With the present lack of adequate policy instruments (e.g. scholarships, local PhDs programmes, new research infrastructure, new permanent posts for researchers, etc.) the possibility of reaching this target by 2020 is very low.
- The 8th NSEDP does not address any strategy to foster women in science and engineering. There is a lack of recent statistics on the distribution of women among researchers and technicians in Lao PDR, the last 2002 survey showed 23% of these employees in S&T were women. By 2014, only 35% of those working at the Ministry of Science and Technology were women. In 2015, the female tertiary enrolment at the International Standard Classification of Education (ISCED) 5 level was only 31.7% of the whole and women made up only 29.3% of the teachers at the same educational level institutions. In 2015, women represented only 32.8% of the graduates and 40.1% of the academic staff of all ISCED levels taken together. There are no existing or planned operational policy instruments of any sort that aim to promote gender equality within scientific and technological research activities, nor are there any incentives specific to encouraging girls and women for performing research and innovation activities.
- Lao PDR's Gross Domestic Expenditure on R&D (GERD) represents approximately 0.04% GDP (or 37 times smaller than the share of GDP that R&D needs to start influencing the national economy, which is 1.5% GDP). The public funding allocation for STI has been approximately 1% of the national public budget and the 8th NSEDP proposes taking that number to 2%. Even if this target is met, this figure remains very low.
- Although Lao PDR researchers published 173 scientific articles in mainstream journals in 2016, this represents just one scientific article per HC researcher every 2.8 years, or 0.35 scientific articles per HC researcher annually. The number of articles per million inhabitants has been increasing in a parabolic way since 1997 reaching 25.9 articles per million population in 2016. The past decade has seen a positive trend: an extraordinary increase in the number of co-publications with foreign countries, which now represent 90–100% of all Lao PDR scientific articles listed at the Web of Science.
- Macro-economic conditions today hamper research and innovation demand in the business and industry sector. No evidence was yet found showing R&D conducted within the Lao PDR business enterprise sector. Even in manufacturing and processing, capital is imported at a premium. The supply chain is also weak because there are few providers that can be found in the system. Similarly, competitive financing is typically unavailable in the country. R&D capacity found in the research institutes and university is limited and does not meet the needs of industry. Despite that the 8th NSEDP sought to promote public–private partnerships, there is no operational policy instrument in place to foster networking among the business, government and university sectors.Lao PDR: mapping the landscape of a small-economy innovation system

Acknowledgments

Mapping Research and Innovation in Lao PDR is the outcome of a collaboration process initiated by UNESCO through its field office at Bangkok and its Division of Science Policy and Capacity Building at Headquarters, joined by the Ministry of Science and Technology of the Government of Lao People's Democratic Republic. Our sincere thanks go to the Government of Sweden and the Swedish International Development Cooperation Agency (Sida) for their financial support during the preparation and publication of this volume.

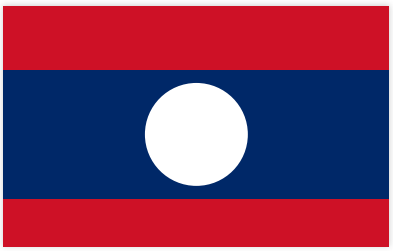
We would also like to express our gratitude to the authorities of the Ministry of Science and Technology (MOST) of Lao PDR: H. E. Houmphanh Intharath, Vice Minister; Kongsaysy Phommaxay, Director General (Department of Science); Chittaphong Ackhavong, Deputy Director General (Department of Planning and Cooperation); Phouthanouthong Xaysombath, Director (Division of International Organization and ASEAN, Department of Planning and Cooperation) and Viengsavanh Bouttanavong, Deputy Director (Division of International Organization and ASEAN, Department of Planning and Cooperation). We express gratitude to the GO→SPIN survey team who provided the information for the different inventories and other relevant documents: Chittaphong Ackavong, Phouthanouthong Xaysombath, Khamla Phoumin, Soutthiphong Vongsaya, Viengsavanh Bouttanavong, Toutou Chittavong, Phout Phommyxay, Thippaphone Sisouvong, Xaybandith Xayavong, Taokham Xayamongkoun, Phoutthasone Pathammavong, and Daloun Intharath. We would also like to thank Alongkot Soseng-Inh, Vongvilay Sounthavong, Sengchanh Kounnavong, Aphisayadeth Insisiengmay, Khamlub Senbounsou, Chanthalath Sihaphone, Chanthasack Bottaphanith, Douangsamone Sivongsa, Souvanthong Rattanasim and Syamphone Phommatham for providing valuable information for different sections of this study.

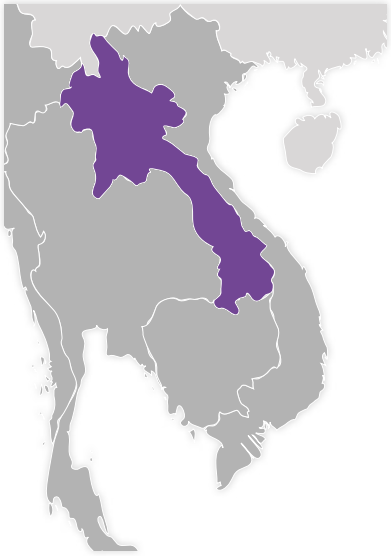
Special thanks go: to Jayakumar Ramasamy, Senior Programme Specialist and Eunhee Lee, Associate Expert from UNESCO Bangkok which co-organized the first GO→SPIN Training Workshop in Vientiane on November 2016 and co-ordinated the GO→SPIN survey and validation workshop activities in December 2017; to the personnel of the Science Policy and Partnership Section from the Division of Science Policy and Capacity Building at UNESCO: Ernesto Fernández Polcuch, Chief of Section, Kornelia Tzinova, Alessandro Bello, Amandine Callens and Cecilia Dixon-Fuentes; to Anathea Brooks and Natalia Tolochko from the Executive Office of UNESCO's Natural Sciences Sector; and to Roshan Bajracharya from the UNESCO Institute for Statistics at Bangkok.

Last but not least, our grateful thanks to the editors of the present volume Guillermo A. Lemarchand (UNESCO Senior Consultant and GO→SPIN Principal Investigator) and April Tash (UNESCO Programme Specialist from the Social and Human Sciences Sector), who transformed the report into an informative and readable study.

Flavia Schlegel
Assistant Director-General for Natural Sciences
United Nations Educational, Scientific and Cultural Organization

Lao PDR: mapping the landscape of a small-economy innovation system





Official name: Lao People´s Democratic Republic

Capital city: Vientiane (Viangchan)

Chief of State: President Bounnyang Vorachit (since 20 April 2016)

Head of Government: Prime Minister Thongloun Sisoulit (since 20 April 2016)

Elections/appointments: The President and Vice President are indirectly elected by the National Assembly for a 5-year term (no term limits). The Prime Minister is nominated by the President and elected by the National Assembly for 5-year term.

Legislative branch: Unicameral National Assembly or Sapha Heng Xat (149 seats; members directly elected in multi-seat constituencies by simple majority vote from candidate lists provided by the Lao People's Revolutionary Party; members serve 5-year terms)

Population: 6 492 000 (2015 est.)

Total area: 236 800 km^2

Ethnic groups: Lao 53.2%, Khmou 11%, Hmong 9.2%, Phouthay 3.4%, Tai 3.1%, Makong 2.5%, Katong 2.2%, Lue 2%, Akha 1.8%, other 11.6%. The Lao PDR Government officially recognizes 49 ethnic groups.

Official languages: Lao (official), French, English, various ethnic languages

Main religions: Buddhist 64.7%, Christian 1.7%, none 31.4%, other/not stated 2.1% (2015 est.)

Unit of currency: Laos Kip

National Day: 2 December 1975

Date of Constitution: before 1947 (pre-independence); latest promulgated 15 August 1991; amended 2003, 2015.

HISTORY OF A PEOPLE

Lao People's Democratic Republic is the only landlocked Southeast Asian country, which lies at the heart of the Indochina Peninsula. It consists of a northern region, centred on the valley of the Mekong River, and a narrower panhandle extending off to the southeast, with the Mekong along its western border. Less than three-fifths of the national territory is contained in the northern region of the country and over two-fifths in the country's southern panhandle.

An ancient human skull was recovered from the Tam Pa Ling Cave in the Annamite Mountains in northern Laos; the skull is at least 46 000 years old, making it the oldest modern human fossil found to date in Southeast Asia (Demeter *et al*., 2012). Stone artefacts including Hoabinhian types have been found at sites dating to the Late Pleistocene in northern Lao PDR. The archaeological evidence indicates that by 3 000 BC, settlers along the Mekong River had learned agriculture, metallurgy, and pottery making. However, little is known about the early history of this region of the world. The lowland Lao are believed to be the descendants of Tai tribes that were pushed southward in the 8th century (Gall and Hobby, 2007).

After Tai tribes were pushed southward, they settled down along the Mekong River or Lancang Jiang (Its Chinese name). Tai tribes named their territory after the name of river as Kingdom of Lancang or Kingdom of Lan Xang (translated as 'million elephants'). Between 750 to 1353, the Kingdom of Lane Xang was ruled by many kings and it had internal conflicts then brought to split into many kingdoms. By 1353, it was reunified by Fa-Ngoum, who had been raised at the court of Angor in Kampuchea and returned with a force of khmer troops. He is also credited with the introduction of Hinaya Buddhism into the kingdom of

LaneXang and for established the capital in Xieng Thong (now known as LuangPrabang). Between 1548 and 1572 during the reign of King Setthathirat, the capital was moved to Vientiane and ThatLuang stupa (now known as the symbol of Lao PDR) was constructed. In 1638, Sourigna Vongsa ascended the throne, and his kingdom expanded its frontiers. His reign is often regarded as Laos's golden age.

During 1707–1713, internal dissensions brought about a split of LaneXang into three kingdoms, LuagPrabang in the north (present-day upper Lao PDR), Vientiane in the centre (present-day capital of Lao PDR) and Champasack in the south. In the late 18th century, the Siamese established suzerainty over much of what is now Lao PDR.

In 1893, France, which had already established a protectorate over what is now central and northern Vietnam, extended its control to both Vientiane and Luang Phrabang, and Lao PDR was ruled by France as part of Indochina. Although French control over Luang Phrabang took the nominal form of a protectorate, the French colonial administration directly ruled the rest of Laos, legal justification being ultimately provided in the Lao-French convention of 1917 (Gall and Hobby, 2007).

During World War II, Lao PDR was occupied by Japan. After the Japanese proclaimed on 10 March 1945 that "the colonial status of Indochina has ended," the king of Luang Phrabang, Sisavang Vong, was compelled to issue a declaration of independence. The nationalist Free Lao (Lao Issarak) movement deposed the monarch soon after, but French forces reoccupied Laos, and on 27 August 1946. The French occupation placed an agreement establishing Sisavang Vong back as king of Laos. In May 1947, the king established a constitution providing for a democratic government.

On 19 July 1949, Laos nominally became an independent sovereign state within the French Union. Additional conventions transferring full sovereignty to Laos were signed on 6 February 1950 and on 22 October 1953. All special economic ties with France and the other Indochinese states were abolished by the Paris pacts of 29 December 1954. Under the final declaration of the Geneva on 21 July 1954, all Viet-Minh and most French troops were to withdraw the ending of hostilities in Indochina (Cambodia, Laos and Vietnam). The conference agreed on the cessation of hostilities allowing Laos henceforth to play its part in full independence and sovereignty in the peaceful community of nation.

During the sixties, Laos was subjected to intensive bombing by the USA in its war against the Democratic Republic of Vietnam (DRV), in one of the worst aerial bombardments in world history. The Laotian segment of the so-called Ho Chi Minh trail emerged as a vital route for troops and supplies moving south from the DRV, which was the target for heavy and persistent USA bombing raids. Between 1964 and 1973, the USA dropped two million tons of bombs on Laos, nearly equal to the 2.1 million tons of bombs the USA dropped on Europe and Asia during all of World War II, making Laos the most heavily bombed country in history relative to the size of its population. Efforts to negotiate a settlement in Laos resumed with USA backing in 1971, but a settlement was not concluded until February 1973, a month after a Vietnam peace agreement was signed in Paris.

On 5 April 1974, a new coalition government was set up, with equal representation for Pathet Lao and non-communist elements. Souvanna Phouma, 73 years old and in failing health, stayed on as Prime Minister, while Prince Souphanouvong was brought closer to the centre of political authority as head of the newly created Joint National Political Council.

On 2 December 1975, the Lao People's Democratic Republic was established, with Prince Souphanouvong as President and Kaysone Phomvihan as Prime Minister. King Savang Vatthana abdicated his throne, ending the monarchy that had survived in Laos for 622 years. Elections for a new National Assembly were called for April 1976.

Within two years the new regime had consolidated its power and given the country its first stable government since 1953. Private industry was then nationalized, and agriculture collectivized. Faced with an economy near collapse and strong resistance to collectivization, the government slowed the pace of socialization during the 1980s and announced a limited return to free enterprise and private landownership.

At the Fourth Party Congress of the Lao People's Revolutionary Party (LPRP), in December 1986, a "new economic management mechanism" (NEM) was set up, aiming at granting increased autonomy in the management of formerly state-run enterprises to the private sector. As part of the reform policies introduced in 1986, the government has attempted to reduce the size of the public sector, including the military. They have done this, however, in humanistic ways by avoiding the direct firing of people. In March 1989, Lao PDR held its first national elections since the Communists came to power in 1975.

In 1991, Lao PDR adopted its Constitution which redefined the country's political and economic systems as well as the rights and duties of the citizens. The following year, elections were held for a new 85-seat National Assembly with members elected by secret ballot to 5-year terms. The National Assembly, which has added seats at every election, names the president, approves a Cabinet headed by a prime minister and also approves all new laws, although the executive branch retains the authority to issue binding decrees.

The President of the Supreme Court is also chosen by the National Assembly, all the other judges are named by the legislature's Standing Committee. The country is divided in 17 provinces and the municipality of Vientiane. The State President names provincial governors and the municipal mayor. Provinces are subdivided into districts, each of which has appointed chief administrator.

Lao PDR joined the Association of Southeast Asian Nations (ASEAN) in July 1997 hosted the ASEAN summit in 2004. Subsequently, Lao PDR started integrating in the global economy and became a full member of the World Trade Organization in 2013.

DEMOGRAPHIC PROFILE

Currently, Lao PDR has a total population of 6.49 million (2015) which is relatively small compared with neighbouring countries. Most of the population is young and 60% is below the age of 25 (MPI, 2016). This is considered to be the core labour force of the country, but the contribution rate of this labour is still very low, resulting in a missed opportunity to gain from the "demographic dividend". Therefore, in order to benefit from having a young population, the Government has been focusing on improving and developing human resources, especially the increasing investment in the education and health sectors, so that people receive education and are knowledgeable and healthy. In addition, several policy interventions have also focused on developing labour skills.

Lao PDR is facing considerable population growth. The population increased from 5.6 million to 6.49 million between 2005 and 2015. Growth of different age groups within the population will vary sharply. According to the 8th National Socio-Economic Developing Plan period, the number of school-aged children (5–14) is projected to decrease by 3.7%, while the working-age population is expected to increase by 10.6% and the elderly population by 10.1%.

Figure 1 show the long-term evolution of the total population in Lao PDR (1960–2016) and also the evolution of the composition by age group (0–14 years, 15–64 years and over 65 years) as a percentage of the total. An important change in the proportion within the groups between 0–14 and 15–64 years-old, took place around the year 1995, meaning a change in the slopes of both curves.

Figure 2 shows the long-term evolution of the population growth rate between 1960 and 2016. The minimum growth rate was achieved in 1978 (1%) after the Laotian Civil War (1953–1975) and the independence of the country. Following this period, the population growth rate raised to 2.9% in 1988 to start decreasing again in a continuous way reaching 1.2% in 2013. In 2016 the population growth rate was 1.4%.

According to Lao Statistics Bureau, the country has not yet completed its first demographic transition – the decline of both mortality and fertility rates to low levels, though it has been moving in this direction. The total fertility rate of 3.2 (in 2008–11) was still more than 50% above replacement level (MPI, 2016).

The under-5 mortality rate had fallen to 66.7 per 1 000 live births in 2015, achieving (and improving) the Millennium Development Goals' target of 70 (UNDP, 2016). Figure 3 shows the long-term evolution of this indicator (1978–2015). The data was fitted by a cubic mathematical function with an extraordinary-high coefficient of determination (R^2=0.9999). This fitting behaviour is unusual to find within socio-economic indicators. However, indicates the existence of a consolidated national policy with the purpose to decrease infant mortality which has been working successfully over decades.

Because the age structure still reflects the high fertility of the past, there are successively large cohorts moving up through the age pyramid. The changing age structure of Lao PDR's population is leading to what is referred to as the "demographic bonus", meaning that the proportion of the population in the working age groups will increase, so that there are fewer dependents for any one worker. Whereas in 2015 the dependency ratio will be down to 0.62, by 2030 it will have fallen to 0.51 and by 2045 even lower (0.43). It will start to rise slowly after 2050. Due to these facts, ageing of the population is not yet an issue for Lao PDR (see Figure 1).

Because much of the land is mountainous and cannot be cultivated, Lao PDR has the lowest population density in ASEAN countries. This density is roughly 1.1 ha of arable land per household, or about 1.7 ha of cultivable land per rural family. According to MPI (2016), the latter will not decrease very much with population growth, as the population depending on agriculture is expected to remain roughly constant with increasing migration to the towns.

The main demographic targets are the following: (a) to achieve an average life span of 71 years; (b) to reduce underweight ratio in children under 5 years old to 20% and the stunting ratio to 32%; (c) to decrease the mortality rate of children under 1-year old to 30/1 000 live births and the mortality rate of children under-5 years old to 40/1 000 live births; (d) to reduce the maternal mortality rate to 160/100 000 live births; (e) to extend the availability of clean water to 90% of the population and the use of latrines to 75% of the population; (f) to extend the measles immunization to 90% of children; (g) to extend the health insurance to 80% of the population by 2020; (h) to implement a policy for providing benefits to 31 830 people who made outstanding and great contributions to the national democratic revolution; (i) to establish a social fund in the 18 provinces of the country for improving quality of life for deprived people and victims of disasters and human trafficking and (j) the establishment of networks for protecting the rights and interests of children, and prevent and combat human trafficking in 800 villages.

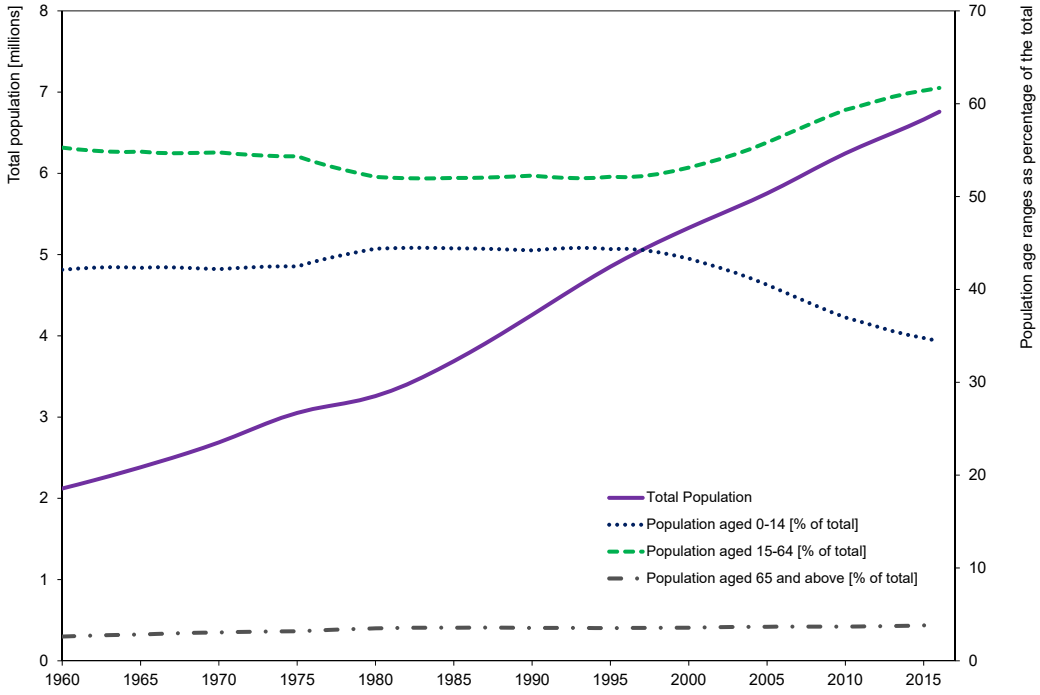


Figure 1: Evolution in the population of Lao PDR, 1960–2016.
Source: UNESCO, based on data provided by UN Statistics Division

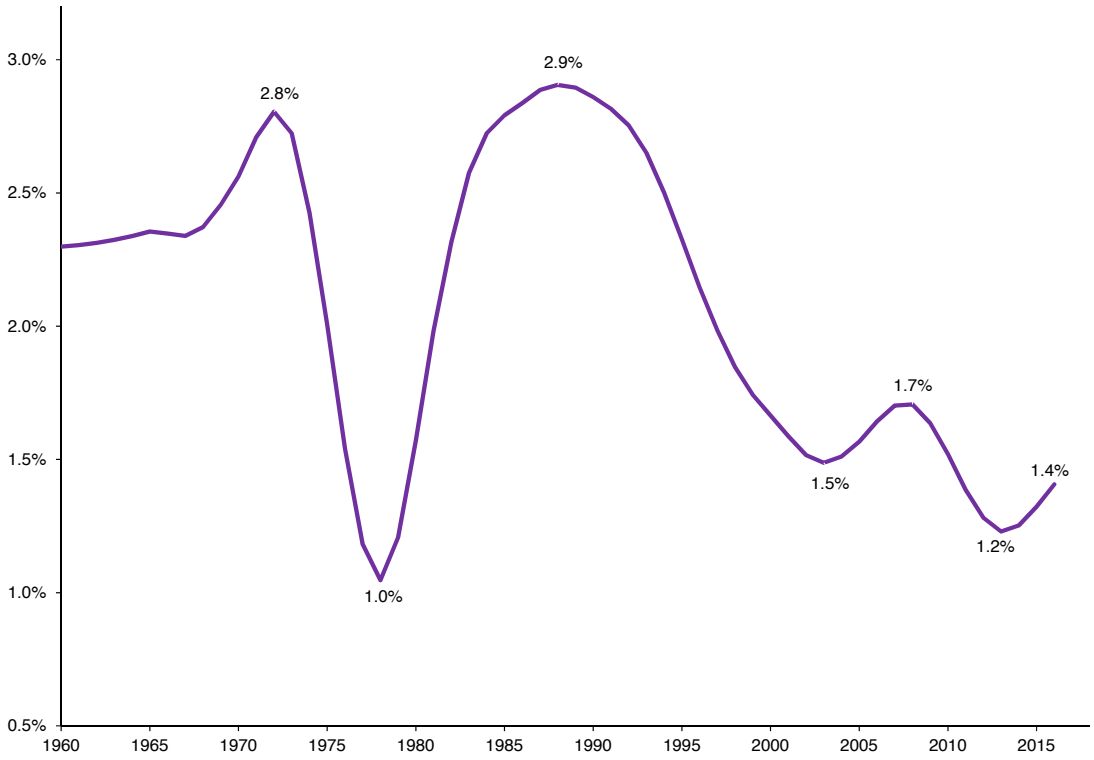


Figure 2: Evolution in the population's growth rate of Lao PDR, 1960–2016.
Source: UNESCO, based on data provided by UN Statistics Division

Figure 3: Evolution of the mortality rate under-five [per 1 000 live births] in Lao PDR, 1978–2015. The dotted line is the best fitted curve.
Source: UNESCO, based on data provided by UN Statistics Division

HUMAN DEVELOPMENT IN LAO PDR

The concept of human development focuses on the result rather than the means of achieving development. This holistic approach puts people at the centre of the development process. Since 1989, the United Nations Development Programme (UNDP) has been measuring the Human Development Index (HDI). It describes in a summary way the achievements of a country in relation to three dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living. The HDI's country coverage is of course limited by data availability. The data for the three dimensions are normalised with the corresponding lowest and highest values obtained from a sample of 187 countries, then combined into a single index. Each country will have a HDI value situated between 0 and 1. The global rank of countries is obtained by representing each individual HDI value in descending order.

Countries are classified as achieving very high, high, medium or low human development, according to their ranking. In 2015, Lao PDR got a HDI of 0.586, which corresponds to a medium human development category positioning it at 138 out of the 188 countries and territories covered by the last report (UNDP, 2016). Lao PDR's 2015 HDI is below the average of 0.631 for countries in the medium human development group and below the average of 0.720 for countries of East Asia and the Pacific.

Between 1985 and 2015, Lao PDR's HDI value increased from 0.370 to 0.586, an increase of 58.4% or an average annual increase of about 1.94%. Figure 4 shows the long-term evolution of the HDI using the latest UNDP methodological approach for the estimation of the different values within the considered period. The best-fitted curved presents a smooth parabolic growth with an extraordinary- high *coefficient of determination* (i.e. R^2=0.9994).

The parabolic growth trend shown in Figure 4 can be best explained by disaggregating the HDI dimensions into their components. For example, one of the components of a long and healthy life is life expectancy at birth (see Figure 5). In Lao PDR, this has continuously increased in a two-step quasi-linear way between 1960 and 2016, with an inflexion point around 1984. After 1984, the life expectancy at birth growth rate increased in comparison to the previous period (1960–1983). In 1970, the life expectancy at birth was 56.2 years while in 2015 reached 66.6 years.

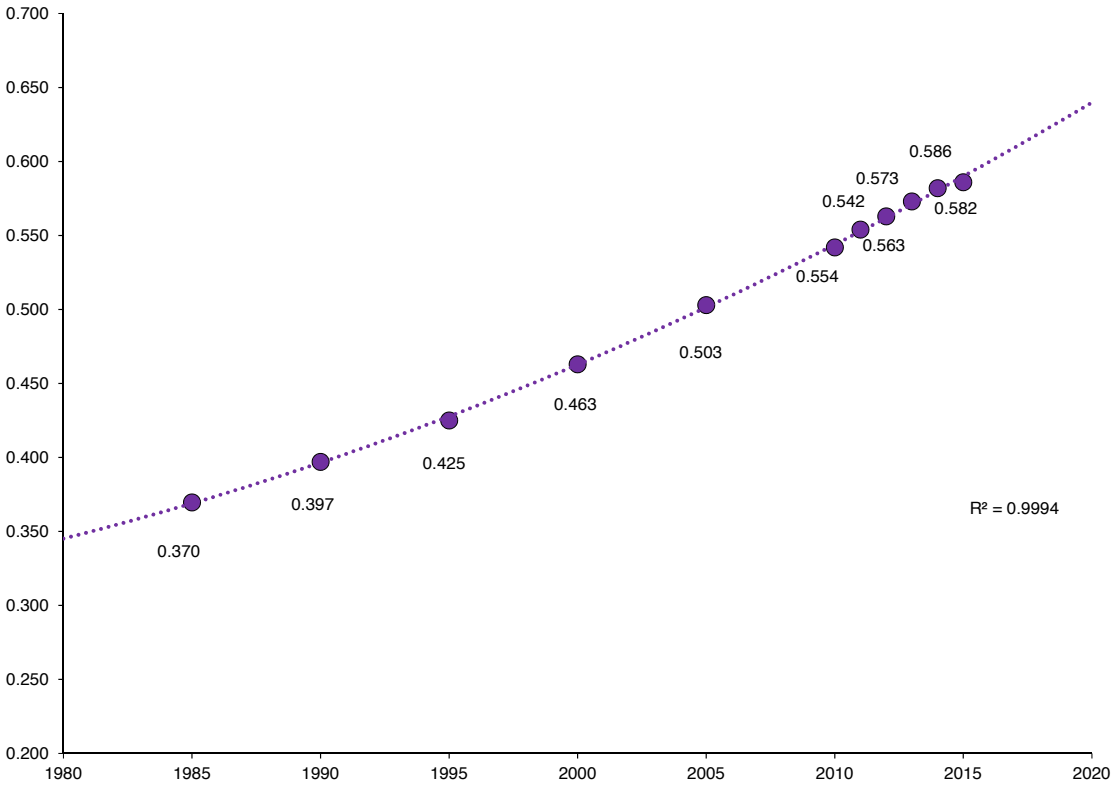


Figure 4: Evolution in Lao PDR's Human Development Index, 1980–2015.
Source: UNESCO estimation, adjusted according to the latest HDI methodological approach and data provided by UNDP (2016)

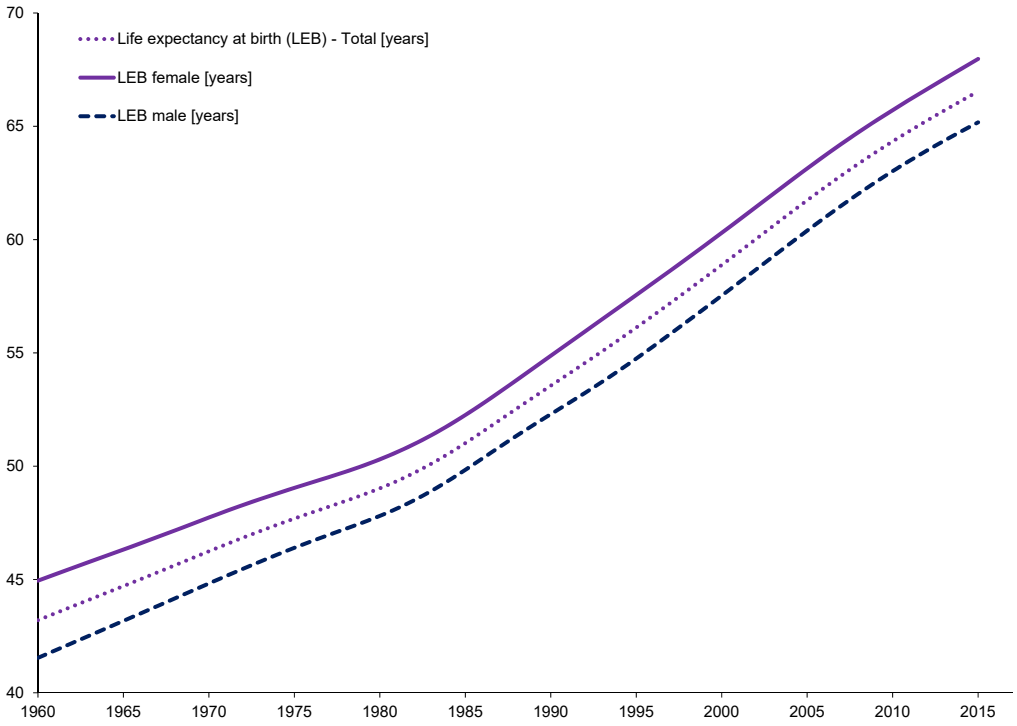


Figure 5: Evolution in life expectancy at birth in Lao PDR, 1960–2015.
Source: UNESCO, based on raw data provided by UN Statistics Division

The mean (average) income level, which helps constitute the measure for decent standard of living, measured as GDP in PPP per capita has been increasing linearly over the last four decades, going from PPP$ 1613 per capita in 1990 to PPP$ 5434 per capita in 2015. Figure 7 shows the data long-term evolution of the GDP per capita expressed in constant 2015 US$ and constant 2011 PPP international $. The data follows a cubic growth with extraordinary coefficients of determination (R^2=0.9996 and R^2=0.9989 respectively).

The mean (average) number of years of schooling for adults has also increased substantially in a quasi-parabolic way over the past 25 years: from 3.1 years in 1990 to 5.2 years in 2015 (see Table 1).

Recent *Human Development Reports* have launched an Inequality Adjusted Human Development Index (IHDI) and Gender Inequality Index (GII) alongside the HDI. When Lao PDR's HDI value is discounted for inequality, the HDI falls to 0.427, a loss of 27.1%. In the region, only Cambodia comes close, showing a loss due to inequality of 22.5%, while the average loss of 19.3% for East Asia and the Pacific is much lower. The human inequality coefficient for Lao PDR is equal to 26.9%.

The GII reflects gender-based disadvantages in reproductive health, empowerment and the labour market. Countries with better gender equality tend to have low maternal mortality, low adolescent fertility and a high proportion of males and females with at least secondary education. The GII can be interpreted as the loss in human development due to inequality between female and male achievements in the three GII dimensions.

Lao PDR has a GII value of 0.468, ranking it 106 out of 159 countries in the 2015 index. In Lao PDR, 25% of parliamentary seats are held by women, and only 30.4% of adult women have reached at least a secondary level of education compared to 42.8% of their male counterparts. For every 100 000 live births, 197 women die from pregnancy related causes; and the adolescent birth rate is 64.1 births per 1 000 women of ages 15–19 years. Women's participation in the labour market is 77.7% compared to 70% for men.

In 2014, UNDP introduced a new measure, the Gender Development Index (GDI) based on the sex-disaggregated HDI. It was defined as a ratio of the female to the male HDI. The GDI measures gender inequalities in achievement in three basic dimensions of human development—health (measured by

female and male life expectancy at birth), education (measured by female and male expected years of schooling for children and mean years for adults aged 25 years and older); and command over economic resources (measured by female and male estimated GDP per capita). Country rankings are based on absolute deviation from gender parity in HDI (UNDP, 2014). The 2015 female HDI value for Lao PDR is 0.560 in contrast with 0.607 for males, resulting in a GDI value of 0.924. In comparison, the average GDI for East Asia and the Pacific is 0.956. Thus, Lao PDR is somewhat behind the average for the region.

Table 1: Quality of life in Lao PDR

Indicator	Value (2015)
Human Development Index (HDI)	
HDI [value]	0.586
HDI [world ranking out of 187 countries]	138
Health	
Public expenditure on health [% of GDP]	0.9
Under-five mortality [per 1 000 live births]	66.7
Life expectancy at birth [years]	66.6
HIV prevalence [% of 15–49 both sexes]	n/a
Education	
Public expenditure on education [% of GDP]	4.2
Pupil teacher ratio	25.0
Primary school dropout rates [% of primary school cohort]	22.4
Expected years of schooling [of children] [years]	10.8
Adult literacy rate, both sexes [% of 15 and above]	79.9
Mean years of schooling (of adults) [years]	5.2
Population with at least some secondary education [% of 25 and above]	36.4
Inequality	
Coefficient of human inequality	26.9
Gini coefficient 2005–2015	37.9
Loss due to inequality in education [%]	34.1
Loss due to inequality in life expectancy [%]	26.2
Loss due to inequality in income [%]	20.3
Gender	
Population with at least secondary education [% of females to males]	30.4
Adolescent fertility rate [births per 1 000 women aged 15–19]	64.1
Labour force participation rate, females [% of 15 and older]	77.7
Gender-related development Index [female to male ratio of HDI]	0.92
Women in parliament [% held by women]	n/a
Maternal mortality ratio [deaths of women per 100 000 live births]	197
Sustainability	
Carbon dioxide emissions per capita [tonnes]	0.3
Natural resource depletion [% of GNI]	12.2
Population living on degraded land [%]	n/a
Impact of natural disasters [deaths per year per million people]	n/a
Fresh water withdrawals [% of total renewable water resources]	1.1
Forest area [% of total land area]	81.3
Demography	
Urban population [% of total]	38.6
Median age [years]	21.9
Dependency ratio of young age [ages 0–14]	56.6
Dependency ratio of old age [65 and older]	6.2

Source: UNDP (2016) Human Development Report

BOX 1 – A REVIEW OF THE MILLENNIUM DEVELOPMENT GOALS IN LAO PDR

In 2015, Lao PDR has achieved the poverty related Millennium Development Goal (MDG) 1 by halving its national poverty rate during the past decade. However, poverty reduction and consumption-growth lag behind GDP growth, and varies by location, education, ethnicity and occupation of household, resulting in increasing income inequality and a rural-urban gap. One third of the population in the uplands remains below the poverty line. While the MDG target of halving the proportion of the hungry was achieved, there is still a significant rate of hunger, with one fifth of the population – children in particular – being food insecure. The MDG 1 target of reducing underweight and stunting among children has not been achieved and requires concerted action. The MDG 2 target of achieving universal primary education has not been met and education from early childhood level to secondary education will have to be improved significantly. Special attention will have to be paid to early childhood education and ensuring retention rates from primary to secondary schooling.

In terms of meeting the MDG 3 target of promoting gender equality and empowerment of women, Lao PDR has done well. However special effort must be made to reach women and girls in rural areas, in certain ethnic cultures and migrant workers, and to ensure greater participation in decision-making.

Additionally, gender mainstreaming and integration are important future issues to implement. The MDG 4 target of reducing child mortality still requires effort. Despite a two thirds reduction in under-five mortality, Lao PDR is still lagging. The country has met the MDG 5 target of reducing the maternal mortality rate by three quarters. Both the child mortality rate and maternal mortality rate still reflect the low coverage and inadequate quality of the health services.

The MDG 6 target of combating HIV/AIDS, malaria and other diseases reflects that considerable effort is still needed in a variety of areas, including drug resistant malaria, wider distribution of bed nets, stronger tuberculosis (TB) detection and counterfeit drugs. While Lao PDR has a low HIV prevalence rate, the incidence of HIV is increasing and requires additional effort for better prevention, prevention of mother to child transmission and reaching key high-risk populations.

Lao PDR has achieved the safe water and sanitation MDG 7, but the high prevalence of open defecation, disparities in sanitation and other issues related to water safety and sanitation remain critical to address. More investment is needed in water, sanitation and hygiene. In terms of MDG 8, and a global partnership for development, better coordination, less duplication and more innovative and results-oriented approach is necessary to optimize outcomes and implementation. The MDG 9 focuses on the unique challenge the country must reduce the impact of unexploded ordnance, the government is taking steps to address the challenges of demining, reporting and mine risk education.

Source: Paragraphs extracted from United Nations (2016)

SUSTAINABLE DEVELOPMENT GOALS (SDGs) IN LAO PDR

The Member States of the United Nations defined the Post–2015 Development Agenda and adopted it officially at the United Nations General Assembly in September 2015, which also marked the day of completion of the Millennium Development Goals. The adoption of the Post–2015 Development Agenda was prepared collectively by many social groups and organizations through initiatives taken by the Member States. As a result, a number of inputs have greatly contributed to the development agenda that contains – at international level – a number of 17 sustainable development goals (SDGs). However, at national level, for Lao PDR, there are 18 SDGs.

The detailed SDGs for Lao PDR are: (i) end poverty in all its forms everywhere; (ii) end hunger, achieve food security and improved nutrition and promote sustainable agriculture; (iii) ensure healthy lives and promote well-being for all at all ages; (iv) ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; (v) achieve gender equality and empower all women and girls; (vi) ensure availability and sustainable management of water and sanitation for all; (vii) ensure access to affordable, reliable, sustainable and modern energy for all; (viii) promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; (ix) build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; (x) reduce inequality within and among countries; (xi) make cities and human settlements inclusive, safe, resilient and sustainable; (xii) ensure sustainable consumption and production patterns; (xiii) take urgent action to combat climate change and its impacts; (xiv) conserve and sustainably use the oceans, seas and marine resources for sustainable development; (xv) protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; (xvi) promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; (xvii) strengthen the means of implementation and revitalize the global partnership for sustainable development; and (xviii) reduce impacts of unexploded ordnance in Lao PDR.

Lao PDR strives to complete the development of the National Master Plan on land use and complete the comprehensive land allocation in 18 provinces, 92 districts and 3 455 villages across the country. The country has a commitment to: (1) Issue 400 000 land titles in the rural and urban areas during the next five years; (2) conduct a survey on land titles and record the data with a computerized system of at least 500 000 land titles; (3) complete land mapping to assess land prices in 100 districts nationwide and (4) modernize land management using IT systems to collect a full set of data (land certificate, land lease and concession, land registration, record of land registration and estimated land value) to ensure that people have legal rights to use land, resolve land disputes and increase revenue from land.

LONG-TERM ECONOMIC GROWTH

Lao PDR is among the small economies in Southeast Asia that have seen rapid economic growth. Its abundance of natural resources has been the driver of its rapid economic growth, and hydropower has been one of the biggest contributors to the Lao PDR economy (OECD, 2017).

According to the implementation report of the 7th Social-Economic Development Plan for 2011–2015, the country's economic growth has continued at an average rate of 7.9% annually, which targeted approximately 8%. The agrarian economy is gradually transitioning into an industry and services led-growth economy. The mining and hydroelectricity sectors have become the country's primary economic growth engine. The generous amounts of income generated from these sectors have improved the country's income status. The country's steady economic growth is also a consequence of increased regional and international integration as well as appropriate macroeconomic management measures and mechanisms of the Lao PDR government, peace in the country, social order, political and economic stability. These have facilitated socio-economic development, especially business operations, production, services and investment. In other words, the country has progressed, graduating from least developed country (LDC) status. In 2011, the World Bank changed the status of Lao PDR from a low-income country to a lower-middle income country.

The following Figure 6 shows the evolution of the GDP in Lao PDR between 1984 and 2016, expressed in billion 2015 constant US$ and in billion constant 2011 PPP international $. The vertical axes are in logarithmic scale while the horizontal axis is in normal scale (time). In this type of log-normal graphs the presence of straight lines indicates exponential growth. The GDP of Lao PDR has grown exponentially, whether expressed in one or the other monetary unit (billion constant 2015 US$ or billion constant 2011 PPP international $), with extraordinary high coefficients of determination (i.e. R^2 = 0.993 and R^2=0.997 respectively).

Figure 7 shows the evolution of GDP per capita in Lao PDR, expressed in constant 2015 US$ and in constant 2011 PPP international $ for the period 1984–2016. Here again the fitting curves show a cubic type growth with extraordinary high coefficients of determination (i.e. R^2 = 0.9989 and R^2=0.9996 respectively). These regular patterns show the constant growth that the country has been facing over the past 35 years and suggests how effectively were the economic policies implemented.

Figure 8 shows the long-term evolution of value-addition by the agriculture, industry and services sectors of the economy, expressed as a percentage of GDP (1989–2016). Over time, the agriculture sector shrunk the most as a proportion of the economy, going from 60.6% of the year's GDP in 1989 to 19.5% in 2016. Meanwhile, between 1989 and 2016, the services sector expanded its share of a given year's GDP from 26% to 48%, while the industry sector did the same, growing its share of GDP from 13.4% to 32.5%.

In 2016, Lao PDR's economy grew 7%. This represents a small contraction compared with growth of 7.4% in the previous year. A marked increase was observed within the energy sector and in a smaller increase in manufacturing, followed by slight growth in construction, flat mining output, and stable public spending. Around 1 350 MW of installed capacity was estimated to have come on stream in 2016 increasing the installed capacity of the power system by more than 20% to above 6 000 MW. According to the World Bank Group (2017b), recent investments in agriculture have also resulted in greater commercialization of the sector and increased exports.

Economic growth on Lao PDR was driven by natural resources which are capital intensive and create fewer jobs, while low productivity in agriculture and weak performance in manufacturing limited the income generating opportunities for most of the population.

GDP growth is projected to remain at around 7% in 2017 and 2018, supported by the healthy pipeline of power projects and growing opportunities for the non-resource sector resulting from closer ASEAN integration and efforts to improve the investment climate (World Bank Group, 2017b). These estimations are consistent with the trends shown in Figures 6 and 7.

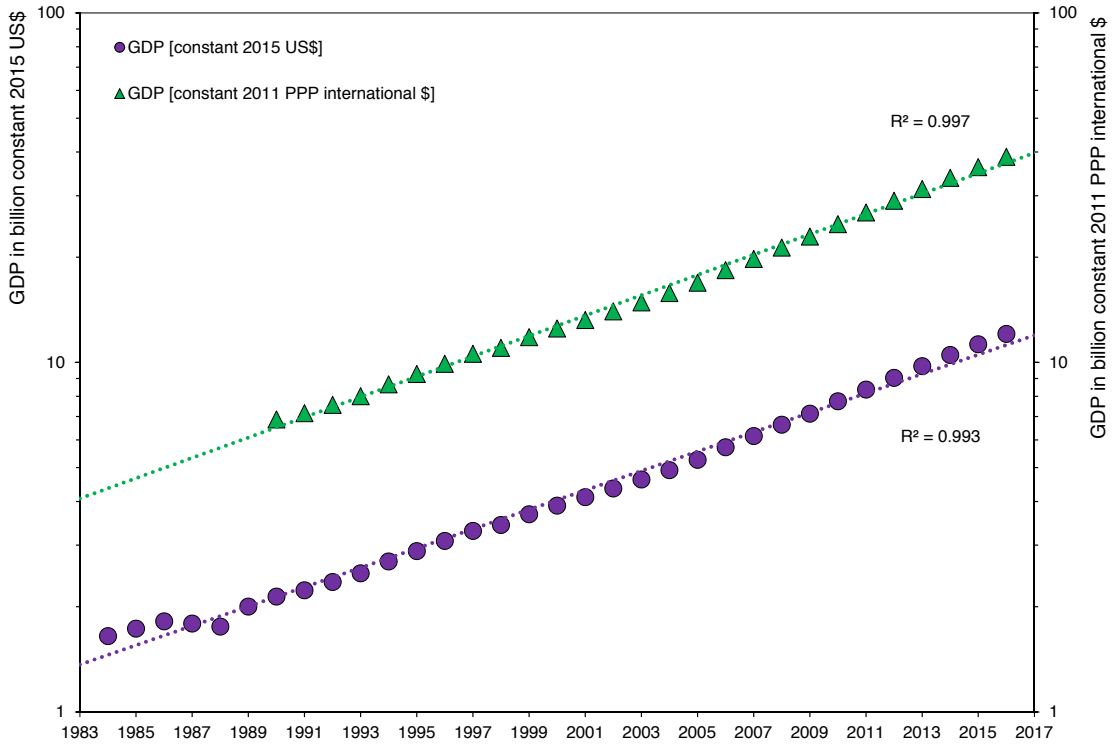


Figure 6: Evolution of GDP in Lao PDR, expressed in constant 2015 US dollars and in constant 2011 PPP international $, 1984–2016. The vertical axes employ logarithmic scales. The dotted lines show the best fitted curves, which follow exponential growths.
Source: UNESCO, based on data provided by the UN Statistics Division, World Bank Databank (August 2017)

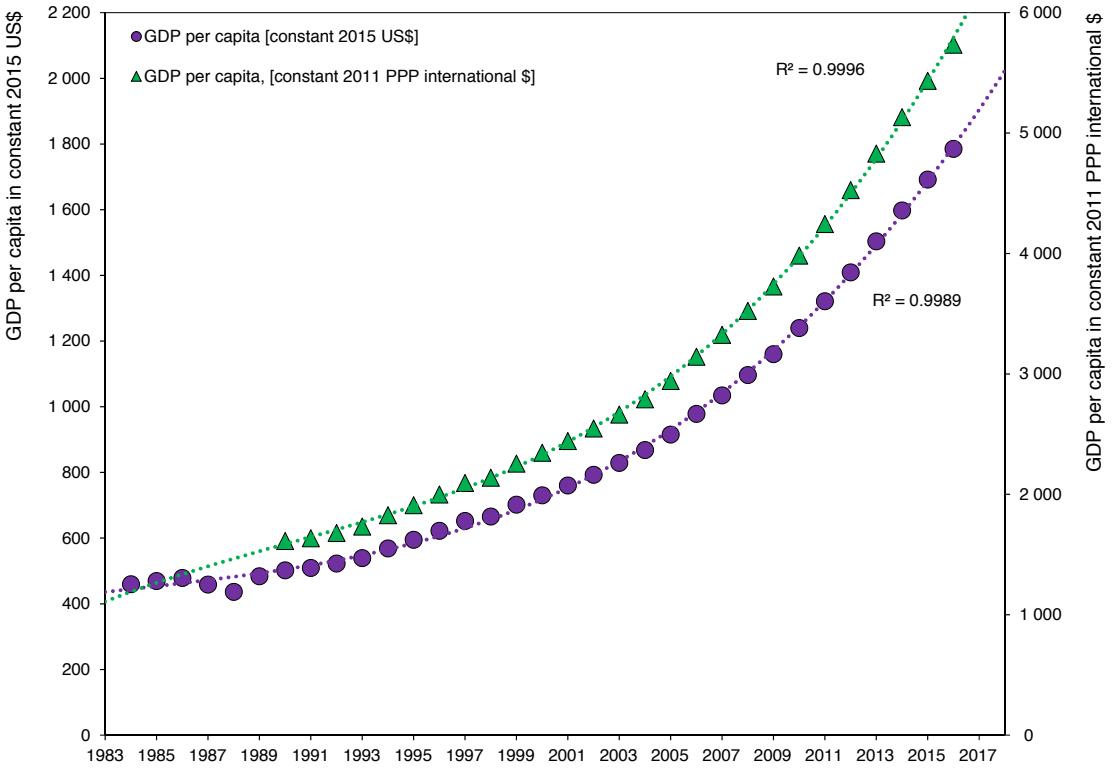


Figure 7: Evolution of GDP per capita in Lao PDR, expressed in constant 2015 US dollars and in constant 2011 PPP international $, 1984–2016. The dotted lines show the best fitted curves, which follow a cubic growth.
Source: UNESCO, based on data provided by the UN Statistics Division, World Bank Databank (August 2017)

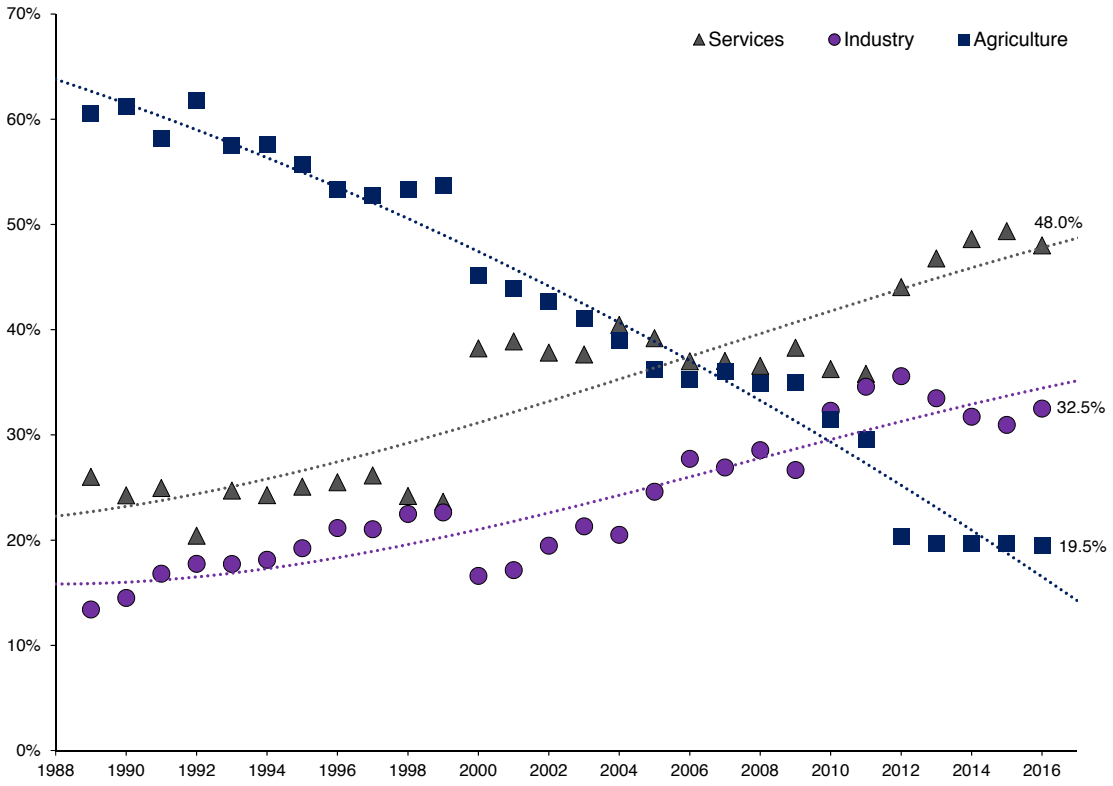


Figure 8: Value added of the agriculture, industry and services sectors of the economy as a percentage of GDP in Lao PDR, 1989–2016. The dotted lines are the best fitted curves.
Source: UNESCO based on raw data from the World Bank databank (August 2017)

ATTRACTING FOREIGN DIRECT INVESTMENT

Foreign direct investment[2] (FDI) is also usually considered a major source of growth. FDI is an important source of finance for transition economies, as it helps to cover the current account deficit and fiscal deficit (in case of privatization-related FDI) and supplements inadequate domestic resources to finance both ownership change and capital formation.

Secondly, compared with other financing options, FDI may facilitate international transfer of technology, expertise and skills, including more advanced technologies and managerial skills, and may help local enterprises expand into foreign markets. It may not only increase the activity of FDI-beneficiary firms but also have a knock-on effect on other firms and sectors through technological spillover and through increased competition, thus raising productivity for the whole industry.

Although FDI is commonly considered an important vehicle of international knowledge transfer, the effectiveness of this process depends crucially on the absorption capacity of the host economy, which is determined by a complex set of political, structural and institutional variables (competition policies, IPR, quality of education, availability of scientists and engineers, R&D infrastructure, etc.).

Countries can increase the inflow of FDI by creating a business climate that makes foreign investors feel that their capital is safe, for example by improving rule of law, stabilizing the regulatory framework,

2 The International Monetary Fund defines (foreign) direct investment in its *Balance of Payments Manual* as the category of international investment that reflects the objective of obtaining a lasting interest by a resident entity in one economy (direct investor) in an enterprise resident in another economy (direct investment enterprise). A direct investor is defined by its ownership of 10% or more of the ordinary shares or voting power in a direct investment enterprise.

establishing and protecting private property rights, and reducing corruption. Among the incentives that governments can offer, one could cite low tax rates or other tax incentives, access to loans and co-funding, zoning in proximity to where workers live, and improved infrastructure that allows products and services to reach markets.

According to UNCTAD (2017), during 2016, the global FDI inflows decreased by 2% to US$ 1.75 trillion, showing that the road to recovery remains bumpy. Flows to developing economies suffered a decline of 14% to US$ 646 billion. They had estimated that FDI remains the largest and most constant external source of finance for developing economies – compared with portfolio investments, remittances and official development assistance. In 2016, FDI flows to developing Asia contracted by 15% to $443 billion. This was the first widespread reduction in five years, with double-digit drops in most sub-regions except South Asia. FDI in both Myanmar and the Lao People's Democratic Republic declined after buoyant performances in 2015.

Economies obtain useful new technologies through various channels, such as FDI, international trade and the international diffusion of knowledge and innovation. Technology transfer may be a major reason for the growth in total factor productivity (TFP) in many economies. Wang and Wong (2012) demonstrated that, over the period 1986–2007, foreign R&D, the products of which were transferred through inward FDI and imports, improved the technical efficiency of countries by an estimated 9.97% on average. In other words, a country with an average technical efficiency score of 0.85 would have dropped to about 0.72 had it not benefited from foreign R&D through FDI and imports.

This research indicates that FDI is an effective conduit for technology transfer through technology spillovers to domestically owned firms in the host country. This is consistent with a vertical technology spillover hypothesis: foreign firms have an incentive to facilitate knowledge transfer to local firms to enable them to produce intermediate inputs more efficiently, thereby making them available to foreign firms upstream at a lower cost.

The potential of FDI for improving technical efficiency

In their study, Wang and Wong (2012) define technical efficiency as a country's ability to obtain maximum output from a given vector of inputs, so technical efficiency improvement refers to the movements toward greater productivity. Based on showing that inflow of foreign R&D via FDI improves technical efficiency in a regular manner across countries, they were able to estimate technical efficiency scores for individual countries (as a multiple of inflow of foreign R&D transferred via FDI).

Whereas least developed countries and low middle-income countries typically do not have adequate domestic resources to promote the accumulation of R&D stock, this work points to the conclusion that adopting preferential policies to promote trade and capital inflows, thereby accessing foreign R&D, can be extremely important to improve technical efficiency and, consequently, industrial competitiveness.

However, technical efficiency, innovation and competitiveness also depend on other variables, such as infrastructure and political stability. Arnold (2004) identified still other factors, typically impediments, such as: managerial deficits; a lack of technological understanding, learning ability or absorptive capacity to make use of externally generated technology; failure to (re)configure public institutions, such as universities or research institutes, to work effectively within an innovation system; deficiencies in regulatory frameworks (e.g. health and safety rules); as well as other indirect factors, related to the sophistication of demand or cultural and social values, which can have a negative effect on innovation and economic performance. Improvements in infrastructure and political stability, combined with adequate human capital policies, can help to improve a country's technical efficiency and its attractiveness for FDI.

Market failures imply a potential for policies to increase welfare by encouraging technology transfer (Sagasti and Aráoz, 1976; Berg and Fuchs, 2013). To be effective, policy must alter the incentives of agents that possess innovative technologies in order to ensure that they transfer these technologies. In practice, this means encouraging the means for technology transfer: for example, licensing and inflows of FDI.

FDI trends in Lao PDR since 1990

Before 1986, the government of Lao PDR used to control foreign trade with different types of policy interventions, including foreign exchange controls, protective tariffs, and import restrictions. It used to monopolize both exports and imports, except the trade by joint public and private companies or a few state enterprises at that time. The government liberalized its external trade system in 1987 and eliminated most of these trade restrictions in 1988. Since the country embarked on an economic transition and business liberalisation programme, foreign direct investment has played an important role in the development of Lao PDR (Freeman, 2001; Gunawardana and Sisombat, 2008; Kyophilavong *et al.,* 2017).

Table 2 shows the long-term evolution of Lao PDR's FDI inflow and outflow as well as the ratio of its net FDI inflow to gross fixed capital formation[3] (GFCF) between 1990 and 2016. Figure 9 presents the long-term evolution of FDI flows as a percentage of the GDP between 1988 and 2016. Figure 10 shows the long-term evolution of GFCF between 1984 and 2016.

From Table 2 and Figure 9 it is possible to reconstruct the long-term evolution of FDI behaviour in Lao PDR between the early '80s and 2016. Figure 9 shows particularly well that since 1988 the FDI expressed as a percentage of GDP has an oscillatory behaviour which was marked by three well-determined peaks (1996, 2007 and 2015). In nominal terms, the highest FDI was achieved in 2015 (US$1.1 billion).

During 2016, the FDI flows in Lao PDR declined 20% to $890 million (see Table 2) but still remained more than 20% higher than in 2014. The country continues to attract projects from other ASEAN members in electricity, construction and financial services (UNCTAD, 2017).

In terms of infrastructure, around 20 power plants are at different stages of construction with about 600 MW expected to come in operation by 2018. This fact will allow the country to expand its energy exports. It was observed that in Lao PDR the investors' interests go beyond pure FDI deals and embrace other forms of involvement, especially public-private partnerships (PPPs). The country carried out 17 hydropower projects on this model between 2011 and 2015, for a total value of US$ 8 billion, including the Sinhohydro Nam Ou 1–7 megaproject. Between 1998 and 2015, 29.8% of the FDI was oriented to electricity generation, 23.3% to mining, 12% to agriculture and 10.4% to services (see Table 3).

For developing large hydropower projects, the country has to contend with a skilled labour shortage. Consequently, several companies, hire in extra workers from abroad, or bring workers from their home countries to meet the skills needed. Lao PDR currently has around 20 000 foreign workers, and the number is set to rise still further in the near future, to meet the 90 000 that the Lao Ministry of Labour believes the country's businesses need to operate (OECD, 2017).

The National Assembly of the Lao PDR passed the Law on Investment Promotion on 8 July 2009. The law was implemented on 10 October 2011, when the related ministries resolved issues regarding administrative responsibility. The main goal of the law is to facilitate the application process for business and investment licenses. It should be noted that under this law, there is no distinction between FDI and domestic investment (see page 177). This legal device specifies that Ministry of Planning and Investment is responsible of the licenses for the business under concessions (mining, and timber harvesting). The Ministry of Industry and Commerce is in charge of all the other business and investment licenses. Implementation of the law provides a one-stop service for the applicants of business and investment licenses and limits the processing period to 10 working days.

Table 3 shows the 15 sectors where FDI was allocated including the amounts and shares invested between 1989 and 2015, while Table 4 shows the top 10 FDI-source countries with their corresponding investments during the same period. The electricity generation sector is at the top of all sectors, accounting for almost 30%. The mining sector is the second one, accounting for 23% of the total. The FDI in Lao PDR

3 GFCF consists of investment in land improvements (fences, ditches, drains and so on); plant, machinery and equipment purchase; and the construction of roads, railways and the like, including commercial and industrial buildings, offices, schools, hospitals and private residences.

is dominated by neighbouring countries. In terms of capital inflows, the top three countries are China, Thailand, and Vietnam, accounting for more than 60% of all FDI.

Recently, the Lao People's Democratic Republic promulgated a new investment promotion law, offering various incentives to attract investment to promoted industries and hardship areas (UNCTAD, 2017). A complex investment licensing and regulatory environment has also suppressed investments in the non-resource sector. At the end of 2016, the government submitted amendments to the Investment Law to rectify deficiencies in incentives and licensing regime: these amendments, once approved, will be implemented by the government in 2017–2018. One of the key amendments will establish a one-stop investment licensing service centre to make it easier for foreign and domestic investors to established operations in Lao PDR.

However, Tachibana (2014) showed that FDI was not promoting the entrepreneurship behaviour in Lao PDR by providing access to specific technology, but through revealing new business opportunities and reducing demand uncertainties in businesses. It was shown that inward FDI and imports were prompting local entrepreneurs into modern manufacturing businesses. In contrast, local entrepreneurs with no foreign involvements tend to choose relatively traditional products, such as furniture and wood products, as their main line of business.

Table 2: FDI inflow and outflow for Lao PDR, 1990–2016

Year	FDI inflow [million current US$]	FDI outflow [million current US$]	(FDI inflow/ GFCF*)
1990	6.0	0.2	n/a
1991	6.9	0.1	n/a
1992	7.8	1.5	n/a
1993	29.9	0.1	n/a
1994	59.2	1.0	n/a
1995	95.1	4.2	n/a
1996	159.8	3.4	n/a
1997	86.3	1.3	n/a
1998	45.3	3.0	n/a
1999	51.6	0.6	n/a
2000	33.9	4.2	0.14
2001	23.9	0.3	0.10
2002	4.5	0.2	0.01
2003	19.5	0.1	0.05
2004	16.9	0.0	0.03
2005	27.7	-6.0	0.04
2006	187.3	33.7	0.20
2007	323.5	37.0	0.22
2008	227.8	-74.7	0.13
2009	318.6	1.3	0.18
2010	278.8	-0.6	0.16
2011	300.7	0.0	0.14
2012	294.4	0.1	0.10
2013	426.7	1.0	0.13
2014	721.0	1.9	0.26
2015	1 119.0	1.1	0.27
2016	890.0	2.0	0.00

**Gross* fixed capital formation.
Source: UNCTAD World Investment Report(s) [several years]

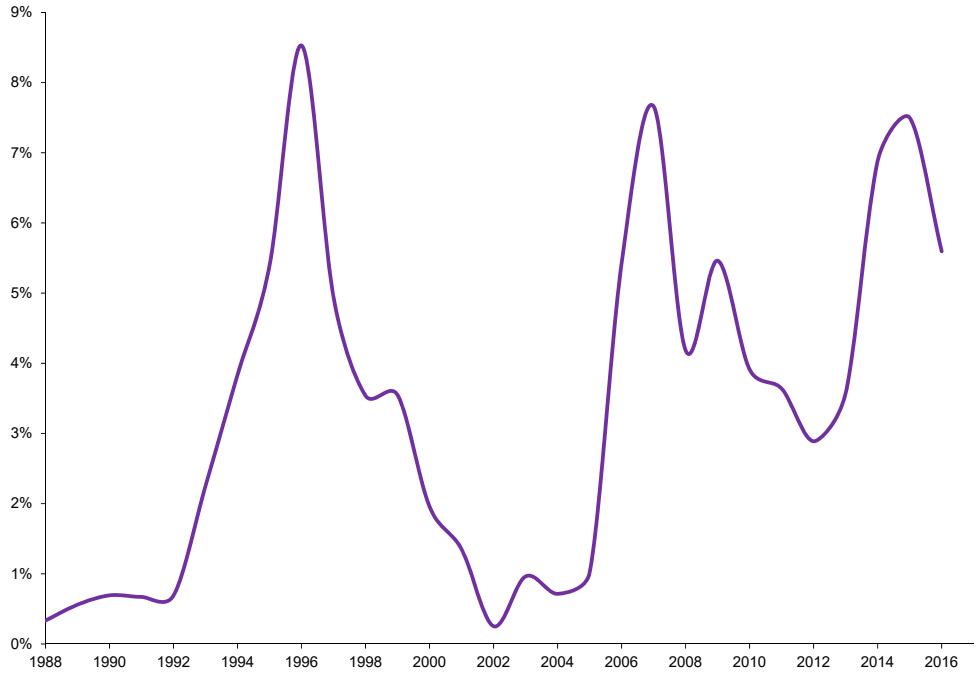


Figure 9: Evolution of net inflow of Foreign Direct Investment (FDI) in Lao PDR expressed as a percentage of GDP, 1988–2016.
Source: UNESCO based on raw data provided by the World Bank databank (August 2017)

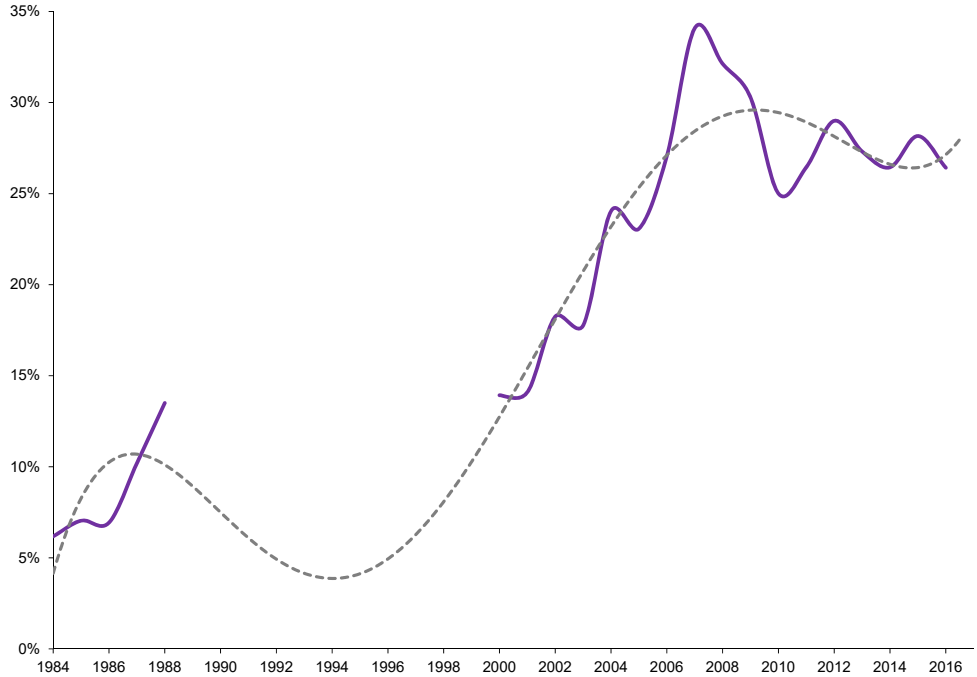


Figure 10: Evolution of gross fixed capital formation in Lao PDR expressed as a percentage of GDP, 1984–2016. The dotted line indicates the best-fitting curve.
Source: UNESCO based on raw data provided by the World Bank databank (August 2017)

Table 3: FDI by Sector, 1989–2015

Sector	FDI [million US$]	FDI Shares
Electricity generation	7 303	29.8%
Mining	5 698	23.3%
Agriculture	2 946	12.0%
Services	3 544	10.4%
Industry and handicraft	2 111	8.6%
Hotels and restaurants	1 023	4.2%
Construction	827	3.4%
Telecom industries	663	2.7%
Wood	410	1.7%
Banking	372	1.5%
Trading	325	1.3%
Garment	95	0.4%
Consulting	67	0.3%
Public health	64	0.3%
Education	31	0.1%
Total	**24 479**	**100.0%**

Source: Investment Promotion Department, Ministry of Planning and Investment, Lao PDR

Table 4: Top 10 FDI source countries, 1989–2015

Country	Investment [million US$]
China	5 484
Thailand	4 491
Viet Nam	3 574
Malaysia	813
Republic of Korea	751
France	491
Japan	438
Norway	436
Netherlands	435
United Kingdom	202

Source: Investment Promotion Department, Ministry of Planning and Investment, Lao PDR

THE CORRELATION BETWEEN GOOD GOVERNANCE AND SCIENTIFIC PRODUCTIVITY

In an increasingly complex innovation landscape, developing effective governance requires better co-ordination at and among the local regional national and international levels. With the broadening of innovative processes players and locations, the systems of governance that nourish their relationships and proper functioning become even more important. As no single actor has the knowledge and resources to tackle the innovation challenge unilaterally, every country – in one way or another – faces the task of better co-ordinating the various actors involved in formulating and implementing policy.

A country's social capital, anchored on good governance and an effective and capable state, is considered a minimal condition to stimulate harmonious development. It is understood that institutions, politics and economics are central features of any system of governance. Where controversy has sometimes arisen, it has concerned what constitutes good and bad governance, and how to link governance to democracy.

Since 1996, the World Bank has published a set of standardized governance indicators each year for every country in the world. The World Bank's team defines governance as the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected monitored and replaced; the government's capacity to formulate and implement sound policies and; the level of respect on the part of both citizens and the state for the institutions that govern economic and social interactions (Kaufman *et al.* 1999).

Within UNESCO's GO→SPIN programme some correlation among these governance indicators and STI productivity was found (Lemarchand, 2013). For example, in Figure 11, countries are represented in a Cartesian graph (four quadrants) according to their positive or negative values for government effectiveness and political stability/absence of violence and terrorism. The size of the bubble reflects the number of scientific publications – listed in the *Science Citation Index Extended*– per million inhabitants. Few nations fall in the first quadrant. Those countries with the largest GDP per capita and number of scientific publications per million population are located in this first quadrant (Lemarchand 2013).

Within the second quadrant, we find those countries, which have negative values for political stability/absence of violence and terrorism, but positive values for government effectiveness. In general, these are countries with some level of violence in their society (i.e. terrorism, war, drugs trafficking, etc.) or which are facing some economic or political crises (i.e. Greece).

The third quadrant (negative values for both indicators) concentrates the great majority of African countries. Lastly, in the fourth quadrant (positive values for political stability/absence of violence and terrorism but negative values for government effectiveness), we have a series of countries which have certain political stability but there are not so efficient in the implementation of their policies. Lao PDR has been evolving within the third and fourth quadrants since the indicators were published for the first time (Figure 12). Figure 11 also informs about differences of scientific productivity using as its measure: the number of scientific publications resident scientists annually published in journals recognized by international indexes per million inhabitants of the country's population. The smallest bubble size represents the least productive countries; larger bubbles represent countries that are more productive. The first quadrant features very high productivity.

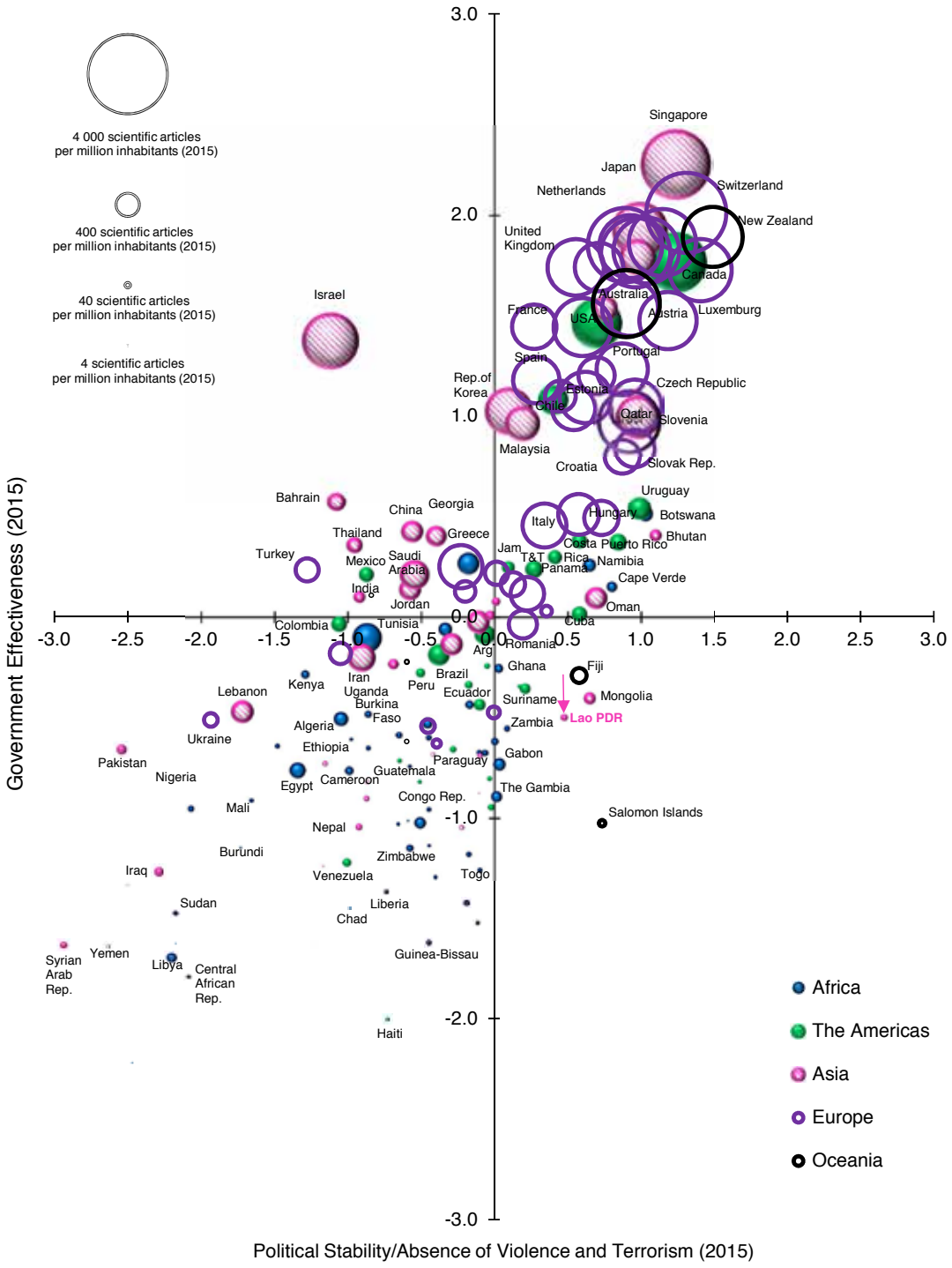


Figure 11: Evolution in government effectiveness worldwide, as measured against political stability/absence of violence, 2015. The size of the bubbles reflects the number of scientific articles in the *SCI Extended* per million population in 2015 for countries with more than 500 000 inhabitants.
Source: UNESCO based on raw data provided by World Bank databank (August 2017), UN Statistics Division and the *SCI Extended*

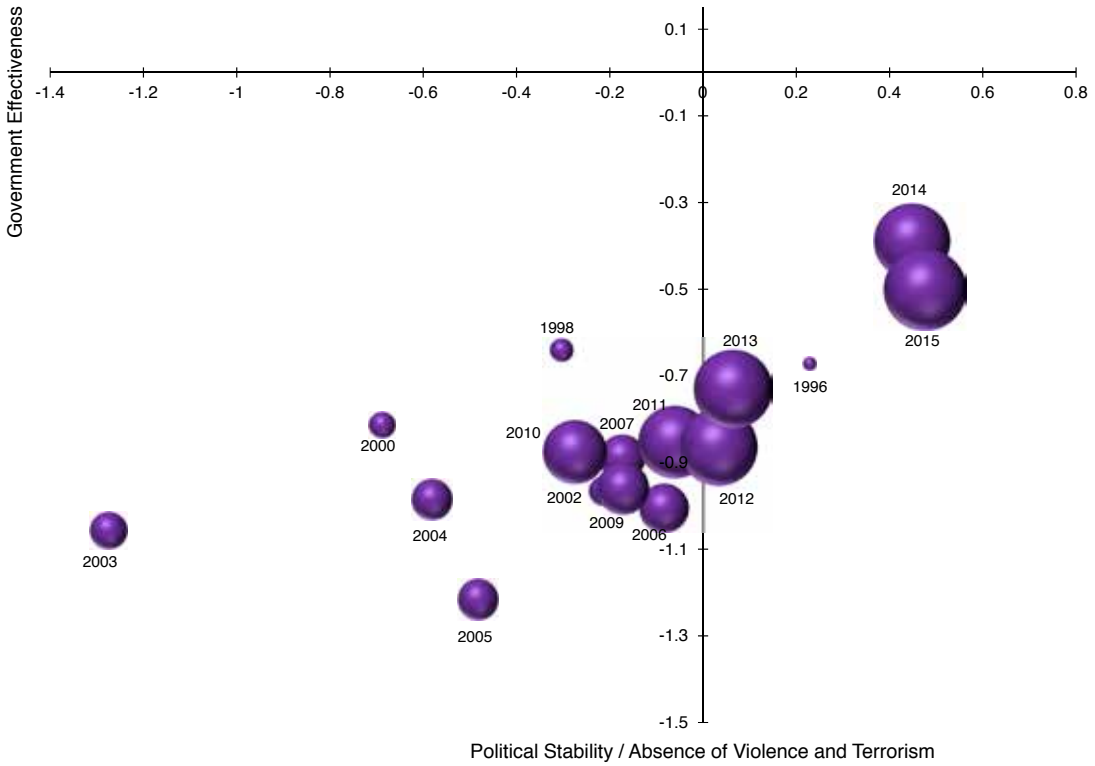


Figure 12: Evolution of the governance indicators and scientific productivity in Lao PDR, 1996–2015.

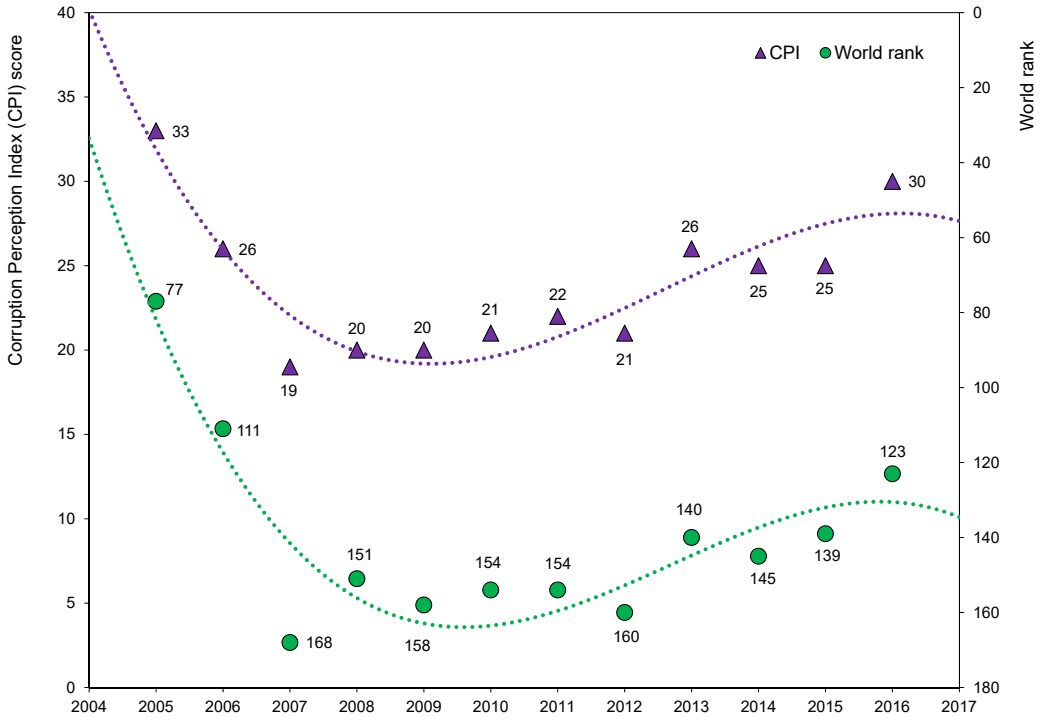


Figure 13: Evolution of the Corruption Perceptions Index (CPI) in Lao PDR (circles associated with the left-axis) and world rank (triangles associated with the right-axis) 2005–2016. The dotted lines represent the best-fitting curves.
Source: UNESCO based on raw data generated by Transparency International

Figure 12 shows on a magnified scale the evolution in the same two governance indicators (and scientific productivity) for Lao PDR over time for the period between 1996 and 2015. The political stability/absence of violence and terrorism dimension had negative values during the period 1997–2011 and positive values in the remaining years of the sample (1996, 2012–2015), while the dimension government effectiveness had negative values the whole period 1996–2015. The scientific productivity of Lao PDR in terms of scientific articles listed at the SCI Extended per million inhabitants remained very low at international standards, however there was a relative growth over recent years (see Figure 12).

Since 1995, Transparency International has published the *Corruption Perceptions Index* (CPI). The CPI ranks countries and territories based on how corrupt their public sector is perceived to be on a scale from 0 (highly corrupt) to 100 (very clean). A country's rank indicates its position relative to the other countries and territories listed in the index. The total number of countries included in the survey varies each year ranging from 85 (1998) to 182 (2011). The last survey performed in 2016 included 176 countries. The CPI is calculated using data from 10 independent institutions. All 13 sources measure the overall extent of corruption (frequency and/or size of bribes) in the public and political spheres and all sources provide a ranking of countries.[4]

Figure 13 shows the CPI scores of Lao PDR and its corresponding world ranking between 2005 and 2016 for all the years that the country participated in the survey. The shape of these curves shows an increase in the corruption level of the country between 2005 and 2007. The levels of corruption in Lao PDR remained high, showing a world rank of 160th (out of 176 countries) in 2012, 145th (out of 175 countries) in 2014, and 123th (out of 176 countries) in 2016.

Political stability and good governance sustained over decades are prerequisites for developing sound public policies. Stability and predictability are particularly important for research and innovation since both endeavours involve risk-taking with long time horizons. They thus require a stable framework of institutions and policies. Political instability may inhibit innovation by increasing uncertainty for innovators and venture capitalists; it may lessen the effectiveness of STI policy instruments by weakening the incentives they provide.

Moreover, research and innovation are crosscutting activities that involve the ministries of science and technology, higher education, health, agriculture, energy, mining, environment, water and planning among others. To be effective, research and innovation measures require co-ordination and coherence among government departments, programmes and policies; empirical studies over the past two decades show that governments find this difficult since their traditionally departmentalised structures are generally ill-suited to deal with cross-cutting policy issues such as research and innovation. Adopting a coherent approach entails not only co-ordinating a multitude of policy moves dictated by the core set of research and innovation policies such as those for higher education and entrepreneurship but also evaluating their possible interaction with policies pursuing other primary objectives such as fiscal policy, competition policy, and laws and regulations which provide the framework for innovation (OECD 2010).

4 To determine the mean value for a country, the data are standardized using the technique of matching percentiles. This method uses the country ranking reported by each individual source. It is useful for combining sources that have a different distribution. Whereas there is some information loss with this technique, it allows all reported scores to remain within the bounds of the CPI, i.e. between 0 and 100. A beta-transformation is then performed on scores. This increases the standard deviation among all countries included in the CPI and avoids a smaller standard deviation from year to year, one of the drawbacks of the matching percentiles technique. All of the standardized values for a country are then averaged, to determine a country's score. The CPI score and the ranking position are accompanied by the number of sources, high-low range, standard deviation and confidence range for each country. The confidence range is determined by a bootstrap (non-parametric) methodology, which allows inferences to be drawn from the underlying precision of the results. A 90% confidence range is then established, whereby there is a 5% probability that the value is either below or above this confidence range. Source: Transparency International (2013)

BOX 2 – CHARACTERISTICS OF THE "GOVERNANCE PILLAR" DESIGNED BY THE UNITED NATIONS PARTNERSHIP FRAMEWORK (UNPF), 2017–2021

The United Nations Partnership Framework 2017–2021 results for Lao PDR focus on three thematic pillars that support and complement the national development priorities. It will facilitate the realignment to the Sustainable Development Goals, supporting the graduation from a least development country status and help achieve sustainable human development and eradication of poverty. It is intended that all UN Agencies, including non-resident, will work collaboratively, share knowledge and resources and make these available to the government. Additionally, the UN Agencies will respect the distinct mandate and independence of the government.

Considering the rapid economic growth, ambition to reach upper middle-income status by 2030 and the governance gap, the *pillar 3* of the UNPF will contribute to improving the functions, financing and capacities of national and sub-national institutions as well as facilitating access to justice and a stronger rule of law, and more effective participation in national decision-making.

The shortcomings in the areas of social development, poverty reduction, labour markets, health and education reflect the need for institutional capacity building, enhanced service delivery and a more accountable and responsive government. This underscores the important role the governance pillar would play in enabling the achievement of the other pillars' objectives. There is a need for increased engagement and dialogue with the population, as well as the need to strengthen their ownership of national development. The UN's role as long-term, trusted and credible partner of the government has provided a strong basis to address those needs in a progressive and constructive manner.

Outcome 7 of this United Nations Partnership Framework 2017–2021 is: Institutions and policies at national and local level support the delivery of quality services that better respond to people's needs.

With regard to this Outcome, the 8th National Socio-Economic Development Plan articulates in detail the commitment to improved public governance and administration, recognizing governance as a critical factor. Lao PDR has made significant advances in certain areas of governance. These include strengthening public administration capacity, decentralizing delivery of local services, and improving accountability, with clearer goals and a greater share of responsibility being taken by the National Assembly. Lao PDR's progress in improving governance was commended at the 2015 Universal Periodic Review.

The deficit in capacity and skills as well as corruption however remain major areas of concern, impairing the implementation of programs and service delivery that is responsive to public needs, particularly for hard-to-reach parts of the country. An efficient and effective public sector that is transparent, accountable and trusted by the people needs to be based on strong institutions and solid public-sector management. This will require the strengthening of government capacities to plan, budget, coordinate, monitor and evaluate public sector programs at national and sub-national level.

The UN draws from extensive experience in supporting national planning and capacity building, including the development of the 8th National Socio-Economic Development Plan, ensuring a results-focus and the establishment of a comprehensive and SDG-based Monitoring and Evaluation framework, as well as strengthening capacity of local administrations to ensure better delivery of services, particularly in rural areas.

Under the UNPF, the UN will continue to support evidence-based policy and decision-making. For instance, the UN will harness innovation and provide technical assistance to the government

in generating, analysing and using disaggregated data to support inter alia the monitoring of the 8th National Socio-Economic Development Plan, reports on which will be debated in the National Assembly. The UN will also continue to support dialogue on effective development co-operation, particularly through the round table process, including increased participation of civil society and private sector to contribute to the achievement of national goals.

The UNPF envisages a gradual shift from traditional support to the government at the central level to a more people-centred approach at a grass-roots level. Local governance interventions will continue to strengthen the capacities of local institutions and promote inclusive decision-making.

Outcome 8 of the United Nations Partnership Framework 2017–2021 is: People enjoy improved access to justice and fulfilment of their human rights.

With regard to this Outcome, the sustainable development agenda envisages a world of universal respect for human rights and human dignity, the rule of law, justice and equality; of respect for race, ethnicity and cultural values; and of equal opportunity. Areas of focus under the SDGs relevant to the Lao PDR context include reducing discrimination and providing equal opportunities for women and girls, eliminating violence against women and girls in the public and private sphere, preventing early marriages and adolescent pregnancies, and recognizing the value of unpaid care and domestic work.

In recent years, Lao PDR has initiated the process for ratifying seven of nine human rights treaties, creating a more conducive legal environment for civil society and actively pursuing regional and global integration. The government expresses its commitment in the 8th National Socio-Economic Development Plan to underpin inclusive and sustainable growth.

The plan articulates the government's intention to target the vulnerable and marginalized in an open and dignified manner. Non-Profit Associations play an important role in this endeavour. However, they have been primarily engaged in community development rather than advocacy. Work is required to strengthen the enabling environment for civil society and support the development of their capacities to better realize their development potential. Moreover, efforts are needed to strengthen the capacity of the government, including provincial and local administrations, to report regularly on the implementation of the international treaties and conventions.

The UN has been a key partner in facilitating improvements in the justice and legal sectors, providing advisory support to ensure participation and follow up to human rights mechanisms such as the Universal Periodic Review, and promoting people's participation in national development. Recommendations of the Universal Periodic Review centred *inter alia* on the need to strengthen the administration of justice, combat corruption, and reform policies and legislation in a number of areas.

The UN will partner with the government in the development of systems and fora to receive public feedback on draft laws and enforcement, enhancing citizens' awareness of their rights, and increasing the number of people benefiting from access to formal and informal justice services, through inclusive and accountable institutions. This will include support to the implementation of the accepted recommendations of the Universal Periodic Review, as well as the finalization of the Penal Code. UN agencies will also work with their respective national counterparts to mainstream gender equality and human rights into relevant sectors and programs and promote women's political and economic empowerment.

Source: Excerpts from United Nations (2016)

The 8th National Socio-Economic Development Plan of Lao PDR indicates it is necessary to enhance the awareness and understanding among ethnic peoples of the Party's and Government's policy directions; to widen and enhance democracy strictly according to the centralization principle; to strengthen the political foundation by providing training on political thinking and regulations set by the Party-Government; to enhance the creativity of students and scholars, and army and police officers, to be able to contribute to the democratic government with peace, independence and prosperity; to enhance the historical leadership of the Party-Government to be able to apply to the current situation science and democracy; and to take ownership in the integration and cooperation with foreign countries in accordance with the foreign affairs guidance of the Party-Government (MPI, 2016).

According to MPI (2016), the priority strategies and activities to improve the governance of the country include: (a) to disseminate policy directions, laws and regulations and educate women, young people, juveniles and ethnic peoples on political thinking for their broad and deep understanding for active contribution to the country's development; (b) to improve the structure of the organization and management according to the '3-builds' directive that proposes building provinces to be strategic units, building districts to be holistically strong units and building villages to be development units and (c) to increase coordination between central and local, local and local, government and private entities and other relevant parties.

Moreover, 8th National Socio-Economic Development Plan of Lao PDR requires improving and simplifying government structure, and the management and administration of government at all levels, to make these more logical and effective. There is a need to identify the role and responsibilities of each type of organization based on clear standards and requirements in order to ensure appropriate staffing in each ministry and other central government agencies that will focus on macro management; strengthen governance at local level and clearly divide the tasks between central and local levels, and among local administrative levels (provincial, district and village) following the 3-builds directive; improve the local government supporting structure at each administrative level to match the development demand and enable effective government policy application.

In this respect, the targets proposed by the plan include: (i) to improve the structure of the central government to be more simple, strong and capable of more effective macro-management; (ii) to improve the structure of the provincial government to be more simple, strong and capable of carrying out the provincial governance assignments more effectively through the implementation of the '3 –builds' directive; and (iii) to improve the structure of the local administration so that it becomes capable of translating the Government's policies and plans into actual implementation and provide services to the people in a more effective and timely manner.

The list of priority activities and projects to improve and simplify the structure of government, and the management and administration of government at all levels include: (1) to improve the government administrative structure to more consistent and appropriate relative to standards and mandates; (2) to classify government authorities by type (e.g. ministries, ministry-equivalent organizations, mass organizations and technical service units), and set standards and conditions for the work of each type; and (3) to improve the coordination mechanism between the provinces, districts and villages, especially those in the remote areas (MPI, 2016). Moreover, the list of policies and legal instruments include: a strategy for public administration's structural improvement and development, regulations to standardize the structure of each level of administration, and regulations and guidelines on procedures and methods on staff appointment, management and promotion. Some of these improvements will be applied to the Ministry of Science and Technology, as well as other line ministries that have under their umbrella science, technology and innovation activities.

CONSTRUCTING A NATIONAL INNOVATION PROFILE: INDUSTRIAL POLICIES AND THE DEMAND FOR R&D

The national innovation systems paradigm usually characterizes the relationship among institutions that support and foster knowledge creation and firms that exploit this knowledge. This stream of work suggests that to maximize innovation, institutions within a country need to complement each other and work in tandem. Moreover, it suggests that a technology policy aiming to create efficient institutional mechanisms for integrating the functions of knowledge production and knowledge commercialization is likely to enhance a country's ability to sustain an innovative technology system over time (Stern *et al.* 2002).

Innovation policy is usually defined as a set of policy instruments and appropriate institutions that assist in the local adoption of technologies and the introduction of new products and services to the market. This may include adapting imported technologies to local conditions. Appropriate technology and innovation policies can be derived only from an understanding of how technical change takes place in local enterprises. Whereas companies everywhere have to try to master or adapt existing technologies, a high level of basic knowledge and capabilities exists in most firms in mature industrial countries or can be easily acquired from other firms, labour markets, supporting institutions, or consultants. This makes it relatively easy and routine to master existing technologies. In developing countries by contrast not only is the internal knowledge base for mastering technologies relatively weak; the support network provided by other enterprises, institutions and human capital also tends to be underdeveloped (Lall and Teubal 1998).

Promoting innovation at firm level involves both public and private sectors (e.g. entrepreneurs, researchers, public servants, financiers etc.) and may include civil society organizations. Successfully launching and running initiatives involving innovation requires aligning interests of numerous stakeholders. This implies a difficult co-ordination process. The state is often best placed for the role of initiating, guiding, or facilitating co-ordination, owing to its stronger convening and co-ordinating power, and it has an important tool available only to it: incentives can be designed in public policies to influence behaviours and the relations of actors involved in the innovation process. For example, by aligning incentives with stakeholders, establishing risk-sharing mechanisms for multi-stakeholder ventures, and promoting knowledge sharing and dissemination, the state significantly promotes the co-ordination process. In developing countries, inadequate public-sector involvement to co-ordinate stakeholders may stymie innovation.

The productive sector and its markets represent demand for STI. The characteristics and behaviour of this STI demand over time determine whether or not it is possible in the economy of a country to absorb the results of research obtained by universities and research centres (STI supply) so as to generate new goods and services. To handle new knowledge and incorporate it in production, a firm has to make a number of technological decisions. Some are clearly concerned with the choice of alternatives regarding the source of new knowledge the source of equipment and the use of such inputs. Others have to do with the building-up of the firm's capacity (technical and design groups, administrative/organisational information) to make such choices to adapt foreign technology and to incorporate new knowledge effectively into production. The adaptation of foreign technology is particularly important since it contributes to the optimal use of foreign technology and can link foreign technology to domestic science and technology.

Supply and demand analysis should guide the public sector's involvement. A lack of adequate understanding of the characteristics and potentialities of the STI supply and demand in a given country will trigger failure for any research and innovation policies policy instruments and incentives put in place.

In recent years, a growing number of surveys have studied the behaviour of entrepreneurship and innovation in different countries. Some of the international reports provide valuable information on Lao PDR. For example, see Table 5 for a series of subjective and objective indicators showing the perception of research and innovation in Lao PDR (World Economic Forum, 2014).

Lee *et al.* (2014) found that industry in Lao PDR is uncompetitive in the global market, which means it cannot serve as an engine of the economy. Firms developed capacities in certain areas but are otherwise constrained in their capacities. For these researchers, the constraints stem from a lack of innovation capacity. Normally, this might be overcome through interactions with universities or R&D institutes. The National University of Laos, which is the largest university (see pages 161–162), has no research capacity. In economically advanced countries, markets are used to coordinate activities between stakeholders, but this is absent in developing economies like Lao PDR. Research and innovation are dependent on having the requisite stock of human capital, defined as the knowledge, skills, competencies and attributes that facilitate the creation of personal, social and economic wellbeing.[5]

Table 5: Selected subjective and objective measurements for Lao PDR

Subjective index: World Economic Forum Executive Opinion Survey 2016 (Max. value = 7)		
Indicator	**Value 1–7**	**Rank out of 138**
Quality of the education system	4.1	54
Quality of Math and Science Education	3.7	91
Quality of management schools	4.0	85
Internet access in schools	3.6	106
Local availability of specialized training services	4.0	94
Extent of staff training	3.8	75
Availability of latest technology	3.8	119
Firm level technology absorption	4.1	105
FDI and technology transfer	9.1	90
Capacity for innovation	4.0	76
Quality of scientific research institutions	3.4	102
Company spending on R&D	3.4	60
University-industry collaboration in R&D	3.5	62
Government procurement of advanced tech products	3.2	73
Availability of scientists and engineers	3.1	127

Objective Measurements		
Indicator	**Value**	**Rank out of 138**
Secondary enrolment gross percentage (2015)	57.2	112
Tertiary education enrolment gross percentage (2015)	17.3	102
School life expectancy in years (2015)	15.7	28
Individuals using internet/100 population (2015)	18.2	118
Broadband internet subscriptions/100 population (2015)	0.5	116
Int'l internet bandwidth kb/s per user (2015)	16.8	97
Mobile broadband subscriptions/100 population (2015)	14.2	118
Mobile telephone subscriptions/100 population (2013)	53.1	131
Fixed telephone lines/100 population (2012)	13.7	73
Patent families filed in 3+ offices/bn PPP$ GDP (2015)	0.2	96
Scientific articles (2015)	218	131
Citable scientific articles – *h* index (2015)	67	134
Life expectancy at birth in years (2015)	66.5	109
Women in labour force ratio to men (2015)	3	103
Imports as a percentage of GDP (2014)	32.3	89

Note: The subjective indicators (from a low of 1 to a high of 7) are based on a series of executive opinion surveys prepared by the World Economic Forum whereas the objective indicators (related to research and innovation) were originally produced by other agencies and have been compiled by the World Economic Forum. Both columns show Lao PDR's ranking out of 138 nations for each individual indicator.

Source: World Economic Forum (2016) *Global Competitiveness Report* 2016–2017

5 In 2017, UNESCO's General Conference adopted a new international standard-setting instrument: "The Recommendation on Science and Scientific Researchers." This instrument considers human capital as the principal pillar of a sound science system. According to UNESCO, Member States should develop policies with respect to the training, employment, career prospects, and work conditions of scientific researchers. These policies should address, inter alia, adequate career development prospects; lifelong learning opportunities; the facilitation of mobility and international travel; the protection of health and social security; and inclusive and transparent performance appraisal systems for scientific researchers. See UNESCO (2017).

BOX 3 – RESEARCH AND TECHNICAL APPLICATIONS IN THE AGRICULTURE AND LIVESTOCK SECTORS

The number of agricultural and forest extension centres throughout the country has increased to 264. There is one service centre that is under the management of the Department of Agriculture Extension and Cooperatives, 80 service centres at provincial level, 145 service centres at district level and 38 service centres at Kum Ban level; of these, 97 centres are in the 3-builds districts and 3 centres are in villages. For technical improvement, there were supplies of equipment, drying and screening machines, and drying yards for seeds in a total of 13 extension centres in 12 provinces, together with job creation that suits production potential and support from field staff to Kum Ban regarding regular production promotion, aiming to assist local villagers to know and understand the new and better planting or livestock husbandry techniques. 100 seed planters and 1 000 leaf colour charts were provided to the Department of Agriculture Extension and to Cooperatives in 18 provinces throughout the country. In addition, application of modern technologies is promoted in rice production to reduce labour and increase productivity and lower the cost of production.

Production of improved rice breeds is an expanding trend. The centres have produced 59 500 tons of improved rice breeds, 12% of which is white rice and the rest sticky rice. In the Central and Northern Regions, 80% of farmers in the wet season and 100% in the dry season are using improved rice breeds.

In addition to rice breeds, the centres also focused on researching economic cash crops and vegetables, such as the 450-year hybrid corn, soybean, banana and others. The planted areas were also enlarged for coffee, cardamom and some seedlings of fruit trees.

Breeding of species of aquatic animals and fish: 196 million fish were bred, achieving 95% of the five-year plan target (206 million), 30% of which are bred by the public extension centres; the other 70% is bred by private enterprise. Experiments have been carried out with eight native fish species: 'Tong', local catfish, 'Kot', 'Keng', 'Kare', 'Soi' and tiger fish in 'Nong Tang' and 'Ban Hard' ponds. A total of 1,200 of these native fish were bred over the five years, or 60% of the Plan's target.

Breeding of large animals and production of animal food: There are eight mixed breeds of local and foreign cattle (with a ratio of 1 male to 25 females, a group of 8 males and 200 females are expected to raise the headcount by 130 per year). At present, one bull was produced as a standard breeder. There are 25 breeder bulls of mixed breed. In total, there are 799 cattle of both pure breed and mixed breed. In total, there are 51 859 local chicken 'gai-toc', turkey, and mixed poultry of two or of three breeds. Production of fodder is 2 500 kg, along with the maintenance of grasslands for cattle and goats. There are four types of grass adapted from Ishull Stilo, Papua New Guinea and Guatemala. An area of 12 hectares can provide 93.2 tons of fresh grass.

Promotion of farmer groups and collective farming: Assessment of producer groups and production clusters has been completed for 3 640 groups, of which there are 1 864 crop plantation groups and 1776 animal husbandry groups. There are nine collective farms established to facilitate these groups and to integrate them into the farming network of ASEAN and with potential partners worldwide in the future.

Source: Selection of paragraphs from the 8th Five-year National Socio-Economic Development Plan 2016–2020 (MPI, 2016)

Renewable energy development, policies and instruments

Lao PDR lacks fossil fuels which are imported mainly through Viet Nam and Thailand. Since 2000 the import of oil to the Lao PDR has increased annually by approximately 5%, and this is likely to accelerate to 10% per year when taking into consideration the rise in numbers of vehicles in the country. Consumption has been rising rapidly, from 450 million litres in 2006 to 716 million litres in 2015 (Vongvisith and Theuambounmy, 2015). The Ministry of Energy and Mines has estimated that in 2020, 914 million litres of fossil fuel will be needed. For these reasons, they have developed a strategic reserve of petroleum fuel to help meet the requirements during times of crisis. In this context the government of Lao PDR has been preparing several scenarios for the promotion of the agriculture sector and renewable energy. The plan is to increase the share of renewable energies to 30% of the total energy consumption in 2025.

Energy consumption in the country is mainly in the form of traditional fuels. Biomass such as fuel wood (56%) and charcoal (12%) is used for cooking and heating in rural areas, as well as by urban people and small-scale factories and industries such as brick factories, tobacco plants, noodle processing factories, salt factories, sugar processing plants and some saw mills. This represents around 69% of the total energy consumption (Vongvisith and Theuambounmy, 2015). Energy consumption by sector shows that residential sector comprised 51% of energy consumption, followed by transportation with 26%, industrial 20%, agriculture 2% and the commercial sector 1%.

Figure 14 shows the consumption of renewable energy as a share of the total final energy consumption in Lao PDR (1990–2014). During this period, the country oscillated from a maximum renewable energy consumption of 94.6% in 1990 to a minimum of 82.4% in 2006. The trend is increasing again to a value of approximately 90%.

Potential of biomass in Lao PDR includes energy crops and organic wastes. Energy crops comprise oil-crop (such as palm, jatropha, sunflower, beans, coconut, etc), sugar and starch (sugarcane, cassava, corn) and quick growing trees and aquatic cultures. Organic wastes include residues of agriculture-Forestry production, by-products of agro-forestry industry (sawdust, wood chips, rice husk, corn cobs, livestock manures) and municipal wastes (households' wastes, communal wastes, food processing wastes...). It was estimated that utilizing of livestock wastes for biogas production could generate around 2.8×10^8 m^3 of biogas per year, or equivalent to 5×10^8 kWh electricity (MEM, 2011).

Hydropower is the most important energy source in Lao PDR. In the Lao PDR hydropower projects with capacity bellow 15 MW are classified as small-scale. Solar irradiance on the country is between 3.6–5.5 kWh/m^2, with sunshine 1800–2000 hrs/year. With such solar energy potential, if photovoltaic technology is applied, assuming an overall efficiency of 10%, it would generate around 146 kWh/m^2/year, or 1.5×10^8 kWh/km^2/year (MEM, 2011). There is lack of data on wind energy potential, particularly at a height above 50 m.

The total domestic energy demand is anticipated to increase by 3.6% per annum, increasing from 1.8 million tonnes of oil equivalent (TOE) in 2005 to 3.9 million TOE in 2025 (MEM, 2011; Vongvisith and Theuambounmy, 2015). Since the overall demand of energy in various economic sectors is estimated to remain high until 2025, the share of household sector will decline from 77.8% in 2005 to 48.5% in 2025. The energy demand in the industrial sector is increasing at around 8% per year, while the transportation sector is growing at 6.8% per year.

The Ministry of Energy and Mines of Lao PDR estimated the energy demand based on different energy sources until 2025. Based on that estimations, Figure 15 shows the energy-demand shares according to each individual component of the energy matrix of the country. Since the demand for fuel, electricity and coal is growing faster than the biomass this figure shows that – in two decades – the shares of biomass will be reduced from 73.4% (2005) to 41.2% (2025).

Figure 14: Renewable energy share of the total final energy consumption in Lao PDR, 1990–2014. The dashed line is the best fitting curve.
Source: UNESCO based in raw data provided by Sustainable Energy for All

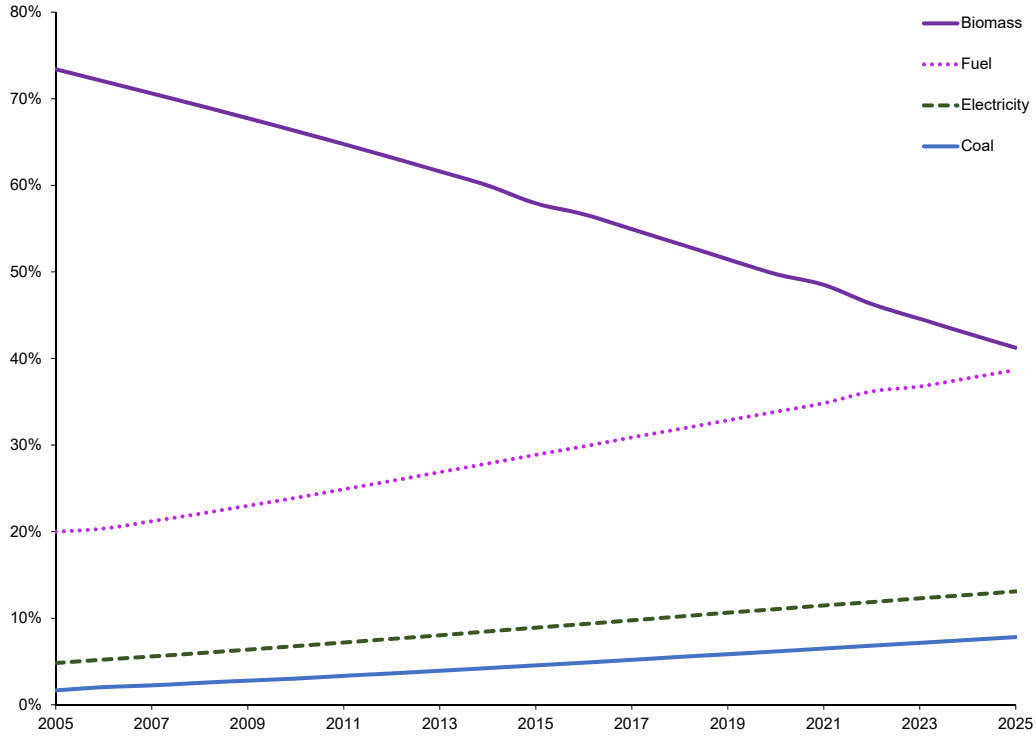


Figure 15: Estimate of energy demand shares – according to the different components of the energy matrix – in Lao PDR by 2025.
Source: UNESCO based on demand estimations made by the Ministry of Energy and Mines

The Ministry of Energy and Mines is fostering the creation of different policy instruments (mechanisms and incentives) for investment by expanding the renewable energy market to attract more private sector investment in the development of renewable energy projects. The objective is to maintain industrial growth while decreasing costs step by step, to promote a competitive market and to develop policies that support fund raising and public investment in the promotion and demonstration of renewable energy (Vongvisith and Theuambounmy, 2015).

The Ministry of Energy and Mines is planning to conduct research and use leading technology in un-developed areas. They are planning to integrate alternative energy within various infrastructures such as education, health, water supply, irrigation and sanitation, roads and communication to promote social welfare, production, trade and economy for people in the rural areas.

The government of Lao PDR is trying to develop policy instruments for the promotion and facilitation to develop new materials and equipment factories for renewable energy technology within the country in order to produce low price technology, improve the service, create more jobs and enhance the technical skills of the local people.

The Ministry of Energy and Mines defined several policies for the promotion and development of renewable energies, development of small power generation capacity for self-sufficiency and grid connection, biofuels production and marketing, and development of other clean energies in the country (MEM, 2011). The government defined priorities for development as follows:

- Provide financial incentives to investors who produce clean energies to meet domestic demand and who commit to be socially and environmentally responsible in order to increase investments in renewable energy projects.
- Formulate and improve laws and regulations to facilitate renewable energy development.

For electricity and energy development in rural areas, important aspects that are being considered are as follows:

- Prioritization of policies which facilitate private sector investments in rural electrification including provision of incentives and financing.
- Development of small power systems, biofuels, solar and biomass energy at the village level to provide electricity and energy to rural and remote communities;
- Generation of electricity for productive uses at the village level using waste materials from agriculture, biogas, hydropower or other local resources. People in rural areas will be encouraged to use renewable energy to enhance self-sufficiency and the government of Lao PDR will seek cooperation with private sector, NGO and development partners to encourage investment support for equipment and necessary machinery adjustments.

Integrated with national climate change strategy:

- Increase public awareness and understanding of climate change impacts and the need for mitigation and adaptation.

The Government aims to increase the share of renewable energies to 30% of the total energy consumption in 2025. To reduce the importation of fossil fuels, the Government outlines a tentative vision to reach 10% of the total transport energy consumption from biofuels. This target will be regularly revisited and revised, feeding in results of studies, lessons learned from on-going implementation, and international technological developments in the field of renewable energy (MEM, 2011).

A strategy was designed to kick-start the development of the biofuels market in the country through the provision of incentives to farmers, domestic and foreign investors to encourage engagement in the production of biofuels for the domestic market and at the same time monitor its development and ensure proper mitigation of negative impacts. The tentative vision for the promotion and development of biofuels includes the substitution of 10% of the transportation fuel demand by 2025 and the deployment of biofuels technologies in rural areas.

However, in a country assessment conducted as part of a decision whether to provide financial support for developing renewable energy technologies in Lao PDR, UNIDO (2014) found that stakeholders identified a series of barriers for such development. The main barriers mentioned include: (1) limited experience in Lao PDR concerning the installation, operation and maintenance of renewable energy systems; (2) limited understanding and awareness of consumers of the advantages of renewable energies; (3) insufficient financial incentives by the government for renewable energy investments; (4) renewable energy investments are capital intensive and the required capital is not available in Lao PDR; (5) unclear procedures and long procedures for obtaining licenses to operate renewable energy systems; (6) high transaction costs in obtaining licences and concessions; (7) overlapping government authorities especially at local level, creating potential conflicts; (8) the available bank financing offers exclude renewable energy investments. Loans are usually short (<3 years), while for renewable energy investment longer term loans are required; (9) high collateral required (up to 130% of the loan amount) and (10) reluctance of banks to consider renewable energy investment proposals because long-term loans are required and there is a (perceived) unattractive risk-return profile.

BOX 4 – OPERATIONAL POLICY INSTRUMENTS FOR THE PROMOTION OF THE ENERGY SECTOR

The country has a series of operational policy instruments and incentive mechanisms which have been in established during the past decade, most of them through legal devises (see the chapter with the Inventory of Lao PDR's legal framework for STI, pages 175–188).

In line with a provision of the Investment Promotion Law of Lao PDR, the government provides both financial and non-financial incentives to investors according to the sector and zone that is promoted. Among incentives we find: (i) tax holidays of up to 10 years; (ii) exemptions from export duty on export products; (iii) exemptions from land lease or concession fee up to 15 years; (iv) exemptions from import duties and taxes on raw materials and capital equipment used in production; and (v) additional tax holidays as negotiated for large concession projects.

Foreign investments subject to the Foreign Investment Law pay an annual profit tax at a rate of 10%, 15%, and 20% depending on the promotion zone (other investments are taxed at 35%). The Government created three promotion zones based on geographical location and socio-economic conditions. The zones are:

- Zone 1: Mountainous, plain and plateau zones, with no economic infrastructure to facilitate investments.
- Zone 2: Mountainous, plain and plateau zones with a certain level of economic infrastructure suitable to accommodate investments to some extent.
- Zone 3: Mountainous, plain and plateau zones with good infrastructure to support investments.

The Renewable Development Strategy of Lao PDR mentioned that all investments in renewable energy projects in Lao PDR, including that for bio-fuels production, grid-connected or isolated systems, off-grid projects, and individual systems, are entitled to investment incentives under the Investment Law of Lao PDR updated in 2009. The financial incentives include the following: (i) Import duty free on production machinery, equipment and raw materials and (ii) import duty free on chemical materials necessary for biofuels production within seven years.

Source: Pillai (2014)

Climate change strategies

Lao PDR recognises the strong link between economic development, sustainability and the need to mainstream environmental considerations, including action on climate change into its development plans. The Climate Change and Disaster Law is being developed and the overarching legal framework for climate change and disaster management will be provided in the law. The law is expected to be approved in 2017 (MNRE, 2015).

The National Strategy on Climate Change of Lao PDR was approved in early 2010 and states a vision of how to address climate change. In addition to the overarching strategy set out in the National Strategy on Climate Change, climate change action plans for the period 2013–2020 define mitigation and adaptation actions in the sectors of agriculture, forestry, land use change, water resources, energy, transportation, industry and public health.

Flooding is a major climate risk in the country, threatening livelihoods almost every year. 14 out of 17 provinces as well as the Vientiane capital have experienced floods since 1995. The country's annual rainfall is expected to increase its variability which, accompanied with an increase in temperature could have significant impact on water resources, ecosystems and agricultural production. In addition, floods have an adverse impact on housing, health and education, industrial activities, and infrastructure (transportation, water and sanitation). As an example, the flooding in 2005 caused widespread disruption and the estimated economic costs were US$ 29 million (MNRE, 2015).

Lao PDR is also experiencing increasingly frequent episodes of drought. Severe drought occurred in 1996, 1998 and 2003. It is estimated that 6 out of 17 provinces are already at high risk of droughts. Droughts adversely affect water resources, hydroelectricity generation and agricultural production resulting in widespread economic losses.

Increasing climate resilience with respect to agriculture is therefore a high priority especially for food security. Another high priority is the provision and management of water resources as this contributes to social wellbeing, economic productivity and water supply for agriculture, industrial processes and energy production.

Lao PDR is highly climate-vulnerable, and Lao PDR has plans to reduce its greenhouse emissions while at the same time increasing its resilience to the negative impacts of climate change. Examples of such plans include the following:

- A target is set out in the National Forestry Strategy to the Year 2020 for increasing forest cover to a total of 70% of land area by 2020 and maintaining it at that level going forward. This will reduce the risk of floods and prevent land degradation, yet at the same time the greenhouse gas mitigation potential of such a target is substantial and long lasting.
- In terms of Lao PDR's large-scale electricity generation, the electricity grid draws on renewable resources for almost 100% of its output. Lao PDR also aims at utilising unexploited hydropower resources to export clean electricity to its neighbours. By supplying neighbouring countries such as Cambodia, Viet Nam, Thailand and Singapore with hydroelectricity, Lao PDR is enabling other countries in South East Asia to develop and industrialise in a sustainable manner.
- The Government of Lao PDR has also laid the foundations for the implementation a renewable energy strategy that aims to increase the share of small scale renewable energy to 30% of total energy consumption by 2030.

The focus areas of Lao PDR's adaptation projects in each of the following key sectors are:

In Agriculture: (i) Promote climate resilience in farming systems and agriculture infrastructure and (ii) promote appropriate technologies for climate change adaptation;

In Forestry and Land Use Change: (i) Promote climate resilience in forestry production and forest ecosystems; (ii) promote technical capacity in the forestry sector for managing forests for climate change adaptation;

In Water Resources: (i) Strengthen water resource information systems for climate change adaption; (ii) manage watersheds and wetlands for climate change resilience; (iii) increase water resource infrastructure resilience to climate change and (iv) promote of climate change capacity in the water resource sector;

In Transport and Urban Development: Increase the resilience of urban development and infrastructure to climate change;

In Public Health: (i) Increase the resilience of the public health infrastructure and the water supply system to climate change; (ii) improve public health services for climate change adaptation and coping with climate change induced impacts.

BOX 5 – THE NAGOYA PROTOCOL

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity is a supplementary agreement to the Convention on Biological Diversity. It provides a transparent legal framework for the effective implementation of one of the three objectives of the Convention on Biological Diversity: the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

The Nagoya Protocol on ABS was adopted on 29 October 2010 in Nagoya, Japan and entered into force on 12 October 2014, 90 days after the deposit of the fiftieth instrument of ratification. Its objective is the fair and equitable sharing of benefits arising from the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity. With Cambodia's ratification, the protocol reached 58 ratifications/accessions, and thereby came into force on 12 October 2014. Lao PDR became a party to the protocol on that day through accession.

It is expected that the Nagoya Protocol will provide greater legal certainty and transparency for both providers and users of genetic resources by creating a framework that promotes the use of genetic resources and associated traditional knowledge while at the same time strengthening the opportunities for fair and equitable sharing of the benefits from their use. The Protocol will create new incentives to conserve biodiversity, sustainably use its components, and further enhance the contribution of biodiversity to sustainable development and human well-being.

The Nagoya Protocol addresses traditional knowledge associated with genetic resources with provisions on access, benefit-sharing and compliance. It also addresses genetic resources where indigenous and local communities have the established right to grant access to them. Contracting Parties are to take measures to ensure these communities' prior informed consent, and fair and equitable benefit-sharing, keeping in mind community laws and procedures as well as customary use and exchange.

Lao PDR continues to develop human and institutional support for policies and issues related to access and benefit-sharing (ABS), and a national ABS Framework is being developed and refined by the Science and Technology Research Institute of the Ministry of Science and Technology of Lao PDR with the support of the United Nations Environment Programme (UNEP) and the Global Environmental Facility (GEF).

Although a national framework on ABS is still to be developed, valuable experiences have been gained in access and benefit-sharing by promoting the planting of economic crops including agarwood, for oil extraction and incense. The key concept is 3-way collaboration between the government, a private company (such as the Lao Agar International Development Company Ltd.) and farmers. Technology is then transferred from research institutions to farmers and additional knowledge, marketing and credit are provided by a private company (MAF, 2016).

Characteristics of the manufacturing sector

The process of industrialisation in the Lao PDR might be divided into two main periods, the co-operative period (1976–1985) and the New Economic Mechanism (NEM) since 1986. NEM might also be divided into a period of preparation (1986–2000) and a period of boosting economic growth toward industrialization and modernization (2001–present). The introduction of the Industrialization and Modernization Strategy (2001–2020) in 2002 made clear the government's intention to develop the industrial sector as the engine of growth in the economy. This strategy is one of the main thrusts of the 2020 Development Vision.

The last period was characterized by several policy interventions aiming at of strengthening the production by promoting potential national and local comparative advantages so as to supply domestic demand; promoting and diversifying the commercial production and services to reduce dependence on natural resources. The government encourage investment in commercial production, such as agro-processing, food processing industries, house supplies, hand-woven textiles, among others, to promote economic growth

In Lao PDR, there are 100 653 registered enterprises, with a total registered capital of 1 680 trillion kip (US$ 200 billion); the industrial sector accounts for 86.5%, agriculture 1.6%, construction 3.2% and the service sector 8.7%; and recently the enterprises registration procedure was made simpler and faster (MPI, 2016). The breakdown according the type of ownership shows that 0.13% of the total are state-owned enterprises (131), while 99.8% are private enterprises (100 473) of which 95.9% are domestic enterprises (96 531), 2.7 % are foreign enterprises (2758), 1.2% are joint ventures (1 184), 0.03% are collective enterprises (29), and 0.05% are mixed enterprises (53).

Recently, two policy instruments were introduced: (1) a promotion mechanism based on the 'one district one product' and (2) the establishment of a cooperation mechanism between large and small enterprises to encourage large enterprises to use the products and services of small enterprises.

According to the Ministry of Planning and Investment (MPI, 2016) there were significant achievements since 2010 in promoting and developing small and medium enterprises (SMEs). Some of the new policy instruments implemented are the following:

- An improved Decree 42/PM on the Law on SMEs, No. 11/NA, dated 21 December 2011;
- Service provider networks to provide consultation on business development, with 21 current members;
- Model enterprises, demonstrating quality and productivity, for instance C&A Bakery, Vern Kham Salt Factory and Mavita Drinking Water Factory;
- Improving registration of enterprises and systems under the Lao Business Forum framework to allow, create and develop the dialogue between the Government and business sectors at provincial level and improve the regulatory environment;
- Simplified enterprise registration procedures, aiming to make them convenient and fast for users; for instance, the cost of registration has been reduced from 100 000–200 000 kip to around 40 000–90 000 kip, the procedure period has been limited, from 60–90 days to 3–10 working days at the most, the number of supporting documents for review has been reduced from 18 to about 4–6 items, and permanent licences are issued rather than renewable ones.

In collaboration with the Ministry of Education and Sports and related sector, the textbooks and manual on business operation were reviewed to create a curriculum for inclusion in the regular course of study, which has already been piloted in some schools for general education and it is being prepared for inclusion in vocational education and at university level (MPI, 2016). The Government of Lao PDR has recognized that there is a need to increase the industry productivity, and the quality and standards of products and services.

In recent years, several executive polls have been conducted by different international organizations to measure the dynamism of innovation and the competitiveness of different countries (i.e. World Economic Forum, 2016; INSEAD *et al.*, 2017; World Bank Group, 2017b).

Figure 15 shows the results of an executive poll designed to determine the major difficulties faced by the productive sector in promoting innovation and improving competitiveness. The poll reveals that inadequately educated workforce, lack of access to financing, poor work ethic in the national labour force, tax rates, and insufficient capacity to innovate are deemed the major hurdles. These factors can be accommodating or constraining for firms and play an important role in whether an economy's private sector will thrive or not.

The World Bank has also been conducting – with four-year periodicity – systematic surveys among top managers and business owners of 368 enterprises in Lao PDR[6]. During the last enterprise survey[7], conducted in 2016, 27% of firms in Lao PDR chose competition from informal competitors as the biggest obstacle to their daily operations. Tax rates and poorly educated workers were ranked 2nd and 3rd (cited by 22% and 13% of firms respectively). These top three obstacles have not changed since 2012. There is partial correlation with the World Economic Forum surveys in the identification of major obstacles. For business enterprises, the provision of electricity has been deteriorating since 2012 according to this source, as this obstacle is now ranked 5th (cited by 13% of firms), while in 2009 it was ranked 9th and cited by only 4% of firms (World Bank Group, 2017b).

According to the World Bank enterprise surveys, the percentage of firms that offer formal training to their employees has declined substantially since 2012. Only 7% of the firms offered formal training in 2016, a significant decline from 29% in 2012, and well below the average for the East Asia Pacific region (32%). However, the share of workers offered formal training has slightly increased, from 33% in 2012 to 38% in 2016. Despite this small improvement, Lao PDR is underperforming compared to the average in the East Asia Pacific region, where 63% of workers are offered formal training (World Bank Group, 2017b).

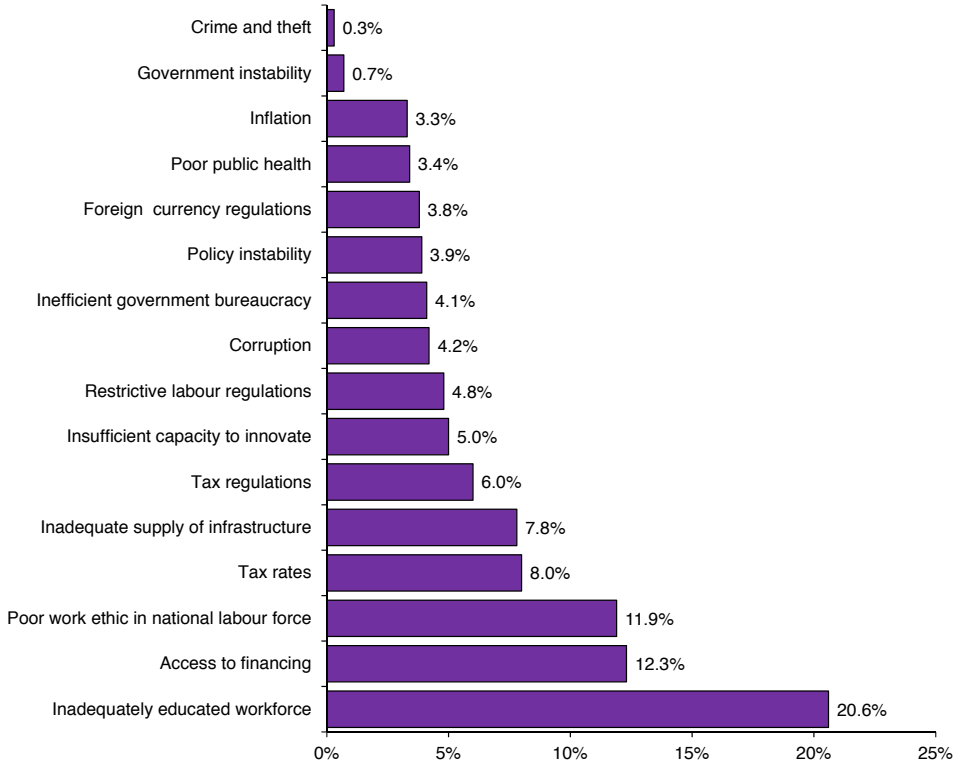


Figure 16: Major difficulties in promoting innovation and competitiveness in Lao PDR, 2015.
Source: World Economic Forum (2016)

6 See URL: http://www.enterprisesurveys.org/

7 Among the 368 firms, 29.9% belong to the manufacture sector, 29.1% to the retail sector and 41% to other services. In terms of size, 12.7% were large firms, 28.3% medium and 59% small. Finally, 41% of the firms are located in Vientiane, 22.3% in central part of the country, 19% in the north and 17.7% in the south.

Policy instruments for the promotion of the industrial sector

In the Lao PDR, small and medium enterprises (SMEs) represent 99% of all companies. They are small even in comparison to SMEs in other ASEAN countries. Regarding sustainability, Lao PDR's SMEs lack funds and skills to promote sustainability activities in the medium and high cost range of options (Phonsavath, 2017).

The recent 8th National Socio-Economic Development Plan (MPI, 2016) is proposing the implementation of the following policies and legal instruments for the promotion of the industrial sector: (a) to set policies, legislation and mechanisms for managing and creating favourable environments for processing industries and handicrafts to grow, especially to encourage participation from the private sector in strengthening public and private partnership in order to build investor confidence; (b) to set policies to promote industries that use raw materials from agriculture, forestry and mining as inputs to process finished products; set policies for science and technology in industry and for the development of green industry, among others, and (c) to encourage the construction of an industrial research and development centre and to encourage industrial products design, industrial products standards and modern technology transfer, as well as their application in industrial processing.

Moreover, in order to promote international logistics, the government is considering the introduction of more concrete measures in this sector, for example, more efficient and transparent customs clearance, and investment incentives determined by Special Economic Zones (SEZs), etc.

The government has created two types of legislation on SEZs, aiming to promote investment, and a favourable business environment; the two types are called either specific or special. At present, there are a total of 13 SEZs in Lao PDR, four of which are special SEZs and nine of which are specific SEZs. Of the total 13 established SEZs, seven were upgraded from general concession investments to become SEZs (MPI, 2016).

There are only six SEZs that were newly established: Phoukhyo, Thakhek, Beung That Luang, Champasack, Luang Prabang and Dongphosy. Since 2011, it can be seen that the development and the management of the SEZs have substantially progressed, as demonstrated by the increase in investments in these areas. By 2016, the investment contract value in the zones is US$ 5 billion while actual investment amounted to nearly US$ 1.3 billion, comprising US$ 16 million of Government investment, US$ 1 billion of developers' investment and US$ 250 million from small sub-investors (MPI, 2016).

The investment opportunities in Special and Specific Economic Zones are divided into three categories (OECD, 2017): (1) Industrial zones, which include the Savan-Seno SEZ, the Vientiane Industrial and Trade Area, the Saysettha Development Zone, the Phoukhyo Specific Economic Zone and the Champasak SEZ; (2) Tourism and new urban centres, including the Golden Triangle SEZ, the That Luang Lake Specific Economic Zone, the Long Thanh Specific Economic Zone, and the Luang Prabang SEZ and (3) Trade and logistics areas, including the Boten Specific Economic Zone, the Dongphosy Specific Economic Zone, the Thakhek Specific Economic Zone, and the Dongphosy 2 Specific Economic Zone.

By 2016, 249 companies had invested in these zones, including: 180 foreign companies, 48 domestic companies and 21 joint venture domestic and foreign companies. These companies invested 49.4% in the service sector, 34.6% in the commercial sector and 16% in the industrial sector. This resulted in the creation of 15 287 jobs, of which 6 769 went to local workers. The zones exported goods to a total value of US$ 43 million and imported goods to a total value of US$ 196.5 million. These zones produced public remittances of US$ 12 million, including: land concession fees of US$ 3.3 million; salary taxes of US$ 1.1 million; profit taxes of US$ 48 thousands; value added taxes (VAT) of US$ 0.9 million; fees and services of US$ 8 thousands; as well as the Government's share of dividends, US$ 300 thousands (MPI, 2016).

From a strategic point of view, it now seems advisable to develop policies to foster business networks, as well as to link SMEs to help them gain access to capital, infrastructure and specialized human resources, as a way forward to continue the growth

The country requires the development of better skills, for example by providing training to the local workforce. This is a necessary condition for diversifying the economy, needed so as to shift the type of investment inflows to the country from those that rely on unskilled labour, and from activities that

make intensive use of natural resources, to those that use skilled labour and capital-intensive production processes (OECD, 2017). Lao PDR also has the potential to expand the production of higher value-added service-sector activities in areas such as information and communications technology (ICT), business support services, knowledge-based activities, and R&D (Lord, 2012).

BOX 6 – THE 8TH NATIONAL SOCIO-ECONOMIC DEVELOPMENT PLAN AND THE PROMOTION OF SMALL AND MEDIUM-SIZED ENTERPRISES

The 8th Five-Year National Socio-economic Development Plan, 2016–2020 is a means to implement the resolutions of the 10th Party Conference that also emphasized the parts of the previous plan that still need to be achieved. The Plan also reflects the Socio-economic Development Strategy until 2025, and Vision 2030, and aims to build a new foundation for graduating from the least developed country status by 2020, and then progressing to become an upper-middle-income country by 2030. The 8th National Socio-economic Development Plan proposes the following policy interventions to promote small and medium enterprises (SMEs):

- Create production chains linking the large enterprises and SMEs to improve productivity qualitatively and quantitatively while generating employment, creating relationships within and between sectors at the local level, such as between enterprises that are delivering comprehensive tourism and those that engage in agro-processing, and so on.
- Improve taxation for SMEs: develop detailed guidelines on lump-sum tax payments, and a simple accounting system to create a favourable environment encouraging SMEs to use a bank account and to pay tax through the banking system, thus facilitating accurate and adequate tax collection.
- Improve and utilize effectively the SME promotion fund.
- Provide information and counselling services to enterprises, for example on how to access funding and markets, or on product standards, trade services, innovation and appropriate technologies for raising their productivity.

Source: MPI (2016)

Doing business in Lao PDR and policy instruments

An economy with an efficient bureaucracy, and rules of governance that facilitate entrepreneurship and creativity among individuals and that provide an enabling environment for people to realize their full potential, can enhance living standards and promote growth and shared prosperity.

Table 6 shows the characteristics in which national policies facilitate doing business for the list of ASEAN countries. The data presented was collected by the World Bank Group's Doing Business initiative, which tries to track and measure (with a series of normalized indicators) how easy it is to do business, trade and exchange in a given country (World Bank, 2017a). The numbers presented in Table 6 are organized by the global rankings of over 189 countries, and by the main components that characterize doing business. The data is consistent with other opinion polls done by different organizations (INSEAD *et al.*, 2017; World Economic Forum, 2016a, 2017c). Lao PDR occupied the 139th world rank in ease of doing business, at the bottom of the index ranks of the ASEAN region.

The Prime Minister's Decree 42 defines SMEs as independent enterprises that are legally registered and that operate according to the prevailing laws of the Lao PDR. Figure 16 shows the evolution in the number of new businesses registered in Lao PDR for between 1985 and 2015. We can distinguish 3 different periods: (i) smooth expansion (1985–1997) characterized by a logistic-type growth; (ii) stagnation (1998–2009) where the number of new businesses per year remained relatively constant; and (iii) step expansion (2010–present) where the application of new policies and incentives promoted a substantial increase in the number of new businesses.

Since 2010, a series of new policy instruments were implemented in order to facilitate doing business in the country. Below we will describe the most important ones according to the information published by the World Bank (2017b).

In 2011, Lao PDR made registering property faster by moving to a title system and replaced the business turnover tax with a new value added tax. In 2012, the country improved access to credit information by establishing a public credit registry.

By 2013, Lao PDR made paying taxes less costly for companies by reducing the corporate income tax rate and made starting a business easier by allowing entrepreneurs to apply for tax registration at the time of incorporation. Moreover, since 2014, the country again made paying taxes less costly for companies by reducing the corporate income tax rate—though it also introduced a new property transfer tax.

Lao PDR capped the duration of renewable fixed-term contracts (previously unlimited) at 36 months and reduced the maximum length of a probationary period from 3 months to 2. It also eliminated the requirement for third-party approval before an employer can dismiss one worker or a group of up to nine workers and reduced the severance payment for employees with 5 and 10 years of tenure. The country has also improved access to credit information by eliminating the minimum size threshold of loans to be included in the credit registry's database, and by expanding borrower coverage.

Lao PDR has been strengthening minority investor protections by introducing requirements for directors to disclose in detail their conflicts of interest to the other board members and for companies to promptly disclose related-party transactions to the Securities Commission and to include the information in their annual reports. It has also reduced the time required to export and import, by implementing the ASYCUDA electronic data interchange system at the Thanaleng–Friendship Bridge border crossing.

In 2017, Lao PDR made the process of starting a business faster by implementing simplified procedures for obtaining a license and a registered company seal. Moreover, the country improved the regulation of outages by beginning to record data for an annual System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI).

Table 6: Ease of doing business in the ASEAN group of countries, 2016

Country from ASEAN	Population [million inhabitants]	Ease of doing business world rank 2016	Starting a business	Dealing with construction permits	Getting electricity	Registering property	Getting credit	Protecting minority investors	Paying taxes	Trading across borders	Enforcing contracts	Resolving insolvency
Brunei Darussalam	0.423	72	86.72	76.06	87.57	50.65	60.00	51.67	72.43	57.69	57.25	55.11
Cambodia	15.578	131	54.93	38.64	56.00	54.96	85.00	48.33	61.97	67.28	32.67	48.10
Indonesia	257.564	91	76.43	65.73	80.92	55.72	60.00	56.67	69.25	65.87	38.15	46.46
Lao PDR	6.802	139	72.42	75.11	48.67	68.70	55.00	35.00	56.98	62.98	58.07	*0.00
Malaysia	30.331	23	83.67	81.10	94.34	76.29	75.00	80.00	79.20	82.38	66.61	62.49
Myanmar	53.897	108	68.87	72.22	59.36	38.35	60.00	55.00	74.97	61.47	56.03	41.96
Philippines	100.699	99	68.86	69.45	86.90	57.54	40.00	41.67	65.74	69.39	49.24	55.24
Singapore	5.535	2	96.49	81.75	92.32	85.38	75.00	83.33	91.85	89.30	83.61	74.31
Thailand	67.959	46	87.01	75.65	83.22	68.34	50.00	66.67	68.68	84.10	64.54	77.08
Viet Nam	91.703	82	81.76	78.89	69.11	70.61	70.00	53.33	49.39	69.92	60.22	35.08

**Note:* No practice. Source: *Doing Business 2017: Measuring Regulatory Quality and Efficiency,* International Bank for Reconstruction and Development and World Bank (2017)

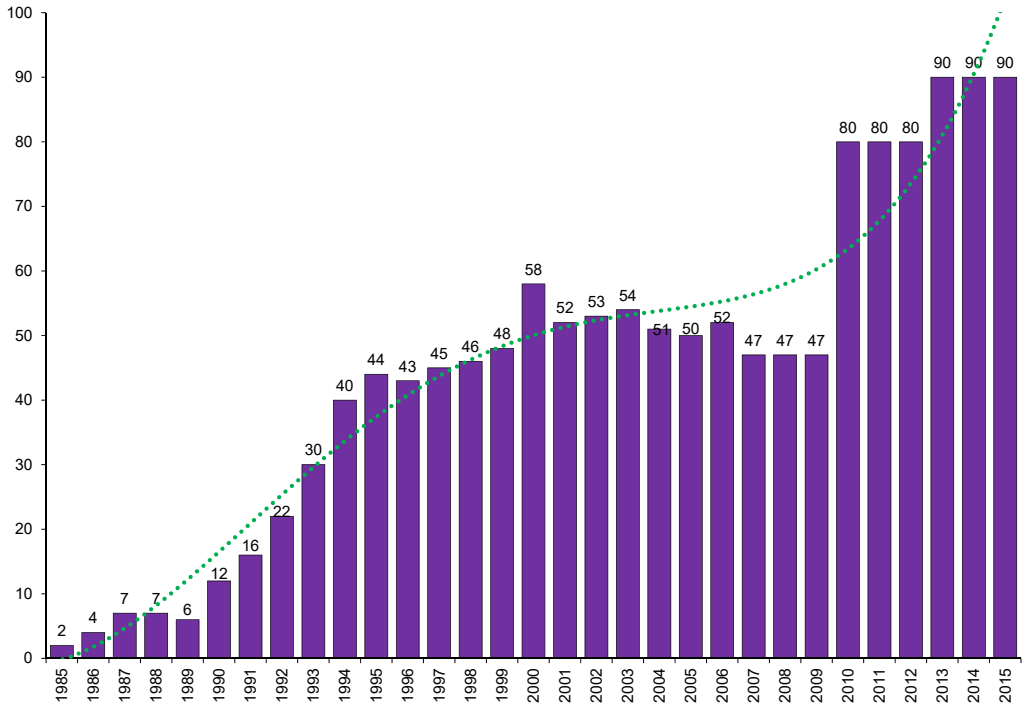


Figure 17: Number of new businesses registered in Lao PDR, 1985–2015. The dotted line indicates the best-fitting curve.
Source: UNESCO based on raw data provided by the World Bank databank (August 2017)

Characteristics of merchandise exports

The effect of exports on economic growth depends on proportion of value added in them, and on how well they generate linkages in the production structure. In turn, an increase in the proportion of value added is sensitive to the technological content of the goods and services in question. Countries that export goods associated with higher productivity levels usually grow more rapidly. Compared to products of low-technological content or those based on natural resources, the production and export of medium- or high-technology goods requires a higher level of physical and human capital and involves more innovation-intensive activities. Governments are interested in setting up support programmes to enable firms to increase their export sales given the positive impact that a surge in exports has on the economic growth and competitiveness of a country.

The gross value of exports from 2011 to 2015 is estimated to reach US$ 14 billion, with an annual growth rate of 12.6%. The annual target proposed by the 8th National Socio-Economic Development Plan is to increase that to18% per annum. Export products include 47.4% minerals and mining products, 24.2% textiles and products from processing industries (tobacco, sugar, cassava flour, instant coffee, etc), 4.2% hydropower, 8.2% agricultural goods (maize, coffee, peanuts, cassava, rice, etc), 3.8% timber and wood products and 1.6% others (MPI, 2016).

In terms of the countries receiving Lao PDR exports, 46.1% goes to Thailand; 13.8% to China; 13.3% to Australia; 12% to Vietnam; 2.2% to the Netherlands, 2% to Germany, 1.7% to Japan, and 8.9% among other countries (MPI, 2016).

Lao PDR has been attempting to link higher value-added agricultural products with the tourism sector (UNCTAD, 2016). It aims to develop eco-tourism services of quality in parallel with improving accommodation-, restaurant-, site- and tourism services, and aims to diversify handicraft and art production in light of tourist demand.

Unfortunately, there are no official statistics about the percentage of merchandise exports that are manufactured, nor about the percentage of manufactured exports that are high-tech. If there were, an analysis of the temporal evolution of these statistics would reveal how quickly the country is adding a high-tech value to its exports. Figure 17 shows the most important groups of merchandise exports of Lao PDR as a percentage of its total exports (2010–2016). It is interesting to observe that among exports there is a growing share of electrical machinery and equipment and parts thereof, sound recorders and reproducers, televisions, etc.

Lao PDR is also on a path of increasing openness to trade flows and toward integration with the world economy. In February 2013, the country completed its accession to the World Trade Organization (WTO). As part of its efforts to secure WTO membership, Lao PDR has made legislative amendments to meet the WTO's requirements in a number of areas, including tax, trade and intellectual property. The country has signed a series of free-trade agreements with China; Japan; Taiwan, China; the European Union; and the USA, among other countries (UNDP, 2015). In addition, the Government has concentrated its efforts on establishing the one-door investment service that since 1 October 2011 helps facilitate fast and transparent investments, in order to ensure public benefits and strengthen the enabling environment for investors.

In 2013, Lao PDR had trade relations with 50 nations in the world and enjoyed bilateral trade agreements (BTA) with 16 countries. Bilateral trade agreements were concluded with economies from various regions, such as ASEAN, East Asia, Eastern and Central Europe, as well as Argentina and the USA. Lao PDR's bilateral trade agreements are slightly different from the conventional ones in which most of the BTA focus on the most favoured nation treatment, followed by cooperation promotion rather than increasing market access (Nolintha and Jajri, 2016).

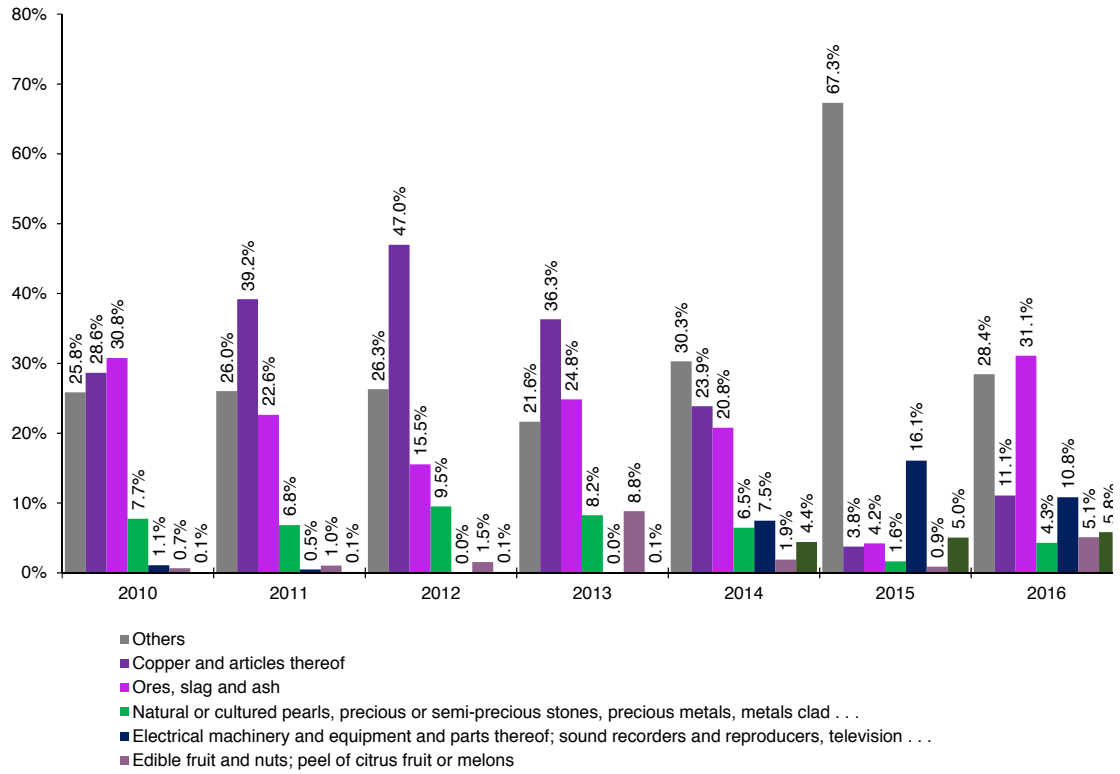


Figure 18: Composition of Lao PDR exports as percentage of total exports, 2010–2015.
Source: UNESCO based on raw data from UN COMTRADE statistics

Policies on the management and application of ICTs

The 8th National Socio-Economic Development Plan (2016–2020) proposes that Lao PDR develop basic infrastructure for telecommunications and electronic information; provide high speed and quality services to support modernization of the service sector; facilitate e-trading; strengthen socio-economic development via application of ICTs; and upgrade telecommunications as a central support for meeting international standards. Moreover, the plan proposes that Lao PDR will establish quality, modern, accurate and up-to-date media outlets in its territory to ensure information safety and security; promote media as a voice of the Party and Government; integrate its media with regional and international media; and improve and develop up-to-date, strict and comprehensive media protection laws.

The proposed targets are the following: (1) Establish automatic post boxes in post offices in all districts and provinces by 2020; (2) construct an internet backup centre in the Northern and Central Regions by 2018; (3) establish two radio frequency management centres and promote the use of a Lao PDR satellite instead of a foreign one; (4) establish a national data centre for consolidated electronic data from both the public and private sectors by 2018; (5) create an intranet and long-distance meeting system to link 50% of government offices, districts and villages; (6) strengthen e-governance at the central level to provide comprehensive services and extend e-governance service coverage in the provinces to 50%; (7) gradually develop e-management and services for 50% of the government offices; (8) complete installation of the management and services system on the national internet service code (.la) before 2016; (9) establish learning centres for applied ICTs for government and the general population in at least village groups and two districts by 2020, focusing the areas targeted by the 3-builds directive; (10) increase the computer and internet literacy rates to 30% and 40% of the population respectively, and increase by 2020: the proportion of households with computer literacy to 20% of all households; the proportion of registered landline and wireless home phone users to 15%; the proportion of registered mobile phone users to 100%; and the proportion of registered landline and wireless internet users to 20% of the total population; (11) expand the fibre optic transmission network, both aerial and underground, by 10 000 km to reach the Vientiane Capital and municipal districts of each province across the country as part of the infrastructure system to support e-governance; (12) extend quality, efficient and low cost 3G and 4G transceiver stations to cover all areas nationwide; and (13) promote that the post and telecommunications sector contribute to reaching the target of annual GDP growth at 8% by 2020.

The priority activities and projects proposed by the 8th National Socio-Economic Development Plan (2016–2020) are the following: (i) review, develop and improve laws, decrees, agreements and regulations related to management of ICT application and services so they are consistent with international agreements and have adequate capacity to facilitate ASEAN Economic Community participation; (ii) establish a National Information and Backup Centre with adequate capacity to efficiently meet domestic demand; (iii) establish an ICT development fund and regulate guidance for its spending in line with the law on telecommunications; (iv) construct two national Internet backup centres in the Northern and Central regions; (v) ensure 100% internet coverage across the country; (vi) expand telephone centres to ensure 100% of local connections; (vii) prepare for ASEAN integration in the area of telecommunications to support the installation of connections devices within and outside the country; (viii) establish a cyber-crime monitoring system to ensure that the internet system in Lao PDR is secure, and enable links with international warning systems; (ix) construct a centre to monitor frequencies in the provinces where necessary; (x) manage radio frequencies and maintain operational communications equipment that can be monitored to reduce impacts on society; (xi) continue implementing the e-government project and satellite project to ensure they are completed as planned and (xii) develop and expand media infrastructure and manage media products, and improve IT as a central service.

The policies and legal Instruments proposed by the national plan are the following: (a) a policy that promotes and attracts both domestic and foreign private investment in the telecommunications sector; (b) telecommunications and internet-related legislation to fit regional and international integration conditions; (c) national policy on broadband services to determine an expansion plan and the ability to ensure access to broadband services by people across the country and (d) policies to promote the development and application of open source software.

BOX 7 – TECHNOLOGICAL CAPABILITIES, GLOBAL PRODUCTION CHAINS AND COMPETITIVENESS WITHIN THE GARMENT INDUSTRY

Foreign direct investment inflows opened the way for Lao PDR to enter garment production-chains from the early 1990s. This industry has benefited from several channels, including sources of investors, raw material supply, market for finished goods and other marketing and logistic supports. However, garment production has fallen in significance since 2005 owing to competition from other sites. The development of garment sector in Lao PDR is linked substantially to the external sector. Half of the total factories are foreign-owned while a quarter are jointly owned by national and foreign capital. Export markets also act the key source of demand for Lao garment firms, especially Italy, England, France and the USA.

Nolintha and Jajri (2016) presented a comprehensive study on the garment industry in Lao PDR analysing the relationship between institutional support and regional production linkages, technological capabilities and firm performance. According to them, the evidence shows that garment firms in Lao PDR have achieved considerable technological upgrading, and that firm performance and technological capabilities are determined by export intensity. The study present evidence that technological capability is determined by the quality of host-site institutional support. They also found that foreign firms have invested little to upgrade human capital in Lao PDR. In addition, firms of all ownership structure types have invested little in R&D activities.

According to the survey performed by Nolintha and Jajri (2016), most firms have invested marginally in R&D activities and human resource development: 8.0% of the respondents engaged in R&D and on average about two full-time workers were assigned R&D duties; 5.8% of respondents have undertaken contract R&D with domestic individuals and institutions, and R&D expenditure accounted for 0.2% of sales value. Nevertheless, 44.0% of the respondents organized some form of training for their workforce. The study shows that the mean training expenditure was about 4.4% of payroll in 2012, which increased slightly from 2006 and 2001 and the amount of training is 240 hours per person per year, again slightly increasing from the previous years.

Other challenges facing the industry infrastructure are significant obstacles for technological capacity improvement. The study showed that foreign affiliation and regional linkages were not significant determinants of firms' technological capabilities.

The study proposes that the Lao government continue the current momentum in improving trade, investment and business enabling environments. Specific support programmes for R&D development, industry development and strengthening competitiveness are valuable for the garment industry to survive and compete, while the Lao economy is increasing its integration with the regional and global economies. Incentives and other specific policy instruments should be given to encourage private firms to invest more in human resource development, innovation, R&D and technology improvement.

According to the authors, local meso-institutions such as training and other high-tech intuitions should be further strengthened in order to attract more of the high-technology and high-value-added segment of the global production network into Lao PDR. Targeted export promotion programmes and export-led industrialization should be considered for the Lao economy.

Source: Excerpts from Nolintha and Jajri (2016)

Protection of national traditions and cultures

According to the 8th National Socio-Economic Development Plan (2016–2020), the government of Lao PDR will: protect and preserve the nation's historical and cultural heritage so that they remain indefinitely to enrich Lao society; enhance the unique cultures of ethnic peoples and cultural tourism; develop civilization, while selectively accepting positive universal cultural values in time of globalization, and deterring cultural problems in society; improve and develop varied and high quality cultural products; actively contribute to the sustainability of national socio-economic development; and develop cultural villages and cultural families to contribute to a peaceful, safe and civilized society.
The proposed targets are: (a) to establish cultural families to comprise 80% of all families in the country, cultural villages to comprise 65% of all villages in the country and cultural cluster villages to comprise 16% of all villages in the country; (b) to restore, preserve and promote the uniqueness of cultural heritage, both physical and nonphysical items; (c) to upgrade provincial cultural heritage, history and nature to identify these as national heritage; (d) to create cultural parks at national and local levels; and (e) to create model cultural villages to be tourist destinations (MPI, 2016).

The 8th National Socio-Economic Development Plan Support proposes the following priority activities: (i) the restoration, preservation and enhancement of the nation's unique historical and valuable cultural heritage; (ii) to disseminate and raise the awareness of ethnic peoples of the nation's cultural values in big cities and communities to establish a livelihood pattern that is in line with the advanced cultures; (iii) to develop a master plan for managing and protecting the Plain of Jars in Xiengkhouang province and Hinnamnor in Khammouane province in order to propose them to be included in the national heritage register; and (iv) to excavate and conduct research on historical places nationwide.

The policies and legal Instruments proposed in the 8th National Socio-Economic Development Plan are the following: (1) to revise and develop legislation for the management work related to culture and the process of registering items as national heritage; (2) to provide incentives in the tourism sector, at each geographical level, for meeting the regional standards; and (3) to increase coordination between central and provincial governments for improving the tourism curriculum at each level of higher education including bachelor courses.

Human capital within the ASEAN context and the 8th NSEDP

Recent studies show that disruptive changes to business models will have a profound impact on the employment landscape over next decades. Many of the major drivers of transformation currently affecting global industries are expected to have a significant impact on jobs, ranging from significant job creation to job displacement, and from heightened labour productivity to widening skills gaps. It was show that 65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist (WEF, 2016b).

According to the World Economic Forum, in 2015, the development and deployment of the human capital potential in the Association of Southeast Asian Nations (ASEAN) ranged from 53% of the ideal situation in Myanmar to 78% versus the ideal in Singapore, according to an Index (see Table 7). This is on a par with the wider Asia region as well as Latin America, and is some way ahead of the Middle East and Sub-Saharan Africa but behind Europe and North America. The ASEAN region features a cluster of solid performers, a few countries significantly underperforming in relation to their potential (Myanmar, Lao PDR and Cambodia) and one global success story: Singapore.

Currently, ASEAN labour migration patterns are centred and in one direction: from Cambodia, Lao PDR and Myanmar people migrate to work in Thailand (55% of the total intra-ASEAN labour migration). In this context, Lao PDR and Myanmar have the lowest scores for all the group ages (see Table 7). This fact introduces a serious constraint for the sustainable development of both countries and for the fulfilment of the sustainable development goals by 2030.

At regional context, the ASEAN countries are focusing in achieving universal literacy, developing education networks at variety skill levels, establishing research clusters and programme level initiatives such as regional technical and vocational education and training (TVET).

Table 7: Human Capital Index for ASEAN countries, 2016

Country	Overall index		0–14 age group		15–24 age group		25–54 age group		55–64 age group		65 and over age group	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Singapore	80.94	13	95.81	5	76.12	25	78.70	6	75.17	39	60.59	52
Malaysia	74.26	42	87.51	46	76.78	20	72.13	30	70.03	65	42.36	106
Thailand	71.86	48	81.71	74	73.31	39	67.91	46	70.71	62	58.65	60
Philippines	71.75	49	81.41	75	71.01	54	66.62	49	74.46	42	65.34	34
Viet Nam	68.39	68	77.21	89	75.43	31	61.19	70	70.92	60	59.64	57
Indonesia	67.61	72	84.08	63	68.51	64	60.83	73	63.66	80	51.57	77
Cambodia	58.88	100	69.44	105	55.60	109	55.38	96	59.81	96	48.41	87
Lao PDR	57.66	106	73.81	98	58.92	96	53.74	105	49.05	116	32.62	122
Myanmar	56.52	109	67.80	110	56.27	107	53.18	107	54.70	107	39.77	110
Brunei Darussalam*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

**Insufficient* data to make the estimations. Source: WEF (2016b)

The 8th Five-Year National Socio-economic Development Plan, 2016–2020 (MPI, 2016) proposes a strategy for developing the workforce in both quantity and quality focusing on agriculture, industry and services, and building capacity for them to compete in the region, especially in the ASEAN region. The plan aims to foster the creation of employment opportunities for Lao workers that are consistent with international labour standards, and to ensure that Lao workers are protected by effective labour laws and domestic and international ILO Conventions.

The proposed targets are: (1) Maintain the unemployment rate at 2%; (2) provide skills development to 658 000 people; (3) successfully provide a recruitment service for 716 200 new workers; (4) improve the skills development centre in Oudomxay to be a testing centre that issues skill standards certificates for workers; to improve the skills development centre in Attapeu; and to establish new skills development centres in Bokeo and Sayabouly; (5) develop skills standards for 25 professions; (6) test and issue skill standards certificates for 10 professions in the construction area, 7 professions in automobiles, 6 professions in IT and 4 professions in tourism; (7) complete 100% of labour force registration in 306 labour units that employ 100 workers or more and (8) organize a labour skills contest at the national and provincial level at least once a year.

The priority activities and projects proposed by the 8th Five-Year National Socio-economic Development Plan, 2016–2020 include: (i) Develop the workforce to be technically expert in their professions; (ii) develop a protection and management mechanism for Lao workers overseas and resolve issues associated with foreign workers in Lao PDR according to the laws; (iii) promote research and application of science and technologies and issue skill standards certificates for labourers to build confidence and trust in the labourers and employers, which will help increase jobs and income security; (iv) increase international cooperation to mobilize financial and technical assistance on Lao labour skills development to improve the quality of the Lao labour force; (v) strengthen the management of recruitment services and safe labour migration; (vi) increase well-regulated and efficient recruitment by collaborating with technical and

vocational education and training (TVET) in improving the teaching-learning curriculum, for instance, to be more suitable with the development situation in each period and responding to employers' demand and (vii) conduct a labour force and labour market survey within the country.

The government proposed the development of the following implementing policies and legal instruments: (a) develop a decree on labour skills development and fund, and a decree on provision of assistance to returning migrants; (b) develop a policy and mechanisms to ensure that labour force restructuring follows the directive on reducing labour engagement in the agriculture sector and increasing labour engagement in the industry and service sectors; (c) create a clear, adequate and transparent legal framework for the management and protection of migrant labour, with strict and efficient legal enforcement on employment; and (d) improve regulations and mechanisms that ensure compliance with labour laws as revised in 2014, and upgrade the capacity of responsible provincial and district staff to ensure effective implementation of these laws.

The 8th Five-Year National Socio-economic Development Plan, 2016–2020 proposes to develop entrepreneurs, technical experts and professionals. The plan considers that human development is a key factor of national development, especially in the generation of advanced science and technology and their integration. Therefore, for the plan, it is essential to build human resources to be knowledgeable, competent and proficient in areas of education and professions, to build experts in specific fields and to employ them in public and private organizations where they can contribute to national development and construction as they are capable of running private businesses efficiently and effectively. At the same time, it treats it as essential to concentrate on developing and managing technical services to build experts who specialize in each profession that can support the national development, and important to encourage Lao entrepreneurs to develop their business with local potential and uniqueness while promoting the use of new and innovative technology in doing business.

In this context, the proposed targets are: (1) build a workforce in the following areas: building/ construction, car mechanics, electrical engineering, civil engineering, mining engineering, geographical engineering, etc., that will enable workers in such areas to run their own business or become a new generation of small enterprises; (2) build a workforce in administration and management, such as business administrators, financial managers, economists and lawyers; (3) build at least one technical school in each province, and upgrade technical schools in some provinces, if applicable, to be colleges that can provide training at various levels in many more ways; (4) create more opportunities to enrol in vocational schools and training courses, for 60 % of graduates at general education level; and (5) build capacity for local firms, especially SMEs in the processing industry, and in handicrafts of local traditional products that represent national uniqueness.

To develop entrepreneurs, technical experts and professionals the priority activities and projects are: (i) focus on improving and updating curriculum for vocational and university education; (ii) improve and expand basic infrastructure for learning and teaching as well as training in different fields of work; (iii) improve and develop the coordination mechanism between the public and private sectors in building skilled mechanics and technical staff; and (iv) improve the data collection system as necessary and disseminate this data regularly.

The proposed implementing policies and legal instruments in this area are: (a) a reform of the vocational education system and vocational trainings that will ensure higher effectiveness and efficiency in labour development and training; (b) actions to develop vocational teachers in various professions (to improve their technical specialization and pedagogy) at different levels, involving both domestic and international training, and sufficiently employing them in the vocational and training institutions across the country at some level; (c) a policy instrument to promote the linkage between production and jobs creation by businesses, and (d) a policy instrument to encourage more secondary graduates, as well as those who lack opportunity to study, to enrol in vocational education.

In terms of human resources targets, policies and legal instruments, the 8th Five-Year National Socio-economic Development Plan, 2016–2020 does not addressed any specific target or legal instrument with a gender perspective.

EDUCATION AND HUMAN RESOURCES IN LAO PDR

Lao PDR has placed significant importance on human resources development and has allocated increased budget to education and sports, which covers 17% of the total government expenditures to improve and develop education infrastructure and improve teaching and learning at all levels (MPI, 2016). The focus has been on achieving the Millennium Developing Goals (see Box 1, page 18) and developing new curriculum for vocational study to respond to demand by the labour market. However, the total public investment in education considered as a percentage of GDP has been around 3.5% which is half of the amount recommended by UNESCO (see Figure 17). The investment in tertiary education has been only 0.46% GDP which is also very small compared with other countries of the ASEAN region. Table 8 shows the government expenditures among the different levels and areas of education between 2011 and 2015, expressed in million kip.

Several projects have been implemented, namely the development of quality education project, accelerated education for all, basic education development, dormitory building for students, school lunch and food supplements project among 30 districts in six target provinces contributing to increased attendance rate while reducing drop-out rates, expansion and improvement of technical schools in the three southern provinces, information communication technology project to enhance secondary education by establishing pilot schools in each province to link them to ICT (MPI, 2016).

Moreover, block grants are provided for school administration to all primary schools nationwide, based on a unit cost of 20 000 kip per student in FY 2011–2012 and increased to 50 000 kip per student in FY 2012–2013. Kindergartens, secondary schools and high schools receive 20 000 Kip per person per year.

The last policy interventions have been gradually improving the education qualitatively and quantitatively. The target that is expected to be achieved is school enrolment rate by children between 3 and 5 years old, which increased from 22.1% in FY 2009–2010 to 43.20% in FY 2014–2015, while the target for FY 2014–2015 is 39%. The school enrolment rate by children at the age of 5 preparing for primary school has increased from 52.9% FY 2012–2013 to 66% in FY 2014–2015, which already exceeded the target of 55%; net primary school enrolment rate increased from 92.7% in FY 2009–2010 to 98.6% in FY 2014–2015, which also exceeded the target for 2015 (98%); the literacy rate of the population above 15 years old has increased from 81.7% to 93.6%, while the target is 87% (MPI, 2016).

The enrolment rate of lower and upper secondary school students has achieved beyond the target; the lower secondary enrolment rate achieved 78% in FY 2014–2015 (the target is 75%) and the upper secondary enrolment rate is 45.7% in FY 2014–2015 (the target is 43%).

However, there are significant challenges in achieving some targets, including the survival rate of primary school students (i.e. the proportion of students who succeed the final test), which reached 71.4% in FY 2012–2013 and 78.3% in FY 2014–2015, while the target is to reach 95% by 2015. The repetition rate at primary level fell from 15.2% in FY 2009–2010 to 6.9% in FY 2013–2014 (MPI, 2016).

Although investment has been put into building more educational infrastructure, the repetition and drop-out rates continue to increase, in particular at primary school 1 and 2. The gender parity index between girls and boys in primary school is 0.95, in secondary school is 0.91, in high school is 0.84, and in vocational education is 0.6. Therefore, it can be concluded that the higher the level of education, the wider is the gap to reach gender parity (see pages 73–75).

To eradicate illiteracy, mobile teaching has been piloted to teach children between 6 and 14 years old outside school in the remote areas in three provinces, Savannakhet, Khammouane and Sekong, under the *Education for All* programme to enable the children to study. To date, 148 districts in 10 provinces have announced the completion of primary level (MPI, 2016).

In the area of vocational education, infrastructure for vocational education institutions has been improved in Savannakhet, Sekong and Attapue provinces. In addition, there is also a policy to provide allowances to students from poor families and remote areas. This has contributed to an increased enrolment rate of

42%. Less than 7% of vocational and higher education students chose vocational education. Only 12% choose to study agriculture and the rest study in the area of industry and services.

Recently, the Lao PDR government has implemented a system of certification for national technical vocational education and training, in order to boost labour skills. However, the programmes are often judged to be insufficient to meet the country's needs. It is crucial to provide a wider range of training courses, and to ensure that they are well targeted.

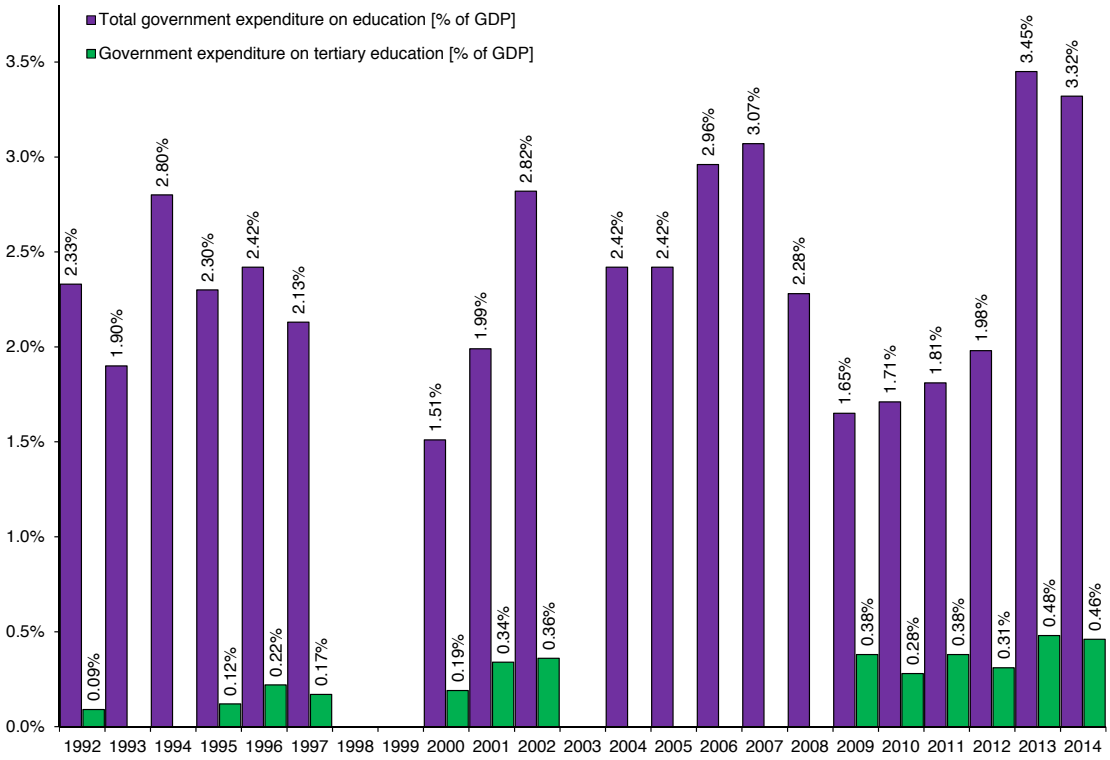


Figure 19: Total government expenditure on education and on tertiary education as percentage of GDP, 1992–2014.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

Table 8: Government expenditure in education by level and area in million kip, 2011–2015

Expenditure [million Kip]	2011	2012	2013	2014	2015	Total	Shares
Early childhood & primary education	455 436	404 204	482 257	433 064	426 004	2 200 965	33.00%
Secondary education	218 369	22 701	217 219	239 069	260 637	1 155 996	17.00%
Technical and vocational education and training	209 862	209 126	205 629	208 029	152 370	985 020	15.00%
Tertiary education	165 424	170 824	160 624	160 624	164 249	821 745	12.00%
Teacher education	61 055	60 226	84 373	113 321	113 321	432 296	6.00%
Non-formal education	18 740	17 322	16 217	16 172	16 172	84 622	1.00%
Private education	700	700	700	700	700	3 500	0.05%
Physical & art education	34 012	32 869	28 004	25 789	21 701	142 374	2.00%
Inclusive education	86.073	79 749	70 341	58 927	47 427	342 817	5.00%
Administration	99 487	100 337	106 890	100 770	148 770	556 254	8.00%

Source: Ministry of Education and Sports

BOX 8 – WHAT IS TVET? UNESCO'S STRATEGY, 2016–2021

Work is a major feature in most people's lives. Not only does it provide them with the means of survival in terms of food, clothing and shelter, but also the type of work undertaken by individuals and groups has a major impact upon their self-identity, social status and standard of living.

One of the important distinctions that traditionally occurs in any consideration of work, and education for the world of work, is between work that has a largely intellectual component, and that which is highly practical in nature and requires the individual concerned to work 'more with their hands than their head.' Thus, the traditional distinction between 'white collar employment,' which generally means the professions and semi-professions, and work in offices, and 'blue collar' work, which involves technical skills in the various crafts and trades, and technicians and technologists, in productive enterprises. In the emerging Information Age, both the nature of work and preparation for work are undergoing major changes, so that such black and white distinctions have become problematical.

The field of *Technical and Vocational Education and Training*, or TVET, requires both definition and differentiation from other designations. Throughout the course of history, various terms have been used to describe elements of the field that are now conceived as comprising TVET. These include: apprenticeship training, vocational education, technical education, technical-vocational education (TVE), occupational education (OE), vocational education and training (VET), career and technical education (CTE), workforce education (WE), workplace education (WE) etc. Several of these terms are commonly used in specific geographic areas.

Participants at the world congress on TVET, held in Seoul in 1999, decided that the best, most comprehensive term to use is *Technical and Vocational Education and Training*. This is reflected in the name of the UNESCO-UNEVOC International Centre in Bonn, Germany, which was established in 2000 as a direct result of recommendations arising from the Seoul congress in 1999.

Originally, the direct preparation for work was the main goal of TVET, and this remains prominent in many developing nations. However, with the technological revolutions and innovations in science and technology, during the 20th century, new domains of knowledge and new disciplines have become important at all levels of education and training. Further, the upward differentiation of TVET from first to second level and then to the third level of education has been an important development of the 20th century and sets the stage for the 21st century. The current focus is increasingly upon preparing knowledge workers to meet the challenges posed during the transition from the Industrial Age to the Information Age, with its concomitant post-industrial human resource requirements and the changing world of work.

UNESCO has recently defined a new TVET Strategy 2016–2021, which is in full alignment with Sustainable Development Goal 4 to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", the Strategy aims to support the efforts of Member States to enhance the relevance of their TVET systems and to equip all youth and adults with the skills required for employment, decent work, entrepreneurship and lifelong learning, and to contribute to the implementation of the 2030 Agenda for Sustainable Development as a whole. This Strategy has three priority areas: (1) Fostering youth employment and entrepreneurship; (2) Promoting equity and gender equality and (3) Facilitating the transition to green economies and sustainable societies.

Rising youth unemployment is one of the most significant problems facing economies and societies in today's world, for developed and developing countries alike. At least 475 million new jobs need to be created over the next decade to absorb the 73 million youth currently unemployed and the 40 million new annual entrants to the labour market. In many countries, the informal sector and traditional rural sector remains a major source of employment. The number of workers in vulnerable employment currently stands at 1.44 billion worldwide. Workers in sub-Saharan Africa and South Asia account for more than half this number, with three out of four workers in these regions subject to vulnerable employment conditions.

TVET can equip youth with the skills required to access the world of work, including skills for self-employment. TVET can also improve responsiveness to changing skill-demands by companies and communities, increase productivity and increase wage levels. TVET can reduce access barriers to the world of work, for example through work-based learning, and ensuring that skills gained are recognised and certified. TVET can also offer skills development opportunities for low-skilled people who are under- or unemployed, out-of-school youth and individuals not in education, employment and training (NEETs).

UNESCO will promote a whole-of-government approach to TVET transformations that foster youth employment and better connect and align relevant policy areas, including but not limited to education, employment, industrial and economic development, agriculture and rural development, health, and social policy. Interventions will be demand-driven, and will be planned, designed, implemented and evaluated in full alignment with the development context and policy priorities in the beneficiary countries.

To promote gender equality in and through TVET, UNESCO will seek to fill knowledge gaps in understanding the issue in various economic and cultural contexts, promoting policy learning and providing policy support and capacity-building services. Particular focus will be placed on developing strategies to promote women's access to occupational areas that offer better employment prospects; identifying relevant international promising practices, including improving the monitoring and evaluation of gender equality in TVET; and facilitating policy dialogue, capacity-building and advocacy which targets key partners, including labour market stakeholders. In addition to promoting targeted measures, UNESCO will support Member States in mainstreaming gender equality when reviewing and developing TVET policies, strategies and activities, so that gender equality considerations positively influence policy priorities and spending patterns.

Source: UNESCO (2016)

Priorities of the quinquennial plan for education (2016–2020)

In the 2001–2020 vision of education, education is placed at the centre of human resource development in order for the people in Lao PDR to: (1) have knowledge in the area of science and technology; (2) be able to have relationship with other countries; (3) have good moral and ethical behaviour, good discipline, good health, to be civilised in their emotional reactions and thinking; and (4) consider education as the duty of all people in society. There is a clear aim to (5) promote private education; (6) complete the primary education system, expand the lower secondary system and plan expansion of the upper secondary education system; and (7) develop vocational and higher education as a means to social and economic development.

According to the 8th National Socio Economic Development Plan (2016–2020), the government of Lao PDR will: (1) continue applying reforms to the education system by concentrating investment on the tasks set in the Education Strategy and Human Resources Development Strategy to give everyone access to education (from kindergarten to vocational and university levels) in response to demand as part of socio-economic development; (2) improve and expand basic infrastructure for education for all, especially those in remote areas; (3) extend educational opportunities to children and adolescents;(4) strengthen the reading skills of preschool children and young people, and (5) improve literacy among adults and those in remote areas, all in order to fulfil the policy on compulsory education at primary level and then at secondary level, and as a foundation for developing and improving labour skills and quality. The government will also ensure an incentive policy is applied to attract more students at vocational education; and will improve and modify the curriculum for vocational and university education in fields that suit socio-economic development, such as engineering, mining, processing, handicrafts, mechanics and services (MPI, 2016).

The education targets of the 8th national Socio Economic Development Plan are the following: (a) the gross enrolment rate of children aged 5 years will reach 80%; (b) the primary school completion rate will be 90%; (c) the lower secondary school enrolment rate will be 85%; (d) the upper secondary school enrolment rate will reach 60%; (e) 5% of lower secondary school graduates will enrol in technical schools and 90% of lower

secondary school graduates will enrol in upper secondary education; (f) 60% of upper secondary school graduates will enrol in TVET and 20% of upper secondary school graduates will enrol in tertiary education; (g) the literacy rate among 15–24-year-old will reach 99% and (h) the literacy rate of the population above 15 years old will reach 95%.

The 8th National Socio Economic Development Plan prioritizes the following activities and projects: (a) to develop basic educational infrastructure, especially by extending kindergarten and primary schools in villages without permanent schools, extending lower and upper secondary schools in the areas where it is possible, improving the quality of education and sports, and building a vocational school for each region; (b) to improve the quality of learning and teaching by paying attention to improving teacher quality and improving learning/teaching tools, building laboratories and other necessary rooms to focus less on learning by theory and more on learning by actual experiment and practice; (c) to improve education's administration, decentralizing it to the provincial level; (d) to prioritize scientific research and the application of research results in the learning and teaching process so as to raise the quality of education for students and pupils; and (e) to promote a school meal sharing practice as a pull factor for educational achievement as well as a social safety net for children in remote and rural areas, and ensure the application of the Policy for Promoting School Lunches.

Evolution of tertiary education in Lao PDR

Education, and tertiary education is considered the most important contributor to technological progress. Higher levels of tertiary education are a prerequisite for conducting R&D, which is important for product innovation, acquisition of technologies, engineering and design. A broad range of skills at different levels is also required to feed innovation in catching-up economies, as well as in advanced economies (OECD, 2013).

Laotian society and education are deeply rooted in an indigenous cultural heritage, colonialism, socialist revolution, and most recently, a movement toward a free market economy and privatization (Ogawa, 2009).

What follows is a short account of the evolution of higher-education system in Lao PDR, based on the descriptions available from the specialized literature (Can, 1991; Sihrath, 2007; Ogawa, 2009 and Adruce *et al*. 2017).

During the period of 1917–1939, the entire Indochinese area had a single educational system with central direction from Hanoi, Viet Nam. In 1939, the decentralization of the educational system was introduced in Lao PDR (Ogawa, 2009). Lao PDR had been a French colony from 1893 to 1955, then from 1956 to 1975 was affected by the Indo-China war. Before and during the French colonial rule, the development of formal education in Laos was very limited. Ogawa (2009) showed that the formal education for Lao Loum young men and boys centred around the village pagoda with monk-teachers playing a key role in the teaching of Lao Loum formal education. The opportunities for higher education favoured the urbanized Lao Loum only. Other tribes such as the Lao Soung and Lao Theung minorities did not have any formal or traditional education. Thus, fewer than 20% of the combined populations of Lao completed 6 years of formal schooling and only less than 2% finished the full 11 years of education during this period. There was a critical shortage of qualified and experienced Lao teachers, particularly for lower and upper secondary schools as well as for technical schools.

Higher education officially started in Lao PDR in 1958 with the Royal Institute of Law and Administration in Vientiane. Then it was followed by the National Institute of Pedagogy of Vientiane (NIPV) which was found in 1964 with the purpose to train the primary and lower secondary school teachers. The Pathet Lao government in Huaphan Province redesigned the Normal School of Viengsay, introducing higher education with the establishment of a section for the training of secondary school educators, in 1974.

After Independence, in 1975, the NIPV and the Viengsay Normal School were combined to become the Higher Institute of Pedagogy of Vientiane (HIPV). The HIPV also had two branches in Luangprabang and Savanakhet provinces (Adruce *et al.*, 2017). In addition, the Faculty of Medicine of what had formerly been the Royal School of Medicine in Vientiane was re-opened as the Higher School of Medical Sciences in 1975.

The National Polytechnic Institute (NPI) was established in Vientiane in 1984. This institute included four faculties: (1) the Faculty of Fundamental Sciences; (2) the Faculty of Civil Engineering; (3) the Faculty of Mechanical Engineering; and (4) the Faculty of Electrical Engineering (Adruce *et al.*, 2017).

Higher education remained strictly limited until the early 1990s. A factor that contributed greatly to the lack of attention to higher education was the opportunity given to many students to study in the Soviet Bloc countries. During the first one and a half decades of the Lao PDR, most tertiary education students would leave for training in Viet Nam, the former Soviet Union or Eastern Europe. The main reason for this was that there were very few tertiary educational institutions in Lao PDR, and the country faced a severe lack of funds, resources and qualified personnel needed for offering training at higher education level. It is noted that there was no complete university level education offered at that time; existing tertiary institutions operated at college level or below and did not offer further training. For one and half decades after 1975, more than 10 000 tertiary education students went for training abroad. Until 1991, the number of tertiary education students who graduated from training abroad was regularly slightly higher than the number of those who graduated from tertiary education institutions in the country (Sihrath, 2007).

In 1986 the Lao PDR government launched an ambitious policy of reforms named the New Economic Mechanism. This led the government to create a Steering Committee on Human Resource Development in 1994 with the objective of improved planning and strengthening higher education in Lao PDR (Adruce *et al.* 2017).

Until 1995, Lao PDR operated six higher education institutions for short-term training under the supervision of the related government ministries. These were the Higher Schools of: Hydraulic Construction; Electrical and Electronic Engineering; Transport and Communications; Forestry; Finances; and Administration. The students were chosen partly from a pool of technicians with some working experience, and partly from the pool of high school graduates (Ogawa, 2009).

Starting from 1995, the Government reformed the public and private higher education system, with the Prime Minister's Decree on Private Higher Education in 1995 and the Decree of the Higher Education Curriculum (National Standard) in 2001. The reforms amalgamated ten higher education institutions under the structure of the NUOL including the College of Law. The objectives of the reforms were twofold: (1) to meet the social and economic needs of the country by liberalizing and privatizing higher education; and (2) to strengthen capabilities for the country to exploit and mobilize for its modernization. (Ogawa, 2009).

The National University of Laos (NUOL) was established in 1996. It was created by integrating three existing colleges and eight higher education institutions. The university's selection of students is conducted through both a quota and a non-quota system. Under the quota system, each province is represented in the university by a certain number of places reserved for its students. Students enrolled in this way are exempt from their tuition. Students may also be selected through normal entrance exams, under the non-quota system.

The university is divided in 11 faculties: Sciences, Engineering, Economics and Management, Literature, Education, Architecture, Agriculture, Forestry, Environmental Science, Law and Politics, and Social Studies. The Faculty of Engineering is the largest among them, followed by the Faculty of Economics. The smallest are faculties of Forestry and Environment Science; however, relatively vigorous research is being conducted in these faculties. According to Table 29 (see page 110) within the period 2005–2014, the National University of Laos was second among institutions most prolific in the publication of scientific articles in the country (14.1%), although in the recent period 2015–2016 was only responsible for 10.1% of the scientific publications of the country.

According to Ogawa (2009) research is considered an important university function and was given specific importance in the decree establishing the NUOL. However, aside from the evidence shown on Table 29 (see page 110), research activities have not been prolific in most of higher education institutions. Most private colleges do not currently undertake research.

Ogawa (2009) identified the potential for incentive mechanisms for the staff undertaking research activities. For them, it is necessary to seek outside funds, organize institutional exchanges of information, and canvass for topics and funds to support university-based research activities. Moreover, he found few staff

members were qualified to conduct research as they did not have a higher degree. Research was meant for individuals going abroad to pursue higher studies. The following three objectives are since then at the heart of the overall research strategy at NUOL: (1) encourage and support all academic staff to carry out research; (2) permit competent staff to deliver consulting services in their field of expertise; and (3) establish a Committee for Research Development and Consultancy.

While the research function of the NUOL is not yet very strong, the Government announced the creation of research institutes under the university by around 2020, with support from the Asian Development Bank (CRDS, 2015).

Lee *et al.* (2014) considered the isolation of industry from science as one of the major bottlenecks for the innovation system in Lao PDR. While universities in developed and developing countries educate the workforce, they also usually provide research to the innovation system. However, in Lao PDR, professors are unable to perform research functions that their job implies within the national research and innovation system. Further, the lack of funds from within Lao PDR means that when research is performed it is typically funded only by foreign sources. These contracts are generally in agriculture, health and the environment, which are interests of foreign funders. As a result, research may be unresponsive to local industry demands, resulting in the research community becoming further isolated from industry. Thus, industry is left less able to adapt; it may have uncompetitive stakes in products and services that are not improving, while it finding it difficult to locally access research that might improve its products and services.

Figure 20 shows the long-term evolution of tertiary education enrolment at all ISCED levels (see Box 9, page 64) between 1955 and 2015, disaggregated by sex. The vertical axis is in logarithmic scale, meaning that what seems to be a straight upward-sloping line in the graph represents exponential growth of enrolments over time. It is possible to distinguish at least four periods, the first one with the highest exponential growth (1955–1986), a period where the enrolment decreased exponentially (1986–1992), a new period of exponential growth (1992–2009) and the last period when the exponential growth constant diminished (2009–present).

Figure 21 presents the total enrolment in tertiary education per 100 000 inhabitants, combining both sexes and all ISCED levels. This figure helps to clearly visualize the exponential growth in enrolments since 1997.

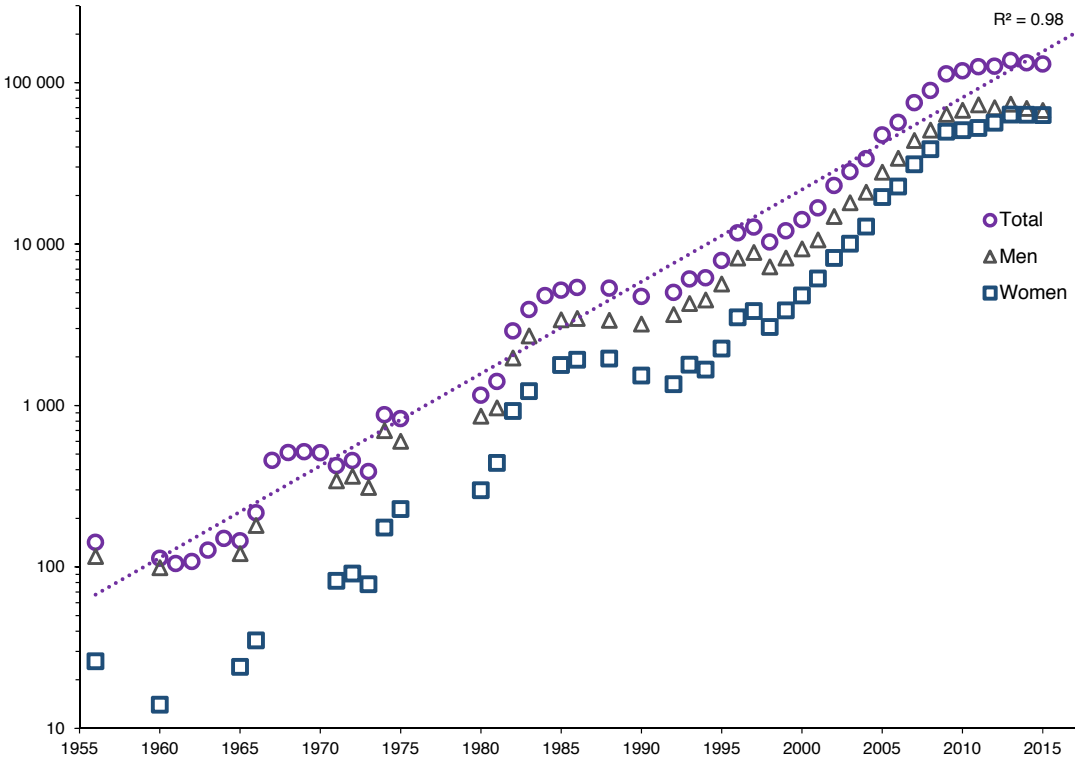


Figure 20: Total enrolment in tertiary education (all ISCED levels) by sex, 1955–2015. The vertical axis is in logarithmic scale.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

Figure 22 also presents the evolution of enrolment in tertiary education by ISCED levels for both sexes, focusing in on the period 1997–2015, and simultaneously showing the evolution of women's enrolment for this period. The vertical axis is again logarithmic. This analysis considers the ISCED levels 5, 6, 7 and 8 (see Box 9, page 64). This figure reveals the low participation of students in master's and PhDs studies. This fact places the most serious constraint for the deployment of an adequate research and innovation policy in the country.

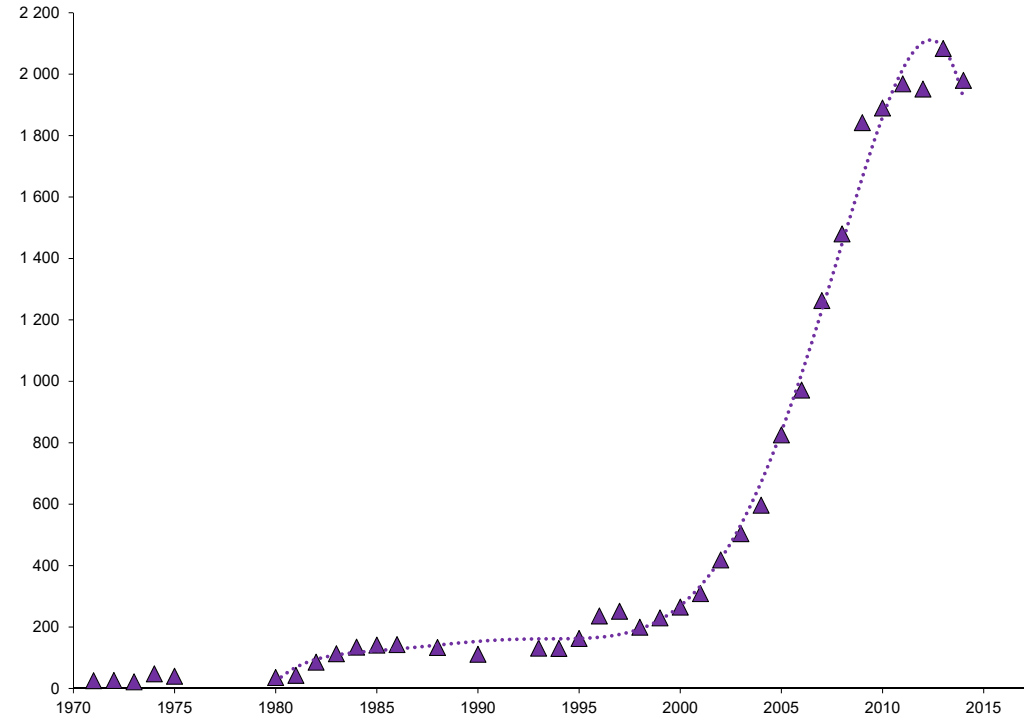


Figure 21: Total enrolment in tertiary education per 100 000 inhabitants (all ISCED levels and both sexes), 1970–2016.
Source: UNESCO Institute for Statistics

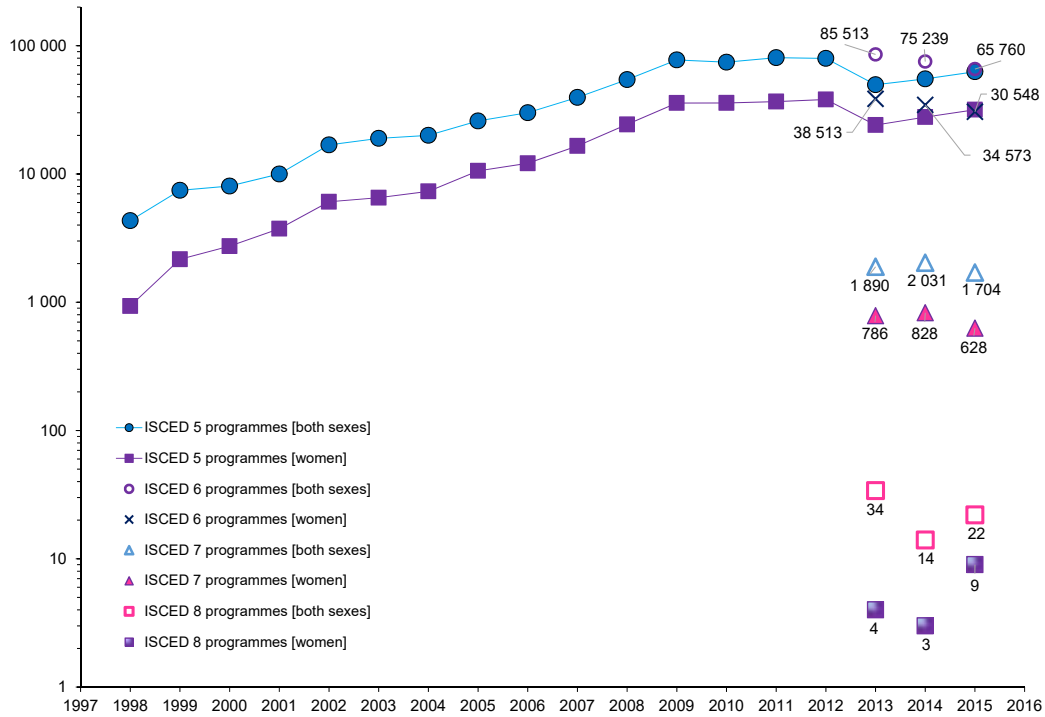


Figure 22: Enrolment in tertiary education by ISCED level (both sexes, and only women), 1997–2015. The vertical axis is in logarithmic scale.
Source: UNESCO Institute for Statistics

BOX 9 – CLASSIFICATION BY LEVEL OF FORMAL QUALIFICATION, ISCED STANDARDS

The International Standard Classification of Education (ISCED) provides the basis for classifying R&D personnel by formal qualification. R&D personnel most commonly have completed a tertiary education degree. Tertiary education builds on secondary education, providing learning activities in specialised fields of education. It aims at learning at a high level of complexity and specialisation. Tertiary education includes what is commonly understood as academic education but also includes advanced vocational or professional education. It comprises ISCED levels 5, 6, 7 and 8. For the purposes of R&D statistics, the UNESCO Institute for Statistics recommends collecting data at the following levels:

- **ISCED level 8** – Doctoral or equivalent level. Programmes at ISCED level 8 are designed primarily to lead to an advanced research qualification. Programmes at this ISCED level are devoted to advanced study and original research and are typically offered only by research-oriented tertiary educational institutions such as universities. Doctoral programmes exist in both academic and professional fields.
- **ISCED level 7** – master's or equivalent level. Programmes at ISCED level 7 are often designed to provide participants with advanced academic and/or professional knowledge, skills and competencies, leading to a second degree or equivalent qualification. Programmes at this level may have a substantial research component but do not yet lead to the award of a doctoral qualification. Typically, programmes at this level, are theoretically-based but may include practical components and are informed by state-of-the-art research and/or best professional practice. They are traditionally offered by universities and other tertiary educational.
- **ISCED level 6** – bachelor's or equivalent level. Programmes at ISCED level 6 are often designed to provide participants with intermediate academic and/or professional knowledge, skills and competencies, leading to a first degree or equivalent qualification. Programmes at this level are typically theoretically-based but may include practical components and are informed by state-of-the-art research and/or best professional practice. They are traditionally offered by universities and equivalent tertiary educational institutions. First degree programmes at this level typically have a duration of three to four years of full-time study at the tertiary level.
- **ISCED level 5** – Short-cycle tertiary education. Programmes at ISCED level 5 are often designed to provide participants with professional knowledge, skills and competencies. Typically, they are practically-based, occupationally-specific and prepare students to enter the labour market. However, these programmes may also provide a pathway to other tertiary education programmes. Academic tertiary education programmes below the level of a bachelor's programme or equivalent are also classified as ISCED level 5.
- All other qualifications (ISCED levels 0 to 4).

Source: UNESCO Institute for Statistics (2014)

Figure 23 shows the long-term evolution in the number of tertiary level graduates (again showing all graduates, and also the women graduates) between 1972 and 2014. This graph is in a semi-logarithmic scale and the evolution in the number of graduates exhibits exponential growth. However, the graph also shows a persistent gender gap among graduates: the number of women graduates is consistently smaller than half of the total graduates. This is the opposite of what is observed in many developed and developing countries during the past decade. Unfortunately, Lao PDR did not reach that gender equality goal yet. Women are not achieving at expected levels.

Table 9 shows the number of graduates by ISCED level and sex, for the period 1998–2015. Again, here we can observe the limited number of master and PhD graduates. Unfortunately, information on these graduates disaggregated according to the six major fields of knowledge (exact and natural sciences, social sciences, health and medical sciences, agricultural sciences, engineering and technology and the

humanities) were not available. This missing information is relevant for planning to meet human resources needs in the context of any national research and innovation policy.

Figure 23: Number of tertiary graduates, both sexes, and only women, 1972–2014. The vertical axis is in logarithmic scale.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

Table 9: Graduates students by ISCED level and sex, 1998–2015

Year	ISCED 5 [both sexes]	ISCED 5 [women]	ISCED 6 [both sexes]	ISCED 6 [women]	ISCED 7 [both sexes]	ISCED 7 [women]	ISCED 8 [both sexes]	ISCED 8 [women]
1998	4 327	935	..	..	..	..	..	..
1999	7 456	2 162	..	..	..	..	..	..
2000	8 054	2 737	..	..	..	..	..	..
2001	9 995	3 743	..	..	..	..	..	..
2002	16 869	6 074	..	..	..	..	..	..
2003	18 950	6 532	..	..	..	..	..	..
2004	20 018	7 321	..	..	..	..	..	..
2005	25 925	10 577	..	..	..	..	..	..
2006	30 048	12 112	..	..	..	..	..	..
2007	39 541	16 540	..	..	..	..	..	..
2008	54 443	24 346	..	..	..	..	..	..
2009	77 533	35 762	..	..	..	..	..	..
2010	74 394	35 822	..	..	..	..	..	..
2011	80 737	36 697	..	..	..	..	..	..
2012	79 644	38 085	..	..	..	..	..	..
2013	49 655	24 081	85 513	38 513	1 890	786	34	4
2014	55 151	27 780	75 239	34 573	2 031	828	14	3
2015	62 705	31 699	65 760	30 548	1 704	628	22	9

Source: UNESCO Institute for Statistics

Figure 24 presents the long-term evolution in the number of tertiary teachers (ISCED 5 level) in a gender disaggregated way from 1960 to 2015. The graph is also presented using a logarithmic scale for the vertical axis. We can distinguish four periods: exponential growth (1960–1983), zero growth (1983–2001), exponential growth (2001–2012) and exponential decrease (2012–present).

Figure 24: Number of teachers (both sexes, and only women) in ISCED 5 programmes, 1960–2015.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

Student mobility

Since the seventies, there has been a great expansion in higher education enrolment across the world. Governments are currently going through a period of policy transition with policy makers seeking to reorient the objectives and instruments of policy to reflect the increasingly sharp awareness of knowledge creation and learning as drivers of innovation growth employment and wealth.

Human resources are recognised as being key for conducting scientific research developing new technologies commercialising and diffusing innovation. Among them doctorate holders are not only the most qualified in terms of educational attainment but also those who are specifically trained to conduct research. Governments and institutions increasingly build internet-based social networks that are expressly designed to allow post-graduate students doctorates and researchers abroad to keep in contact with institutions in the home country e.g. diaspora networks.

The international mobility of tertiary students has been a phenomenon of growing interest for scholars and policy makers since the sixties and can have a significant impact on shaping the structure of national innovation systems. The mobility of students worldwide is perhaps the most visible form of cross-border higher education and one that has been monitored over years.

According to UNESCO Institute for Statistics (2012), the population of internationally mobile students was about 1.1 million in 1980. The number increased slightly to 1.3 million in 1990 but by 2009 had tripled to 3.4 million. The number of mobile students has been expected to grow to 8 million by 2020 (Altbach, 2006).

Students from Lao PDR are dispersed across a wide range of host countries. A wider dispersion may imply that students are returning to their home country with a richer mix of new ideas. Table 10 shows the number of tertiary students from Lao PDR studying abroad in the top-25 countries over the past 18 years (1998–2015). In order of importance, the top 10 destinations selected by Laotian nationals to study abroad are: Viet Nam, Thailand, Japan, China, France, Australia, USA, Republic of Korea, New Zealand, and Poland.

Table 10: Number of tertiary students from Lao PDR studying abroad, 1998–2015

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Australia	87	145	127		127	125	117	111	125	162	162	167	163	170	180	191	218	207
Belgium		5	2	3	12	8		1				1		1	1			2
Cambodia		5		9					15									
Canada	6	6	3	6	3	3	3	3		16	21			9	12	12		
Cuba		1	1	1		14			20		35	40	44	35	27			
China						403	509	569			320	320						
France		663	273	214	158	183	168	151	137	132	104	117	102	112	106	85	69	
Germany		46	39	20	22	18	18	10	3	6	9	3	9			17	11	10
Hungary	1			2	3	2	1	1	2	3	1					3	3	7
India			2	7	5	3	2	7	6					29	18	14	30	24
Italy				10	1	1	1		2	3	1	2	1	3	3	5	2	1
Japan	46	64	72	90	151	173	231	255	256	257	251	264	275	268	246	218	203	
Malaysia	11	14	20	12	31	20	14		20	17		16	17	28	18			16
Mongolia			1	1								6	17	17	26	49	39	42
New Zealand	1	2		1	2	2	1	1		19	26	29	32	28	31	47	69	64
Poland	21	27	32	40	48	39	30	21	15	3	3	4	1		3	2	1	
Republic of Korea				1	5	9	15	15	24	37	35	33	47	57	63	75	70	69
Russian Federation											11	16		31			1	2
Sweden		3	5	4	8	7	12			2	2	18	21	17	6	3	3	3
Switzerland		5	5	3	2	2	1	1	1	2	4	3	3	4	3	23	3	5
Thailand		301		79	44		226	229	436	493	664	1 301	1 254	1 311	1 344		807	793
Turkey	2	2	2	2	2											9	9	15
United Kingdom	9	8	5	9	7	4	8	11	11	8	7	8	12	8	11	20	32	
USA		90	121	83	133	108	65	66	67	46	69	79	63	48	42	48	54	51
Viet Nam		233	358	370	455	700		1 448		2 251	2 435		1 744	1 936	2 153	1 832	1 442	1 772

Note: empty cells indicate that no information on the number of tertiary students from Lao PDR was submitted to the UNESCO Institute for Statistics by the host country. Source: UNESCO Institute for Statistics. For China the data was provided by the Ministry of Education of China

Women in science and engineering

Contextual and cultural factors enhancing the gender gap

The development and promotion of science, technology and innovation (STI) activities in a given nation will depend not only on the existence – or not – of policies and policy instruments that encourage their growth, but mainly on contextual factors, educational and cultural factors that affect this development directly.

The gender dimension in science and engineering describes the way in which culturally-imposed differences in the treatment, expectations and opportunities of men and women will interact with scientific and technological practices in a particular historical moment of a particular society. Scientific and technological practices inform gendered social relations, and, in turn, they are conditioned by gendered social relations. (Harding and McGregor, 1996).

In order to properly assess the gender dimension within STI activities and its progress over time, a set of indicators that reflect the contextual, educational and cultural characteristics of the country under study must be analysed. In this work we will use the so-called Global Gender Gap Index (World Economic Forum, 2016d). It was introduced, in 2006, by the World Economic Forum, in order to capture the magnitude of gender-based disparities and track their progress over time. This index compares national gender gaps using economic, educational, health and political criteria. This index attempts to build a grid of countries so as to facilitate effective comparisons between regions and income groups.

Instead of measuring the levels of resources and opportunities available, the index is designed to measure only disparities (gender gaps) in access to resources and opportunities between men and women, boys and girls. In this way, the index can inform about the relative magnitude of the disparities irrespective of the level of economic development achieved by a country, and comparison becomes possible. For example, in general terms, rich countries can offer more education and health opportunities to all members of society, although gender gaps may persist and could worsen these higher levels of health or education. The two dimensions are independent. The Global Gender Gap Index therefore is designed to reward countries in which disparities between men and women, boys and girls, are the smallest when it comes to accessing available resources.

Therefore, in the case of education, the index penalises, or rewards countries based on the size of the gap between male and female enrolment or graduation rates at any level, but it does penalise, or reward based on which levels of education the highest achievers obtain. While the Index considers four key indicators to measure the gender gap in education outcomes, it also provides information on additional gaps between women and men, girls and boys—in their rates of participation in primary and secondary education, educational attainment rates, advanced degrees, participation in STEM education and skill diversity (World Economic Forum, 2016d).

The index also includes a comparison of the gap between men and women who occupy highly qualified positions such as legislators, senior officials and managers (results indicator). However, it does not include data on the duration of maternity leave (a policy-relevant indicator).

The Global Gender Gap Index has become well-recognized since 2006 because its underlying approach is accepted. The index rewards countries that reach the point where women's outcomes are equal to those of men but does not reward or penalise cases in which women outperform men in certain indicators in some countries. In this way, a country that has a higher enrolment for girls than for boys in secondary school will be the same as a country where the enrolment of boys and girls is the same.

Table 11 presents the scores and global ranks, overall and according to various components of the Global Gender Gap Index, for member states of the Association of Southeast Asian Nations (ASEAN). In terms of the Global Gender Gap Index overall, Lao PDR occupies the 43th global rank and the second position after

the Philippines among ASEAN countries. However, by analysing the individual components, an intriguing picture emerges. Despite that in terms of gaps for economic participation and opportunity Lao PDR has one of the best scores at global level (global rank 2), the gap between women and men in terms of education is one of highest in the world (global rank 115). In real terms, this gap starkly contrasts with what women attain in other ASEAN countries.

It is also important to analyse how cultural factors affects gender gap outcomes because they influence for example the life choices individuals make and how society and families distribute opportunities in education among girls and boys. Particularly, Lao society consists of 68 ethnic groups. They are broadly classed into three major categories: Lao Lum, Lao Theung, and Lao Sung. Each group has a rich and long cultural history. However, there are several commonalities between them, particularly in the sphere of religion. The country was exposed to Indian civilization through which first the elements of Hinduism and later of Buddhism arrived and got assimilated into Laotian culture (UNESCO, 1989). This cultural background had an impact on gender (See Box 10, page 76).

Differences in political awareness, empowerment, and participation may also influence gender gap in education. According to the government, the Lao Women's Union at each level has witnessed improvements in terms of political awareness, mindset, structure, leadership styles and methods of work. At present, there are 930 963 Lao Women's Union members, 10 636 Lao Women's Union groups and 1 550 local-level establishments. The Lao Women's Union is one of the strongest arms of the ruling Party was formed in 1946, proclaimed in 1975 and restarted in the 1980s to be the voice of women in the Party.

The number of members who received political and technical training increased, as did the number of women in management and leadership positions from the village level to the central level. Figure 25 shows the distribution of seats at the parliament occupied by women (1990–2016). In 2016, women occupied 27.1% of the parliament seats. In 2015 there were 404 female officials among the district-level party members (12.3% of all members), 56 among the provincial-level party members (10%), 8 in the provincial permanent party committees (4.6%), 54 among the ministerial-level party members (15%), and 13 in the ministerial-level permanent party committees (16.8%).

Table 11: The Gender Gap Index for ASEAN countries, 2016

Country	Global index		Economic participation and opportunity		Educational attainment		Health and survival		Political empowerment	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Philippines	0.786	7	0.780	21	1.000	1	0.980	1	0.386	17
Lao PDR	0.724	43	0.832	2	0.944	115	0.972	90	0.146	79
Singapore	0.712	55	0.793	17	0.975	95	0.967	121	0.111	97
Viet Nam	0.700	65	0.736	33	0.978	93	0.950	138	0.138	84
Thailand	0.699	71	0.770	22	0.990	74	0.980	1	0.057	131
Indonesia	0.682	88	0.598	107	0.987	87	0.976	58	0.168	72
Brunei Darussalam	0.669	103	0.696	56	0.992	70	0.966	130	0.021	141
Malaysia	0.666	106	0.658	80	0.985	89	0.969	109	0.051	134
Cambodia	0.658	112	0.659	77	0.897	128	0.980	1	0.098	108
Myanmar*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

**Insufficient* data to make the estimations. Source: WEF (2016d)

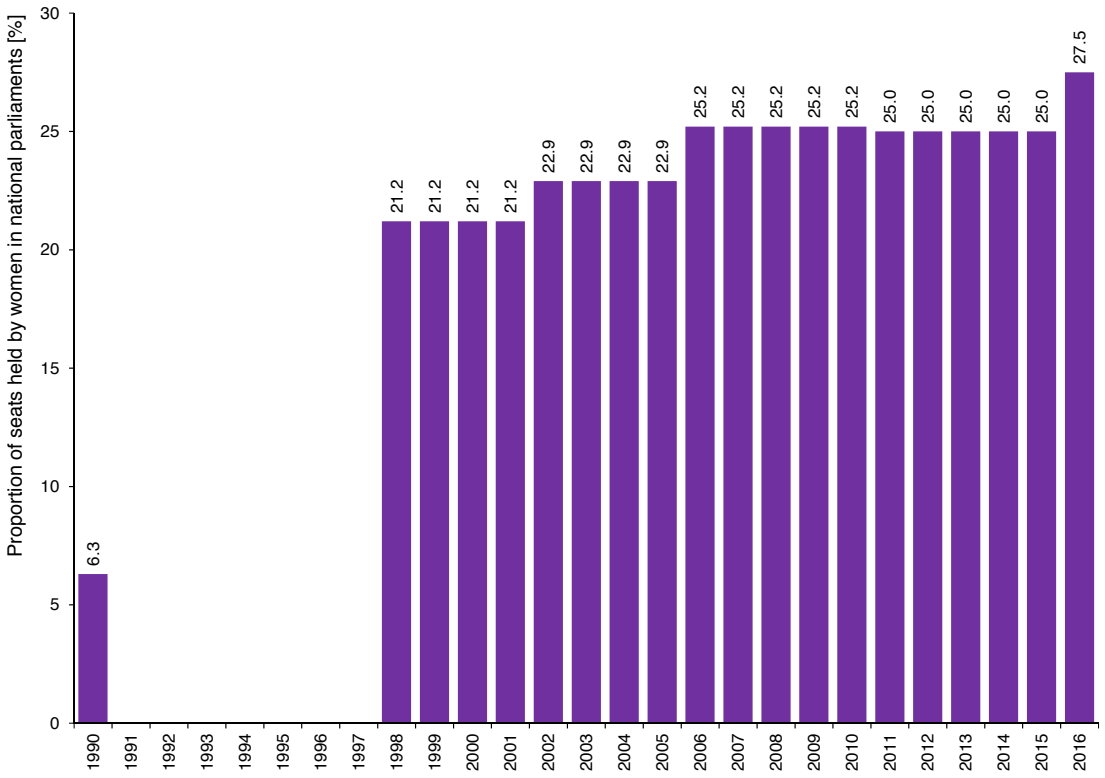


Figure 25: Distribution of parliamentarian seats occupied by women in Lao PDR, 1990–2016.

Table 12: Distribution of government staff by level of education and gender, 2012

Education level	Percentage over total personnel	Number of women by level of education	Number of men by level of education	Total personnel by level of education	Percentage of women	Percentage of men
PhD	0.14%	74	353	427	17.3%	82.7%
Master	1.77%	1 234	4 016	5 250	23.5%	76.5%
Bachelor	12.20%	13 060	23 106	36 166	36.1%	63.9%
Pre-Bachelor	14.96%	19 832	24 536	44 368	44.7%	55.3%
Diploma	18.23%	26 330	27 731	54 061	48.7%	51.3%
Certificate	52.45%	7 259	148 282	155 541	4.7%	95.3%
Non-professional	0.24%	318	396	714	44.5%	55.5%
Total	**100.00%**	**68 107**	**228 420**	**296 527**	**23.0%**	**77.0%**

Source: Ministry of Home Affair, 2012

Table 12 shows the distribution of government staff against their level of education and gender. The great majority of the government staff has only a Certificate education level (52.45%), while only 0.14% has a PhD, and 1.77% has a Masters. Only 23% of the total government staff are women. Among these employees (not shown in the table), only 0.11% has a PhD, while 1.8% a master's degree, 19.2% a bachelor's degree, 29.1% a pre-bachelor's degree, 38.7% a Diploma and 10.7% a Certificate. As a group average, they score as more qualified than the average employee. Among male employees 0.15% has a PhD, 1.8% a master's degree, 10.1% a bachelor's degree, 10.7% a pre-bachelor's degree, 12.1% a Diploma and 64.9% a Certificate. The last figure points to that while women represent fewer than a quarter of the Government staff (they are underrepresented), as staff they are relatively highly qualified, having typically entered government service with a level of education higher than that of their male counterparts.

The Lao Women's Union has been performing a survey in 11 provinces on the existing laws on women's retirement, as well as working on ensuring the availability of counselling services, and working for the protection of women's and children's rights. The Union has provided counselling to women and children in need, by working in conjunction with concerned organizations to solve the problems those women and children encountered. To make the counselling services effective, the Lao Women's Union is making sure these consultants have proper knowledge, and it has provided counselling services for a total of 100 579 cases and resolving problems for 366 participants since the start of these services.

The Union has also provided vocational training to 8 791 poor people and 1 009 disadvantaged people, 1 003 of whom were female, aiming to increase employment and income, especially for women and families as a whole. It has implemented the Lao Women's Union fund, working at village and grass-roots levels to create favourable conditions for women to access the resources of the fund in order to invest in their family development, commercial production, services and so on. All of these activities are to contribute to improving their livelihoods.

Kusakave (2005) considered that a nationwide women's network like Lao Women's Union does not necessarily carry the message of gender equality throughout society. This study shows the difficulties to incorporate knowledge of gender issues and a gender lens for problem-analysis and identifying needs into the work of various sectors and departments. Moreover, the legacy of mobilising women for national goals, without challenging traditional gender norms and roles, appears difficult to change in the organisational culture of Lao Women's Union. The former focus of the Union was to support nation building. For Kusakave (2005) such efforts to mobilize women to contribute to certain causes can be easily shifted towards a focus on women contributing to the well-being of the family/community or to national economic development, by their submission and sacrifice of equality. It is more difficult to shift toward a focus on protecting, respecting and promoting women's rights and equality as itself a contribution toward the well-being of family/community and national economic development, and promoting their participation to influence political processes and changes in gender relations.

Education and gender

From the beginning of their lives, girls are often victims of unequal educational opportunities due to socio-economic, cultural and religious obstacles. In many cases, only those who manage to overcome the barriers of the contextual and cultural conditions of a particular-society will have the possibility of entering the school and eventually – in the future – being part of the seedbed of talents that dedicate their lives to the tasks of scientific research, technological development and productive innovation.

Inequality between men and women usually begins before entry into formal education and can be subtle. The attitudes of the parents and community can influence the options that their daughters choose. Transmitted values can undermine, without warning, the confidence and aspirations of the girls, as well as the images they have of themselves. Indeed, it is social stereotypes, which parents transmit to their children, that commonly discourage girls and women from pursuing technical or scientific training if they do not correspond to the traditional image of women in a given culture (McGregor and Harding, 1996).

Recently, Bian *et al.* (2017) showed evidence that – in Western societies – commonly accepted stereotypes associate strong intellectual ability for mathematics, physics or philosophy, more with men than with women. For Bian *et al.* (2017), these stereotypes discourage women from pursuing careers related to science and engineering. Specifically, their study showed that 6-year-old girls are less likely than boys to believe that members of their gender are "really too smart" to devote their lives to science. Also, at the age of 6, girls already begin to avoid activities that are said to be only for "talented and bright" children. These findings suggest that notions of talent and genius are acquired at an early age and have an immediate effect on the interests and pursuits of girls and boys. These sociocultural conditions, together with others of a socioeconomic nature, would impose on women a barrier of entry – of psychological and cultural origin – to science and engineering careers. Having failed to pursue learning from such early ages, increasing exclusion at later stages of learning will follow.

The quality of science and math education in the middle cycle and the performance of students in these areas have a significant effect on the number of students who will later opt for a career in science, engineering or mathematics. Rozek *et al*. (2017) showed that the performance and interest of the secondary students with respect to said courses are usually associated with the stereotypes that their parents teach them. For this reason, they designed a motivational training aimed at parents, to make parents more aware of the importance of mathematics and science in the formal education of all children. This study showed as results increases in daughters' interest in science and mathematics. As a result, the intervention alone appears to have led to an improvement in 12 percentiles in the performance that the affected US students achieved in the scores of the standardized tests of mathematics and sciences for the preparatory examinations for university. These findings demonstrate that a motivational intervention with parents can have important effects not only on the preparation of science and mathematics in secondary education, but can rapidly produce a subsequent effect of importance to socio-economic development: increasing interest in tertiary education in science and engineering, opening the way to science and engineering careers among women.

Governments are committed to guarantee basic education for all. However, socioeconomic conditions impose serious constraints on access to education. As the level advances (from the primary to the university postgraduate level), the constraints tend to increase, and those who did not start early are later excluded. In this way, in many societies, the potential creative talent of millions of young people is excluded via the educational system when it cannot adequately welcome all at an early age due to socioeconomic conditions.

In Lao PDR between 40 and 70% of the population could be classified as an ethnic minority, and within these minorities girls and women are considerably disadvantaged educationally and economically. During the past decades, different foreign interventions have pointed out the need to fund projects based on ethnic minority, focusing on girls' needs in education (Fox, 2003).

Figure 26 presents the evolution of the Gender Parity Index (GPI), which is simply the ratio of the number of females to the number of males, for primary- and secondary education enrolment in Lao PDR (1970–2015). 1.0 or near 1.0 would represent parity. Figure 27 shows the GPI for tertiary education enrolment in Lao PDR (1970–2014). In both cases, a constant increase in the GPI can be observed since 1995 probably due to the application of new education policies in the country. Already in 2012, women employed in public administration demonstrated high levels of educational achievement, despite being a small cohort (see Table 12).

Figure 26: Gender parity index of the gross primary and secondary enrolment ratio, 1970–2015.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

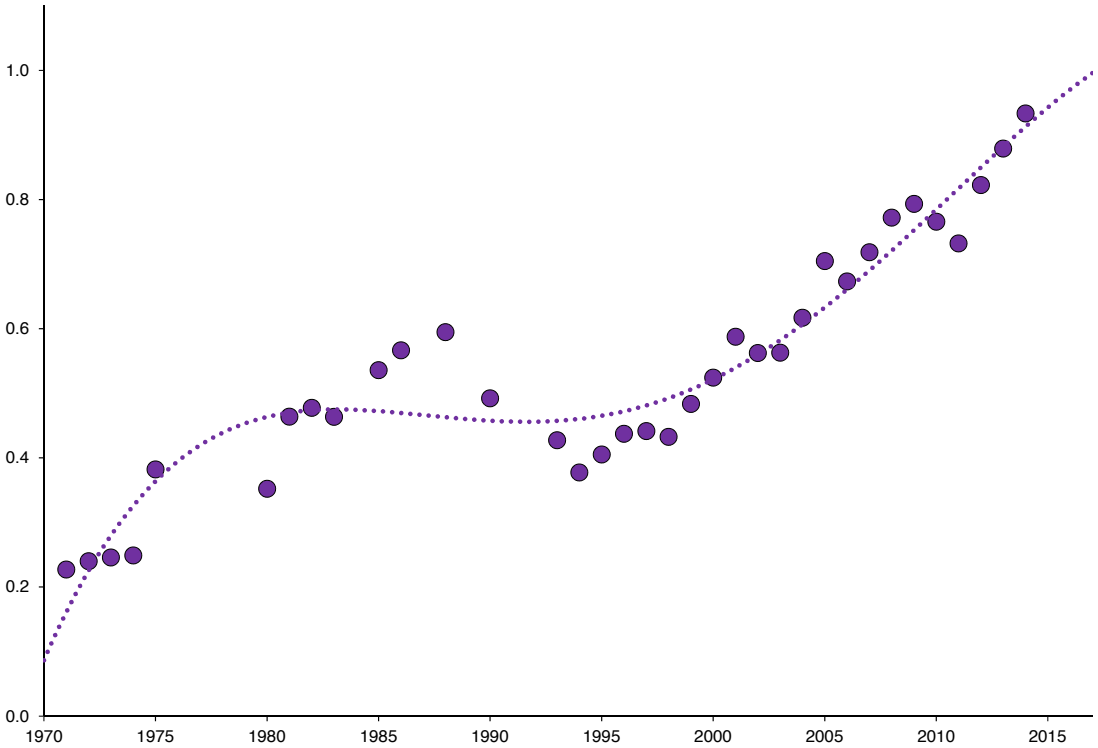


Figure 27: Gender parity index of the gross tertiary enrolment ratio, 1970–2014.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

BOX 10 – LAO TRADITIONAL GENDER IDEOLOGY

Lao gender ideology has been mediated through many literature traditions, which have tended to favour men and have tended to enforce rigid sets of rules upon women, to encourage that women of all ages behave submissively choosing roles subordinated to those of their male counterparts.

Ngaosyvathn (1994) traces the status of Lao women in Lao society since the earliest period. He points to Buddhist religion as one important foundation for current gender ideology. Buddhism was imported from Cambodia and spread during the reign of king Fa Ngum, who laid the foundation of Laos Lane Xang Kingdom in the 14th century, which was the first unification of Lao national territory, including a large part of the other side of the Mekong River. King Fa Ngum had married the Princess of Cambodia named Nang Keo Kenggna, who encouraged the king to import Buddha images into Laos as symbols of the Buddhist religion. Buddhism was then proclaimed the national religion and become an important part of Lao culture. This Buddhism as practiced in the Lao kingdom included ideas about gender and gender practices (Ngaosyvathn 1994). Crawford and Rhoda (2004), who argue that women's status and the images of women in many countries are shaped by religion, have brought attention to religion as an important factor in defining gender patterns.

Ngaosyvathn (1994) describes how numerous beliefs in Lao society originate from two main sources: Buddhism and Animism. She finds that when Buddhism started to be practiced in Lao PDR, women's status was lowered from what it had been previously. She also points out that during the period of colonization, both under Siam and France, Lao women increasingly lost status and power until they were considered second class citizens. A Royal Lao dictum suggests that women should not be allowed to interfere in politics, nor monks in the affairs of the state.

The association between religious ideology and the exclusion of women from the public sphere was also noted by Trankell (1993). Trankell explains how in the context of Lao PDR the Hindu-Buddhist culture played an important role in defining women's position. Trankell found that women's lives were hindered by religious rules that restricted the freedom of movement. Similarly, Ireson (2004) shows how Buddhist's rituals define highly distinct roles for men and women, defining subordinate roles for women, for instance that men can be monks and women can only be novices.

Source: Excerpts from Khouangvichit (2010)

Women's development policies within the 8th NSEDP

The Constitution of the Lao PDR guarantees the principle of gender equality. The Constitution clearly reflects that men and women are equal in all aspects including politics, economy, and culture, social and family life. In the Constitution, many articles guarantee women's rights and equality between women and men, and between husband and wife concerning family assets. Although equality is even further promoted in several specific laws, legal awareness remains low, partly because more women than men are illiterate.

The Lao government has been committed to gender equality and gender mainstreaming. In May 2000, the Prime Minister's Office issued a directive on the integration of sex-disaggregated statistics in policy and planning of gender-sensitive development programmes/projects. In 2002, the government established the Lao National Commission for Advancement of Women (NCAW). The government's commitment to gender equality is also expressed in a number of policy documents, including those on population, health, and human resources.

The Lao Women's Union has been focusing on promoting knowledge of several laws for empowering and protecting women, as well as other legal devices, such as the Convention on Eliminating All Forms of

Discrimination Against Women (CEDAW). Since initiating this work, it has hosted workshops on enhancing political theories and the preservation of the nation's great history, to the members of the Union as well as to various ethnic women groups, 39 691 times reaching an audience of 3.61 million. This promotional activity is also communicated through 469 200 Lao Women's Union newspapers and Lao magazines, and through 560 knowledge programmes targeting women, of which 280 are TV programmes. The media's promotion of gender development and equality has been improved and expanded to reach the national level, encouraging greater exchange of information at central and local levels.

According to the 8th National Socio Economic Development Plan (2016–2020), the government of Lao PDR will take actions (1) to encourage women to access education so as to improve their professional/vocational/labour skills and ensure access to public health services; (2) to increase their political awareness to enable them to contribute to socio-economic development and the conservation and transmission of the national culture; (3) to strengthen the Lao Women's Union at each level to be representative and protect women's and children's rights and interests; (4) ensure equal rights and development between men and women in the areas of politics, economics, sociocultural affairs and the family; and (5) to reduce discrimination and violence against women and children while promoting gender equality.

The 8th NSEDP proposes to achieve the following targets: (1) increase the proportion of Lao Women's Union members who are educated in political theory, constitutions, laws, treaties, international agreements relating to the development and protection of women, gender equality, and national traditions and culture, to 80%; (2) increase Lao Women's Union membership to 70% of women of 15 years of age and older; (3) expand a Lao Women's Union committee network to cover 20% of all business units in the private sector; (4) encourage the Lao Women's Union to conduct a campaign on "three goods" linking with the 3-builds directive implementation; (5) promote women to take up 20% of leading management-level positions: at village level (10%), at district level (20%) and at provincial and capital level (20%); (6) encourage women to take up to 30% of the management-level positions at central level, especially in the organizations where women officials account for more than half of all officials; (7) increase the proportion of female members of the 8th National Assembly to 30%; (8) increase to 85% the proportion of the population of young women who will graduate from secondary school; (9) achieve gender parity in services such as education, health and social welfare; (10) increase the proportion of poor women with vocational education, skills and stable employment to generate income; (11) develop the Lao Women's Union Fund for women's development and family support; and (12) create and widen opportunities for women and children to access the legal system.

The 8th NSEDP proposes the following priority activities and projects: (i) raise awareness on directions, the Constitution, laws and international treaties associated with women's and children's development and protection of their rights and interests; (ii) mainstream gender issues in the work of all sectors; (iii) strengthen capacity for each level of the Lao Women's Union; (iv) improve vocational training centres to develop and strengthen women's skills at the vocational level; (v) provide counselling services for women and children who encounter problems; (vi) improve and expand the Lao Women's Union Fund for women's development and family support; (vii) expand cooperation with women's organizations in other countries, such as the ASEAN Committee on women and other related organizations; (viii) monitor and evaluate the implementation of the Lao Women's Development Strategy and Plan; (ix) raise awareness and carry out activities to promote non-violence toward women; and (x) report progress on implementing the Beijing Declaration and the Convention on Eliminating All Forms of Discrimination Against Women.

The 8th NSEDP proposes the development of the following policies and legal Instruments: (a) an initiative to deepen understanding of policy directives and orders of the Party and Government on women's and children's development and protection, and to promote advancement of women and gender equality; (b) a Law on the Lao Women's Union; (c) a Law on Women's development and protection; (d) a Law on non-violence toward women and children; (d) Vision 2030 on Women's Development, and a 10-year Women's Development Strategy (2016–2025); (e) a Five-year Lao PDR Women's Development Plan (2016–2020); (f) National Plan of Action on Protection and Elimination of Violence Against Women and Children of the Lao PDR (2014–2020); (g) Vision 2030 and 10-year National Strategy on Gender Equality (2016–2025); and (h) the 3rd Five-Year National Plan of Action on Gender Equality (2016–2020).

BOX 11 – ACHIEVING GENDER EQUALITY IN STEM: THE UNESCO STEM AND GENDER ADVANCEMENT (SAGA) PROJECT

Why is it important?

Despite the remarkable progress women have made in education and in the workplace in recent decades, progress has been uneven. According to estimates by the UNESCO Institute for Statistics (UIS), only 28% of the world's researchers are women and percentages are even lower at the highest levels of decision-making. Furthermore, women are still underrepresented in the fields of science, technology, engineering and mathematics (STEM), both in the number of graduates (especially at the Ph.D. level), and in research professions (UNESCO, 2015 and UIS, 2017), with the gender gap particularly apparent in disciplines such as mathematics, engineering and computer science. Although the development of STEM fields is widely regarded as beneficial to the expansion of national economies, the underrepresentation of women in STEM represents the loss of a critical mass of talent and ideas.

Achieving gender equality in STEM implies further encouraging the participation of girls and women at all levels of education, and providing equal opportunities for scientists and engineers throughout their careers. Achieving gender equality is an overarching UNESCO priority, both as a matter of human rights and in order to enhance countries' science, technology and innovation (STI) capacities. It must be seen as a crucial means not only to promote scientific and technological excellence but also to ensure that the scientific agenda incorporates the needs and perspectives of women that enable society to achieve sustainable development. In this context it is crucial to achieve the 2030 Agenda for Sustainable Development, in particular, Sustainable Development Goal 5: "Achieve gender equality and empower all women and girls", but also all other SDGs that rely on STI capacities.

The current gender imbalance in STEM is partly a consequence of long-term implicit and explicit policies and policy instruments put in place at various levels, inside and outside the systems closely related to STEM education and science and engineering careers (government, funding agencies, higher education institutions, research centres, *inter alia*), in addition to social and cultural factors. However, no guidelines exist at the global level to assist governments and policy-makers in the creation of policies aimed at ensuring the participation of girls and women in STEM. Moreover, the lack of data from which to draw useful indicators and proceed to analytical studies can obstruct the design, monitoring and evaluation of the STI policies that aim at gender equality. Likewise, the way in which STEM data are predominantly collected renders women and the challenges they face in balancing social expectations and professional careers invisible. There is a lack of reported sex-disaggregated data, and a lack of reported data on drivers and barriers they face in STEM.

SAGA

In response to this, the *STEM and Gender Advancement (SAGA)*, a global UNESCO project supported by the Government of Sweden through the Swedish International Development Cooperation Agency, was established. The objective is to contribute to the reduction of the gender gap in STEM at all levels of education and research by supporting the design of policy instruments and policies that promote gender equality and by strengthening capacities in Member States for the collection of data on gender equality in these fields. SAGA provides guidelines and

tools for evidence-based policymaking and generates new information, both on the driving factors to encourage women joining careers and on the barriers to their careers in science and engineering.

Data and analysis is fundamental for decision-makers responsible for governance, for formulating evidence-based policies and for evaluating/understanding their impact. The information generated by the SAGA project provides the evidence needed to identify the obstacles that hinder gender balance and the ones that favour the participation of girls and women in STEM.

One of the great differences of SAGA with respect to other projects is its approach. SAGA has two complementary strategies: on the one hand, it helps to improve current STI policies focused on gender balance and, on the other hand, it improves the availability of statistics on which decision-makers can rely to formulate evidence-based policies. SAGA has a holistic and multidimensional perspective by building consistent links between analysis and policy formulation, by considering that multiple factors contribute to the gender gap in STEM, and by including among these culturally and socially entrenched gender discrimination including unconscious bias, and unequal access to education and opportunities in professional development. Addressing the challenges associated with the gender gap in STEM also means promoting the gender dimension in the content of the research agenda, and in research practices, through in-depth analysis of research processes, the development of concepts and theories, the collection, dissemination and of interpretation of data, and the use of analytical tools specific to each scientific area. SAGA enables the evaluation of national STI policies through a gender lens, enables identification of gaps, while extracting information from existing data sources. It also identifies and provides a basis for collecting information about the characteristics of drivers and barriers to careers in STEM.

UNESCO's SAGA project has already been implemented in a number of pilot countries with excellent results. Based on the review of experience in these countries, a final version of these tools will be published. The publication will be available to all countries and will provide guidelines for future interventions, particularly aimed to produce policies and instruments to improve the situation of girls and women in science and engineering. The policies and instruments collected throughout the project will be incorporated, in a second phase, into the UNESCO GO-SPIN database.

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Women in science and engineering in Lao PDR

Huyer (2015) showed that women's participation in research overall at the global level can be seen as a leaky pipeline. Women are actively pursuing bachelor's and master's degrees and even outnumber men at these levels, since they represent 53% of graduates globally. However, these numbers drop off abruptly at PhD level to 43%. The discrepancy widens at the researcher level, with women representing 28% of the global pool. For these reasons, the growing proportion of women in higher education is not necessarily translating into a greater presence in research.

As it was shown in the previous chapter, over the past four decades both enrolment (see Figures 20 to 22, pages 62 – 63) and the number of graduates and teachers at tertiary level (see Figures 23 and 24 pages 65 – 66 and Table 9, page 65) have been expanding almost exponentially. However, graduates and post-graduates are still scarce compared with other countries (UNESCO, 2015). The above-mentioned figures also show that the enrolment and graduation of women is increasing over time. However, even as the numbers increase, they still lag behind the enrolment and graduation numbers of men.

Similar patterns are observed in the proportion of women among ISCED 5 teachers (see Figure 24, page 66) and in the proportion of women among the academic staff of tertiary institutions (Figure 28).

The lack of R&D comprehensive surveys in Lao PDR prevent our having reliable statistics on the number of researchers, technicians, and administrative support staff in R&D by level of education, field of science, socioeconomic level and gender. A first survey conducted by UNESCO for 1965–1966 found 3 women researchers out of 174 researchers, and 16 women technicians out of 278 technicians, in the country (see Table 13, page 85). Table 16 shows the distribution in 2017 among the Ministry of Science and Technology's permanent staff (1199 persons): 420 are women (35%). Among these women employed in the permanent staff of the Ministry of Science and Technology, 0.24% has a PhD degree, 4.8% a master's degree, 58.3% a bachelor's degree, 31.7% a pre-bachelor's degree, 4.8% a Diploma and 0.24% a Certificate.

Figure 28: Percentage of women within the academic staff in tertiary education, 1960–2015.
Source: UNESCO Statistical Yearbook (several years) and UNESCO Institute for Statistics

When comparing these employees to the whole population of Lao PDR including both women and men, the female personnel at the Ministry of Science and Technology of Lao PDR hold 10% of the total number of PhDs, 23.3% of the Masters, 39,9% of the Bachelors, 36.8% of the pre-Bachelors, 17.2% of the Diplomas and 9.1% of the Certificates. That is to say: not only are there fewer women than men graduating, but most of these few women graduates enter the Ministry as employees rather than entering research careers. These rare statistics give a hint that there is an even larger gender gap in science and engineering than in the Ministry (Huyer, 2015 and UNESCO, 2015).

Moreover, the text of the 8th National Socio-Economic Development Plan (2016–2020), has no single mention or proposed-intervention to promote the participation of women in science and engineering careers, nor any specific STI policy instrument to reduce this gap.

R&D indicators for Lao PDR

UNESCO has been conducting global surveys on R&D indicators since the early 1960s (UNESCO, 1960). For decades, this work was performed by the organization's former divisions of Science Policy and of Statistics on Science and Technology. Between 1970 and 1995, information from UNESCO's global R&D surveys was published in the annual UNESCO Statistical Yearbooks and in special reports prepared by the aforementioned divisions. Between 1960 and 1990, several R&D surveys were conducted in Africa, Asia and the Pacific, the Arab States, Europe and Latin American and the Caribbean.

In the late 1990s, the Statistical Office, then the Statistics Division, left UNESCO headquarters in Paris to become the UNESCO Institute for Statistics (UIS) and settled in the city of Montreal (Canada). Since then, the UIS has become the international repository of statistics on science and technology for the United Nations system. As of 2014, in addition to the traditional series of R&D input indicators, the UIS incorporated into its database the first results of a new biannual survey on innovation focused on innovation in firms. The latter was recently updated in 2016.

The first UNESCO R&D survey in Lao PDR was conducted in the sixties (UNESCO, 1968). In the following sections we provide a description of the scarce information on R&D indicators which were produced in Lao PDR over the past decades.

TRENDS IN R&D PERSONNEL IN RESEARCHERS

Policymakers have increasingly emphasized the importance of skilled people — what social scientists refer to as human capital — to both knowledge creation and productive innovation. As technical content spreads throughout knowledge-based societies, skills associated with research and innovation are increasingly demanded. The planning and formulation of STI policies requires the knowledge of the total numerical strength of the most qualified human resources namely the total stock and the number of economically active persons who possess the necessary qualifications to be scientists, engineers and technicians.

To the extent that science, technology and innovation activities are the best instruments to guarantee an authentic sustainable development, they require essential training of specialized human capital. To adapt to changing contextual conditions in a developing country, the training of scientists and engineers requires an educational structure that must be complex and flexible. The construction of a knowledge-based society presupposes the existence of a critical mass of trained personnel actively engaged in the tasks of scientific research, technological development and productive innovation. The human potential, highly qualified, is the irreplaceable base on which the sustainable development of a nation is based.

Both STI policy makers and scientists, technologists and other specialists have increasingly emphasized the importance of qualified personnel in the creation of new knowledge and the dissemination of new technologies in the productive system. As the technical content extends through a knowledge-based economy, the knowledge and skills associated with science and engineering are essential within the productive sector and public administration of any nation. This fact determines a growing demand for workers with formal training in science and engineering skills. To increase the added value of production, more complex jobs are needed. The demand requires workers who can understand in depth data analysis, device management and application development, at the same time they must have skills such as creativity, innovative design and entrepreneurship.

In order to properly plan and formulate STI policies, it is necessary to have a regular statistical survey about the fraction of the national labor force that performs both scientific research, technological development and productive innovation activities as well as those that provide scientific and technological services.

Since the late 1950s, Lao PDR, with the help of UNESCO started with the first attempts to generate regular statistics on the higher education system (see figures 20, 21 and 22, pages 62–63). Statistics on science and technology activities began – with the support of UNESCO – in 1968. Unfortunately, the collection, standardization and publication of data has not been regular and is very scarce. On the other hand, the International Food Policy Research Institute (IFPRI), using a group of Indicators of Science and Technology in Agriculture (ASTI), has since 1998 been generating very complete statistics on a regular basis about R&D in the agricultural sciences in Lao PDR.

BOX 12 – UNESCO'S FIRST R&D SURVEY IN LAO PDR, 1965–1966

On 14 November 1958, the General Assembly of the United Nations (13th session, 780th plenary meeting) adopted Resolution 1260 requesting the Secretary-General:

> … in co-operation with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the other Specialized Agencies concerned with the peaceful application of science, as well as the International Atomic Energy Agency, to arrange for a survey to be made on the main trends of inquiry in the field of the natural sciences and the dissemination and application for peaceful ends of such scientific knowledge, and on the steps which might be taken by the United Nations, the Specialized Agencies and the International Atomic Energy Agency towards encouraging the concentration of such efforts upon the most urgent problems, having regard to the needs of the various countries…

In the same resolution, the General Assembly requested that the Secretary-General 'submit this survey to the Economic and Social Council at its thirtieth session' in July 1960.

Ultimately, this report was co-ordinated and edited by Pierre Auger, a prominent physicist and former Assistant Director-General for Science at UNESCO. The study included a description of the most influential trends in scientific research and a series of analyses of their potential long-term impact on humanity (Auger, 1961). The report introduced the need for states to establish national scientific and technological policies, as well as new schemes fostering international scientific co-operation, one example being UNESCO's proposal in the early 1950s for the creation of the European Centre for Nuclear Research (CERN).

Auger's report broke new ground. For the first time, the UN system proposed a standard classification for scientific research and experimental development and defined scientific researchers, technicians and engineers. This preceded the OECD's Frascati Manual (c. 1963) and even the OECD itself, founded in 1961.

Using the standard classification proposed by Auger, UNESCO conducted a series R&D surveys for the fiscal year 1965–1966 in Lao PDR, which was later published as part of *UNESCO Statistical Yearbook 1968*. Unfortunately, no other R&D survey was conducted in Lao PDR until 2002.

The following Table 13 was constructed based on the measurements conducted in 1965–1966 and shows the breakdown of R&D personnel according the major fields of science as well as the distribution of higher education students by available fields of study.

Table 13: Results from the historical R&D survey in Lao PDR, 1965–1966

S&T total personnel [HC] 1965	Natural sciences	Engineering & technology	Medical sciences	Agricultural Sciences	Social sciences	Total
Researchers [HC]	10	28	20	19	97	174
Technicians [HC]	n/a	n/a	n/a	n/a	126	278

S&T women personnel [HC] 1965	Natural sciences	Engineering & technology	Medical sciences	Agricultural Sciences	Social sciences	Total
Researchers [HC]	0	0	2	0	1	3
Technicians [HC]	n/a	n/a	n/a	n/a	3	16

Higher education enrolment	Number of students		Medicine		Law	
	Total	Women	Total	Women	Total	Women
1965	146	24	69	17	77	7
1966	216	35	113	7	103	28

Source: UNESCO Statistical Yearbook 1968

In this section, the assumed definitions for the different categories of R&D personnel follow the ones presented in the Glossary (see pages 213–216). Certain categories of measures are better adapted for addressing some questions than others and not all general population and workforce surveys include questions in each category. Unfortunately, the available data for Lao PDR have been extremely scarce, thus reducing the possibility to find long-term trends which would have made it possible to assess if policy change caused impacts or not.

Table 14 presents all the available data on R&D personnel expressed in head counts [HC] in Lao PDR, broken down by the categories of researchers, technicians and gender. It also shows that all the previous surveys were conducted with the assistance of UNESCO. The last one was done in 2002.

Table 15 presents the results of the 2002 survey on R&D personnel broken down in total personnel, researchers, technicians and other support staff, classified by their employment sector and expressed in full-time equivalent [FTE]. According to these figures, 48% of the total personnel works for the government sector, 27% for the higher-education sector and 25% for the private-enterprise sector.

Table 16 shows the distribution of the staff in the Ministry of Science and Technology (MOST) of Lao PDR at its HQ in Vientiane between 2012 and 2017, broken down by level of education and gender. For a detailed analysis of the figures in this table please see page 87. According to the authorities of the Ministry, most of this staff perform administrative work. Table 17 presents the distribution of staff at MOST at HQ by department/institute and gender. Table 18 shows the staff of MOST by level of education and gender in Provincial Science and Technology Departments, 2012–2016. Table 17 presents the distribution of staff of MOST by province and gender in 2017.

Figure 29 presents the long-term evolution (1965–2012) of the number of researchers and researchers per million inhabitants in Lao PDR, based on all the available data. The best fitting curves show a clear parabolic behaviour with a very high coefficient of determination (R^2=0.999). Due to a breakthrough observed in the production of scientific publications since 1997 (see Figure 35, page 105), most probably this trend changed to a continuous linear growth in the number of researchers since then. This conclusion is also supported by the observed behaviour of scientific co-authorship networks (see Figures 39–42, pages 108–109): trends in these co-authorship networks linking Lao PDR with its four most important partners present parabolic growths, implying that the national scientific network is growing linearly (Lemarchand, 2016).

Table 14: R&D personnel in Lao PDR, 1965–2002

Year	R&D Personnel Total [HC]	R&D Personnel Women [HC]	Total number of researchers [HC]	Number of women researchers [HC]	Total number of technicians [HC]	Number of women technicians [HC]	Source
1965	452	19	174	3	278	16	UNESCO (1969)
1970	n/a	n/a	354	n/a	n/a	n/a	UNESCO (1978)
1980	n/a	n/a	630	n/a	n/a	n/a	UNESCO (1985)
2002	n/a	n/a	209	n/a	n/a	n/a	UIS database

Table 15: Results from the surveys of FTE R&D personnel in Lao PDR, 2002

Sector	Total R&D personnel [FTE]	Researchers [FTE]	Technicians and R&D administrative personnel [FTE]
Business-enterprise	68	n/a	n/a
Government	128	n/a	n/a
Higher education	72	n/a	n/a
Private non-profit	n/a	n/a	n/a
Total	**268**	**87**	**181**

Source: UNESCO Institute for Statistics

Table 16: Staff by level of education and gender at MOST, 2012–2017

Level of education	2012			2013			2014			2015			2016			2017		
	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [total HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]
PhD	7	2	5	8	1	7	10	1	9	12	2	10	13	2	11	13	2	11
Master	44	11	33	56	17	39	68	20	48	78	26	52	90	36	54	111	42	69
Bachelor	143	61	82	163	78	85	257	116	141	365	168	197	438	207	231	455	222	233
Diploma	61	25	36	61	22	39	82	36	46	78	36	42	70	25	45	56	24	32
Certificate	12	4	8	15	5	10	16	8	8	9	4	5	4	2	2	4	2	2
Non-professional	2	1	1	0	0	0	2	1	1	2	1	1	1	0	1	1	0	1
Total	**269**	**104**	**165**	**303**	**123**	**180**	**435**	**182**	**253**	**544**	**237**	**307**	**616**	**272**	**344**	**640**	**292**	**348**

Source: Department of Organization and Personal, Ministry of Science and Technology (2017)

Table 17: Staff by level of education and gender at Departments/Institutes of MOST, 2017

Name of Department or Institute at MOST	2017		
	Total Personnel [HC]	Women [HC]	Men [HC]
Cabinet Office	50	23	27
Department of Organization and Personnel	35	23	12
Department of Inspection	23	9	14
Department of Science	30	14	16
Department of Technology and Innovation	43	21	22
Department of Digital Technology	53	26	27
Department of Intellectual Property	61	32	29
Department of Standard and Metrology	80	29	51
Institute of Biotechnology and Ecology	71	40	31
Institute of Renewable Energy and New Materials	47	15	32
Institute of Computer Science and Electronics	44	15	29
Institute of Science and Technology Management	10	4	6
Office of National Science Council	48	23	25
Total	**640**	**292**	**348**

Source: Department of Organization and Personal, Ministry of Science and Technology (2017)

Table 18: Staff by level of education and gender at Provincial Science and Technology Departments, 2012–2016

Level of education	2012			2013			2014			2015			2016		
	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]	Total personnel [HC]	Women [HC]	Men [HC]
PhD	1	0	1	1	0	1	2	0	2	1	0	1	2	0	2
Pre PhD													1	0	1
Master	15	2	13	14	3	11	16	1	15	8	2	6	24	4	20
Pre master										2	0	2			
Bachelor	103	34	69	152	43	109	166	50	116	195	66	129	235	78	157
Diploma	102	42	60	131	49	82	134	51	83	148	57	91	136	52	84
Certificate	38	4	34	37	8	29	30	6	24	31	5	26	26	5	21
Non-professional	2	0	2	1	0	1	1	1	0	1	0	1	1	0	1
Total	**261**	**82**	**179**	**336**	**103**	**233**	**349**	**109**	**240**	**386**	**130**	**256**	**425**	**139**	**286**

Source: Department of Organization and Personal, Ministry of Science and Technology (2017)

Table 19: Staff at Provincial Science and Technology Departments, 2017

Name of Province	2017		
	Total Personnel [HC]	Women [HC]	Men[HC]
Phongsaly	25	8	17
Oudomxay	26	8	18
Houaphanh	27	10	17
Bokeo	27	8	19
Luangnamtha	23	10	13
Xayabouly	24	7	17
Xiengkhuang	22	12	10
Xaysomboun	16	3	13
Luangphabang	28	12	16
Vientiane Province	25	9	16
Vientiane Capital	35	11	24
Bolikhamxay	26	10	16
Khammouan	22	10	12
Savannakhet	32	7	25
Xekong	21	7	14
Salavanh	20	7	13
Auttapeu	29	7	22
Total	**428**	**146**	**282**

Source: Department of Organization and Personal, Ministry of Science and Technology (2017)

Figure 29: Evolution in the number of researchers [HC and HC per million inhabitants], 1965–2022. The dotted lines are the best fitting curves.

Source: UNESCO and MOST for the year 2012

In a report prepared for this GO→SPIN study, the Ministry of Science and Technology identified that there are 169 institutes comprising of business enterprises, government institutions, higher education and private non-profit organizations. Within them, there are 1 946 persons working on science and technology activities, and these are distributed among higher education (58%), government research institutions (31%) and business enterprises (11%). The total of FTE personnel devoted to R&D is 550 HC comprising 55% in higher education, 31% in government research institutions and 14% in business enterprises.

BOX 13 – HUMAN RESOURCES WITHIN THE "STRATEGY ON THE PROMOTION AND MANAGEMENT OF HEALTH RESEARCH BY 2020"

The Ministry of Health of Lao PDR considered health research as a health programme and in 2012 they established the Department of Training and Research as the focal point for the implementation of the Strategy on Promotion and Management of Health Research by 2010 (the Strategy). In addition, there was the Public Law on Science and Technology was endorsed by the National Assembly, No. 03/NA, dated 19 July 2013 and the Presidential Decree, No. 169/P, dated 20 August 2013 (see page 176). The health research strategy of the World Health Organization promulgated in 2012 was also used as an input for this Strategy.

The Strategy on Promotion and Management of Health Research comprises the following six components: (1) Research governance; (2) capacity development of researchers; (3) defining and implementing research priorities; (4) dissemination and application of research outcomes; (5) seeking funding sources and mobilization for health research and (6) monitoring and evaluation of a research strategy.

In this context, the Department of Training and Research was established to manage the macro actions in terms of health research in cooperation with the National Institute of Public Health, University of Health Sciences and departments attached to the Ministry of Health as well as the Vientiane Capital Health Department, and to implement the Strategy on Promotion and Management of Health research.

The National Institute of Public Health continues to cooperate with the World Health Organization to manage health research by using Information Technology (IT) to register all health research conducted in Lao PDR through the website "Lao Health Research Portal", as well as to produce Lao health research guidelines and standard operating procedures, in support of the National Ethics Committee for Health Research. Technical staff within the Ministry of Health were trained in health research ethics. The Council of Medical Sciences, the National Ethics Committee for Health Research and the Ethics Committee of the University of Health Sciences were also improved.

An annual Health Research Forum was established to promote knowledge exchange while research results were also disseminated between the Lao PDR and international networks on a continuous basis. The research paper on "Health in Transition" (Lao HIT) was published in an international publication.

According to the Ministry of Health (2014), in 2013, the total number of researchers increased to 1 224 persons, including two post-doctorates, 39 doctorates, 542 persons with master's degrees at level II, 35 medical specialists, 608 medical specialists at level I. Considering this 2013 average of 1.8 researchers per 10 000 population should be raised, two targets were set in the Sciences and Technology Development Strategy in terms of research and capacity building throughout all sectors. These targets are: 3.3 researchers per 10 000 population in 2015, and 11 per 10 000 population in 2020.

Source: Ministry of Health (2014)

The number of individual researchers among human resources devoted to R&D is 490 HC, distributed among higher education 55%, government research institutions 31% and business enterprises 14%. Counted in full-time equivalent units, there are only 120 FTE researchers, distributed to higher education 42%, government research institutes 33% and business enterprises 25%.

The lack of consistent collection of R&D statistics in the country following international standards (UNESCO, 1978, 1984a, 1984b; UNESCO Institute of Statistics, 2014; OECD, 2015) generates inconsistencies in the data about researchers in the country. This becomes evident when we contrast the total numbers provided by the Ministry of Science and Technology for the GO→SPIN study with the number of researchers in the health sector (see Box 13 and Ministry of Health, 2014) or the recent evolution in the number of researchers in the agricultural sciences (see next section). There is an urgent need to standarize the definition and accountability procedures in terms of R&D personnel (researchers, technicians and administrative staff) in Lao PDR, and then to produce these statistics on an annual basis.

Reseachers in agricultural sciences

As was described in previous chapters, in 1986 the government of Lao PDR implemented a series of necessary reforms and slowly took the first strides toward opening up the economy by encouraging private enterprise and foreign direct investment. Rates and prices of agricultural produce were reset to close the gap with actual market prices, and import barriers were lifted. Though its share decreased in recent years (see Figure 8, page 22), the agricultural sector no-longer dominates the Lao economy as it did in the past[8].

Since 1998, the International Food Policy Research Institute (IFPRI) has been recording, within its international database of Indicators of Agricultural Science and Technology (ASTI), science and technology personnel who perform R&D tasks agriculture in Lao PDR. ASTI collected the data on agriculture FTE researchers[9] and expenditures on agriculture research in the country (Stads and Manivong, 2006). This is a reliable and complete international database, although only covering to the agricultural sector. It can be used to compare the quality of the data that is recorded by other sources.

The total number of agricultural researchers excluding the private sector for profit includes all researchers employed in the government, non-profit and higher education sectors of the country. The totals are presented in full-time equivalents [FTE] to reflect the proportion of time that scientists actually invest on R&D activities. Figure 30 presents the long-term evolution in the number of FTE researchers in agricultural science combining data from UNESCO and ASTI. It is clear, that after a period (1965–1985) of modest growth, the curve has a minimum in 1985–1986, when the economic reforms were introduced and the number of FTE researchers in agricultural sciences started growing again until 2008. It is also observed, that between 2008 and 2014, this number decreased at a relative constant rate.

The most important observation is that the total numbers of FTE researchers presented by the 2002 survey is somehow contradictory with the figures of ASTI, considering that the number of researchers in agricultural sciences should only be a fraction of the total number of FTE researchers in all fields of science. Regular and comprehensive R&D surveys in Lao should be a priority for the government for planning purposes.

Figure 31 shows the histogram of the number of FTE researchers in agricultural sciences estimated by ASTI between 1998 and 2014, while Figure 32 presents the evolution of the number of FTE researchers in agricultural sciences per million inhabitants and per 100 000 farmers in Lao PDR. In all cases there is a constant decrease in the number of these FTE researchers between 2008 and 2014. The only apparent

8 As was shown in Figure 8, page 22, in 2016, the agriculture sector represented only 19.5% of the economy, while the industry sector 32.5% and the services sector 48%.

9 The data were compiled by ASTI-IFPRI using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD, 2015 and UNESCO, 1984). The authors grouped estimates using three major institutional categories — government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and non-profit institutions. The researchers defined public agricultural research to include government agencies, higher-education agencies, and non-profit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre-, on-, and post- farm technologies related to agriculture.

exception is a ratio of FTE researchers in agriculture science per 100 000 farmers: its evolution demonstrates that the total number of farmers also shrunk in recent years, due to the smaller shares of agriculture's decreasing share of the whole economy.

Table 20 shows the distribution of agriculture researchers by sector of performance, government, higher education or non-profit (2000–2010). The government accounts for more than 80% of these FTE researchers. The National Agriculture and Forestry Research Institute (NAFRI) is the most important governmental agency involved in agricultural R&D in Lao PDR. NAFRI was established in 1999 through the amalgamation of existing agriculture, livestock, fisheries, and forestry research centres, and is responsible for the tasks of designing, implementing, and coordinating all governmental agriculture and forestry research in Lao PDR (Stads and Manivong, 2006).

NAFRI is administered by the Ministry of Agriculture and Forestry (MAF) and—unlike counterpart institutes in many other Asian countries—is not governed by a Board of Directors. Instead, matters related to the governance of the institute are handled by the office of the Director General and NAFRI's Administration Department. According to Stads and Manivong (2006) the institute is headquartered just outside the capital, Vientiane, and has an additional eight research centers: the Agriculture Research Centre (ARC), the Coffee Research Centre (CRC), the Forestry Research Centre (FRC), the Horticulture Research Centre (HRC), the Livestock Research Centre (LRC), the Living Aquatic Resources Research Centre (LARReC), the Northern Agriculture and Forestry Research Centre (NAFReC), and the Soil Survey and Land Classification Centre (SSLC). All centres are situated in or around Vientiane with the exception of NAFReC, which is based in the north, and CRC, which is based in the south.

Higher-education plays a limited role as a setting for agricultural research in the Lao research system, accounting for just 15% of the country's total FTE research staff in agricultural sciences (see Table 20) and an estimated 9% of agricultural R&D spending (see next section). There are two faculties involved in agricultural R&D under the Vientiane-based National University of Laos (NUOL). The Faculty of Forestry (FoF) is the larger of the two and their research activities concentrate mainly on silviculture and to a limited extent agroforestry and community forest issues. Most research activities are performed by individual staff members as part of collaborative programs initiated by others actors.

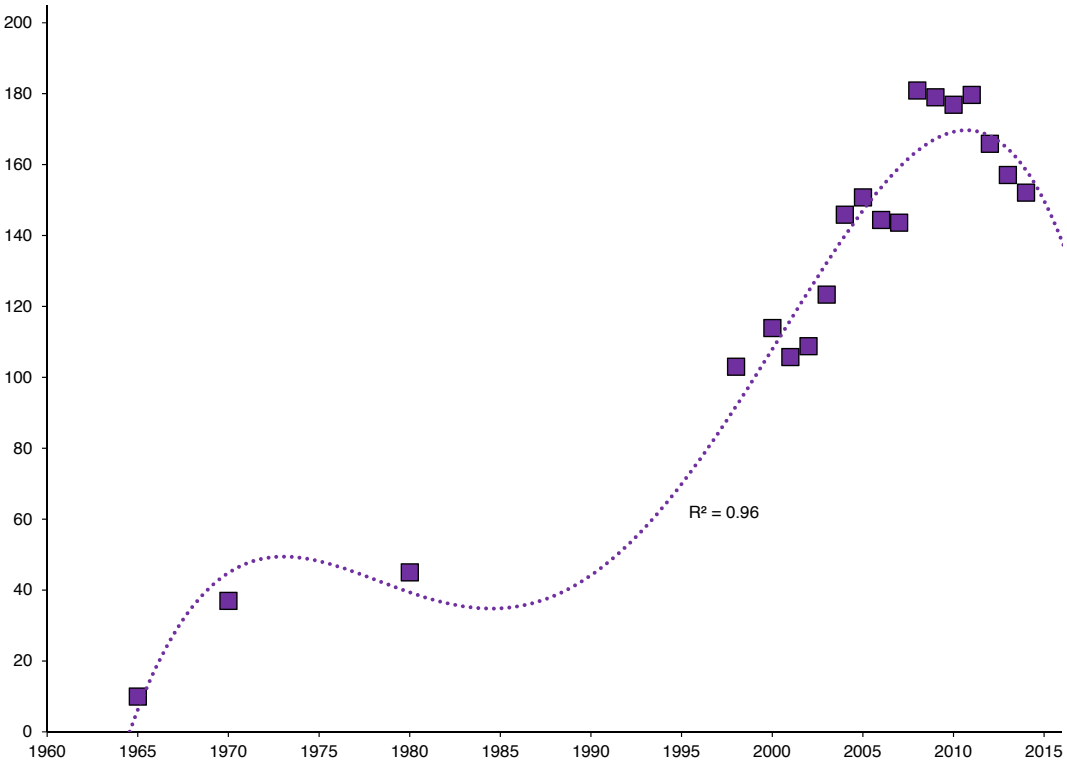


Figure 30: Evolution of the number of FTE researchers in agricultural sciences, 1965–2014. The dotted line is the best fitting curve.
Source: UNESCO based on raw data from UNESCO Statistical Yearbooks (several years) and Agricultural Science and Technology Indicators (ASTI) led by IFPRI

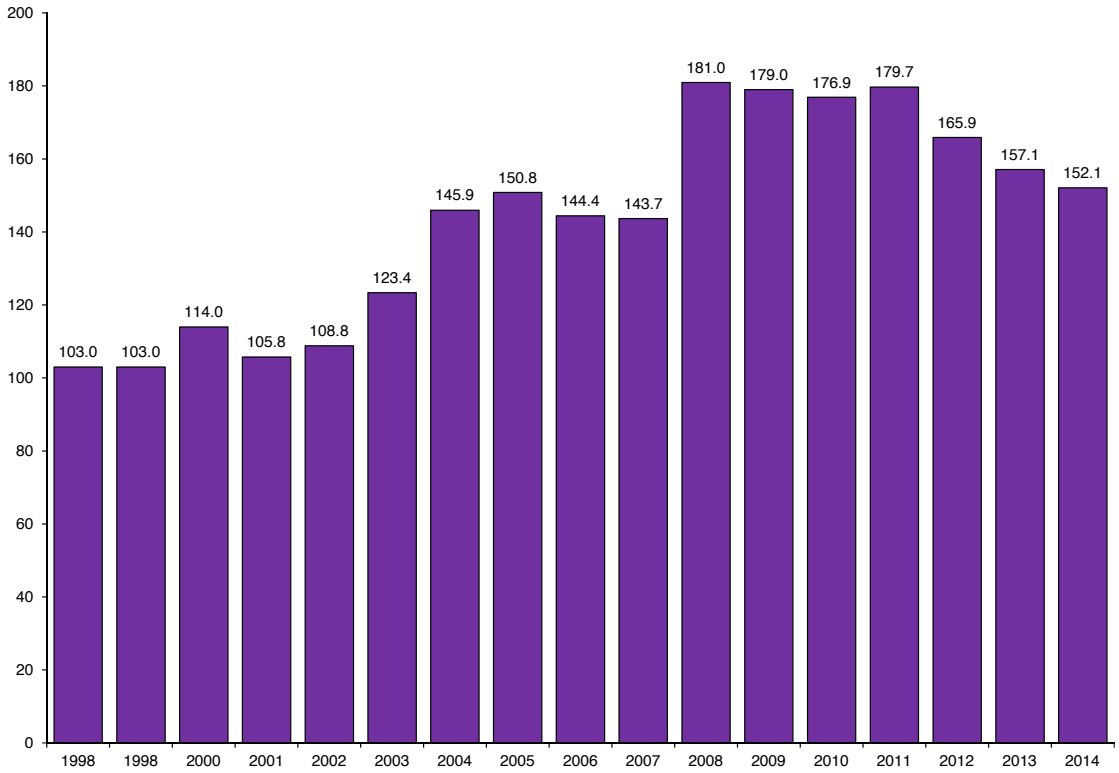


Figure 31: Number of FTE researchers in agricultural sciences, 1998–2014.
Source: Agricultural Science and Technology Indicators (ASTI) led by IFPRI and Stads (2016)

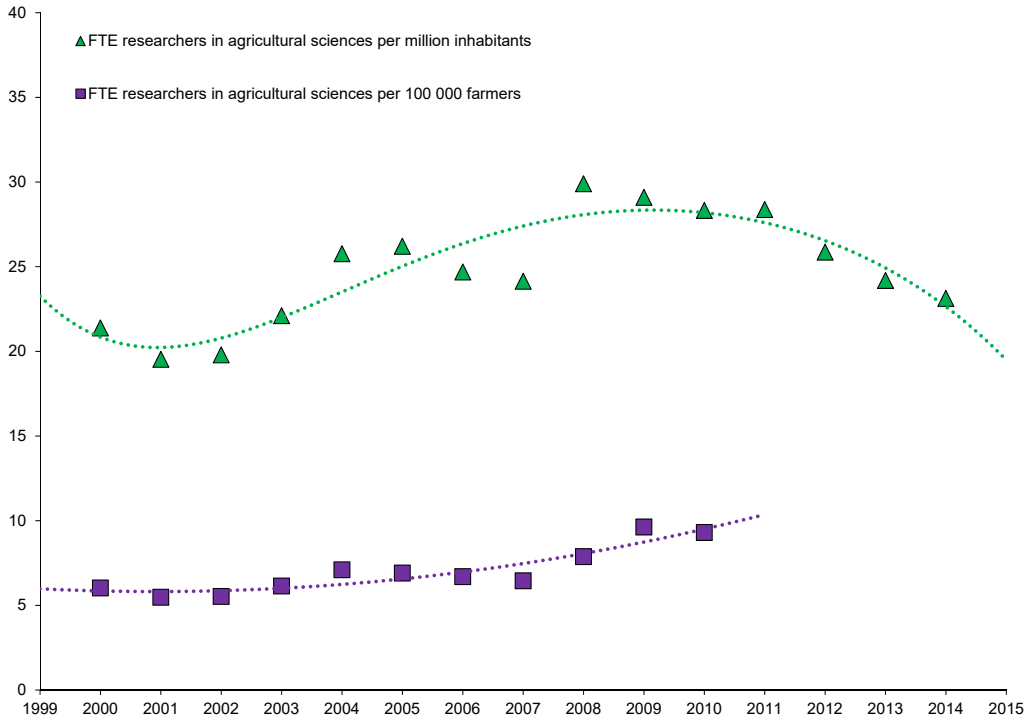


Figure 32: Number of FTE researchers in agricultural sciences per million inhabitants and per 100 000 farmers, 2000–2010.
Source: Agricultural Science and Technology Indicators (ASTI) led by IFPRI

Table 20: FTE researchers shares by sector of performance in agricultural sciences, 2000–2010

Year	Agricultural sciences: FTE researchers shares by sector of performance		
	Government	Higher education	non-profit
2000	86.0%	14.0%	..
2001	85.1%	14.9%	..
2002	84.6%	15.4%	..
2003	85.1%	14.9%	..
2004	85.7%	14.3%	..
2005	83.8%	16.2%	..
2006	81.9%	18.1%	..
2007	80.1%	19.9%	..
2008	80.1%	19.9%	..
2009	83.7%	16.3%	..
2010	84.1%	15.9%	..

Source: Agricultural Science and Technology Indicators (ASTI) led by IFPRI

Table 21: FTE researchers in agricultural sciences per million inhabitants for a series of Asian countries

Country	2000	2005	2010	2011	2012	2013	2014
Bangladesh	12	12	13	13	14	n/a	n/a
Cambodia	13	20	21	n/a	n/a	n/a	n/a
China	38	45	n/a	n/a	n/a	n/a	n/a
India	13	11	10	10	10	10	14
Indonesia	21	21	21	21	21	22	23
Lao PDR	21	26	28	28	26	24	23
Malaysia	48	49	57	60	59	57	59
Nepal	16	15	16	16	15	15	n/a
Pakistan	25	22	20	14	21	n/a	n/a
Sri Lanka	28	27	31	31	31	29	n/a
Viet Nam	32	39	43	43	43	44	44

Source: UNESCO based on raw data provided by Stads (2016) and UN Statistics Division

Table 22: Distribution of FTE researchers by their maximum academic degree in agricultural sciences, 2007–2010

Year	Agricultural sciences FTE researchers shares by maximum academic degree		
	PhDs	Masters	Bachelors
2007	6.6%	49.4%	44.1%
2008	7.4%	47.5%	45.0%
2009	6.9%	44.9%	48.2%
2010	6.5%	46.4%	47.2%

Source: Agricultural Science and Technology Indicators (ASTI) led by IFPRI

The second faculty involved is NUOL's Faculty of Agriculture (FoA). Their researchers are spread across three formal research programs: cropping systems and crop management, livestock and fisheries, and agroeconomics and agroprocessing (Stads and Manivong, 2006).

According to Stads and Manivong (2006), the low level of qualified staff seriously constrains NAFRI's ability to achieve its organizational objectives. Very low civil servant salaries and benefits make attracting, motivating, and retaining highly qualified research staff extremely difficult, particularly as new job opportunities with international organizations, nongovernmental organizations (NGOs), and private-sector agencies arise. In addition, government policies severely limit the number of new civil service staff that can be recruited.

Table 21 presents the ditribution of FTE researchers in agricultural sciences per million inhabitants for a group of Asian countries between 2000 and 2014. The number of FTE researchers in agricultural sciences per million inhabitants in Lao PDR is a ratio comparable to those in Indonesia or Pakistan, but smaller than those in Malaysia, China, Sri Lanka.

Table 22 shows the distribution of FTE researchers in agricultural sciences against the levels of education achieved (PhD, Masters and Bachelors) for the years from 2007 to 2010. These figures show that the majority of the researchers (around 47%) hold Bachelors and Masters degrees, while a minority (around 6.5%) are PhD holders.

The fact that NUOL only offers Bachelor-in-Science level training compounds the relatively low qualification levels of Lao scientists, obliging them to go abroad for any postgraduate training (see Table 10, page 67). Further, Lao PDR's political isolation from the outside world during the 1970s and 1980s seriously hindered such opportunities abroad. The few researchers that were able to receive PhD training went to other socialist countries, such as the former Soviet Union and Vietnam. This was also reflected in terms of co-authorship of scientific papers (see pages 108–109). According to Stads and Manivong (2006) the number of NAFRI research staff eligible for PhD-level training abroad has risen since the late 1990s, given the improved English language skills among certain scientists.

Stads and Manivong (2006) showed that NAFRI and NUOL maintain close linkages. The instutions share a portion of their information and communications technology infrastructure, and NAFRI supervises students from NUOL for their research on a regular basis. NAFRI and NUOL staff also participate in joint research activities. NAFRI hires university staff on contract to increase its capacity to develop and deliver products and services. A 3-way Memorandum of Understanding (MOU) has also been formalized between NAFRI, the Department of Forestry under MAF and NUOL's FoF. The MOU establishes formal cooperation for upgrading the knowledge of teachers and forestry officers; developing curricula; participating in workshops, meetings and training programs; facilitating research work; and sharing information. Linkages have also been established between NAFRI and agricultural research agencies in neighboring countries such as Thailand and Vietnam, and with various regional organizations including: the Asia Pacific Association of Agricultural Research Institutions (APAARI), the Asia Pacific Association of Forestry Research Institutions (APAFRI), the Mekong River Commission (MRC), and various centres of the Consultative Group on International Agricultural Research (CGIAR)—mainly the International Rice Research Institute (IRRI) and the International Center for Tropical Agriculture (CIAT).

NATIONAL GROSS EXPENDITURE ON R&D (GERD)

In developed countries, R&D activities are usually an important input for innovation and for satisfying most of the objectives of government agencies. R&D is part of a class of intangible inputs that also include software production, higher education and capacity building. Intangible inputs are as important sources for long-term economic growth as physical investments in machinery. Without an industrialized economy and without a minimum threshold of R&D personnel it is practically impossible to determine any high correlation between investment in R&D and its impact on economic growth in developing countries. Empirical studies show that the internal rate of societal return from R&D activities becomes visible only when a certain fraction of the GDP (greater than 1%) is invested, and a minimum critical mass of FTE researchers per million of inhabitants (approximately between 1 000 and 1 200 FTE researchers per million inhabitants) are allocated, to research and innovation activities. When the national STI system does not reach these threshold proportions, it is almost impossible to measure any visible economic impact.

It often happens that R&D expenditures of a given year do not correspond exactly to what was expected, due to changes in the sources of funds (for example, new contracts) and the gradual expenditure of the amounts allocated to the STI activities (for example, the acquisition of scientific equipment can be a procedure that exceeds a year from the decision of purchase until the payment of the invoice). It should be noted that financial credits and actual expenditures are two complementary indicators, each emphasizing some aspects, and demanding different treatments and data sources. It should be remembered that STI policymakers attach great importance to financial credits, especially for the public sector. However, the highest priority is attributed here to the actual financial effort made by the STI organizations, as evidenced by actual expenditures.

Funds supporting R&D tasks typically come from a variety of sources, including businesses, national governments and others, academic institutions, foreign donors and other nonprofit organizations. The combination of funding sources varies according to the characteristics of each country. No recent data on the profile of R&D expenses in Lao PDR is available since 2002.

Table 23 shows that in 2002 the gross domestic expenditures on R&D (GERD) activities in Lao PDR was approximately 0.04% of the GDP, an extremely low investment at international standards (UNESCO, 2015).

Table 24 present the percentage breakdowns of GERD both according to the sector where spending takes place (sector of performance), and according to the origin and allocation of funds (sector of finance). In 2002, 54% of the funds for GERD had a foreign origin, while the government allocated 8% of their funding, the business-enterprise sector contributed 36% and higher education allocated only 2% of funds for GERD.

In terms of where R&D spending takes place (sector of performance), during 2002, the government expenditures on R&D activities made up 50.9% of the GERD, whereas the business-enterprise sector spent 36.9% and higher education spent 12.2% of the GERD.

Unfortunately, Lao PDR did not perform any other R&D survey more recently to provide a clearer idea about investment and performance of R&D activities in the country. Moreover, the country did not perform an innovation survey to measure with more confidence what business enterprises are doing with regard to R&D and innovation in the country.

Table 23: GERD as percentage of GDP and by sector of performance, 2002

GERD 2002 [% GDP]	0.04%
GERD by sector of performance [PPP 2015 constant international $]	**2002**
Government	2 774 963
Business enterprise	2 010 601
Higher education	664 622

Source: UNESCO Institute for Statistics

Table 24: GERD breakdown according to the sectorial origin and allocation of funds, 2002

By sector of finance	2002
Government	8.0%
Business enterprise	36.0%
Higher education	2.0%
Foreign	54.0%
By sector of performance	**2002**
Government	50.9%
Business enterprise	36.9%
Higher education	12.2%
Other	n/a

Source: UNESCO Institute for Statistics

In Lao PDR, the government's STI budget for R&D is allocated by the Ministry of Finance and approved by the National Assembly each year. Managed by the Ministry of Finance, this STI budget is spread between the National Social Science Council, the National Science Council, the Ministry of Science and Technology and the National Agriculture and Forestry Research Institute (NAFRI). Of these funds, 1% comes from domestic revenues and other sources of funding (e.g. ODA, grants, fees, etc). By and large, the Ministry of Finance set up its fiscal development strategy to 2025 and vision to 2030 and decided to support the 8th National Socio-Economic Development Plan 2016–2020, including STI. It aims to improve revenue collection and expenditure management. As a result, it is expected that the government overall will experience a better fiscal position and provide a higher budget allocation to STI.

According to the Ministry of Science and Technology, between 2002–2012, Lao PDR's GERD was 0.04% of GDP, which was very small percentage compared to neighbouring countries, such as Cambodia, Thailand or Viet Nam (UNESCO, 2015).

Expenditures on R&D in agricultural sciences

The statistics on investment in agricultural sciences R&D are also scarce. Most of them were collected by ASTI and their researchers (Stads and Manivong, 2006; Stads, 2016). Figure 33 presents the gross expenditure on agriculture R&D activities in constant 2015 US$ between 2000 and 2004.

On the other hand, according to Figure 34, the total agricultural research expenditures in Lao PDR followed a steep downward trend during 1998–2014. Throughout this period, spending fell at 5.5% per year, from $37.2 to $8.8 million (in 2011 PPP international dollars). In 1999, the year in which NAFRI was established, the institute's expenditures were higher (US$23 million) than those of the institute's predecessors the year before (US$20 million).

Nevertheless, spending levels followed a declining trend thereafter, more than halving between 1999 and 2014. Increased donor funding during 2004 caused total NAFRI spending to rise again to $12.6 million that year. Lao PDR endured mass inflation during the late 1990s. The rapid decline in total agricultural R&D expenditures during 1998–2014 is less severe when expenditures are expressed in current Lao kip.

During this time, the funding for NAFRI's agricultural research came from a number of sources, principally foreign donors, the national government, and internally generated resources. During 1998–2004, more than 60% of NAFRI's total funding was contributed by bilateral donors, close to one-third by multilateral donors, 5% by the Lao government, and less than 1% through internally generated resources (Stads and Manivong, 2006).

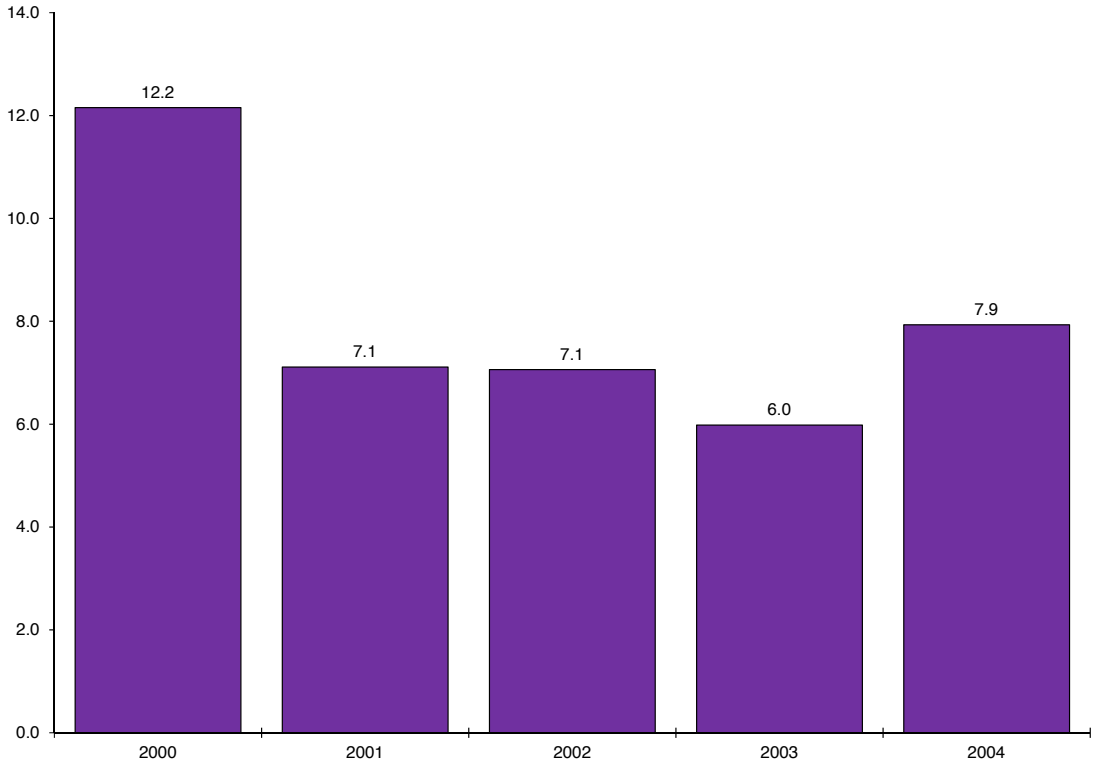


Figure 33: Agriculture GERD in millions constant 2015 US$, 2000–2004.
Source: Agricultural Science and Technology Indicators (ASTI) led by IFPRI

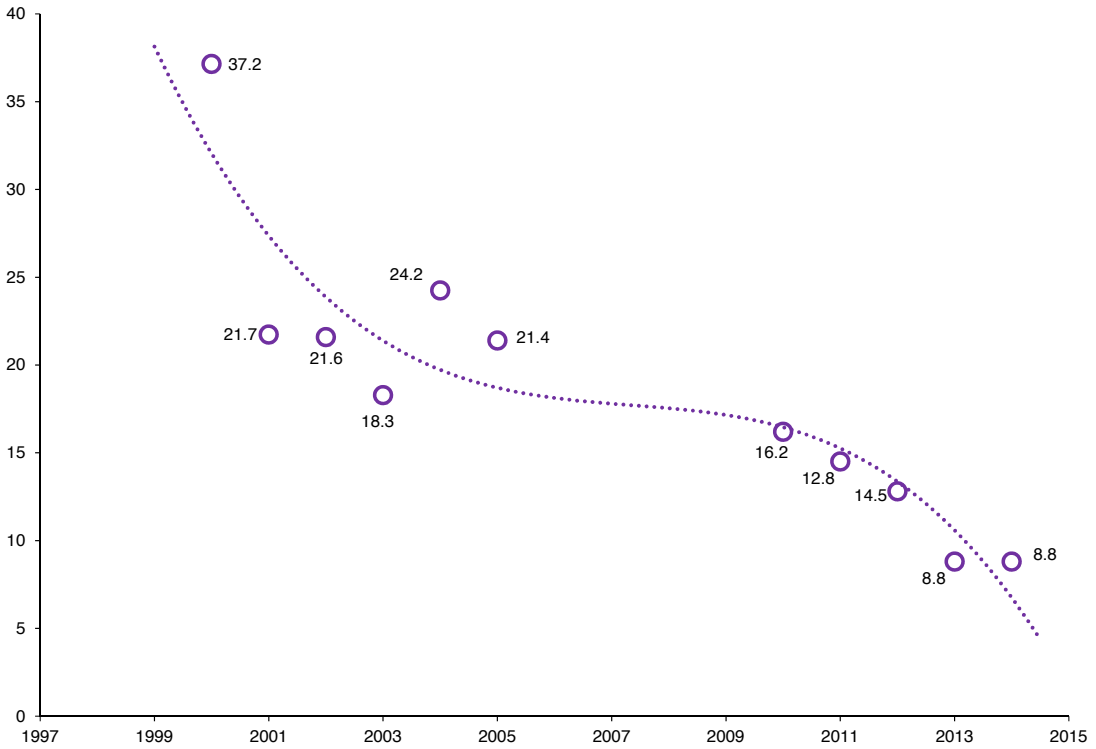


Figure 34: Agriculture GERD in millions constant 2011 PPP international $, 2000–2014.
Source: UNESCO basd on raw data from Agricultural Science and Technology Indicators (ASTI) and Stads (2016).

A scientometric analysis of Lao PDR

INTRODUCTION

Basic research is usually carried out in universities or other academic institutions. The traditional method used to measure or assess the results of academic research uses bibliometric indicators. Bibliometrics is a general term for the inventory and statistical analysis of articles publications and citations and other more complex indicators of scientific production derived from such statistics. Bibliometric indicators are important tools for assessing R&D performance and the specialization of countries' institutions, laboratories, universities, thematic areas and individual scientists. As with any indicator, they are not faultless and should therefore be interpreted with caution.

The procedure for assessing the impact of industrial R&D is essentially based on an analysis of patent statistics and when it comes to the impact of industrial R&D on trade, based on an analysis of high-tech products as well as through studies of the trade balance of high-tech items for each country.

Both bibliometric analyses and patent statistics are included in a discipline known as scientometrics. At present thanks to exponential growth in our data-processing capacity, it is possible to prepare sophisticated multidimensional indicators on the production of scientific articles in all disciplines from exact sciences to humanities. Moreover, very precise analyses can be made of the impact of publications, the state-of-the-art of knowledge in various subject areas in each country, the level of co-operation in terms of co-authorship of publications, co-citations, the creation and evolution of scientist networks (i.e. 'invisible colleges') etc. By analysing cross-references used in patent applications or by cross-referencing information published in scientific literature we can use bibliometrics to examine the links between STI and patents (Lemarchand, 2010).

One of the most relevant sources of information about the productivity of scientific knowledge is accessible through international databases (Lemarchand, 2012). This type of information is not usually open access. In particular, a very well-established class of indicators about scientific production can be estimated by counting the number of articles and citations published in mainstream journals. One of the most complete databases is the Web of Science, which includes the Science Citation Index (SCI) Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (A&HCI). The latter is now maintained by Thomson-Reuters a private company and covers 12 000 peer-reviewed journals. The other major database is SCOPUS which is maintained by Elsevier Science and covers 18 000 peer-reviewed journals.

An analysis of the aggregated temporal evolution in the data available in the Web of Science shows a homogeneous trend that is independent of any academic discipline and avoids any substantial change in national trends owing to the continual incorporation of new journals in the databases. In this way, it is also possible to study the evolution in cooperation patterns among countries and institutions search for the most developed disciplines and analyse the impact of scientific research based on how other scientists have made use of this material.

Not all Lao PDR' scientists submit their research results to mainstream journals listed by the Web of Science. Therefore, the existence of local and regional journals in several countries may reflect some peculiar domestic circumstances or a specific national scientific agenda that are not considered by the mainstream journals. For this reason, publication in mainstream journals represents only a fraction of the total scientific production of any particular country. The main advantage of using these databases is that they have been systematically collected and organized over several decades using similar methodologies allowing us to perform a long-term analysis with a relatively high level of confidence (Lemarchand 2012).

In spite of the drawback of underrepresented local and regional journals, it can be argued that there is a good correspondence among Web of Science database (SCI Extended SSCI A&HCI) and other international databases on scientific knowledge production. De Moya-Anegón and Herrero-Solana (1999) and Lemarchand (2012) have shown a strong correlation in the distribution of citable articles between the

Science Citation Index Extended and other databases like PASCAL, INSPEC, COMPENDEX CHEMICAL ABSTRACTS BIOSIS MEDLINE and CAB. They have obtained the following values for the correlation coefficient (R) among the different databases: $0.957 \leq R \leq 0.997$. This finding supports the hypothesis that the combination of SCI Extended SSCI and A&HCI listed by the Web of Science database is a good indicator for any study of mainstream scientific knowledge production and trends in co-authorship networks among different countries.

At this point, it is important to consider that during the period analysed here (1966–2016) the number of journals has expanded substantially and consequently so has the total number of published articles included in the Web of Science database. Mabe (2003) showed that journal growth rates have been remarkably consistent over time with average rates of 0.034 since 1800 to the present day. This study presents evidence that during the entire 20th century these growth phenomena appear to show a system that is self-organizing and in equilibrium with a 0.032 growth constant. Considering that the Web of Science database includes only a fraction of all the new journals that are published the growth rate for databases should be even smaller than that estimated by Mabe (2003).

Lemarchand (2012, 2016) has developed a mathematical model showing the proportionality between the size of the national scientific network (e.g. number of FTE researchers in a country) and the corresponding scientific productivity (in terms of the aggregate number of publications per year and the number of co-authored scientific articles between pairs of countries). In this way, the productivity of scientific articles over time is a good proxy for estimating the extent of growth in the number of full-time-equivalent researchers.

THE SCIENTIFIC PRODUCTIVITY IN LAO PDR

In this section, we will analyze – in some detail – the behavior and characteristics of the scientific publications in mainstream journals that have at least one author or authors residing in Lao PDR. Within the group of scientific publications there are different categories of publications, such as, for example, articles, summaries, reviews, comments, conference proceedings, letters, etc. (see Table 25).

With a few exceptions, in this section all the studies and information presented are more narrowly focused to examine solely the subset of publications that are articles, meaning only those publications published in mainstream journals that have been evaluated by a committee of peers. All articles pass through similar evaluation processes that guarantee a certain quality and originality. In this way, the results of a scientific investigation are communicated to the peer community.

The production of scientific articles is thus a good indicator of the level of "R&D activity" or of the aggregate productivity of a given individual, institution or country. As the American sociologist Robert Merton observed opportunely, if a scientist carries out R & D activities and obtains certain results, he will be motivated to communicate them to his peers through those channels that optimize the visibility of his discoveries (Lemarchand, 2012). For this reason, international mainstream journals are the best channel of communication with other scientists. Regardless of the quality, originality and impact of the published scientific article, as previously stated, the fact of its publication will always be an excellent indicator of the aggregate productivity of an individual, institution or country. This is so, because in order to publish an article any scientist had to develop a research project that has achieved certain results, had to invest time in communicating those results through writing a text, and had to undergo the assessment of peers so that it is finally published. This procedure will set up a minimum threshold by which to measure R&D activity, a measure that will be independent of the country where a researcher works. On the other hand, the contextual factors of each individual country will modulate the results by a certain factor, according to how efficient is the researcher and the national system of research and innovation under study.

Table 25: Distributions of publications of Lao PDR by type, of those listed in the Science Citation Index Extended, Social Science Citation Index and Arts and Humanities Citation Index, 1973–2017

Type of document	Number of items	Percentage
Articles	1 574	83.9%
Meeting abstracts	127	6.8%
Reviews	75	4.0%
Letters	55	2.9%
Editorial material	28	1.5%
Proceedings papers	27	1.4%
Book reviews	9	0.5%
Corrections	9	0.5%
Book chapters	5	0.3%

Source: WoS

Table 26: Scientific publications, citations, *h* index, regional Asian-rank and world rank for the countries members of ASEAN, 1996–2016

Country	Documents	Citable articles	Citations	Self-citations	Citations per document	h index	Regional ASEAN rank	World rank
Singapore	241 361	224 763	4 097 146	486 934	17.0	454	7	32
Malaysia	214 883	207 498	1 299 378	341 788	6.1	224	8	34
Thailand	139 682	132 845	1 510 067	238 251	10.8	269	10	43
Indonesia	54 146	51 665	380 569	50 906	7.0	175	12	55
Viet Nam	35 445	33 937	347 394	51 341	9.8	167	13	62
Philippines	23 843	21 861	340 738	33 779	14.3	189	15	69
Cambodia	2 990	2 694	47 555	5 376	15.9	86	21	123
Brunei Darussalam	3 041	2 679	21 986	2 409	7.2	57	22	122
Lao People's Democratic Republic	2 087	1 937	26 911	3 365	12.9	67	26	137

Source: Scimago Lab and Scopus

When we study the aggregate behavior of a given country, the potential differences between the methodologies and characteristics of different scientific fields, as to the distribution of publications per researcher in any branch of science, are diluted by examining only the statistical average.

Table 26 shows the number of scientific publications (including articles, meeting abstracts, reviews, letters, etc.), citable articles, number of citations, number of self-citations, the number of citations per article, the h-index[10], the regional ASEAN rank and the world rank for the period (1996–2016) for the group of countries members of the Association of Southeast Asian Nations (ASEAN). During this period the scientific productivity of Lao PDR was the smallest of all the ASEAN countries.

In a similar way, Table 27 shows the number of scientific publications (including articles, meeting abstracts, reviews, letters, etc.), citable articles, number of citations, number of self-citations, the number of citations per article, the h-index, the regional rank and the world rank for 2016 for the group of countries members of UNESCO's Asia and the Pacific region. In this case, considering the number of articles with at least one author from Lao PDR listed at the SCOPUS database, the country occupied the rank 131 at global level and the rank 25 within the member countries of this Asia and the Pacific region. In 2016 Lao PDR registered 241 scientific articles at SCOPUS.

10 In recent years, a more coherent way to estimate the impact of scientific publications was proposed by Hirsch (2005). The so-called h-index is an indicator of the impact of an individual's scientific output, which can be generalized to institutions and countries. At an aggregated level indicates the number of articles (h) of a given country that have received at least h citations.

Figure 35 shows the evolution in the number of scientific articles produced by at least one author living in Lao PDR listed in SCI, SSCI and A&HCI (1973–2016), while Figure 36 presents the number of articles per million inhabitants in the same period. From both figures it is very clear that practically no R&D activity resulted in the publication of a scientific article in a mainstream journal before 1997. This was the year when Lao PDR became a member of ASEAN.

It is interesting to observe that the trend for whole period (1973–2016) shown by Figure 35 can be described by a mathematical quartic trend with a high coefficient of determination (R^2=0.98) as well as the trend observed in the evolution over time of the number of articles per million inhabitants (R^2=0.98) presented in Figure 36.

The clear majority of countries that have a consolidated research and innovation system that has exceeded a minimum number of scientists per million inhabitants, will usually present a very high correlation between the number of articles per million inhabitants and GDP per capita in constant currency (see UNESCO 2013, 2016). Figure 37 presents the behaviour of the number of scientific articles per million inhabitants against the GDP per capita in constant 2011 $ PPP. The graph shows a mathematical logistic growth correlation (R^2=0.97), meaning that the increase in the number of publications per capita correlates in a logistic way with an increase in the GDP per capita expressed in constant $ PPP. It also implies that the number of publications against income is reaching a plateau.

Figure 38 shows the evolution of international collaboration in terms of the percentage of articles co-authored by scientists from other countries over the total number of articles produced by Lao PDR each year. The graph shows the very high dependence on international co-authorship in Lao PDR for the publication of scientific articles.

Table 28 lists the 25 countries within which Lao PDR authors most frequently co-authored publications internationally, during four different periods (1973–1994, 1995–2004, 2005–2014 and 2015–2016). During the first period, characterized with an extremely low production, USA, USSR and India were the most important partners in descending order. However, during the second period, co-publication was dominated by Thailand, USA, UK and France, and in the last two periods Thailand, UK, USA and France were the most relevant countries for international scientific co-authorship.

In this way, considering the whole history of scientific publications (1973–2016) the most important partners of Lao PDR in terms of scientific co-publications are in order of importance Thailand, UK, USA and France. Figures 38 to 41 represent the temporal evolution of Lao PDR's co-publications with these four countries. It is interesting to observe that – in the four cases – the temporal evolution is characterized by parabolic growth patterns. This is a property of self-organizing co-publication networks (Lemarchand, 2012). Due to the fact that the growth constants with the largest scientific networks (USA, UK and France) are practically the same, Lemarchand (2016) showed that this pattern is a direct indication that the number of FTE scientists in Lao PDR should be increasing in a linear way. Unfortunately, the lack of regular R&D surveys in the country prevent us to test this theoretical prediction for the moment.

Table 29 shows the production of scientific articles by the top 25 national institutions and laboratories, within four different periods (1973–1994, 1995–2004, 2005–2014 and 2015–2016). The most prolific institutions within all the periods are the Ministry of Health, the Mahosot Hospital, the National Agriculture and Forestry Research Institute (NAFRI), the National University of Lao PDR (NUOL) and most recently the University of Health Sciences.

Table 30 presents the 15 most important foreign and international research organizations responsible for co-authoring scientific articles with Lao PDR's researchers, according to articles listed in the SCI Extended SSCI and A&HCI. The most important foreign partners, considering all the periods are Oxford University (UK), Mahidol University (Thailand), the International Water Management Institute (IWMI), Khon Kaen University (Thailand) and the *Institut de recherche pour le développement* (France).

Table 31 analyses in detail the production of articles, by breaking it down into 30 sub-fields of science and four different periods between 1973 and 2016. The data show clearly that the most productive sub-fields are public environmental occupational health, tropical medicine, infectious diseases, agriculture and environmental sciences/ecology.

Table 27: Scientific publications, citations, *h* index, regional-rank and world rank for the countries of Asia and the Pacific, 2016

Country	Documents	Citable documents	Citations	Self-citations	Citations per document	h index	Regional rank	World rank
People's Republic of China	525 660	509 315	498 250	294 824	0.93	655	1	2
India	138 986	128 760	89 952	35 652	0.65	478	2	5
Australia	89 767	80 133	123 355	34 527	1.37	795	3	10
Republic of Korea	78 660	75 162	76 386	21 464	0.97	536	4	12
Islamic Republic of Iran	49 572	47 390	47 438	22 989	0.96	234	5	16
Malaysia	28 546	27 400	19 024	5 892	0.67	224	6	23
Singapore	19 992	18 571	32 504	6 512	1.63	454	7	31
Thailand	14 176	13 287	11 331	2 448	0.80	269	8	39
Pakistan	13 772	12 999	13 789	5 530	1.00	197	9	40
New Zealand	14 268	12 699	17 221	3 712	1.21	428	10	38
Indonesia	11 470	11 126	4 604	1 815	0.40	175	11	45
Viet Nam	5 563	5 287	4 970	1 152	0.89	167	12	57
Bangladesh	3 995	3 786	3 246	949	0.81	154	13	59
Kazakhstan	3 066	2 945	1 034	307	0.34	75	14	63
Iraq	2 766	2 677	2 299	959	0.83	71	15	66
Philippines	2 642	2 460	2 598	420	0.98	189	16	67
Sri Lanka	1 673	1 570	1 302	240	0.78	135	17	80
Nepal	1 132	1 001	1 000	215	0.88	106	18	90
Azerbaijan	882	846	786	173	0.89	76	19	94
Uzbekistan	575	530	214	43	0.37	77	20	102
Brunei Darussalam	480	444	525	126	1.09	57	21	109
Cambodia	377	359	552	122	1.46	86	22	116
Fiji	326	311	451	53	1.38	67	23	125
Myanmar	272	261	485	27	1.78	58	24	129
Lao People's Democratic Republic	256	241	338	50	1.32	67	25	131
Kyrgyzstan	214	200	134	24	0.63	51	26	135
Papua New Guinea	176	162	245	19	1.39	79	27	137
Afghanistan	162	149	132	12	0.81	40	28	140
Tajikistan	115	105	48	10	0.42	34	29	153
Bhutan	97	85	109	12	1.12	32	30	159
Democratic People's Republic of Korea	56	51	29	1	0.52	85	31	170
Solomon Islands	47	46	46	10	0.98	36	32	176
Vanuatu	46	45	39	8	0.85	33	33	177
Timor-Leste	28	25	25	9	0.89	16	34	185
Maldives	21	15	19	1	0.90	24	35	194
Federated States of Micronesia	11	11	30	1	2.73	27	36	204
Palau	11	11	14	1	1.27	30	37	206
Turkmenistan	12	11	3	1	0.25	23	38	203
Tonga	12	10	229	3	19.08	24	39	202
Cook Islands	8	8	8	0	1.00	15	40	211
Kiribati	6	6	5	0	0.83	9	41	214
Marshall Islands	4	4	2	0	0.50	19	42	216
Tokelau	3	3	0	0	0.00	1	43	221
Tuvalu	3	3	2	0	0.67	9	44	223
Nauru	2	2	0	0	0.00	8	45	225

Source: Scimago Lab and Scopus

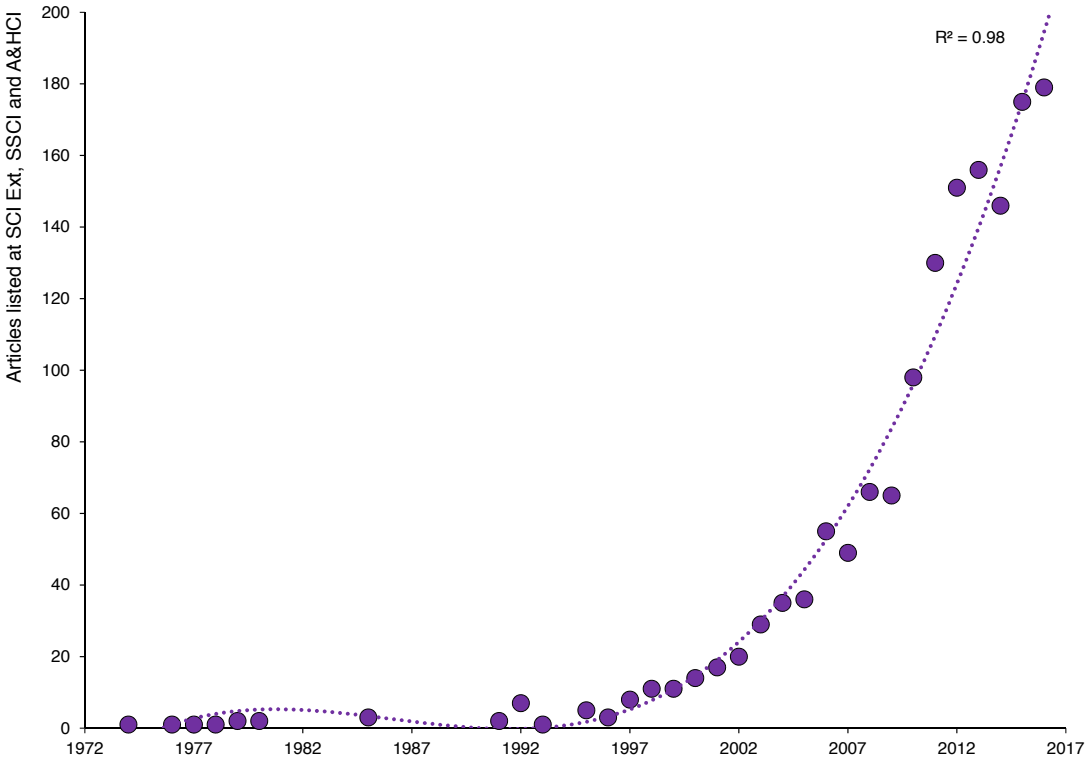


Figure 35: Number of articles by Lao PDR's authors that are listed in SCI, SSCI and A&HCI, 1973–2016.
Source: UNESCO based on raw data by WoS and UN Statistics Division

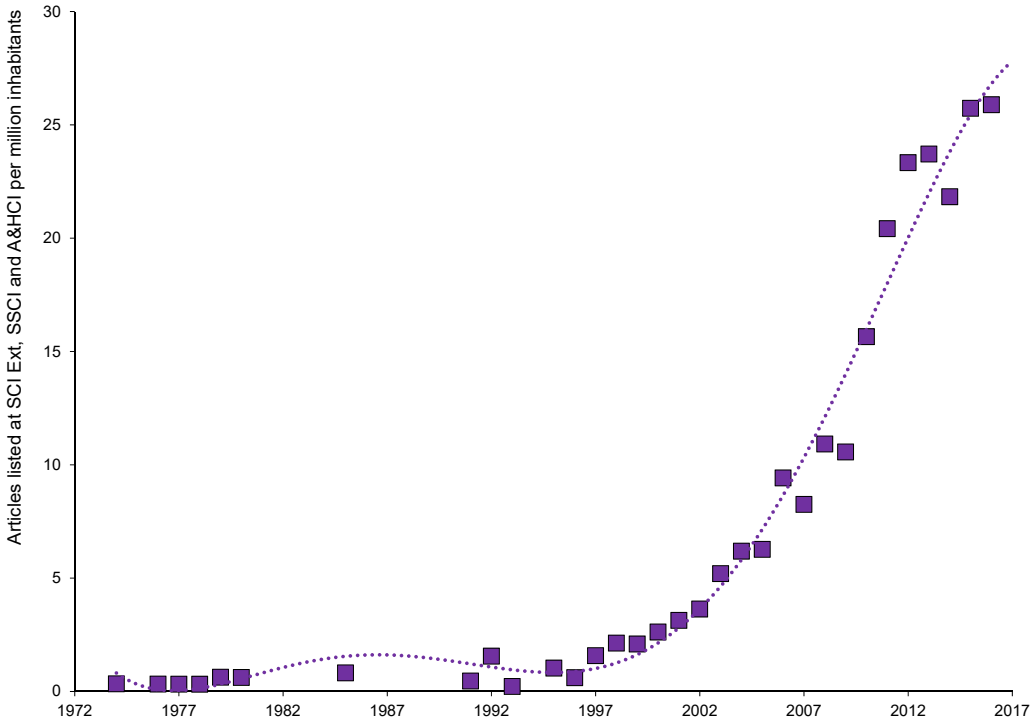


Figure 36: Number of articles by Lao PDR's authors that are listed in SCI, SSCI and A&HCI per million inhabitants, 1973–2016.
Source: UNESCO based on raw data by Web of Science and the UN Statistics Division

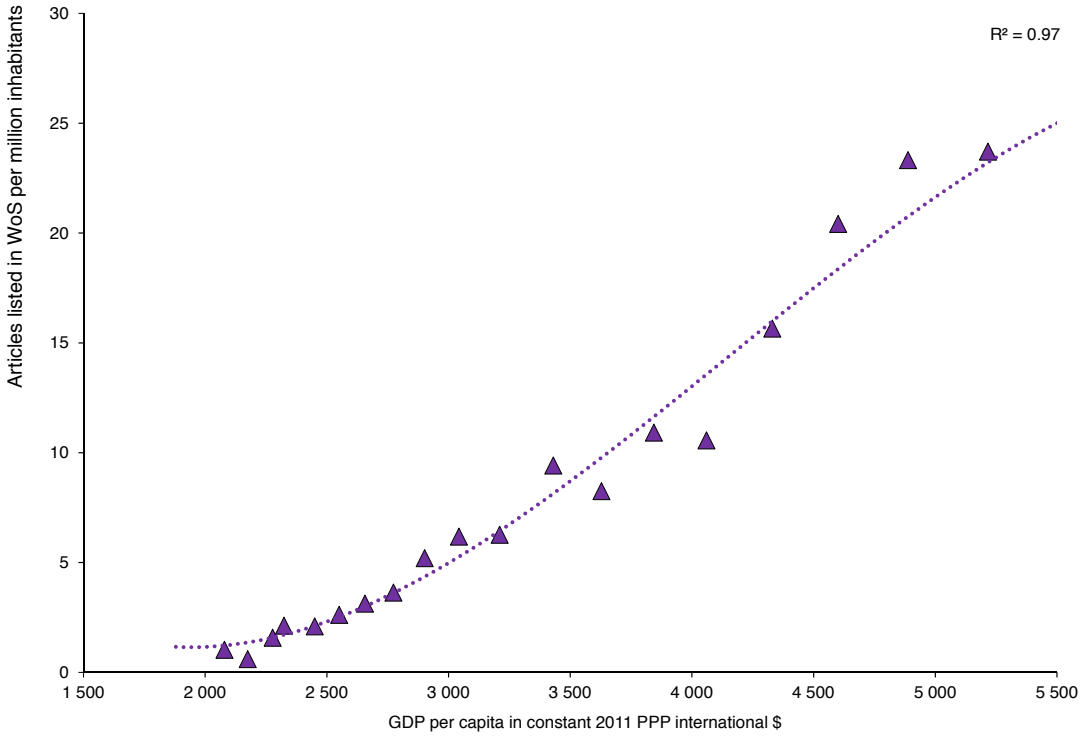


Figure 37: Number of articles by Lao PDR's authors that are listed in SCI, SSCI and A&HCI per million inhabitants against GDP per capita in constant 2015 US dollars. The fitting curve follows a logistic growth.
Source: UNESCO based on raw data by Web of Science, World Bank and UN Statistics Division

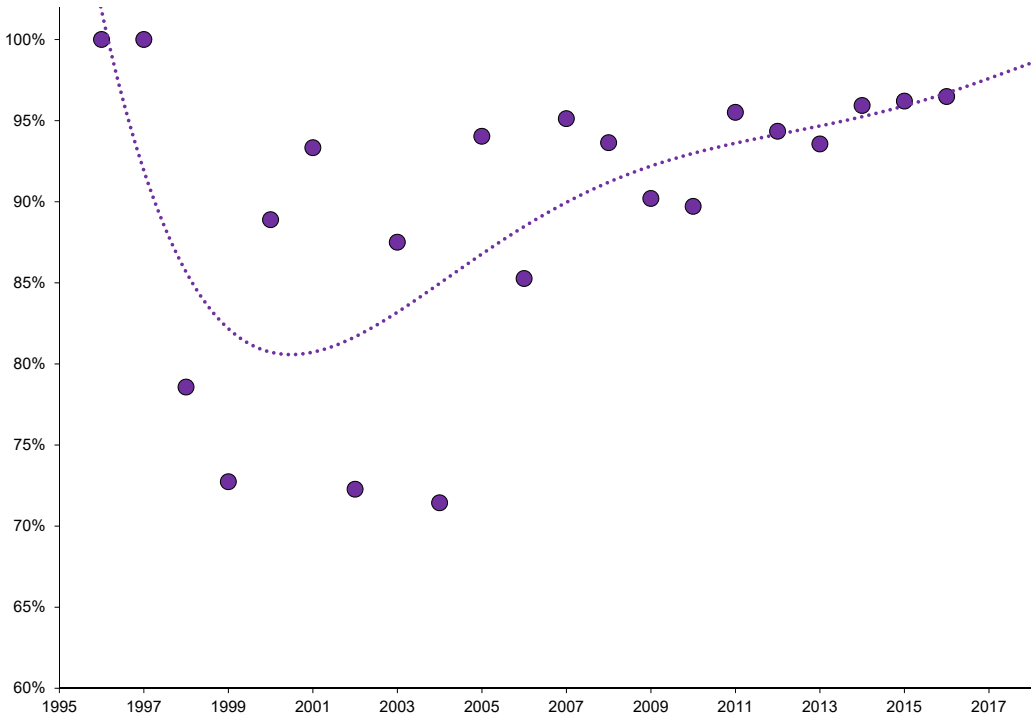


Figure 38: Evolution in international collaboration in scientific publications as a share of total annual publications in Lao PDR, 1996–2016.
Source: UNESCO based on raw data by Web of Science

Table 28: Countries with which Lao PDR's scientists co-authored mainstream scientific publications, 1973–2016

Rank	1973–1994			1995–2004			2005–2014			2015–2016		
	Country	Art	Share of total [%]	Country	Art	Share of total [%]	Country	Art	Share of total [%]	Country	Art	Share of total [%]
	Lao PDR	16	100.0%	Lao PDR	126	100.0%	Lao PDR	1 068	100.0%	Lao PDR	346	100.0%
1	USA	3	18.8%	Thailand	23	18.3%	Thailand	267	25.0%	Thailand	120	34.7%
2	USSR	3	18.8%	USA	21	16.7%	UK	238	22.3%	UK	91	26.3%
3	India	2	12.5%	UK	23	18.3%	USA	212	19.9%	USA	80	23.1%
4	Australia	1	6.3%	France	19	15.1%	France	197	18.4%	France	78	22.5%
5	Bangladesh	1	6.3%	Australia	12	9.5%	Australia	152	14.2%	Australia	50	14.5%
6	Canada	1	6.3%	Philippines	11	8.7%	Japan	152	14.2%	Japan	46	13.3%
7	Czechoslovakia	1	6.3%	Japan	10	7.9%	Viet Nam	100	9.4%	Switzerland	35	10.1%
8	Lebanon	1	6.3%	Sweden	10	7.9%	Switzerland	81	7.6%	Cambodia	33	9.5%
9	Pakistan	1	6.3%	Viet Nam	9	7.1%	Cambodia	79	7.4%	Viet Nam	33	9.5%
10	UK	1	6.3%	Canada	6	4.8%	Sweden	67	6.3%	Germany	25	7.2%
11	Tanzania	1	6.3%	Germany	6	4.8%	Germany	58	5.4%	India	21	6.1%
12				Belgium	5	4.0%	China	56	5.2%	Canada	19	5.5%
13				Cambodia	4	3.2%	Indonesia	48	4.5%	China	16	4.6%
14				Kenya	4	3.2%	Philippines	43	4.0%	Netherlands	15	4.3%
15				Brazil	3	2.4%	Netherlands	41	3.8%	Sweden	15	4.3%
16				China	3	2.4%	Malaysia	32	3.0%	Indonesia	14	4.0%
17				Sri Lanka	3	2.4%	India	31	2.9%	Philippines	13	3.8%
18				Ethiopia	2	1.6%	Belgium	28	2.6%	Singapore	13	3.8%
19				Iceland	2	1.6%	Rep. of Korea	28	2.6%	Bangladesh	12	3.5%
20				India	2	1.6%	Sri Lanka	27	2.5%	Rep. of Korea	12	3.5%
21				Myanmar	2	1.6%	Canada	26	2.4%	Belgium	11	3.2%
22				Russian Federation	2	1.6%	Denmark	21	2.0%	Brazil	9	2.6%
23				Senegal	2	1.6%	Singapore	21	2.0%	Denmark	9	2.6%
24				South Africa	2	1.6%	Kenya	19	1.8%	Myanmar	9	2.6%
25				Switzerland	2	1.6%	Myanmar	17	1.6%	South Africa	9	2.6%

Source: UNESCO based on articles listed at the *Science Citation Index Extended, Social Science Citation Index* and *Arts and Humanities Citation Index*

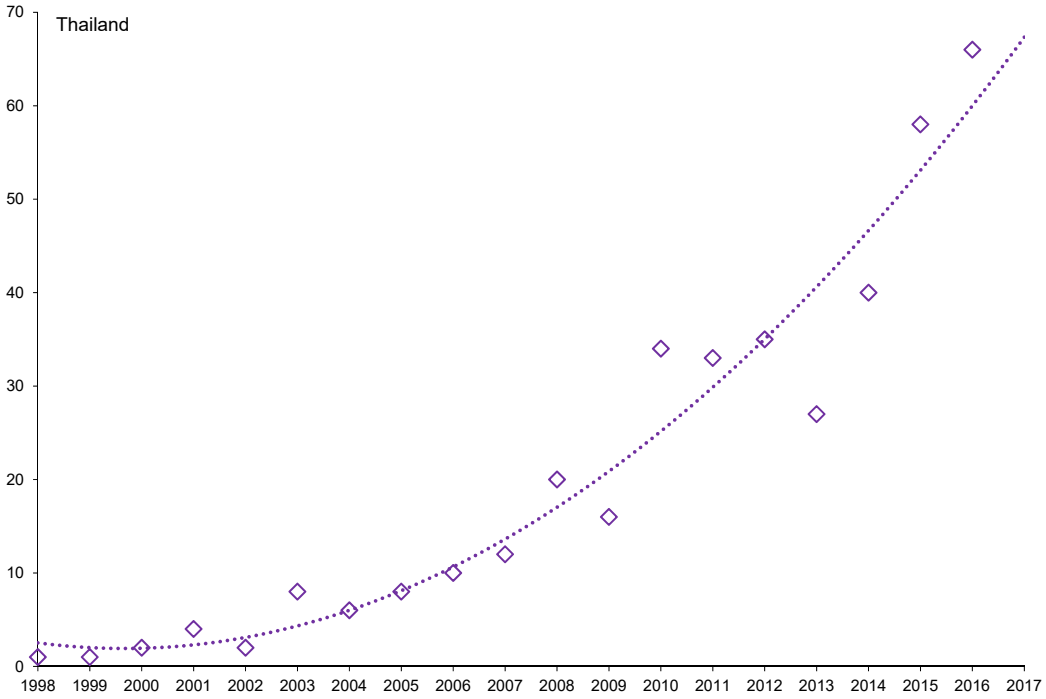


Figure 39: Co-authorship of scientific articles between Lao PDR and Thailand, 1998–2016.

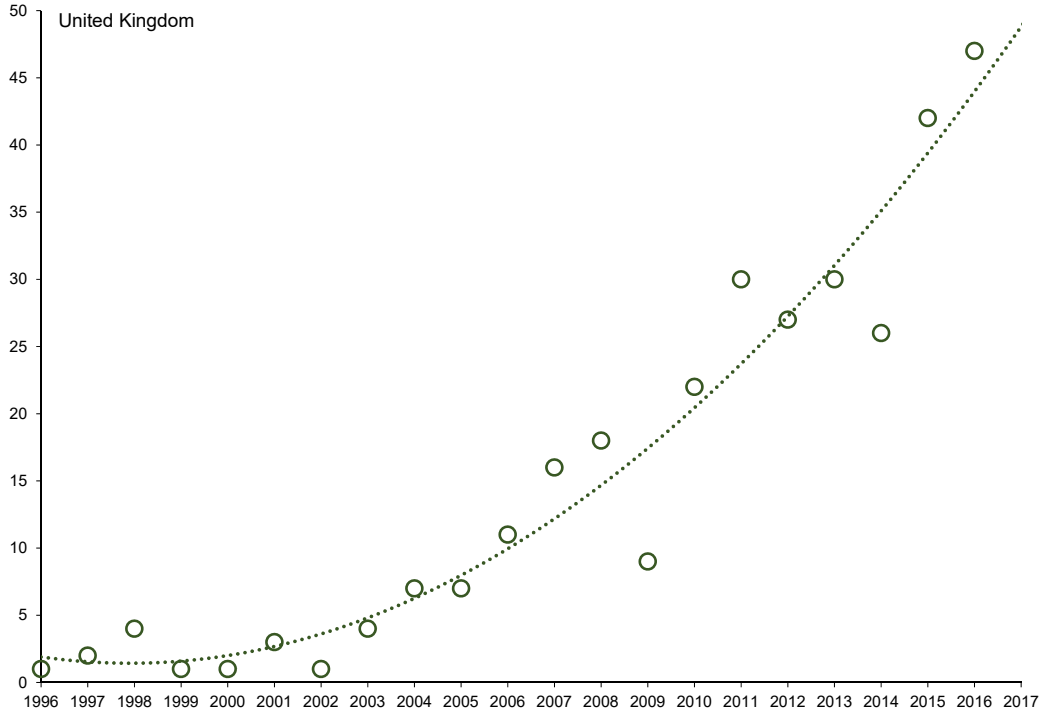


Figure 40: Co-authorship of scientific articles between Lao PDR and the United Kingdom, 1996–2016.

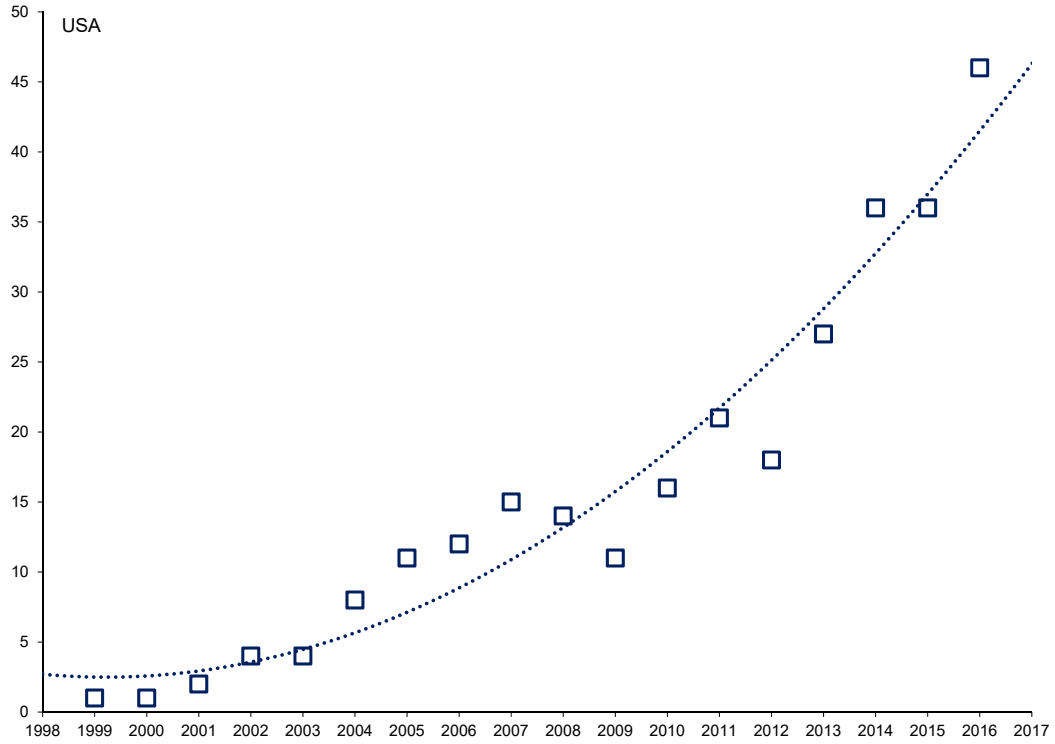


Figure 41: Co-authorship of scientific articles between Lao PDR and USA, 1999–2016.

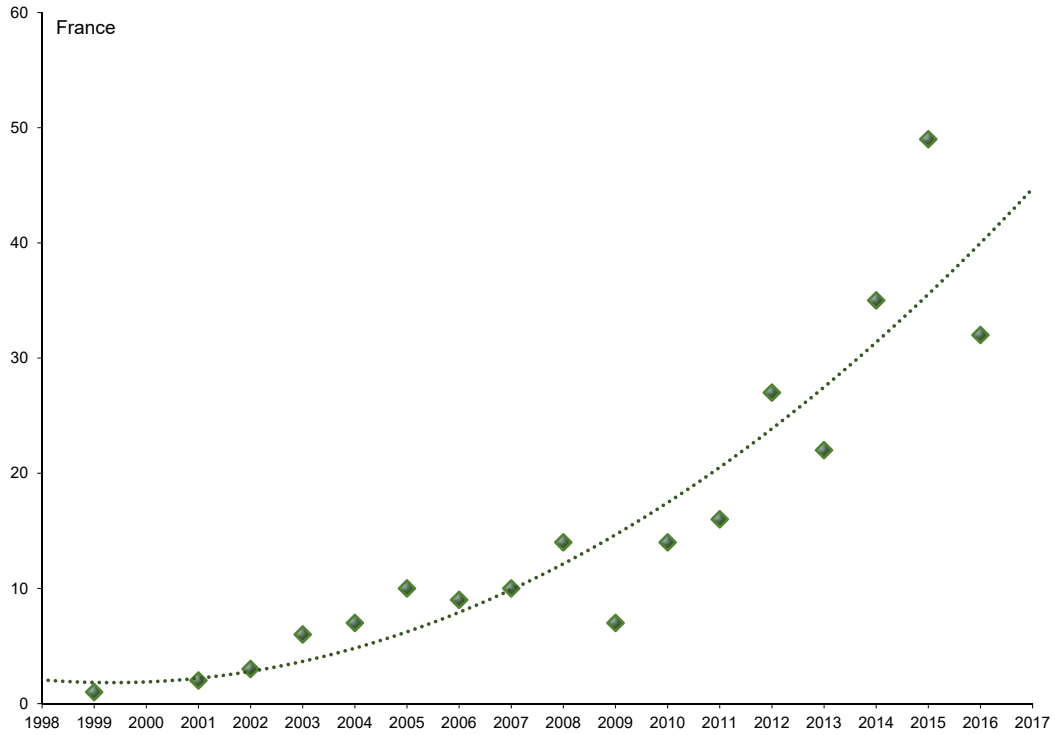


Figure 42: Co-authorship of scientific articles between Lao PDR and France, 1999–2016.

Table 29: Production of mainstream scientific articles in Lao PDR by national institutions and laboratories, 1973–2016

Rank	1973–1994			1995–2004			2005–2014			2015–2016		
	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]
	Lao PDR	16	100.0%	Lao PDR	126	100.0%	Lao PDR	1 068	100.0%	Lao PDR	346	100.0%
1	Lao PDR-IRRI Project	3	18.8%	Ministry of Health	23	18.3%	Mahosot Hospital	154	14.4%	Mahosot Hospital	66	19.1%
2	Ministry of Health	1	6.3%	Lao PDR-IRRI Project	16	12.7%	National University of Lao PDR (NUOL)	151	14.1%	University of Health Sciences	52	15.0%
3	Ministry of Education	1	6.3%	Centre for Malariology, Parasitology and Entomology	14	11.1%	Ministry of Health	144	13.5%	Ministry of Health	41	11.8%
4	National Polytechnic Institute	1	6.3%	Mahosot Hospital	13	10.3%	National Agriculture and Forestry Research Institute (NAFRI)	94	8.8%	National University of Lao PDR (NUOL)	35	10.1%
5				National Agriculture and Forestry Research Institute (NAFRI)	12	9.5%	University of Health Sciences	85	8.0%	Ministry of Agriculture and Forestry	15	4.3%
6				National University of Lao PDR (NUOL)	7	5.6%	Institut de la Francophonie pour la Médecine tropicale	74	6.9%	National Agriculture and Forestry Research Institute (NAFRI)	13	3.8%
7				Wildlife Conservation Society - Lao Programme	7	5.6%	Ministry of Agriculture and Forestry	43	4.0%	Institut de la Francophonie pour la Médecine tropicale	12	3.5%
8				Ministry of Agriculture and Forestry	4	3.2%	Institute Pasteur Lao PDR	39	3.7%	Centre d'Infectiologie Christophe Mérieux du Laos	9	2.6%
9				Lao PDR	3	2.4%	National Institute of Public Health	23	2.2%	Institute Pasteur Lao PDR	8	2.3%
10				Institut de la Francophonie pour la Médecine tropicale	2	1.6%	Centre for Malariology, Parasitology and Entomology	22	2.1%	National Institute of Public Health	6	1.7%
11				Institute Pasteur Laos	2	1.6%	Savannnakhet University	12	1.1%	Mekong Reg. Futures Institute	3	0.9%
12				Lao Australian Animal Health Project	2	1.6%	Mekong River Commission	11	1.0%	WHO Lao country office	3	0.9%
13				Ministry of Science and Technology	2	1.6%	Luang Namtha Provincial Hospital	9	0.8%	Government of Lao PDR	2	0.6%
14				Vientiane Municipal Public Health Department	2	1.6%	Population Serv. Int. Lao PDR	7	0.7%	Lao Friends Hospital for Children	2	0.6%
15				National Polytechnic Institute	2	1.6%	Souphanouvong University	7	0.7%	Lao PDR Programme	2	0.6%
16				Lao PDR Programme	1	0.8%	WWF Greater Mekong Programme	7	0.7%	Ministry of Industry and Commerce	2	0.6%
17				National Institute of Public Health	1	0.8%	Lao Red Cross	6	0.6%	Ministry of Information, Culture and Tourism	2	0.6%
18				Savannakhet Hospital	1	0.8%	Lao Field Epidemiology Training	5	0.5%	National Economic Research Institute	2	0.6%
19				Savannakhet Province Malaria Station	1	0.8%	Ministry of Information, Culture and Tourism	5	0.5%	WWF Greater Mekong	2	0.6%
20				Serv. Information Culture - Province Savannakhet	1	0.8%	Salavan Province Hospital	4	0.4%	Homsavanh School	2	0.6%
21							Setthathirath Hospital	4	0.4%	University of Vientiane	1	0.3%
22							Indochina Research Lao PDR Ltd	3	0.3%	Vientiane Capital	1	0.3%
23							Ministry of Natural Resources and Environment	3	0.3%	Vientiane College	1	0.3%
24							Mittaphab Hospital	3	0.3%	Vientiane Health Office	1	0.3%
25							National University of Vientiane	3	0.3%			

Source: UNESCO based on the articles listed at the Web of Science

Table 30: Top ten foreign research institutions and centres co-authoring articles with Lao PDR's scientists, 1973–2016

Rank	1973–1994			1995–2004			2005–2014			2015–2016		
	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]	Institution	Art	Share of total [%]
	Lao PDR	16	100.0%	Lao PDR	126	100.0%	Lao PDR	1 068	100.0%	Lao PDR	346	100.0%
1	Food and Agriculture Organization of the United Nations	4	25.0%	Mahidol University	17	13.5%	Oxford University	136	12.7%	Mahidol University	102	29.5%
2	Indian Institute of Technology	2	12.5%	Institut de recherche pour le développement (IRD)	15	11.9%	Mahidol University	130	12.2%	Oxford University	74	21.4%
3	All-Union Geological Institute	1	6.3%	World Health Organization	10	7.9%	International Water Management Institute (IWMI)	58	5.4%	Institut de recherche pour le développement (IRD)	50	14.5%
4	American University of Beirut	1	6.3%	Institute of Tropical Medicine Prince Leopold	7	5.6%	Khon Kaen University	48	4.5%	Centre National de la Recherche Scientifique (CNRS)	32	9.2%
5	Australian National University	1	6.3%	Institut National de la Recherche Agronomique (INRA)	6	4.8%	Institut de recherche pour le développement (IRD)	41	3.8%	CIRAD - Agricultural Research for Development	21	6.1%
6	Czech Academy of Sciences	1	6.3%	John Radcliffe Hospital	6	4.8%	University of Queensland	39	3.7%	University of London	21	6.1%
7	Ford Foundation	1	6.3%	Karolinska Institute	6	4.8%	World Health Organization	35	3.3%	Sorbonne University	20	5.8%
8	Institute of Chemical Sciences	1	6.3%	Ministry of Public Health	6	4.8%	Karolinska Institute	28	2.6%	International Water Management Institute	19	5.5%
9	International Centre for Diarrhoeal Disease Research, Bangladesh	1	6.3%	Med Sans Frontieres	5	4.0%	The London School of Hygiene & Tropical Medicine	28	2.6%	Pierre and Marie Curie University	18	5.2%
10	Johns Hopkins University	1	6.3%	University Ryukyus	5	4.0%	University of Tokyo	27	2.5%	World Health Organization	18	5.2%
11	Mendeleev University of Chemical Technology of Russia	1	6.3%	University of California System	5	4.0%	University of California System	25	2.3%	The London School of Hygiene & Tropical Medicine	16	4.6%
12	National Research Council of Canada	1	6.3%	Wildlife Conservation Society	5	4.0%	Churchill Hospital	24	2.2%	Centres for Disease Control Prevention USA	15	4.3%
13	United States Department of Agriculture	1	6.3%	University of Munich	4	3.2%	Wildlife Conservation Society	24	2.2%	Khon Kaen University	15	4.3%
14	University Dar es Salaam	1	6.3%	University of Paris	4	3.2%	Kyoto University	23	2.2%	Languedoc Roussillon University	15	4.3%
15	University of Minnesota	1	6.3%	CSIRO	3	2.4%	Georgia Institute of Technology	22	2.1%	University of Montpellier	15	4.3%

Source: UNESCO based on articles listed at the Science Citation Index, Extended Social Science Citation Index and Arts and Humanities Citation Index

BOX 14 – VIENTIANE'S SCIENCE CAFE

Recently, Cheah *et al* (2016) reported that on July 21, 2016, the University of Health Sciences and the Ministry of Health, in collaboration with the Lao–Oxford–Mahosot Hospital–Welcome Trust Research Unit, organised the first Science Café event in Lao PDR. According to the results presented in Tables 26 and 27, these institutions are among the most prolific of the country in terms of scientific publications.

According to the organizers, more than 50 students and staff of the Faculties of Medicine, Pharmacy, Dentistry, Nursing Sciences, Medical Technology, Basic Sciences, and Public Health attended the event on "Medical and Research Ethics." Lively discussions included what makes a research study ethical, what makes consent valid, and whether children should be involved as participants in clinical research.

Historically, little medical- or scientific-research-related communications have taken place in Lao PDR, but according to Cheah *et al* (2016) this research communication has grown over the past decade, with increasing interest in research's implications in society. Funded by the Welcome Trust, the Vientiane Science Café was created with the hope of facilitating engagement between scientists, health workers, and the public in a discussion that can further understanding of science, its effects on and relevance to society.

On the five continents around the world, the usual aim of the so-called science cafés is the popularization of science, giving scientists the opportunity to communicate effectively the results of their work. Since the first event, different topics have emerged from medicine, zoology, botany, and ethics, to physics and chemistry. These events are open to the general public, and have been organized on along these lines: a researcher is invited to give a short presentation for laymen about their work or a controversial area, after which the session is opened for discussion and exchange of ideas (Cheah et al, 2016). Similar science cafés have been organized in other countries of the region, such as Thailand, Malaysia or Viet Nam.

Source: Cheah *et al* (2016)

Table 31: Distribution of mainstream scientific articles by sub-field of science, 1973–2016

Rank	1973–1994			1995–2004			2005–2014			2015–2016		
	Research area	Art	Share of total [%]	Research area	Art	Share of total [%]	Research area	Art	Share of total [%]	Research area	Art	Share of total [%]
	Lao PDR	16	100.0%	Lao PDR	126	100.0%	Lao PDR	1 068	100.0%	Lao PDR	346	100.0%
1	Agriculture	4	25.0%	Agriculture	29	23.0%	Public environmental occupational health	172	16.1%	Tropical medicine	66	19.1%
2	Public environmental occupational health	4	25.0%	Public environmental occupational health	26	20.6%	Tropical medicine	156	14.6%	Infectious diseases	60	17.3%
3	Tropical medicine	3	18.8%	Tropical medicine	23	18.3%	Infectious diseases	144	13.5%	Public environmental occupational health	53	15.3%
4	Veterinary sciences	2	12.5%	Environmental sciences ecology	14	11.1%	Agriculture	115	10.8%	Parasitology	47	13.6%
5	Chemistry	1	6.3%	Infectious diseases	13	10.3%	Environmental sciences ecology	111	10.4%	Environmental sciences ecology	45	13.0%
6	Demography	1	6.3%	Plant sciences	10	7.9%	Parasitology	86	8.1%	Science, technology & other topics	36	10.4%
7	Engineering	1	6.3%	Parasitology	8	6.3%	Science, technology & other topics	61	5.7%	Agriculture	20	5.8%
8	Entomology	1	6.3%	Microbiology	7	5.6%	Zoology	61	5.7%	Water resources	17	4.9%
9	Environmental sciences ecology	1	6.3%	Health care sciences services	6	4.8%	Water resources	53	5.0%	Geology	16	4.6%
10	Forestry	1	6.3%	Zoology	6	4.8%	Geology	39	3.7%	Zoology	14	4.0%
11	Geology	1	6.3%	Immunology	5	4.0%	Veterinary sciences	37	3.5%	Microbiology	13	3.8%
12	Infectious diseases	1	6.3%	Geology	4	3.2%	Immunology	36	3.4%	Immunology	12	3.5%
13	Materials science	1	6.3%	Pharmacology & pharmacy	4	3.2%	Pharmacology & pharmacy	36	3.4%	Veterinary sciences	11	3.2%
14	Pathology	1	6.3%	Veterinary sciences	4	3.2%	Plant sciences	35	3.3%	Business economics	9	2.6%
15	Polymer science	1	6.3%	General internal medicine	3	2.4%	Microbiology	31	2.9%	Biochemistry molecular biology	8	2.3%
16	Psychiatry	1	6.3%	Water resources	3	2.4%	Biodiversity conservation	30	2.8%	Health care sciences services	8	2.3%
17	Substance abuse	1	6.3%	Biochemistry molecular biology	2	1.6%	Engineering	29	2.7%	Plant sciences	7	2.0%
18	Water resources	1	6.3%	Biodiversity conservation	2	1.6%	General internal medicine	27	2.5%	Chemistry	6	1.7%
19				Biotechnology applied microbiology	2	1.6%	Health care sciences services	23	2.2%	Engineering	6	1.7%
20				Dermatology	2	1.6%	Forestry	19	1.8%	Entomology	6	1.7%
21				Education & education research	2	1.6%	Physical geography	19	1.8%	Geography	6	1.7%
22				Genetics & heredity	2	1.6%	Biochemistry molecular biology	16	1.5%	Pharmacology & pharmacy	6	1.7%
23				Geography	2	1.6%	Life sciences biomedicine & other topics	16	1.5%	Dentistry oral surgery medicine	5	1.4%
24				Neurosciences & neurology	2	1.6%	Genetics & heredity	15	1.4%	Research experimental medicine	5	1.4%
25				Pathology	2	1.6%	Nutrition dietetics	14	1.3%	Biodiversity conservation	4	1.2%
26				Paediatrics	2	1.6%	Haematology	13	1.2%	Evolutionary biology	4	1.2%
27				Psychology	2	1.6%	Neurosciences & neurology	13	1.2%	Genetics & heredity	4	1.2%
28				Rehabilitation	2	1.6%	Paediatrics	13	1.2%	Public administration	4	1.2%
29				Respiratory system	2	1.6%	Chemistry	12	1.1%	Virology	4	1.2%
30				Spectroscopy	2	1.6%	Geography	12	1.1%	Area studies	3	0.9%

Source: UNESCO based on articles listed at the *Science Citation Index Extended Social Science Citation Index* and *Arts and Humanities Citation Index*

WHAT PATENTS TELL US ABOUT RESEARCH AND INNOVATION

A patent is a document issued by an authorized government agency granting the right to exclude—using the legal system—anyone else from the production or use of a specific new device apparatus or process for a stated number of years (see Glossary page 213). The grant is issued to the inventor of this device or process after an examination that focuses on both the novelty of the claimed item and its potential utility.

Measuring the link between publications and patents has been a subject of academic research in recent decades. It helps us to understand the intensity and orientation of research as well as the relation between science and technology. A measurable relation allows us to investigate knowledge transfers and potential spillovers; to describe the knowledge base of particular technologies; to disclose the technological neighbourhood of scientific themes or research fronts; to reveal an ongoing innovation process (from research to technology then on to commercialisation).

A patent constitutes a milestone in the progress of a given technology. However, it is only one piece in a larger puzzle of technological innovation, which entails combining new knowledge with a suitable business strategy and other factors to achieve commercial success. Patent data have been widely used in many innovation studies (Griliches, 1990). Next to patent count data, it is obvious that patent documents because of legal reporting requirements provide the STI policy expert with a wealth of information, which can be used for various types of foresight and strategic analysis. For instance, typical patent documents contain the names and the addresses of the inventors and their applicants as well as references to other scientific and technological documents. This information can easily be used to map progress and collaboration in technological fields as well as to assess the vitality of various organisations (firms as well as universities) in a particular field of technological development or in a particular system of innovation.

The kind of economic studies in which patent statistics have been used include those that examine: the long-term changes in the amount and direction of inventive output in particular industries; the relationship between these changes and other long-term economic indicators; the relative efficiency of company-financed and government-financed industrial R&D; the contribution of individual firms to particular areas of innovative activity; the relative significance of foreign and home-generated technology; and individual inventive output.

Patent analysis takes many forms with important distinctions between micro- and macro- analyses (Trippe, 2003). In the private sector, for instance intellectual asset management groups probe deeply to understand the development of individual technologies through a systematic mapping of the content of patents. From the perspective of STI policy studies, the methodological approach has recourse to macro-analysis. This analysis focuses on studying the patenting patterns at national level combining this with bibliometric research.

Even though patent grants can be thought of as a moving average of past applications, statistical studies reveal that the figures for granted patents tend to fluctuate as much or more than the number of patent applications. It is also clear that economic conditions impinge on the rate of patent applications (Griliches, 1990). Any analysis of long-term temporal series of patents will reflect the innovation behaviour of a particular country and the stage of national development at different epochs as well as any economic political and societal crises along the way.

Patents comprise a unique source for technological knowledge. They are considered a good proxy for invention skills, R&D activities and for the scope of technological innovation of countries, regions, sectors and firms. The use of patent statistics makes it possible to track technological changes and to examine knowledge transfer and R&D cooperation between various sectors and countries. Since patent indicators are calculated in different ways, one must be careful when using them for international comparisons of STI outputs.

According to WIPO (2016) around 2.9 million patent applications were filed worldwide in 2015, up 7.8% from 2014. Driving that strong growth were filings in the People's Republic of China, which received about 174 000 of the nearly 208 000 additional filings in 2015 and accounted for 84% of total growth. Others among the largest contributors were the United States of America and the European Patent Office – combined they accounted for 8.6% of total growth. Excluding China from the sample, the applications in the rest of the world grew by only 1.9% in 2015.

Lao PDR became a member of the World Intellectual Property Organisation (WIPO) in 1995 and the Paris Convention (Industrial Property) in 1998. In 2006, the country signed the Patent Cooperation Treaty and in 2016 the Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks. The national law on IPR was enacted on 2011 (see page 176).

Figure 43 presents the number of patent applications filed in the Lao PDR by origin of the applicant (residents and non-residents) between 1960 and 1995, as well as the number of patent applications filed by residents of Lao PDR abroad between 2001 and 2015. The small number of patent applications and granted patents in Lao is due to the lack of an appropriate legal system on IPR until recent years.

Looking beyond the very small number of patent´s applications filed by residents in Lao PDR, Figure 44 shows the distribution of patents (2001–2015) by top field of technology. Medical technologies, transport, audiovisual technologies, pharmaceuticals, environmental technologies and handling are the main technological fields.

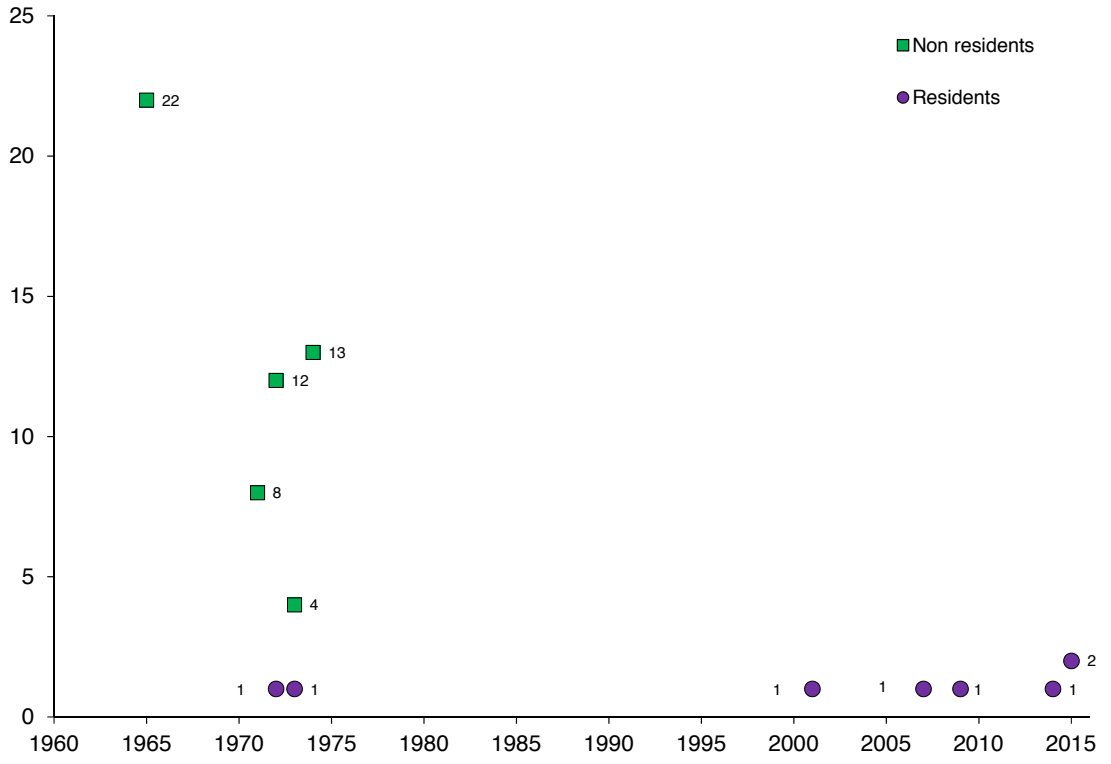


Figure 43: Number of patent applications by residents and non-residents at the Lao PDR Patent Office, 1960–1995 and by residents abroad, 2001–2015.
Source: WIPO

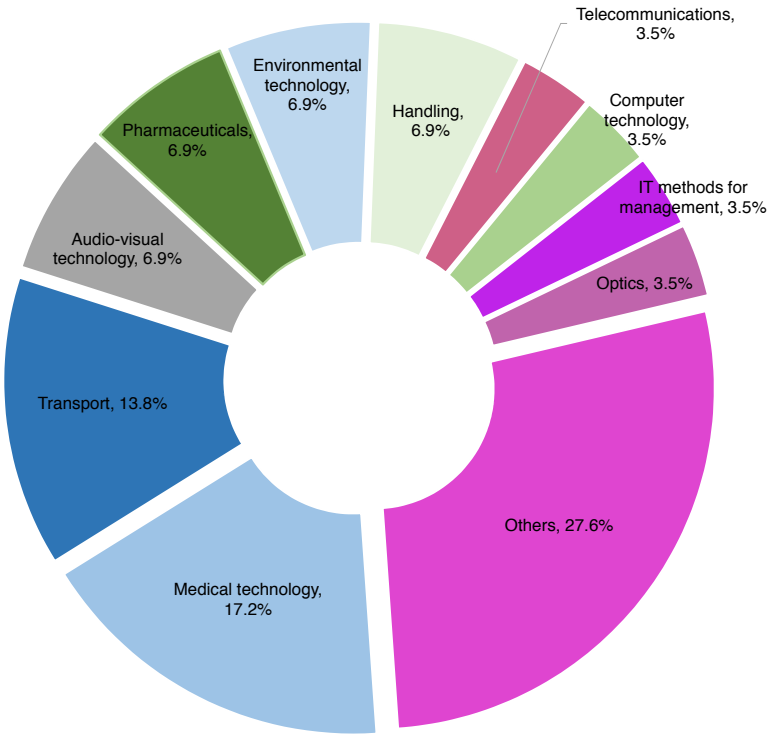


Figure 44: Patent applications in Lao PDR by top field of technology, 2001–2015.
Source: WIPO

WHAT TRADEMARK AND INDUSTRIAL DESIGN DATA REVEAL ABOUT INNOVATION

Recently trademark data have also been used to convey information on two key aspects of innovation, which are not usually covered by traditional indicators: marketing innovation and innovation in the services sector (Millot, 2009). Different empirical studies have shown a link between trademark counts and other indicators of innovation performance, when available. For instance, trademark numbers at the firm level have been found to correlate positively with innovation (as reflected in responses to innovation surveys), with R&D (for certain industries) with patents and with the number of new product launches. These correlations are particularly strong in knowledge-intensive service industries, and in high-tech industries such as pharmaceuticals. An advantage of using trademarks as an indicator is their broad availability and relatively easy accessibility.

A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of other enterprises. Trademarks are protected by intellectual property rights. In principle, a trademark registration will confer an exclusive right on the use of the registered trademark. This implies that the trademark can be used exclusively by its owner or licensed to another party for use in return for payment. Registration provides legal certainty and reinforces the position of the right holder for example in case of litigation. The term of registration can vary but is usually ten years. It can be renewed indefinitely on payment of additional fees. Trademark rights are private rights and protection is enforced through court orders.

The link between trademark deposits and product innovation is relatively straightforward: the commercialisation of new products is sometimes associated with the creation of a new trademark in order to communicate about the innovation and later possibly become the reference on the market for the product, which in turn enables firms to appropriate the benefits of their innovation. When it comes to marketing innovation, the link with trademark deposits is more complex.

According to WIPO (2016) an estimated 5.98 million trademark applications were filed worldwide in 2015, 15.3% more than in 2014, representing the highest growth rate since 2000. There are now twice as many applications being filed around the world than in 2000 – applications increased every year but three during that period, but only four years saw annual growth exceed 10%. To obtain trademark protection in multiple countries or jurisdictions, applicants can either file their applications directly at each individual office – the Paris Treaty – or file an application for international registration through the Madrid System (WIPO, 2016). Lao People's Democratic Republic joined the Madrid System in 2015.

However, data on trademarks are available for Lao PDR from 1960 onwards. Figure 45 shows the evolution in trademark applications by residents and non-residents between 1960 and 2010 and Table 32 shows the recent distribution of applications and registrations for the period 2001–2015. The vertical axis has a logarithmic scale.

WIPO (2016) also estimated that at worldwide level, 872 800 industrial design applications were filed in 2015. With annual growth of 2.3%, industrial design applications worldwide rebounded after experiencing a sharp drop of 10.2% in 2014.

Industrial designs are applied to a wide variety of industrial products and handicrafts. They refer to the ornamental or aesthetic aspects of a useful article including compositions of lines or colours or any three-dimensional forms that give a special appearance to a product or handicraft. The holder of a registered industrial design has exclusive rights against unauthorized copying or imitation of the design by third parties. Industrial design registrations are valid for a limited period. The term of protection is usually 15 years for most jurisdictions. In an industrial design application or registration, some offices allow applications to contain more than one design for the same good or in the same class—others allow only one design per application. To capture the differences in application filing systems across offices one needs to compare their respective application and registration design counts (WIPO, 2016).

Table 33 shows number of industrial designs applications and registrations by residents and non-residents in Lao PDR (2001–2015).

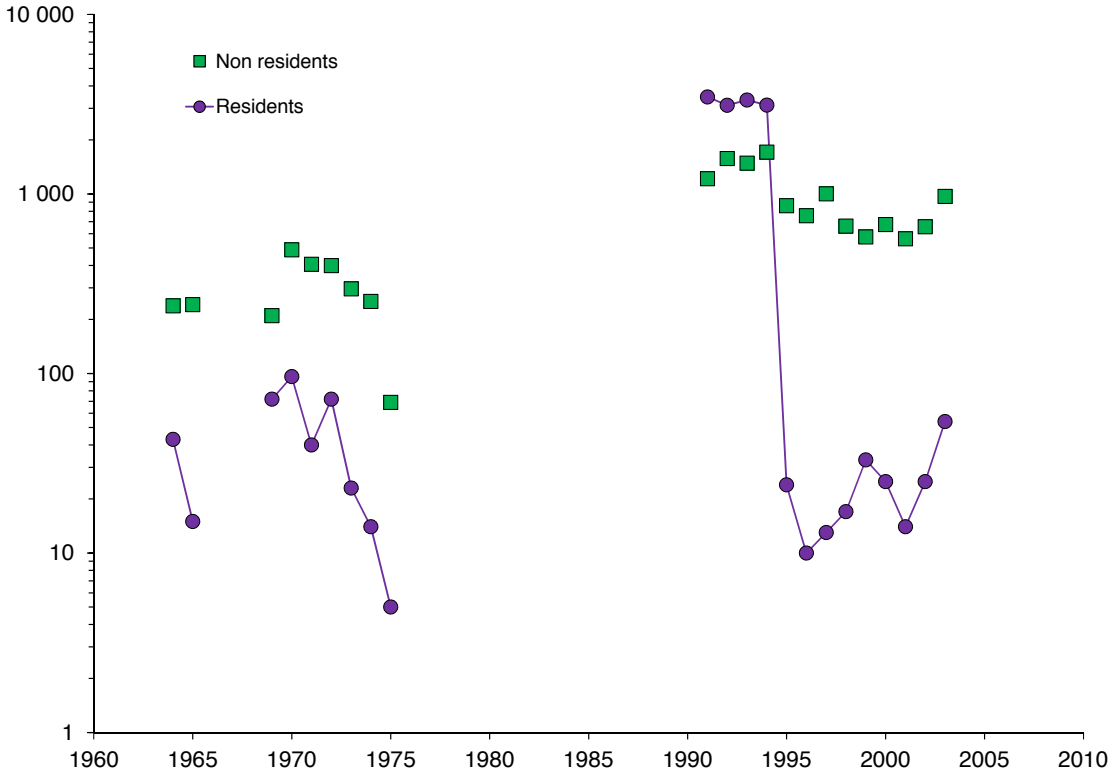


Figure 45: Trademarks applications by residents and non-residents, 1960–2010.
Source: UNESCO based on data provided by WIPO

Table 32: Trademarks applications and registrations, 2001–2015

Year	Trademarks applications						Trademarks registrations					
	Resident	World rank	Non-resident	World rank	Abroad	World rank	Resident	World rank	Non-resident	World rank	Abroad	World rank
2001	14	119	563	114	..	..	18	92	513	102	..	..
2002	25	116	656	113	..	..	19	91	672	97	..	..
2003	54	111	970	101	..	..	45	91	675	90	..	..
2004	..	..	..	..	..	..	..	..	..	..	..	..
2005	..	..	..	..	..	..	..	..	..	..	..	..
2006	..	..	..	..	..	..	..	..	..	..	..	..
2007	..	..	..	..	..	..	..	..	..	..	..	..
2008	..	..	..	..	..	..	..	..	..	..	..	..
2009	..	..	..	..	..	..	..	..	..	..	..	..
2010	..	..	..	..	..	..	..	..	..	..	1	177
2011	..	..	..	..	219	120	..	..	..	..	140	114
2012	..	..	..	..	4	180	..	..	..	..	2	178
2013	..	..	..	..	1	182	..	..	..	..	4	165
2014	..	..	..	..	176	132	..	..	..	..	29	159
2015	..	..	..	..	3	180	..	..	..	..	86	133

Source: WIPO

Table 33: Industrial design applications and registrations, 2001–2015

Year	Industrial design applications						Industrial design registrations					
	Resident	World rank	Non-resident	World rank	Abroad	World rank	Resident	World rank	Non-resident	World rank	Abroad	World rank
2001	18	92	513	102	..	..	..	..	..	..	..	..
2002	19	91	672	97	..	..	..	..	..	..	..	..
2003	45	91	675	90	..	..	..	..	..	..	..	..
2004	..	..	..	..	..	..	..	..	..	..	..	..
2005	..	..	..	..	..	..	..	..	..	..	..	..
2006	..	..	..	..	..	..	..	..	..	..	..	..
2007	..	..	..	..	..	..	..	..	..	..	..	..
2008	..	..	..	..	..	..	..	..	..	..	3	95
2009	..	..	..	..	..	..	..	..	..	..	..	..
2010	..	..	..	..	1	177	..	..	..	..	..	..
2011	..	..	..	..	140	114	..	..	..	..	..	..
2012	..	..	..	..	2	178	..	..	..	..	2	113
2013	..	..	..	..	4	165	..	..	..	..	..	..
2014	..	..	..	..	29	159	..	..	..	..	..	..
2015	..	..	..	..	86	133	..	..	..	..	..	..

Source: WIPO

Historical background to STI policies in Lao PDR

SCIENCE AND TECHNOLOGY IN LAO PDR AFTER THE INDEPENDENCE

The science and technology sector of Lao PDR has grown and improved steadily to suit in the evolution of the socio-economic conditions of the country. Before the country's independence, circa in 1975, there are scarce records of any scientific research, technological development or productive innovation activities. Few exceptions were found. On the one hand, in 1963, the Royal Society of Natural Sciences of Laos was created as a non-profit making society with the objective of promote the scientific knowledge in Laos with regard to fauna, flora and geology. It was a private society under the patronage by then King of Laos (UNESCO, 1968). On the other hand, in 1967, the Geology and Minerals Department, was established to undertake the major tasks of managing and developing the minerals industry and providing technical views upon the request of local and foreign investors intending to establish manufacturing companies.

After independence, Lao's development programmes implicitly emphasized the need to increase the technological means as well as the need to have the technical mastery of the operation of these means. This early strategy implied that imported technologies were supposed to be used and organized accordingly to ensure their proper use. The scientific and technological activities were organized to achieve the goals and objectives of the National Socio-Economic Development Plan, which in the long term was supposed to lead the strengthening of scientific and technological potential, the gradual mastery of science, technology and innovation to guarantee national independence (UNESCO, 1985).

The 1981–1985 National Socio-Economic Development Plan contemplated the creation of the State Committee on Science and Technology (circa 1982). Its mission was to give impetus and manage scientific and technological development. This committee was supposed to make the link between the base, namely the different scientific centres and ministries on the one hand, and the National Development Plan Committee on the other hand, so that the group thus formed a vast system of research and development, scientific and technological actions from the central level to the base, of which the State Committee for Science and Technology was the driving force. It was composed by 37 executives who have a university education: physical and mathematical sciences (18) natural sciences (6), social sciences (13). The main activity was a self-centred reflection on the "policy-making" function. In those days, where less than 0.26% of the population had university studies, R&D, technology transfer and innovation activities could not be undertaken. The same was true for the deployment of scientific and technological services such as S&T information, technical assistance, metrology or standardization (Gonod, 1987). The State Committee for Science and Technology was also in charge of developing and managing a national centre for scientific and technical documentation and was supposed to have permanent and non-permanent members chosen from among scientists and engineers working in different departments (UNESCO, 1985; Gonod, 1987).

During the 1980's the scientific and technological activities were focused on the agriculture and forestry sector. A dozen bases for research and experimentation of both animal and plant species were installed, as well as scientific and technical services essential for the development of agriculture, such as soil analysis services, study of irrigation systems, inventory and prospecting of forests, veterinary diagnosis, among others. Agricultural technical training centres were created and expanded across the country (UNESCO, 1985). The most important research stations were created in 1985 with different objectives and roles. For instance, the NaPhok Station was established for developing plants and rice varieties in the plain field and mountainous zone, the Salakham Station was set up for R&D of varieties and to analyse plants disease and insects, and NongTeng Centre was founded for R&D of fish species.

In addition, there were scientific and technical activities under the National Geodesy and Mapping Service and the Geological Laboratory of the Mining Directorate. The Ministry of Education and Sports, in those days were in charge of adapting textbooks for socialist education and new scientific terminology in the Lao language (Gonod, 1987; NatCom, 1990; UNESCO, 1990 and 1991). In accordance with this policy, the organization of technical and vocational schools (to speak only of the priority sector) and curricula was strengthened and gradually improved, a balance between general courses, general technical courses and practical work in the workshop or in the field was considered a priority in those days.

BOX 15 – UNESCO'S ORIGINAL PROPOSAL FOR A SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT PLAN IN LAO PDR

In the early 1980s, at a request of the Government of Lao PDR, UNESCO hired Pierre F. Gonod – who was an international recognized expert in science and technology policy – to assist the authorities of the country in development an STI policy.

The proposed action plan had two main characteristics: (i) The design of the scientific and technical infrastructure which was going to be done around the State Committee for Science and Technology and (ii) the science and technology activities were going to be incorporated into major national activities of the National Socio-Economic Development Plan reflecting and fulfilling their main directions.

Thus, the proposed science and technology activities were going to be constitute a transversal programme for fulfilling the National Socio-Economic Development Plan. The dynamic was going to be driven by the driving force of the priorities setup within the last. This conception had an important consequence: As these priority programmes derive from the national political dynamic, this leads to the consideration of a new generation of co-operation projects and a pool of ideas, which, in addition to UNESCO, concern other United Nations agencies and bodies.

The proposed Scientific and Technological Development Plan comprised subsets consisting of projects and followed the usual categorization of the activities and functions established by UNESCO. The activities included: research and development, technology transfer, innovation, scientific and technological services (information, technical assistance, quality control, standardization, etc.). The functions related to policy-making, programming-coordination, evaluation, implementation, international cooperation.

The architecture of the Scientific and Technological Development Plan was designed as follows:

a. A programme of setting up the scientific and technical infrastructure, centred on the State Committee for Science and Technology and in the identification of the human resources forming the first concentric circle around this core, as well as the organization of the necessary progress to put in place in the country, the functions of science and technology policy
b. The need for scientific knowledge of the country, both of its natural ecosystems and of its ethnic diversity, has been expressed as a real prerequisite in all sectors, particularly for agriculture, forestry, the exploitation of natural resources, mining and others.
c. The Technical Development Programme of the Upstream and Downstream Activities of Agriculture results from the observation that agriculture was the central activity and priority No. 1. The production of this is a function of its inputs, the problem food is responsible for the processing of agricultural products, the need to export requires specific programs to improve the quality of agricultural and forestry products.
d. The programme for raising the technical level of priority enterprises was derived from the three-fold concern of the authorities to initiate the industrialization of the country, to ensure the profitability of public sector enterprises within the framework of a greater autonomy of management, increase the productivity of all businesses.
e. The purpose of the Political Synthesis Programme was to give a clear objective to the State Committee for Science and Technology, through the preparation of the Science and Technology Programme for the National Socio-Economic Development Plan 1991–1995.

The original proposal included the implementation of 37 different projects: (1) Scientific and Technical infrastructure installation, (2) creation of a reference library on science and technology policy, (3) organization of a seminar on the "Fundamentals of Science and Technology Policy," (4) establishment of individual self-training curricula for the State Committee on Science and Technology managers, (5) adaptation of the structure and organization of the State Committee

on Science and Technology to the new responsibilities, (6) organization of a seminar on "Science and Technology Policy Instruments," (7) establishment of the permanent inventory of the S&T human resources, (8) organization of the First National Science and Technology Conference in Lao PDR, (9) mobilization of external information on Lao PDR, (10) study and research of natural ecosystems, (11) study and research of ethnicities, (12) forest investigations, (13) mining prospecting, (14) study and research of renewable energy technologies, hydraulic, solar, wind, (15) improvement of rural technologies (tools and instruments), (16) development of machinery technologies for agriculture, (17) development of technologies for appropriate transformations of agricultural products, (18) manufacturing policy for capital goods, (19) establishment of technical information for the fulfilment of priority activities, (20) training in quality control and standardization techniques, especially for export, (21) training for the mixed activity of technical assistance-information for companies, (22) training in Administrative Techniques, the projects (23), (24), (25), (26), (27) proposed different techniques enabling the use of local raw materials; bamboo, rice balls, thatch, wood tiles, terracotta, (28) development of techniques for the use of medicinal plants, (29) research for malaria eradication, (30) training in systemic analysis and technological foresight techniques and (31) Preparation of the Science and Technology Programme for the Five-Year Plan 1991–1995.

At this point, and within the context of the GO→SPIN methodological approach we must call the attention within the original plan of the existence of a proposal to organize a Seminar on "Science and Technology Policy Instruments." This seminar had the aim of extending the knowledge on how to design an adequate science and technology policy for Lao PDR. According to the original proposal this seminar would address the common problems of budgeting, organization of research, evaluation, and would also deal with instrumentality in technology transfer and innovation policies, ending with a practical exercise applied to the realities of Lao PDR.

Source: Gonod (1987)

ORGANIZATION CHANGES IN SCIENCE AND TECHNOLOGY UNDER THE NEW ECONOMIC MECHANISMS

In December 1986, the government of Lao PDR implemented a "new economic management mechanism" (NEM), aiming at granting increased autonomy in the management of formerly state-run enterprises to the private sector. Under this new economic and political environment, on 12 October 1987, the Council of Ministers issued Decree No. 104 /CM, adopting rules for a new committee on science and technology, specifying its location, role, duties, rights, the structure of the organization and system to work. With this decree the State Committee for Science and Technology was replaced by the new National Scientific Technique Committee.

In August 1988, the Council of Ministers changed the name of the National Scientific Technique Committee to establish the Ministry of Science and Technology. So that the new Ministry of Science and Technology support economic-social development, the government designated that it should work in four areas:

1. Scientific and technological services,
2. Scientific research and technological development,
3. Science and technology management,
4. International co-operation in science and technology.

During this period, the role of science and technology was focused on international co-operation activities with foreign countries and international organizations.

By June 1991, the *First Workshop on the Formulation of Basic Sciences and Technology Policy* was organized in Vientiane. The last was part of the original proposal made by UNESCO few years before (Gonod, 1987).

On 10 April 1993, the Ministry of Science and Technology became the new Science, Technology and Environment Organization. This was done through the issue of the Prime Minister Decree No. 63/PM on the management and organization on Science, Technology and Environment. In addition, the decree also required the establishment the Board of Science – Technique to allow the government to determine the policy on science and technology and praised the science.

On 23 July 1997, Lao PDR became part of the Association of Southeast Asian Nations (ASEAN). This was an important step forward to synergies co-operation on science and technology at regional level (see Box 16, pages 124–125).

In 1999, the Agricultural and Forestry Research Institute was established with 10 research centres, projects, stations and experimental centres in the provinces and districts nationwide to conduct research related to planting, livestock, fishery, forestry, agricultural irrigation, meteorology and inundation. Among the centres are: The Soil Survey and Classification Centre, the Plants, Vegetables and Fruits Research Centre, the Coffee Research Centre, the Northern Agriculture and Forestry Research Centre, the Livestock Research Centre, the Fishery Research Centre, the Forestry Research Centre, the Forest Survey and Planning Centre, the Agricultural and Forestry Mechanical Research Centre and the Slope Land Agriculture Research Centre.

In 2000, the Health Science Institute was established with a set of research centres to develop research on health science for improving the analysis of disease, prevention and treatment and health promotion, in order to ensure good health and long life. Among these we can find the Traditional Medicine Research Centre, the Malaria Centre, the Analytical and Epidemiology Centre, the Maternal and Children Centre, the Ophthalmology centre and the Health Information Centre.

In 2003 the First National Science and Technology Policy was released and was implemented up until the year 2010. The policy outlined five main goals related to science, technology and innovation. The first goal was to improve R&D to ensure the mobilization of STI resources. The second was to upgrade education for higher STI knowledge aimed to serve agricultural, industrial and services development contributing to the poverty reduction strategic program and to the industrialization and modernization of the country. The third was to strengthen co-ordination and co-operation between different sectors and research institutions to ensure the participation of production sectors and the scientific community for maximizing the country's benefits from STI activities. The fourth was to upgrade and strengthen the public's awareness on science and engineering knowledge, and the last was to essentially promote the technological innovation and adaptation system. These policy goals were meant to be accomplished through increased funding and international cooperation.

The primary mechanism for policy implementation was setting the target for the Gross Domestic Expenditures on R&D (GERD) between 4% and 5%. This was approximately 100 times the expenditures on R&D estimated by the 2002 R&D survey (see pages 95 – 96). The increased spending was meant to support human resources development, and acquisition and adaption of technologies. The target sectors were to be agriculture, tourism, energy/environment and ICTs. The 2003 STI policy also called for a reorganization of government agencies and international cooperation to compensate for weak capacity.

In 2007, due to the expansion of science, technology and environmental activities beyond Vientiane to the provinces, the government transformed the Science, Technology and Environment Organization into the National Organization of Science, Technology and the Environment. With the purpose of improving the efficiency implementation of its activities, after few months, this new organization was divided into two new organizations: The National Authority of Science and Technology (NAST) and the Resources and Natural Environment Organization.

BOX 16 – THE ASEAN PLAN OF ACTION ON SCIENCE, TECHNOLOGY AND INNOVATION, 2016–2025

The ASEAN Plan of Action on Science, Technology and Innovation (APASTI) for the period 2016–2025 was adopted by the higher authorities of the Association of Southeast Asian Nations, on 6 November 2015 during the 16th ASEAN Ministerial Meeting on Science and Technology. Its vision, goals strategic thrusts and actions are presented hereinafter.

The APASTI highlights the need for 'building on the milestones, significant achievements, lessons and best practices learnt from the implementation of the past ASEAN Plans of Action on Science and Technology' and 'the role and benefits that innovation can provide to the ASEAN peoples'.

It makes reference to and announces that it is 'guided by the relevant Declarations of ASEAN Leaders, directives from the Committee on Science and Technology (COST) and the ASEAN Ministerial Meeting on Science and Technology (AMMST), and new developments in ASEAN and beyond its borders'.

The APASTI 2016–2025 states that it vision is: A Science, Technology and Innovation-enabled ASEAN, which is Innovative, competitive, vibrant, sustainable and economically integrated.

The APASTI 2016–2025 states that its goals are: (1) ASEAN Science, Technology and Innovation (STI) addressing the Grand Challenges of the new millennium; (2) economically integrated ASEAN involving active collaboration between the public & private sectors especially SMEs and enhanced mobility of talents; (3) deep awareness of STI & the beneficial impacts of STI on the bottom of the pyramid; (4) an innovation-driven economy with a deep STI enculturation and a system of seeding and sustaining STI by leveraging ICT and the resources of our talented young, women and private sectors; (5) active R&D collaboration, technology commercialisation and entrepreneurship and network of centres of excellence; and (6) an enhanced STI management system in the new AEC so as to support ASEAN Innovation reaching global markets and that promotes innovation, integration and narrowing of development gaps across ASEAN Member States.

To meet these goals, the APASTI 2016–2025 presents strategic thrust and actions while reiterating that the strategic thrusts and actions of the past ASEAN Plans of Action on Science and Technology remain valid. The APASTI 2016-2025 strategic thrusts and actions are general enough such that during their implementation, the AMMST, COST and its subsidiary bodies, dialogue partners and other relevant stakeholders may propose amendments or enhancements to achieve the APASTI goals:

Thrust 1: Strengthen strategic collaboration among academia, research institutions, networks of centres of excellence, and the private sector to create an effective ecosystem for capability development, technology transfer and commercialization

- *Action 1.1*: Intensify the engagement of academe, private sector and relevant partners in the planning, implementation and assessment of joint undertakings in human resource development, and research and development;
- *Action 1.2:* Enhance and sustain the utilisation of the ASEAN Science and Technology Network and strengthen other S&T networks to facilitate information sharing;
- *Action 1.3:* Establish policy frameworks including IPR protection, risk and benefit sharing mechanisms for joint-collaboration and technology transfer among centres of excellence;
- *Action 1.4:* Strengthen existing regional STI initiatives in priority areas including Sustainable Development Goals.

Thrust 2: Enhance mobility of scientists and researchers, people-to-people connectivity and strengthen engagement of women and youth in STI

- *Action 2.1:* Establish a policy framework for exchange of scientist, researchers and students including women and youth

- *Action 2.2:* Establish scholarship, fellowship and/or attachment programs for students, researchers and other STI personnel
- *Action 2.3:* Intensify efforts towards standardisation of certification and accreditation in education and technical competency
- *Action 2.4:* Expand opportunities for women, youth and the disadvantaged group to contribute in STI through incentives and support mechanisms.

Thrust 3: Establish innovative system and smart partnership with dialogue and other partners to nurture STI enterprises to support micro, small and medium enterprises, nurture knowledge creation and STI applications to raise competitiveness

- *Action 3.1:* Establish support mechanism such as mentorship and incentive program to support and nurture STI enterprises from start-up to the next competitive level of development
- *Action 3.2:* Engage dialogue and other strategic partners in joint undertakings on appropriate and commercially viable STI initiatives

Thrust 4: Raise public awareness and strengthen STI enculturation to enhance ASEAN science and technology cooperation

- *Action 4.1:* Encourage the participation of scientists, researchers and industries in the ASEAN S&T events such as ASEAN Food Conference and ASEAN Science and Technology Week;
- *Action 4.2:* Enhance the contents of the articles published in the ASEAN Journal of S&T for Development and other journals;
- *Action 4.3:* Leverage on the ASEAN Science and Technology Network in publicizing ASEAN initiatives in STI;
- *Action 4.4:* Develop a resource database and network to facilitate information sharing and technical cooperation among agencies in the public and private sector
- *Action 4.5:* Engage relevant stakeholders in developing and implementing an effective communication and STI enculturation plan

Source: ASEAN (2016)

THE NEW MINISTRY OF SCIENCE AND TECHNOLOGY (MOST) AND THE HARMONIZATION OF STI POLICIES AT REGIONAL LEVEL

In 2007, the National Authority for Science & Technology (NAST) was moved under the Prime Minister's Office. NAST acted as a secretary to the central government and managed all the science and technology activities in the country, intellectual property rights, standardization and metrology, even formulating legislation (see pages 176 – 177).

On 28 September 2011, by a decree of the Prime Minister of Lao PDR No.309/PM the government of Lao PDR (re) created the Ministry of Science and Technology (MOST), which was originally in operation between 1988 and 1993. MOST began working with the local governments through the Provincial Department for Science and Technology (PDST). Within the institutional chapter a description of all the organizations, institutes and centres which are under the umbrella of MOST is presented (see pages 148–152). Figure 46 shows the main characteristics of its internal structure.

MOST is addressing important challenges such as: (i) Improvement of the organizational structure for the design and implementation of STI policies; (ii) development of the legal framework related to science, technology and innovation; (iii) capacity building and human resources development; (iv) infrastructure development; and (v) normalization and standardization functions.

In the field of science and technology, the priority areas are: (a) biotechnology and ecology; (b) renewable energy and materials; and (c) ICT. While Laos is trying to develop a science and technology system in this way, the bottleneck for it is the shortage of talented people (see pages 84 – 94).

Since its establishment, it has submitted several laws to the National Assembly (see pages 176–188). Its first two proposed laws were on intellectual property and electronic transactions. Another law was designed to encourage socio-economic development and ease integration into the regional and international arena, especially in relation to the ASEAN Economic Community.

In 2013, the Government of Lao PDR sanctioned the Science and Technology Law (see page 176), which consists of 69 articles and stipulates the principle of promoting science and technology, the budget for science and technology, the role of the Ministry of Science and Technology and so on. The following are characteristic articles. According to this legal instrument, science, technology and innovation activities should guide industrialization and modernization in accordance to the policies and strategies described in the social and economic development plan of the state (Art.5).

Considering the investment in STI activities (R&D, scientific and technological services, administration, etc.), the legal instrument proposes that the government shall aim to invest 1% of the government budget every year in research and development in science and technology and shall continue to increase the budget every year towards that end (Art. 24).

The law then proposes the establishment of the National Academy of Science and Technology to provide advice for the formulation of STI policies and strategies in order to plan scientific research, technological development and innovation; to garner evidence for policy directions; to continuously evaluate research and to propose research agendas, to certify and to accredit research results, to grant scientific positions, titles, honours and awards to recognize outstanding performance in scientific research and technological development.

At the same time, proposes the creation of a Sectoral Science Council (Art. 32). This council is a technical organization convening representatives of several ministries, agencies, local level and sectoral authorities with the approval of National Academy of Science and Technology, in order to provide advice for studying, considering, and assessing the achievement of supported research, and analysing and developing applications of technology with a view to ensuring consistency with policy objectives, strategic goals, the national social-economic development plan, and sectoral development plans in each period.

Finally, the law indicates these rights and obligations of the Ministry of Science and Technology for managing policies on science and technology among others: (1) To prepare draft laws concerning policies, strategic plans, development plans, and science and technology activities, and (2) to reflect these laws in the implementation of programmes, plans, projects, and regulations, as well as managing their implementation (Art. 55).

In other words, policies on science and technology are clearly made subject to the social and economic development plan of the state, and at the same time this law stipulates the level of government budgets for science and technology. Moreover, the Ministry of Science and Technology plays a central role in promoting policies on science and technology (CRDS, 2015).

MOST was responsible of drafting the Prime Minister's decrees on Transfer of Technology (2012), National Science Week (2013), and the Science and Technology Fund (2014); as well as drafting Article 24 of Lao Constitution (2015) and the National Strategic Plan on Science and Technology Development 2013–2020 and Vision 2030 (August 2016).

Recently, the priority mission of MOST was adjusted. It should now apply scientific and technology knowledge productively and positively in all spheres of socio-economy and governance, aiming to help the country leap to a higher level of overall development, particularly in terms of poverty reduction targets, as well as helping Lao PDR achieve the Sustainable Development Goals (SDGs). This is consistent with Art. 5 in Science and Technology Law, which requires that science and technology activities are consistent with the policy direction and strategy of the state, in other words consistent with prioritizing the country's graduation from least developed country status by 2020.

The innovation system is to be developed by increasing capacities in R&D so that jobs are available for researchers. STI management will review policies to increase technology transfer and programme assessment. Industry sectors are targeted for development. Some mechanisms are specified including infrastructure development (e.g. ICT and intellectual property rights), new agencies (e.g. an STI Foundation and national research institutes), and measures (e.g. decrees, policies, and an exposition). Future plans target new innovative sectors, SMEs, and research-industry linkages. Table 34 presents an account of the 2011–2015 action plan implemented by MOST.

Recently, the number of agricultural and forest extension centres throughout the country has increased to 264. There is one service centre that is under the management of the Department of Agriculture Extension and Cooperatives, 80 service centres at provincial level, 145 service centres at district level and 38 service centres at Kum Ban level; of these, 97 centres are in the 3-builds districts and 3 centres are in villages. For technical improvement, there were supplies of equipment, drying and screening machines, and drying yards for seeds in a total of 13 service centres in 12 provinces, together with job creation that suits production potential, and support from Eld Sta to Kum Ban regarding regular production promotion aiming to assist local villagers to learn and understand new and better planting or livestock husbandry techniques. One hundred seed planters and 1 000 leaf colour charts were distributed by the Department of Agriculture Extension and Cooperatives in 18 provinces throughout the country. In addition, application of modern technologies is promoted in rice production to reduce labour and increase productivity and lower the cost of production.

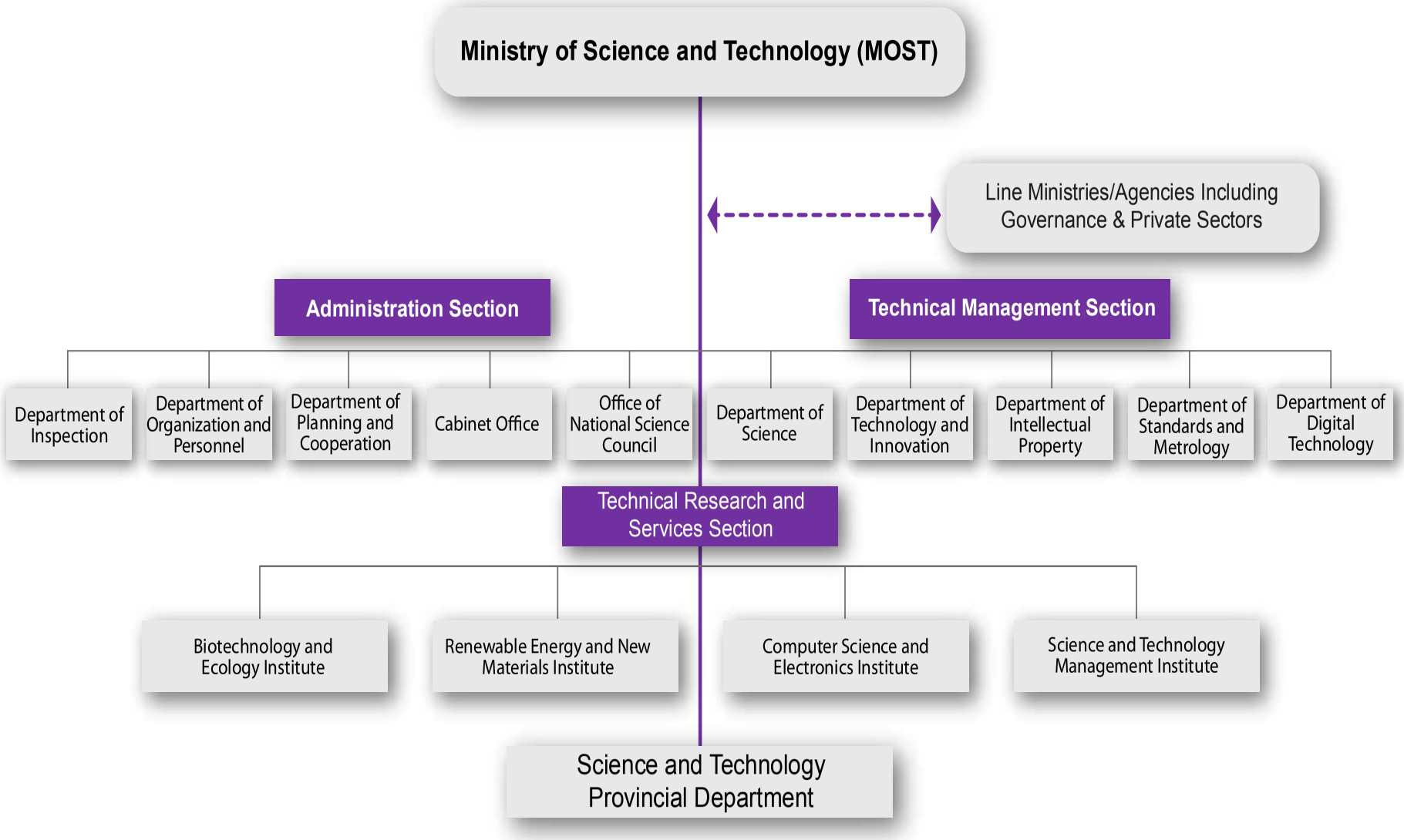


Figure 46: Structure of the Ministry of Science and Technology (MOST) circa 2017.
Source: MOST

Table 34: Ministry of Science and Technology Action Programmes, 2011–2015

R&D Infrastructure	• Develop innovation System • Improve the research capability of National Research Institutes • Improve and develop the intellectual property infrastructure so as to encourage R&D • Improve ICT infrastructure and network (Fibre Optics as Backbone, PLC, Wireless) • Increase knowledge and competence in STI • Create jobs for excellent researchers • Improve STI-relevant curricula at different education levels and in various schools • Promote STI learning • Increase quantity and competition by sending researchers abroad for studies
STI Management	• Review and formulate/implement: • A technology transfer policy, decree and law • Technology assessment and appraisal in various investment projects • internationalized policies, plans, programs and projects • Technology management for sustainable development • Regulations • An STI Foundation • Decrees on Recognition and awards for excellence in STI and regulations to sanction misconduct • The national Science and Technology Day (Science and Technology Exposition)
Science Technology and Innovation Huma Resource Development	• Priority Areas: • Agriculture, industry, tourism and services • Engineering (ICT, agriculture production and industry) • Bio-technology • Renewable energy • Training for professional and technical staff in traditional industries
Creation of National Science and Technology Research Institutes	• Support the establishment of various National Research Institutes • Encourage and promote research and development for manufacturing • Promote the linkage between industries and the National Research Institutes
Collaborative	• The Ministry of science and Technology shall pay an important and supporting role in developing various projects in ministries and research institutions, as is provided by the Law on Science and Technology
Possible Future Plans	• Renewable energy (e.g. bio-fuel, solar energy) • ICT development (e.g. e-learning, e-commerce) • Biotechnology • Green health (e.g. traditional medicine) • Assistance to SMEs by improving and using new and updated technologies • Links between producers/industries and researchers • Sustainable tourism
Measures for the Implementation of Science and Technology Policy	• The 1% budget allocated by the National Assembly, which should be shared with other sectors involved in STI • The National Strategic Plan on Science and Technology Development (2013–2020) and Vision 2030 shall be promoted throughout the country so as to provide a basis for plans, programs and projects • This National Strategic Plan shall be implemented effectively by state and public organizations

Source: Phommaxay, Ministry of Science and Technology (2014)

BOX 17 - UNESCO'S CONTRIBUTION TO STI POLICIES IN LAO PDR

UNESCO has been collaborating and accompanying Lao PDR in its efforts in the area of STI policies and governance over the past decades. As early as 1966, UNESCO consultants were engaged to assist in the compilation of information for the purpose of create a directory of scientific and technological facilities in Asia (UNESCO, 1968). UNESCO also conducted a series of R&D surveys in Lao PDR for the fiscal year 1965–1966 which was published as part of UNESCO Statistical Yearbook 1968. Unfortunately, no other R&D survey was conducted until 2002 (see pages 84– 94).

In 1983, UNESCO prepared a feasibility study for the implementation of a polytechnic institute in Vientiane (UNESCO, 1983). At the request of the Government of Lao PDR, in the early 1980s, UNESCO hired Pierre F. Gonod to assist the country in implementing a science and technology policy (See Box 15, pages 121 – 122 and Gonod, 1987). He also assisted the government to produce the national report on STI policies which was published by UNESCO in a special volume on Science and Technology in Countries of Asia and the Pacific: policies, organization and resources (UNESCO, 1985).

In the late 1980s, UNESCO prepared and published a report on the status of women in Laos (UNESCO, 1989). Most of UNESCO´s interventions in these days were related to science and technology education at all levels, including the proposal for the creation of a polytechnic institute in Vientiane. In 1990, Lao PDR participated in a UNESCO Regional Workshop on Science and Technology Education at Lower Secondary Level, held in Katmandu (Nepal). This workshop, focused on: (a) policies and strategies related to science and technology education for all at lower secondary level; (b) application of learning in science and technology to real life situations in the students' environment, with particular reference to improving the quality of life and productivity; (c) implications for curriculum development and pupil evaluation, including the 'effective' domain; (d) implications for teacher training and for community/parental involvement, and (e) planning and implementation difficulties. An extensive report, written in the style of a guidebook for reform of science and technology education was published with a specific chapter on Lao PDR (UNESCO, 1991).

Group of participants at the GO→SPIN training workshop, held in Vientiane on 16–17 November 2016. Seated in the centre is H. E. Houmphanh Intharath, Vice Minister of Science and Technology of Lao PDR. Photo: © UNESCO 2016.

In 2016, UNESCO through its field office at Bangkok and its Division of Science Policy and Capacity Building at Headquarters and joined by the Ministry of Science and Technology of the Government of Lao People's Democratic Republic and the Laos National Commission for UNESCO, conceived and developed the Global Observatory of STI policy Instruments (GO→SPIN) project for Lao PDR. The project became operational in November 2016, with a first technical

mission in Vientiane. During the mission, a GO→SPIN training workshop was organized. Several visits and consultations were conducted within the major STI stakeholders for the completion of the inventories needed for the development of the GO→SPIN country profile in STI policy. One of the core objectives of the project is to strengthen capacities in data collection, assessment and evaluation of the strengths, weaknesses, opportunities and threats of the research and innovation system.

By November 2017, the first draft of this GO→SPIN Country Profile was distributed among the most important stakeholders of the country and a Validation Workshop to discuss its contents was organized in Vientiane by the UNESCO Bangkok Office in December 2017. This volume benefitted from the important suggestions and comments received during this event.

The STI policy cycle of Lao PDR

The term 'policy cycle' refers to the recurrent pattern of processes that lead to the creation of a public policy and its renewal. The greatest advantage of the analytical model of a STI policy cycle is that it facilitates an understanding of public policy-making by breaking down the complexity of the process into a limited number of stages and sub-stages each of which can be investigated alone or in terms of its relationship to any or all of the other stages of the cycle. This also allows for an examination of the role played by all actors and institutions dealing with STI policies rather than solely those governmental agencies formally charged with the task.

The GO→SPIN methodological approach divides the STI policy cycle into five stages. Here are the working definitions provided for the survey:

I. *Agenda setting:* refers to the process by which problems involving STI in relation to society and the economy come to the attention of the government. Agenda setting is also a socially- constructed process in which actors and institutions influenced by their respective ideologies play a fundamental role in determining which problems or issues require government action (Howlett and Ramesh 2003).
II. *Policy formulation:* refers to the process by which STI policy options are formulated by the government. Policy formulation involves identifying and assessing possible solutions to policy problems weighing the pros and cons and deciding which should be accepted and which rejected. The relationship between the government and social actors thus exerts a significant influence on the formulation of public policies.
III. *Decision-making:* refers to the process by which governments adopt a particular course of action or non-action.
IV. *Policy implementation*: refers to the process by which governments put STI policies into effect. This is when a decision is carried out through the application of government directives and is confronted with reality.
V. *Policy evaluation:* refers to the process by which the impact of STI policies are monitored by both state and societal actors the result of which may be a re-conceptualisation of policy problems and solutions.

STI POLICY CYCLE IN LAO PDR

Here is the Science Technology and Innovation (STI) policy cycle of Lao PDR broken into the five different stages:

Agenda Setting

The Ministry of Planning and Investment through the National Socio-Economic Development Plan (NSEDP) establishes the agenda and the priorities for the country's development including those related to science, technology and innovation (STI) activities. The STI components of the of the NSEDP are proposed by the Ministry of Science and Technology. The National Assembly of Lao PDR must approve the NSEDP.

Policy Formulation

STI Policy formulation is usually following a process involving the creation of a task force. STI policy formulation thus involves co-operation among the Ministry of Science and Technology; the Ministry of Agriculture and Forestry; the Ministry of Health; the Ministry of Education and Sports; the Ministry of Industry and Commerce; the Ministry of Energy and Mines, the Ministry of Post and Telecommunications and the Ministry of Natural Resources and Environment. Other specialized units within the Government might make different contributions in specialized topics.

Decision Making

After a policy is drafted, the policy document will normally be reviewed at difference levels before adoption. Decision-making may cut across government sectors, for example for the process of setting STI policies, which are generally adopted by the National Assembly and then declared by the Prime Minister's office whether policy or law.

Policy Implementation

Implementation considers research and innovation. A plan for implantation usually includes lists of activities and performance indicators. The Implementation plans are under the responsibility of the line Ministries and specialized units such as: The Ministry of Science and Technology; the Ministry of Agriculture and Forestry; the Ministry of Health; the Ministry of Education and Sports; the Ministry of Industry and Commerce; the Ministry of Energy and Mines, the Ministry of Post and Telecommunications and the Ministry of Natural Resources and Environment.

Policy Evaluation

Monitoring and evaluation of the STI policy's implementation is done by and according to the policies of: The National Assembly of Lao PDR; the Ministry of Planning and Investment and the Ministry of Science and Technology.

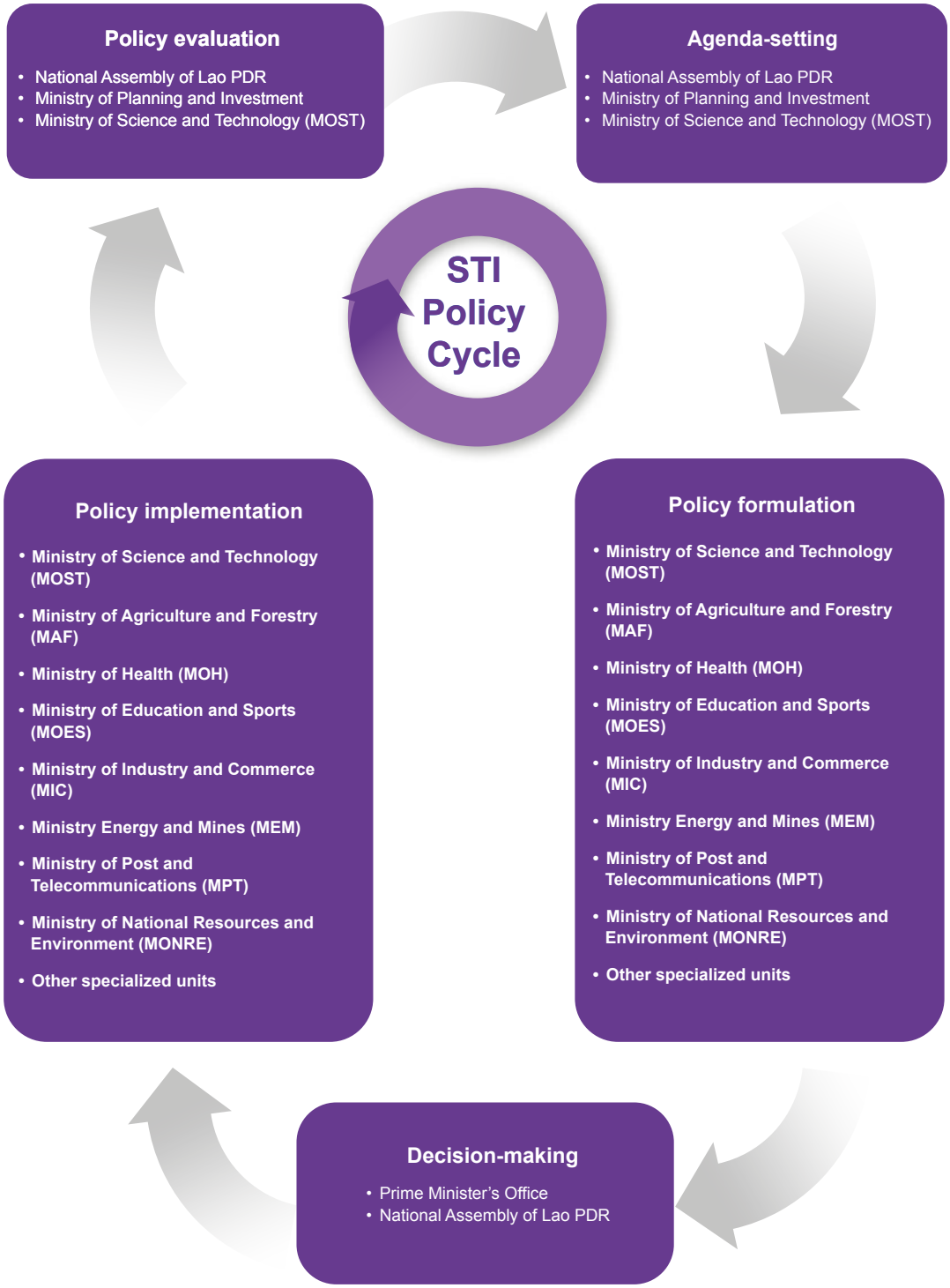


Figure 47: STI policy cycle in Lao PDR, circa 2018

Analytical Content of Lao PDR's STI Policy

This section analyses the formal content of the National Science Technology and Innovation Policy of Lao PDR in accordance with the methodological approach of the GO→SPIN survey, which has been designed to allow for international comparisons of the STI policies adopted by different countries.

All the statements in the pages that follow have been reproduced from the official policy document but are organized hereafter according to the 14 standard fields proposed in the GO→SPIN methodological approach.

At the moment when this GO→SPIN Country Profile was published, no explicit STI policy document was published by the Government of Lao PDR. However, in this section we analyse the content of the policy interventions on science, technology and innovation proposed within the 8th National Socio-Economic Development Plan (MPI, 2016).

ANALYTICAL CONTENT OF THE SCIENCE, TECHNOLOGY AND INNOVATION POLICY

I. **Policy vision:** n/a

II. **Policy mission**: n/a

III. **Policy goals:** (1) Develop and improve science and technology as a potential sector for contributing to achieving the objective of the National Socio-Economic Development Plan; (2) Develop science and technology as a key driving force for rapid and stable economic growth, strengthen science, technology and innovation for industrialization and modernization, and promote the innovative economy; (3) develop knowledgeable and competent human resources in the science and technology sector that contribute intellectually to national development; (4) to apply science and technology as a tool for effective environmental protection and sustainable development; prepare and respond to natural disasters effectively.

IV. **Policy objectives:** (1) Set up policies, plans and programmes to promote the development of science and technology, in particular, policies that promote: national innovations, research and development, and related regulations; the development of clean technologies; intellectual property; a national development strategy for science, technology and innovation; a biotechnology management strategy; a plan of action to industrialize and modernize the field of science and technology; a plan of action on the management and application of chemical, biological, radioactive and nuclear elements, etc. (2) Develop legislation on the management and promotion of science and technology development, such as laws on radiation and nuclear safety, and technology transfer, as well as decrees on advanced technology, the National Week of Science, the innovation fund, a national organization for radiation and nuclear safety, the National Science and Technology Academy, scientist protection, management of dangerous chemicals, and other matters.

V. **Priorities at the strategic level of the STI policy:** (1) Establish and begin construction of a science and technology zone by 2018; (2) allocate budget for research projects related to promoting sustainable development that covers 25% of the annual research budget; (3) adopt and apply international technology that is suitable within the Lao context, to increase national productivity and competitiveness; (4) develop and expand basic infrastructure in the media industries and IT to become a hub for providing social media services and products.

VI. **Normative planning strategies of the policy**: (1) Increase investment in research and development from 1% to 2% of public investment by 2020; (2) promote private investment in research and development to cover at least 30% of public investment by 2020; (3) train 11 researchers per 10 000 of the population by 2020.

VII. **Policies related to the supply of STI:** (1) Improve and upgrade research institutes under the Ministry of Science and Technology so at least one institute is comparable with international standards by 2020; (2) support the development of researchers at universities across the country by allocating a budget to promote research work on at least 50 projects by 2020; (3) create a science magazine, promote research work and publish findings in science magazines and international magazines, in at least 250 articles by 2020.

VIII. **Policies related to demand for STI:** (1) Promote local Innovation and utilization of science, technology and telecommunications and management and Application of ICT; (2) promote local innovation along with the management and utilization of science; (3) attract private domestic and foreign investment in the telecommunications sector development; (4) encourage private investment in the development of technologies and innovation that are appropriate to the actual situation, to support sustainable development.

IX. **Policies to foster networking between the STI supply and demand sides:** (1) Establish science promotion and technology transfer centres that match the local development potential of four centres throughout the country by 2020; (2) establish and begin construction of a training centre for officials on science and technology management by 2016.

X. **Regional and international dimensions of STI policies:** Align with the international organizations to conduct research and development on science; application in a broad-based manner, especially in the priority development areas.

XI. **Monitoring, assessment, technological forecasting and prospective scenarios:** (1) Establish a national science and technology data centre by 2020; (2) establish a laboratory to develop technology for forecasting and early warning of climate change by 2020.

XII. **STI policy start date:** 2016

XIII. **Timespan for STI policy planning**: 2016–2020

XIV. **URL:** http://la.one.un.org/images/publications/8th_NSEDP_2016-2020.pdf

BOX 18 – SCIENCE AND TECHNOLOGY ACCORDING TO THE 8TH NATIONAL SOCIO-ECONOMIC DEVELOPMENT PLAN, 2016–2020

The Government has improved and developed science and technology by allocating budgets to scientific research each year, in order to use the research results to accommodate socio-economic development.

This has included research projects such as: extracting chemical components and testing the toxicity of cancer cells using some extracts from a local herb (ton meu nang) in Savannakhet; extracting and using organic substances as pesticide for rice farming in Attapeu studying species of food crops in four southern provinces (Saravan, Sekong, Attapeu and Champasak); determining scientific potential in the priority development areas of government; conserving banana species, medicinal orchids and mushrooms in northern provinces using biotechnology; producing and testing of a biofuel from used vegetable oil, Jatropha and vernicia seeds ("mark kao"); drying agricultural products with solar energy and biomass; applying a robot for clearing and terminating unexploded ordnance; constructing an information and counselling service centre on technology for youth; and sustainable development in Lao PDR. There are also projects in cooperation with Vietnam to conduct research and produce organic fertilizer in Sayabouly province, which yielded 2 400 tons per year, and to carry out research on cultivation and production of oils from local fruit seeds and cultivation of medical herbs.

There is also improved research and services on intellectual property rights, such as industrial licensing, certified trademark registration, certificate on copyright, resolving conflicts on intellectual property rights, quality control on import commodities, and producing a 5-litre container template.

Apart from this, six pieces of legislation and two decrees have been developed and amended as the legal basis for science and technology, including the Law on Science and Technology, Law on Biotechnology Safety, Law on Electronic Transactions, Amended Law on Measurement, Amended Law on Intellectual Property Rights, Law on Standards, the Decree on the Development of Science and Technology and the Decree on Enforcement of the Law on Standards. Meanwhile, the Cooperation Plan with the Ministry of Science and Technology of Vietnam has been developed, to adopt the application of modern science that is suitable for the conditions of our country, and the National Strategic Plan on Science and Technology Development (2013–2020) and Vision 2030 have been drafted.

Source: Excerpts from NPI (2016)

BOX 19 – AGRO-BIODIVERSITY RESEARCH AND DEVELOPMENT AGENDA BY KEY AGENCIES AND CENTRES

Lao PDR is globally unique in regard to agro-biodiversity with well over 100 plant and animal species being cropped and between 1 000–2 000 species being collected for food and other purposes. It is endowed with very high bio-diversity values comprising 8 000–11 000 species of flowering plants, over 100 species of mammals, 700 species of birds and 166 species of reptiles and amphibians and an unknown number of fungal species. The country has a highly diverse ethno-cultural make-up involving many ethnic groups following different farming systems and livelihood practices, producing a rich cultural dimension to agrobiodiversity.

Lao PDR is largely an agrarian society and its agro-biodiversity resources not only support national social and economic development generally, but also underpin rural livelihoods and promote self-sufficiency and food security. As such, agro-biodiversity is particularly important to the poor and remote marginalized groups and plays a key role in poverty reduction.

Lao PDR's rich agro-biodiversity is not only important for agriculture by helping to maintain ecological services for nutrient recycling, soil moisture retention, pest and disease control and pollination. It also helps to sustain wider ecosystem services for the supply of water, energy, minerals and raw materials and wildlife conservation on which the business, transport, energy and tourism sectors are dependent. Finally, agro-biodiversity plays a key role in socially important ecosystem services such as the provision of potable water, maintenance of water quality, waste removal, soil erosion control, reduction of rainfall runoff and flood-control. Thus, the protection and sustainable use of the agro-biodiversity and its supporting systems significantly increase the country's resilience to climate change.

The Lao PDR National Agro-Biodiversity Programme and Action Plan II has identified the following research agenda (MAF, 2016):

Rice and major food crops – Agriculture Research Centre (ARC)

The Agriculture Research Centre has identified the following agro-biodiversity issues for crop-based agro-biodiversity conservation, management and use: (i) strengthen existing crop gene-bank facilities at ARC and develop a National Gene-bank for plant genetic resources to support the exchange and in situ/ex situ conservation of plant genetic resources for food and agriculture; (ii) facilitate seed multiplication, dissemination and storage; develop processing and value added activities; promote trade and the marketing of major crops both nationally and in the region; (iii) set-up a national policy framework aligned with the agro-biodiversity conventions promoting plant genetic resources for food and agriculture; (iv) strengthen the capacity of farmers to conserve seeds, manage the cultivation and value chain marketing of major crops, and develop new varieties based on indigenous germplasm; and (v) increase public awareness on the value of plant genetic resources, document and disseminate successful management practices and develop partnerships with key stakeholders.

Agro-biodiversity in Agriculture Systems – Horticultural Research Centre (HRC)

In pursuing its goal of optimizing the integration of diversified crops/small animal productions systems/crop-associated biodiversity into traditional and improved integrated farming systems, in order to achieve self-sufficiency and to provide a balanced diet and increase cash-income for farmers, the Horticultural Research Centre (HRC) has proposed following interventions: (i) strengthen the existing fruit and vegetables seed gene-bank at HRC and/or develop a national gene-bank on plant and animal genetic resources for the exchange and *in situ* and *ex situ* conservation of plant and animal genetic resources; (ii) emphasize the importance and promote household-based integrated agriculture production systems and home gardens in the three eco-regions of Lao PDR; (iii) diversify household-based integrated agriculture production techniques to improve the quality of agro-biodiversity resources (fruits, vegetables, mushrooms, livestock, insects, fish and other aquatic resources) for family-consumption and cash-income generation; (iv) evaluate the impact of climate change on the resilience of integrated agriculture systems and modify agro-biodiversity techniques to maintain ecosystem services; and (v) raise awareness on nutritional needs in upland areas in collaboration with the Ministry of Health (MOH).

Livestock – Livestock Research Centre (LRC)

In the support of its goal to sustainably conserve livestock breeds and develop the value chain (breeding, feeding, housing, handling) of the main livestock and small animal husbandry in different production agro-systems and eco-regions, in order to achieve self-sufficiency and to ensure food security and increase market-oriented cash-income for livestock farmers while using and conserving animal genetic resources, the Livestock Research Centre (LRC) is proposing to: (i) characterize and inventory livestock genetic breeds and monitor trends and associated risks; (ii) reinforce the existing livestock gene-bank at LRC and (or) develop a National Gene-bank on animal genetic resources, exchange breeds, and conserve these resources, both *in situ* and *ex situ* in the context of emergencies and climate change; (iii) use and develop sustainably these

animal production systems (breeding, feeding, housing, handling); (iv) secure the diversity of indigenous livestock species by better implementing and harmonizing the Global Plan of Action for Food and Agriculture; conserve the genetic diversity of indigenous livestock breeds; and (v) draft policies and regulations, and strengthen capacity of institutions and all stakeholders to sustainably developed livestock breeds, and disseminate knowledge products on best livestock management practices to all actors.

Forestry sector – Forestry Research Centre (FRC)

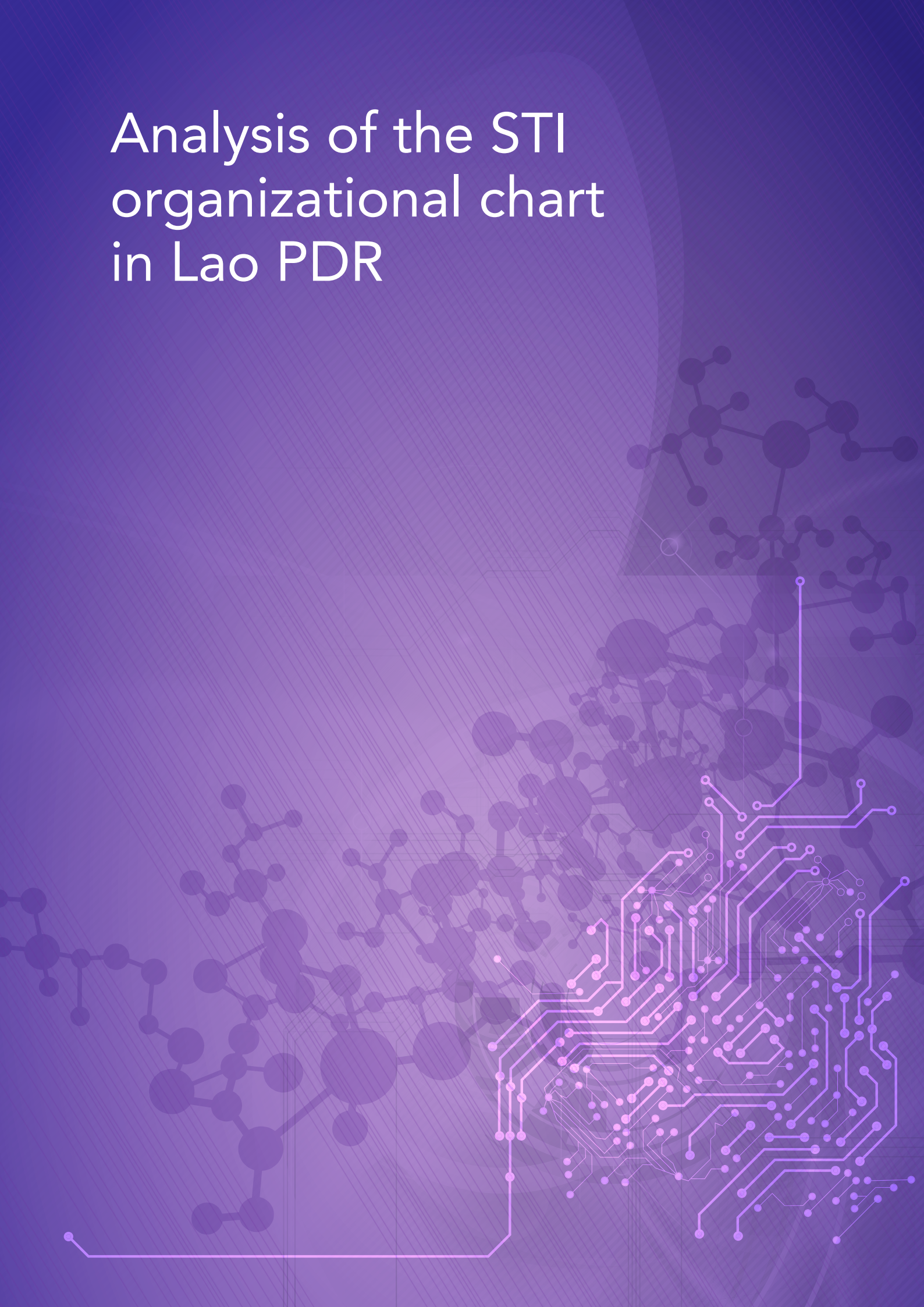
The overall goal of the Forestry Research Centre (FRC) related to agro-biodiversity management in the forestry sector is to conserve non-timber forest products' biodiversity and to develop and sustainably manage the value chain (harvesting, planting, storage, processing, marketing and trade) of non-timber forest products from forest ecosystems and agro-ecosystems, in order to achieve self-sufficiency sustained food security and to provide complementary cash income for farmers while using and conserving plant and animal genetic resources. Under this overall goal, FRC has the following strategic priorities for the forestry sector: (i) increase awareness on the availability, value, importance and distribution of non-timber forest products in the eco-regions of Lao PDR; (ii) foster the conservation and sustainable use of non-timber forest products (harvesting, storage, processing, marketing and development) at community level; (iii) expand the successful pilot models for harvesting, domesticating, processing and marketing key non-timber forest products and increase the planting of domesticated varieties (cardamom, rattans, bamboos, etc.); (iv) study the less-used species of non-timber forest products and establish *ex-situ* and *in-situ* conservation systems; and (v) develop national and provincial plans for the sustainable use, monitoring and trade of non-timber forest products that are fully-aligned with international treaties and conventions.

Fish and Aquatic Animals – Living Aquatic Resources Research Centre (LARReC)

Pursuing its goal to sustainably conserve fishery resources and other aquatic biodiversity in different aquatic systems and eco-regions and develop aquaculture systems for indigenous fish in order to achieve self-sufficiency, ensure food security, provide a protein-rich diet and increase cash-income for farmers while using and conserving aquatic genetic resources, the Living Aquatic Resources Research Centre (LARReC) has proposed to: (i) improve knowledge of the status, abundance, trends, and threats relating to indigenous fish resources; and other aquatic animals in various aquatic systems and eco-regions; (ii) strengthen institutional and human capacity at the community level to promote the sustainable use of fish resources at national and provincial levels to support sustainable fish capture and aquaculture; (iii) reinforce biodiversity related to national legislation, markets and trade, aligned with international conventions and treaties (i.e. the International Treaty on Plant Genetic Resources for Food and Agriculture, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Wetlands of International Importance especially as Waterfowl Habitat, and the Convention on Biological Diversity); (iv) increase awareness and communication of the value of fisheries and other aquatic resources, and document and disseminate successful management practices; and (v) foster resilience of aquatic-systems and adaptation to climate change, and control alien fish species proliferation in rivers, reservoirs, lakes and tributaries.

Source: Lao PDR National Agro-Biodiversity Programme and Action Plan II, 2015–2025 (MAF, 2016)

Analysis of the STI organizational chart in Lao PDR



The STI organizational chart shows the distribution of responsibility for implementing a given policy. In the organisational chart, there are five distinct levels: (1) the policy-planning level (policy design); (2) the promotional level (funding); (3) the performance level (scientific research, technological development and productive innovation); (4) all science and technology services' level; and (5) the assessment/ evaluation level.

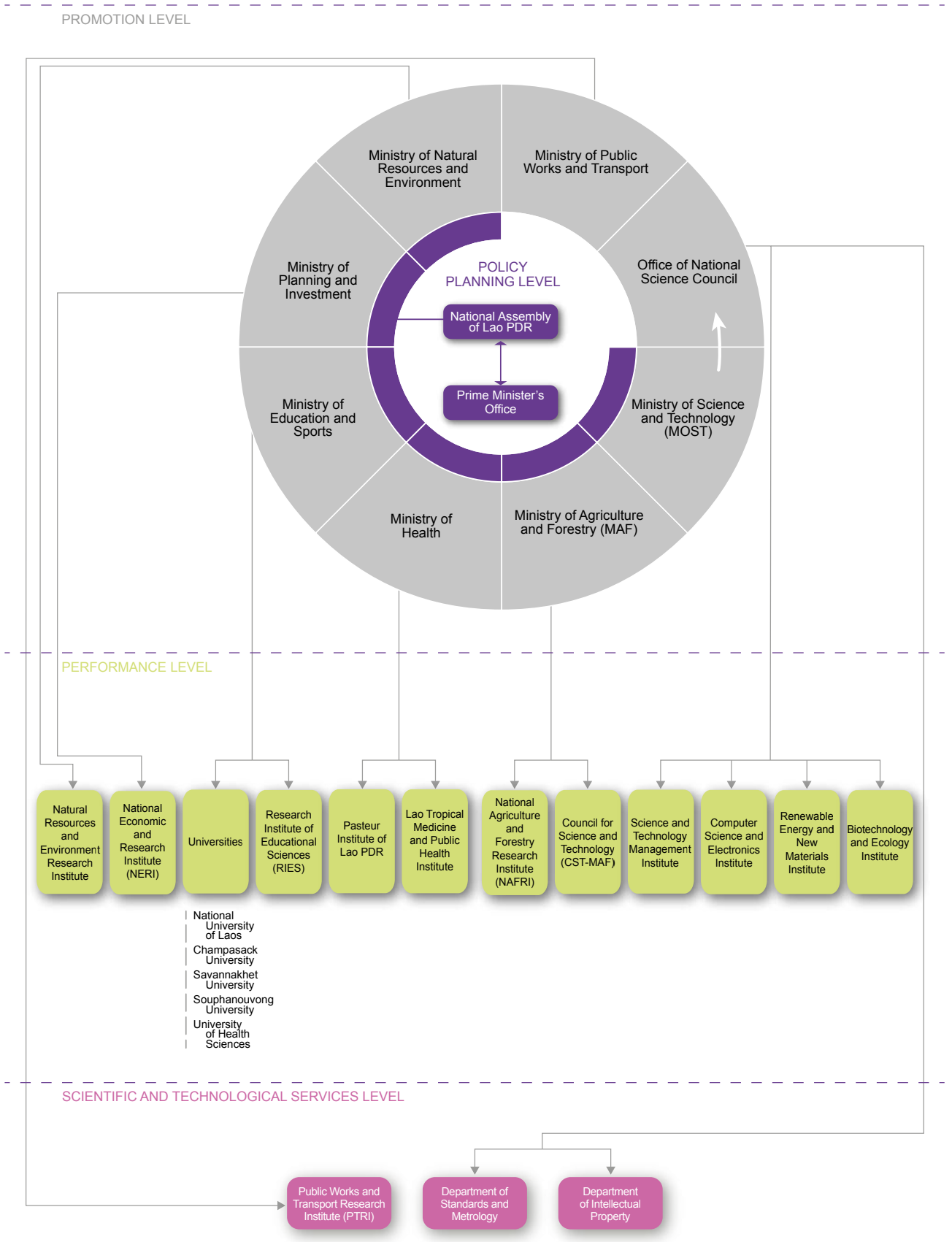
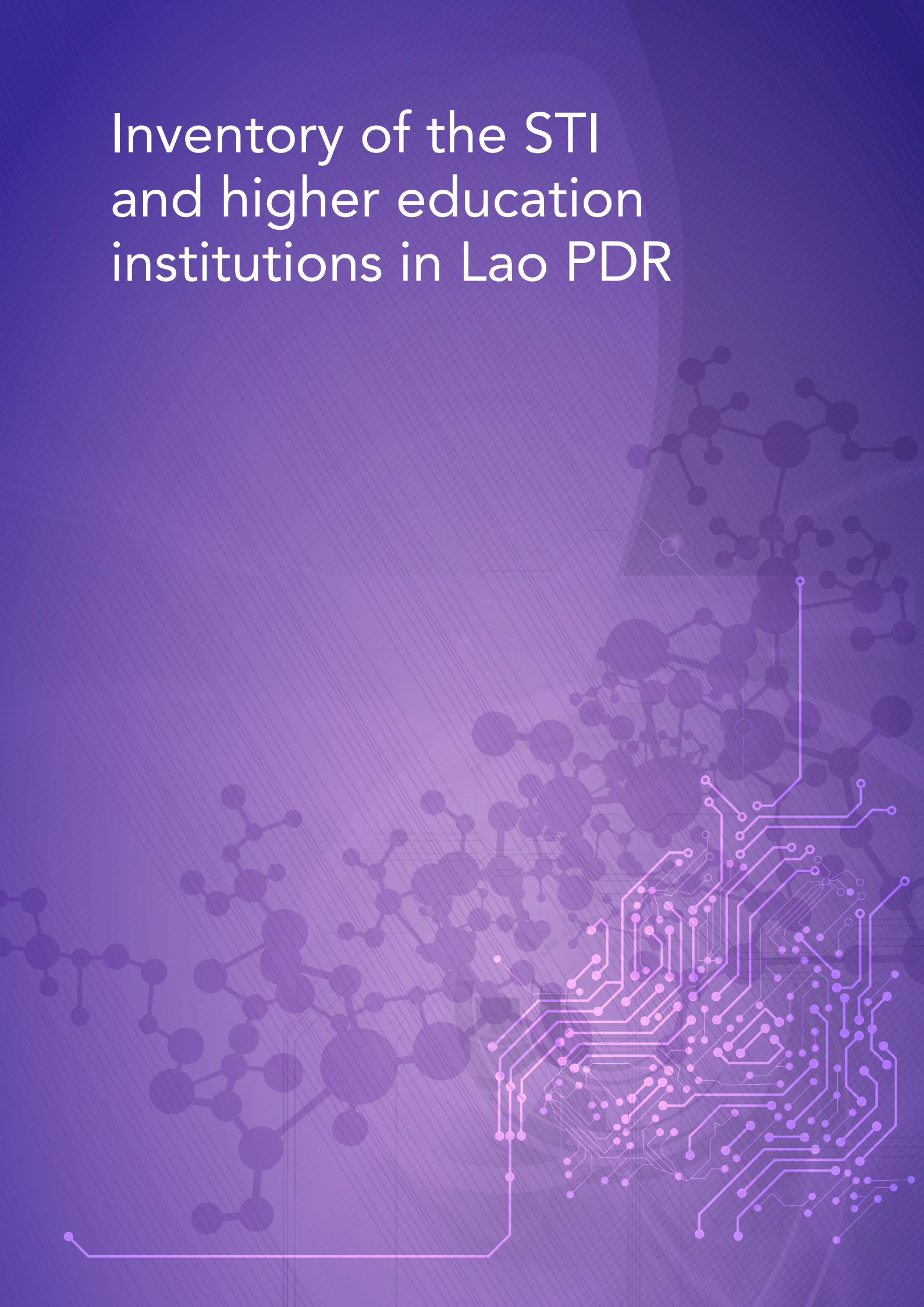


Figure 48: Organizational chart showing Lao PDR's research and innovation system, circa 2017.
Source: UNESCO

Inventory of the STI and higher education institutions in Lao PDR



Government Ministries and Public Agencies

Ministry of Science and Technology

Address: Nahaidiao Road, P.O. Box 2279, Ban Sidamdua, Chanthabouly District, Vientiane Capital
Telephone: +856-21 213470,
Fax: +856-21 213472
URL: http://www.most.gov.la

Executive head: Academician Prof. Boviengkham Vongdala

Year of establishment: 2011

References of main legislative texts governing the organization: Prime Minister's decree 309, dated 28/9/2011, amended with decree 314/PM, dated 29/9/2017.

Aims and responsibilities of the organization: The Ministry of Science and Technology has a role of secretariat to the Government for developing and managing on macro level science, technology, innovation, Intellectual Property, standards and methods regimes throughout the country.

Priority level of the following functions:

1. Planning/programming/budgeting of STI activities: (a) highest priority
2. Promotion/financing/co-ordination of STI activities: (a) highest priority
3. Application/transfer/assessment of STI activities: (a) highest priority
4. Advocacy of STI activities: (b) high priority
5. General policy advice: (b) high priority

Name of the administrative entity specifically in charge of exchange of information with foreign organizations: Department of Planning and Cooperation. Preferred language(s) of communication: Lao and English.

STI policy publications of the organization: National Science and Technology Policy (2000); National Strategic Plan on Science and Technology Development 2016–2025 and Vision 2030; Five Year Plan for Science and Technology, 2016–2020

Number of professional staff and gender distribution: at headquarters and field offices in the whole country

Table 35: Staff by level of education and gender at MOST, 2017

Level of education	Personnel [total HC]	Women [HC]	Men [HC]
PhD	10	1	9
Master	86	20	66
Bachelor	614	245	369
Pre-bachelor	361	133	228
Diploma	116	20	96
Certificate	11	1	10
Non-professional	1	0	1
Total	**1 198**	**420**	**778**

Source: Department of Organization and Personal, Ministry of Science and Technology (2014)

Last annual budget: In period of 2011–2015, the budget for supporting 104 research projects totalled 44 billion kip (5.5 million US$).

Historical notes: Originally formed as the Science Committee for Science and Technology, the National Authority for Science and Technology (NAST) was moved under the Prime Minister's Office in 2007. NAST

was upgraded to a ministry in 2011, called Ministry of Science and Technology (MOST). MOST acts as a secretary to the central government in managing science, technology, innovation, intellectual property (IP), standardization and methods, even formulating legislation. The central agency works with the local governments through the Provincial Department for Science and Technology (PDST). Until September 2017, MOST consisted of 8 Departments, 3 Institutes and 2 Cabinet Offices, according to PM's decree number 319, dated 24 September 2017. MOST established a new institute namely Institute of Science and Technology Management. Since its creation, MOST has also moved to build its capacity (especially infrastructure development and human resources development). The Ministry of Science and Technology still handles IPR as part of the World Trade Organization Trade-related Aspects of Intellectual Property (TRIP) Agreement, as well as handling FDI.

Institutions under the Ministry of Science and Technology

1. Cabinet Office
2. Department of Organization and Personnel
3. Department of Inspection
4. Department of Planning and Cooperation
5. Department of Science
6. Department of Technology and Innovation
7. Department of Digital Technology
8. Department of Intellectual Property
9. Department of Standards and Metrology
10. Biotechnology and Ecology Institute
11. Renewable Energy and New Materials Institute
12. Computer Science and Electronics Institute
13. Science and Technology Management Institute
14. Office of National Science Council

BIOTECHNOLOGY AND ECOLOGY INSTITUTE

Address: Tha Gnon Road, P.O. Box 2279, Ban Danxang, Xaythani District, Vientiane Capital
Telephone: + 856-21 740630
Fax: + 856-21 740630
URL: http://www.most.gov.la

Mandate: The Biotechnology and Ecology Institute (BEI) has role in research, development, application and service in biotechnology and ecology. BEI consists of six Divisions and one Centre namely: The Division of General Affairs, the Division of Biotechnology, the Division of Genetic Resources, the Division of Ecology, the Division of Chemical Technology, the Division of Technical Service and the Parksan Ecology Centre

Brief description of main activities: BEI has established collections of orchid flowers consisting of more than 140 species and has more than 165 other species in its glasshouse. BEI was set up as an herbarium and a natural history museum and has a function to disseminate and raise awareness on science and ecological systems. BEI carried out several research projects such as studies on Delbergia, Bryophytes, Zingiberaceae, Begoniaceae, Areceae and Ebenaceoe, in different provinces. Moreover, BEI conducts some research activities to apply biotechnology to identify plant and animal diseases.

Staff: n/a

Outputs: (a) One herbarium (800 Mushroom samples, 37 Begonia samples, 30 Araceae samples, 32 Ochidaceae samples, 81 dry vegetable samples); (b) one Natural Science Museum

Historical notes: BEI was formed in 2011. The former name was the Science and Technology Research Institute (STRI) and it was under National Authority for Science and Technology (NAST). When NAST was transformed into MOST, STRI became BEI in 2011.

RENEWABLE ENERGY AND NEW MATERIALS INSTITUTE

Address: Tha Ngon Road, P.O. Box 2279, Ban Danxang, Xaythani District, Vientiane Capital
Telephone: +856-21 739011
Fax: +856-21 739009.
E-mail: remi_most@yahoo.com
URL: www.most.gov.al

Mandate: The Renewable Energy and New Material Institute (REMI) was established by the Ministerial decree number 0841/MOST, dated 21 December 2011. It plays its role as secretariat to MOST in research, development, transfer, promotion, applications and services related to renewable energy and new materials. The main mandate of REMI is conducting applied and adaptive research on renewable energy and new materials.

Brief description of main activities: REMI consists of five divisions such as the General Affairs Division, the Bio-energy Division, the Alternative Energy Division, the Mechanical Engineering Division and the New Materials Division. Several research and demonstration projects were conducted by REMI in the last five years on Solar Photovoltaic, cooking stoves, gasification technologies and on agriculture wastes as an energy source. In addition, REMI also organized several training courses on renewable energy technology and viable applications.

Staff: n/a

Outputs: List of projects conducted by REMI: (a) development of a bio-diesel production process; (b) demonstration of a solar home system and solar pumping; (c) research on agricultural waste for solid fuel, and (d) research and development of other appropriate technologies.

Historical notes: REMI was established in 2011. In the period 2007–2010, The Technology Research Institute (TRI) and The Science Research Institute (SRI) were transformed into the Science and Technology Research Institute (STRI) that was operating within the National Authority for Science and Technology (NAST). Some functions were separated, and REMI was formed when NAST became MOST.

COMPUTER SCIENCE AND ELECTRONIC INSTITUTE

Address: Nahaidiao Road, P.O. Box 2279, Ban Sidamdua, Chanthabouly District, Vientiane Capital
Telephone: +856-21 3470
Fax: +856-21 213472
URL: www.most.gov.la or http://tcei.most.gov.la/

Mandate: The Computer Science and Electronic Institute (CSEI) functions as the secretariat to MOST in research, development software, hardware, network, automation, transfer and providing technical services related to computer science and electronics. CSEI consists of five divisions and one centre: The Administration Division, the Software R&D Division, the Computer and Electronics Division, the Network Division, the automation division and the transfer and service centre.

Brief description of main activities: CSEI sets up and maintains the network system of MOST, develops training materials and training courses on IT and its applications. CSEI conducts range of research and development projects such as development of Lao Fonts, E-book and E-dictionary.

Staff: 34 persons

Outputs: (a) competition for the network Installation for MOST and its institutes; (b) developed and distributed training manuals for Microsoft Office to provincial S&T Departments (270 sets) and (c) contributed to the Network-based ASEAN Languages Translation Public Service Project.

Historical notes: CSEI was established in 2011 by transforming the Institute of Information Technology which had been created in 2008 under the National Authority for Science and Technology.

SCIENCE AND TECHNOLOGY MANAGEMENT INSTITUTE

Address: Tha Ngon Road, P.O. Box 2279, Ban Danxang, Xaythani District, Vientiane Capital
Telephone: +856-21 213470
Fax: +856-21 213472
URL: www.most.gov.al

Mandate: The Science and Technology Management Institute is a new institute under MOST established by the PM's decree 319, 24/9/2017. Its role and responsibility are still being drafted.

OFFICE OF NATIONAL COUNCIL OF SCIENCE

Address: Nahaidiao Road, P.O. Box 2279, Ban Sidamdua, Chanthabouly District, Vientiane Capital,
Telephone: +856-21 213310-ext 0
Fax: +856-21 243311
E-mail: last@most.gov.la
URL: www.most.gov.la

Mandate: Referring to Prime Minister's decree number 04, dated 28 January 2002, the National Council of Science (NCS) is responsible for setting up the Cabinet Office of NSC that will assist NSC and MOST in coordinating with research institutes, universities, ministries and equivalent agencies across the country for research and development on Science and Technology, and for promoting NCS activities.

Brief description of main activities: The National Science Council is managing the Science Development Fund for which the Government budgeted annually 1 % of total public investment. In 2011–12, Government invested 22 bill Kip (US$ 2.7 million) in Research and Development, which funded about 41 research projects. In 2012–13, about 63 projects were funded by this Science Development Fund.

Staff: n/a

Outputs: Decree on the Science Development Fund

Ministry of Planning and Investment

Address: Souphanouvong Avenue, Sikottabong District, Vientiane Capital
Telephone: +856-21 217020
Fax: +856-21 217010
URL: www.investlaos.gov.la

Executive head: Souphanh Keomixay
E-mail: ipd@investlaos.gov.la

Year of establishment: 2007

References of main legislative texts governing the organization: Primer Minister's decree number 374, dated 22/10/2007.

Aims and responsibilities of the organization: The Ministry of Planning and Investment (MPI) has a role as a secretariat to the Government and manages national planning and investment on a macro level: formulating national strategy, a master plan, a socio-economic development plan, policies and an implementation mechanism for economic management, statistics, domestic and international investment, and international cooperation on economics.

Priority level of the following functions:

1. Planning/programming/budgeting of STI activities: (a) highest priority
2. Promotion/financing/co-ordination of STI activities: (c) low priority
3. Application/transfer/assessment of STI activities: (c) low priority
4. Advocacy of STI activities: (c) low priority
5. General policy advice: (b) high priority

Name of the administrative entity specifically in charge of exchange of information with foreign organizations: Department of International Cooperation and National Bureau for Statistics. Preferred language(s) of communication. Lao and English

STI policy publications of the organization: The 8th Five Year National Socio-Economic Development Plan (2016–2020).

Number of professional staff and gender distribution: n/a

Last annual budget: n/a

Institutions under the Ministry of Planning and Investment

NATIONAL ECONOMIC RESEARCH INSTITUTE (NERI)

Address: 5th Floor, MPI, Souphanpuvong Ave., Sikottabong, Vientiane capital, 01001
Telephone: +856-21 254826
Fax: +856-21 254826
URL: http://www.neri.gov.la/

Mandate: National Economic Research Institute is a governmental think tank.

Brief description of main activities: NERI is providing research-based policy recommendations and advocacy at the macro level in globalization context. They are following a country–specific tailor-made advocacy methodology so as to make the best use of the potentiality of the country. NERI has a good network of co-operation and partnership with various ministries, institutes and universities in the country, as well as international organizations like UNDP, SIDA, and JICA etc. NERI is implementing many projects supporting by these donors and making promising progress. For example, they are focusing on many micro-economic projects, treating specific sectors, and Agricultural and rural development, Economic integration, SME development, finance and on other issues.

Staff: n/a

Outputs: n/a

Historical notes: The National Economic Research Institute was established in 1997 as a strategic research institute under the supervision of the Committee for Planning and Investment (CPI). CPI has recently become the Ministry of Planning and Investment (MPI). As a think-tank of the Ministry of Planning and Investment, NERI's main functions are to formulate the long-term provincial, regional, and national socio-economic development strategy.

Institutions under the Ministry of Agriculture and Forestry

COUNCIL FOR SCIENCE AND TECHNOLOGY (CTS - MAF)

Address: CST Centre for Agricultural Statistics, Phonxay Village, Saysettha District, Vientiane Capital, Lao PDR
Telephone: +856-21 263160
Fax: +856-21 263160
Mobile: + 856-20-22439488
Email: thatheva@gmail.com
Mobile: + 856-20-22439488
URL: http://cst-maf.la

Mandate: The core mandate is to facilitate science and technology research and innovation in the Ministry of Agriculture and Forestry (MAF). CST contributes to the achievement of the MAF research outcomes.

Brief description of main activities: The Council for Sciences and Technology (CST) of the Ministry of Agriculture and Forestry has the main role to formulate the policies and regulations relating to promote local brand of agriculture products and to develop the agriculture technology and other.

Staff: 25

Outputs: Approve innovation to achievement of agricultural research.

Historical notes: CST was established in March 2003. Initially the secretariat team had been functioning as a division under the Permanent Secretary and was chaired by the Minister of Agriculture and Forestry. In 2008 the secretariat unit was moved to NAFRI and become passive for couple of years. In 2013, the MAF re-activated CST and the secretariat unit became equivalent to a Department, managed independently and chair by the Minister.

NATIONAL AGRICULTURE AND FORESTRY RESEARCH INSTITUTE (NAFRI)

Address: P.O. Box 7170, Dong Dok, Xaythani District, Vientiane Capital
Telephone: +856-21 770094/770084
Fax: + 856-21 770047
URL: http://www.nafri.org.la

Mandate: Contribute to Agricultural Development Strategy 2025 by carry out research for development on agro-biodiversity, sustainable use and conservation, productivity improvement, climate change adaptation and mitigation, and the supportive policy environment.

Brief description of main activities: Modernized agriculture technologies are developed for improvement of agricultural production systems which support national food security and nutrition, commercialized production, and the use of resources is managed at a sustainable level. The main research themes are the following: (i) promotion of bio-diversity to create a gene bank, while deepening the understanding of native plants and wild animals; (ii) improvement of agricultural productivity, including a programme for each rice-plant and livestock species and other programmes which focus on maize, cassava, and coffee; (iii) response to climate change is given priority, such as research on protecting crops from floods; and (iv) information provision to farmers (CRDS, 2015).

Structure: NAFRI restructured itself to reflect changes in the government's policy and rapid economic changes taking place in Lao. NAFRI is now composed of the following Divisions and Centres across the country:

I. Divisions:

1. Administration and Personnel Division (APD)
2. Planning and Cooperation Division (PCD)

II. Commodity based Research Centres:

1. Agriculture Research Centre (ARC)
2. Horticulture Research Centre (HRC)
3. Livestock Research Centre (LRC)
4. Forestry Science Research Centre (FSRC)
5. Maize and Cash-crop Research Centre (MCRC)
6. Research Centre to Climate Change Resilience in Agriculture (RCRA)
7. Living Aquatic Resources Research Centre (LARReC)

III. Non-commodity-based Research Centres

1. Agriculture and Forestry Policy Research Centre (AFPRC)
2. Centre for Agriculture and Forestry Information and Communication (CAFIC)

IV. Regional Research Centres and Agencies

1. Upland Agriculture Research Centre (UARC)
2. Coffee Research and Multiplication Centre (CRMC)
3. Thasano Agriculture Research Centre (TARC)
4. Nong Daeng Agriculture Research Centre (NARC)
5. Luangnamtha Agriculture Research Centre (LTARC)

Staff: NAFRI currently employs 332 staff (97 women); 25 PhDs (and 8 doctoral students), 84 masters' and 152 BScs.

Outputs: n/a

Historical notes: Established in 1999, NAFRI is a research institution in the field of agriculture and forestry. It has 11 research centres, including those on agriculture and agricultural products, and is expanding its size. Its main mission is to promote private agriculture by providing good-quality and various kinds of crop seeds. The annual budget is about 2–3 million dollars. Assistance from the Japan International Cooperation Agency and other international co-operation agencies accounts for 50% of the budget. All other funds come from the public sector. Research funds from the Ministry of Science and Technology have been increasing over time. On the other hand, only a small part of funds from the Ministry of Agriculture and Forestry can be spent on research. It should be noted that provinces in Lao PDF have relatively abundant agricultural research related budgets. Each province has a research institute, which receives funds from the central government (CRDS, 2015).

Relevant URL:
Lao Agriculture Database(LAD): http://lad.nafri.org.la/index.php
NAFRI Library System: http://nalis.nafri.org.la/opac/index.php

Institutions under the Ministry of Health

LAO TROPICAL MEDICINE AND PUBLIC HEALTH INSTITUTE

Address: Ban Kaognod, Sisattanack district, Samsenethai road, Vientiane, Lao PDR
Telephone: +856-21 250 670
Fax: + 856-21 214012
Email: sengchanhkounnavong@hotmail.com
URL: https://www.nioph.gov.la

Name of the executive head: Dr Souraxay Phrommala

Mandate: The roles and functions of the Lao Tropical and Public Health Institute (Lao TPHI) were approved by Minister of health agreement no. 2979/MOH dated December 6, 2017. It is a macro technical organization level 1 of the MOH. Its mandates are: (a) serving as a central focal point for promoting,

supporting, consulting, advising, coordinating and implementing health research; (b) developing regulation and standard measures to protect benefits for human subjects participating in research; (c) providing evidence based scientific research to decision makers for developing, improving health policy, strategies, action plans, and health work plans of the MOH in order to enhancing quality of health services for better health of the population; (d) developing and improving health research data bases as a centre of excellence, providing the evidence base and research outputs that can be synthesizes so as to offer policy recommendations; (e) providing in-country short-term training on Public Health management for health professionals at all levels, according to each five year socio-economic plan of the country; (f) providing regional long-term training on Public Health and tropical medicine in order to: (i) enhance the competence of junior medical doctors and public health professionals committed to improve ASEAN populations' health, (ii) deliver an international master degree, focusing on practice in priority health issues: Public Health, epidemiology, clinical medicine, therapeutics, research, and management, (iii) to foster and monitor health development projects based on students' initiatives and implementations, (iv) to create a forum for academic exchange and research, with an international perspective, and to expand scientific networks in the region; (g) co-ordinate for the Council of Medical Sciences and serve as secretariat for the National Ethics Committee for Health Research; and (h) other roles assigned by MOH.

Brief description of main activities: n/a

Vision: To achieve significant improvements in people's health and in the health system through excellence in research and training.

Strategic goals: (1) To improve the people health status through a better understanding of public health disease priorities in the country; (2) to create national leadership in research by providing short and long term training for health institutions in Lao PDR at all levels as needed; (3) to serve the research findings to Ministry of Health (MOH) for policy making in order to improve the health system in the country; (4) to collaborate with internal and external institutions for strengthening research capacity

Staff: Number of administrative staff is 31; there are 11 men and 20 women. Number of researchers is 20; there are 7 men and 13 women.

Research funds: (a) Government funds: 700 000 000 Kip for 2017, (b) co-funds and (c) grants from international organizations (in 2017, funds from Nutrition International-Canada, and the Bill & Melinda Gates Foundation through the University of California Davis).

Outputs: Since 1990, some 80 peer-reviewed papers. Please see attached five-year summary of research Reports related to health and nutrition only.

Historical notes: The National Institute of Public health (NIOPH) of the Ministry of Health (MOH) was founded under the Decree of the Prime Minister No 114/PM and the NIOPH was approved by MOH, Decree No. 247/MOH in 22nd February 1999. NIOPH is a macro-organization of the Ministry of Health. It has the mandate to assist the Minister in management; promote, support, advise, coordinate and implement health research activities related to health research policy and law; build qualifications of health professionals at each level in the country; collaborate internationally through close cooperation with departments of organizations and institutes of tropical medicine in Francophone countries and act as secretariat for the Council of Medical Sciences of MOH. The roles and functions of NIOPH were revised once in August 2013: it was called to act as micro-technical organization without a coordination role (because the department of research and training would coordinate). In 2013 the *Agence Universitaire de la Francophonie* (AUF) announced its firm intention to start withdrawing its financial support to IFMT in 2015. The withdrawal was completed by 25th August 2017 and since then the institute is fully active under the direction of the Lao government. This was accomplished by integrating IFMT into the National Institute of Public Health and become "The Lao Tropical and Public Health Institute" of the Ministry of Health. Of particular importance is the desire of all stakeholders to put in place conditions that will guarantee that the Lao-TPHI becomes a high standard training and research institution.

PASTEUR INSTITUTE OF LAO PDR (IPL)

Address: Samsenthai Road, Ban Kao-Gnot, Sisattanak district, P.O. Box 3560, Vientiane, Lao PDR.
Telephone: +856-21 285321
Fax: +856-21 285326
URL: http://www.pasteur.la/

Mandate: The Pasteur Institute of Lao PDR (*Institut Pasteur du Laos – IPL*) is a Lao National Institution created by Prime Ministerial Decree no 402, dated 16 November 2007. The IPL has a mandate from Lao Ministry of Health to fulfil activities of public services: (1) Research and diagnostic on emerging infectious diseases and vector borne diseases; (2) training, Education and Capacity building and (3) technical assistance to National Centre for Laboratory and Epidemiology (NCLE) for investigation of epidemics.

Brief description of main activities: The IPL has a scientific autonomy within its mandate provided by the Ministry of Health. It is able to engage freely in collaborative research and investigations with other Lao and international research and public health organisations. The budget is independent from the Lao public finance system. The IPL is able to receive outside funding (donations, grants, bequeaths, etc.) and to generate its own resources through its own discoveries to insure its sustainability.

The IPL operations started in December 2011 with 4 laboratories: 1) arbovirus & emerging viral diseases, 2) vaccine preventable and infectious diseases, 3) medical entomology and 4) parasitology.

Staff: about 70 persons

Outputs: The following annual reports are available, *Institut Pasteur du Laos* Activities *Report 2016–2017* (URL: http://www.pasteur.la/institut-pasteur-du-laos-activities-report-2016-2017/); *Institut Pasteur du Laos Activities Report 2015–2016* (URL: http://www.pasteur.la/institut-pasteur-du-laos-activities-report-2015-2016/); *Institut Pasteur du Laos* Activities *Report 2014–2015* (URL: http://www.pasteur.la/institut-pasteur-du-laos-activities-report-2014-2/)

Historical notes: The Pasteur Institute of Laos is a research institute under the Lao Ministry of Health. The Pasteur Institute in France has allowed it to use the name of Pasteur and is giving certain support. Cooperation between the Pasteur Institute and the Lao government started in 2004 when the Lao Ministry of Health requested the French government for counter-measures and capacity-building against SAAS and H5N1. Later, following the request from the Lao government for a long-term support, cooperation stared with the Pasteur Institute consequently lending its name to the institute under the Ministry of Health (CRDS, 2015). Regarding specialized human resources, the institute´s endeavour is to train Lao researchers, upon the request from the Lao PDR government. Lao research staff are mainly persons who received their medical degree in Lao PDR. The Pasteur Institute engages in international cooperation in accordance to the philosophy at its establishment in the XIX century; namely, to share knowledge with the world, to promote health of people in the world, and to eliminate threats from the world.

Institutions under the Ministry of Natural Resources and Environment

NATURAL RESOURCES AND ENVIRONMENT RESEARCH INSTITUTE

Address: Nahaideoa Road, Chanthaboury District, Vientiane Capital, Lao PDR
Telephone: +856-30 9832286
Fax: +856-21 263 799
E-mail: nrei@monre.gov.la
URL: http://nrei.monre.gov.la/

Mandate: The NREI play a role as secretariat to Ministry of Natural Resources and Environment in studying, research on natural resources and analysis environment quality and provide technical services in the arear

of natural resources and environment. Its mandate includes implementing the policy, strategy, regulation, action plan on natural resources and environment; to promote research, development, and the utilisation of prototype on natural resources and environment which best suitable for Lao context; and other tasks.

Staff: 47 persons (28 women)

Outputs: (a) several training courses; (b) training materials and (c) publication and dissemination materials

Institutions under the Ministry of Education and Sports

RESEARCH INSTITUTE FOR EDUCATIONAL SCIENCES (RIES)

Address: Mahosoth Road, Ban Sisakheth, Chanthaboury, Vientiane Capital
Telephone: +856-21 213 161
Fax: +856-21 213 161
URL: http://www.moe.gov.la/ries

Mandate: (a) Study and develop curriculum for formal school; (b) draft and improve legislation for use and determination of curriculum and (c) train on application of developed curriculum.

Brief description of main activities: n/a

Staff: n/a

Outputs: n/a

Historical notes: RIES is the successor institution to the Department for Textbook Compilation and (Pedagogical) Research founded in 1975, with no substantive change in function. Research conducted is for most part, curriculum/textbook related. Its professional staff cover all the subjects of General Education as well as evaluation and research. The institute has a long track record of designing and delivering teacher education programmes (in-service).

Institutions under the Ministry of Public Works and Transport

PUBLIC WORKS AND TRANSPORT RESEARCH INSTITUTE (PTRI)

Address: Dongpalane Road, Phonesinouane Village, Sisattanak District, Vientiane Capital, Lao PDR
Telephone: +856-21 412285
Fax: +856-21 416527
Email: pphengsida@yahoo.com; bottaphanith@yahoo.com
URL: http://www.mpwt.gov.la/en/

Name of the executive head: Mrs Phonesavanh Phengsyda, Director General of PTRI

Mandate: The principle mandate of PTRI is to assist the ministry in the planning, analysing and studying, as well as carrying out research in the areas of infrastructure (road-bridge), transport systems, housing and urban planning, water supply and sanitation, as well as the environment and disaster prevention. Furthermore, PTRI also has roles to evaluate, promote, provide consultation services, disseminate scientific advances, techniques and technology as well as research outcomes in the public works and transport sector. In addition, PTRI is also responsible for other tasks as to be directed and assigned by the Minister of Public Works and Transport.

Brief description of main activities: With government funds the PTRI conducts and promotes: (a) development of regulation on environmental impact assessment of road project in Lao PDR (PCAP2016); (b) study on setup of the unit cost for urban planning (PCAP2016); (c) study on urban parking design

manual (PCAP2017); (c) study on an appropriate of urban road asset design (PCAP2017); (d) study on the risk of landslide along road No. 13 north (PCAP2018); (e) study on building construction safety in Vientiane Capital (PCAP2018); (f) study on fire risks in buildings in Vientiane Capital (PCAP2018) and (g) study on roundabout design manual (PCAP2018). With grants provided by international organizations PTRI conducts and promotes: (a) research on mobile livelihood and gendered citizenship, for example the counter-geographies of indigenous people in Lao PDR, India and China (2010–2013); (b) study of gender impact of the cross-border agricultural investment, for example, cast of rubber plantations in Northern Lao PDR, Myanmar and Cambodia (2014–2016); (c) a Lao road sector project 1 (2012–2016) and a Lao road sector project 2 (2017–2022) funded by World Bank; (d) the environmental and social operation manual (ESOM) funded by World Bank; (e) study for an urban development master plan in Vientiane capital for 2030 funded by JICA (2012); and (f) study on urban development management in Vientiane capital funded by the Japan International Cooperation Agency (2013–2016).

Staff: The administrative staff is composed of 6 men and 12 women. The researcher staff is composed of 24 men and 5 women.

Outputs: The following list includes the major achievements

- The research on mobile livelihood and gendered citizenship: The counter-geographies of indigenous people in Lao PDR, India and China (2010–2013) supported by AIT;
- Gender impact of cross-border agricultural investment: Cast of rubber plantations in northern Lao PDR, Myanmar and Cambodia (2014–2016) supported by AIT;
- Lao road sector project 1 (2012–2016) and Lao road sector project 2 (2017–2022) supported by World Bank;
- Environmental and social operation manual (ESOM) funded by World Bank;
- The study on urban development master plan in Vientiane capital for 2030 supported by the Japan International Cooperation Agency (2012);
- The study on urban development management in Vientiane capital funded by the Japan International Cooperation Agency (2013–2016);
- Annual road asset report 2010–2016;
- Annual report on road maintenance 2010–2016;
- Urban master plan of Longcheng district, Xaysomboun province;
- Urban master plan of Longsan district, Xaysomboun province;
- Urban master plan of Hom district, Xaysomboun province;
- Urban master plan of Xaythany district, Vientiane capital.
- Development plan of Hatkieng, Huaxieng and ThaNgone Village Group

Historical notes: Established in 1982 as the Urban Planning Division under the former Ministry of Construction's Integrated Institute for Survey, Design and Construction. In 1985, the Institute for Urban Technique was established, separated from the Integrated Institute for Survey, Design and Construction. In 1994, it was renamed to the Institute for Urban Planning. In 1999, the institute was upgraded to Urban Research Institute (URI) under the former Ministry of Communication, Transport, Post and Construction (MCTPC). In 2008, it changed its name to the Public Works and Transport Institute (PTI) under the Ministry of Public Works and Transport (MPWT). In 2017, upgraded to Public Works and Transport Research Institute (PTRI).

Institutions under the Ministry of Energy and Mines

INSTITUTE OF RENEWABLE ENERGY PROMOTION

Address: Nongbon Road, Ban Phay, Saysettha district, Vientiane Capital
Telephone: +856-21 413012
Fax: +856-21 285144
URL: https://mem.gov.la

Mandate: The Institute of Renewable Energy Promotion (IREP) has role to promote, manage, monitor, inspect, develop and provide technical service on renewable energy, energy efficiency, rural electrification, alternative energy and manage the energy promotion fund in the country.

Brief description of main activities: (a) Develop policy, strategy, planning and action plan on renewable energy, alternative energy, energy efficiency, rural electrification and energy promotion fund; (b) promote application of renewable energy to contribute to poverty eradication and sectoral development; (c) develop necessary legislation, regulation and mechanism for macro management and promotion of renewable energy and (d) carry out other duties as mentioned in the decree.

Staff: total number: 34 persons of whom 11 are women.

Structure: IREP consists of six divisions and one office as follows: (1) Executive Planning Division; (2) Division of Wind, Solar and Small Hydro Power Promotion; (3) Division of Energy Efficiency and Conservation Promotion; (4) Division of Alternative Energy "Hydrogen, Methanization and Nuclear" promotion; (5) Bio-Energy Promotion Division; (6) Rural Electrification Promotion Division, and (7) the Energy Management Fund Office.

STI Institutions within the business – enterprise sector

NAM THEUN 2 POWER COMPANY (NT2)

Nam Theun 2 Power Company is the first hydroelectric dam project in Lao PDR that was made possible through a public-private partnership guaranteed by the World Bank. Although it has a potential of 6000 GWH, the dam was not economically viable because the domestic economy was only able to use less than 5% of its output. To begin, the project required private sector insurance guarantees, and distributed risk among twenty-seven institutions. The hydroelectric dam project started by guaranteeing to provide 95% of its electricity for export. Thai EGAT, the electricity company of Thailand, became the guaranteed buyer at a set price. In order to begin operating, Nam Theun 2 imported technology and expertise. The concession agreements became the mechanism that enforced and provided financing and technology for the project. With all the international partners involved, the agreements were also a means to introduce best practices to Laotian industry and government. In addition to the financial, labour and technology specifications, the agreements established social welfare provisions for the affected populations. Source: Lee; Maliphol and Kang (2014)

DAO-HEUANG GROUP

Headquartered in Vientiane, the Dao-Heuang Group is a conglomerate that specializes in import-export and consumer goods. It began as an importing company that supplied international goods to the domestic market and exporting raw materials abroad. The founder of the Dao-Heuang Group originally developed business plans based on exposure and knowledge of foreign business management. It now has duty free shops at airports and border checkpoints. Since Lao PDR is landlocked, the Dao-Heuang Group targets neighbouring country markets, mainly with sugar, instant coffee and organic foods. Plans also include expansion into pharmaceuticals. Coffee is one of the Dao-Heuang Group's principal consumer products.

The business model is based on the Vietnamese coffee industry. Local coffee is sourced from domestic farmers. In order to develop its production capacity, an instant-drying technology was imported from Denmark. The company financed the venture using bank loans. In order to access skilled labour to operate and maintain the technology, Vietnamese workers are employed. The company has also been supported with government policies including tax exemptions for exports and land concessions. Restrictions on foreign ownership of property also encouraged foreign direct investment to partner with companies like Dao-Heuang. Source: Lee; Maliphol and Kang (2014)

ELECTRICITÉ DU LAO (EDL)

Electricité du Lao is a state-owned utility company under the Ministry of Energy and Mines that autonomously manages the hydroelectric production in the country. Lao PDR uses international agreements to meet market demand for electricity. The agreements are used to arrange financing, technology and expertise to facilitate the functioning of its electricity infrastructure. The government is expanding its infrastructure and was advised to build a smart grid. Feasibility studies are being conducted using technology supplied by US companies. Pilot projects are held in industrial zones with funding from China. The next stage of the project will commence in 2015. Hydroelectric dams were first established using public-private partnership models that enabled their construction. All dams are suppliers to *Electricité du Lao*. Electricity generation is handled internally and externally through independent and small power producers. There is usually a surplus of electricity, but it is seasonal, so Lao PDR must import during the dry season. *Electricité du Lao* buys electricity from companies that construct the dams but does not work directly with construction companies from the dam.

The company supplies electricity to Lao PDR nationally and exports to neighbouring countries. There is limited capacity to meet household demand but 90% of the population is connected to the grid. Industry is the main consumer of electricity, especially in the industrial zones. Companies that consume to most electricity are mainly steel-rolling factories, hotels and other manufacturing firms. Many companies are under Chinese control through investment/land ownership, which is why China funds related projects. Source: Lee; Maliphol and Kang (2014)

ETL

ETL provides telephone and internet communications services in Lao PDR. Although it is a state-owned enterprise, ETL operates independently from the government. The technology for the hardware and software infrastructure was acquired from abroad through licensing. Since it began, it has been growing quickly in subscribership and in the number of services, focused on the domestic market. Through advertising and market development (i.e. new services), it targets tourists and young users. It mainly licenses its technology in an attempt to keep up with the rapid pace of global technology. ETL is expanding its services to increase its market appeal, especially for young Laotians and tourists. SMS is currently limited by Lao language availability and literacy. There are in-house and outsourced customization services being developed but there are few suppliers and experts who have the technical capabilities. These limitations also extend to policy, which creates an environment that allows the company to operate more freely but also fails to support necessary infrastructure required for growth. Policy can encumber the company by imposing regulations that are difficult to meet. For instance, ETL is expected to provide universal coverage throughout the country but this means that it must enter markets that are not profitable. The human resource development is an area that requires attention for the company to become more competitive because the education system does not provide needed skills for the company to operate fully. Source: Lee; Maliphol and Kang (2014)

PHARMACEUTICAL COMPANY No. 2

The Pharmaceutical Company No. 2 is a state-owned enterprise that uses imported machinery at two factories to produce 200 medicines for four hospitals. The Ministry of Health manages factory production goals, which now includes integration into the ASEAN Community. A new factory is planned. It develops the formulas domestically but most originated in the former Soviet Union and Germany. The company currently produces vaccines but cannot expand its production. The company employs twenty pharmacists, who are trained at the pharmacy college at the medical school and an herbal medical school in Lao PDR. Source: Lee; Maliphol and Kang (2014)

Higher Education Institutions

NATIONAL UNIVERSITY OF LAOS

Address: Dong Dok Campus, Vientiane, Lao PDR
Telephone: +856-21 770070
Fax: +856-21 770070
URL: http://www.noul.or.la/

Vision: The NUOL is to be the centre of excellence in higher education, research and cultural preservation and contribute to capacity building, to the strengthening of human resources through fostering intellectual vitality, promoting knowledge and skills, positive attitudes, loyalty, dignity, good physical and mental health. One of the aims is to make the university's graduates the most-sought-after human resources for the country's and, at large, the region's most demanding employers and to enable them to become accomplished professionals.

Mandate/mission: The NUOL's mission is to support Laos' development in a suitable, efficient and equitable manner. It can be broken down as follows:

1. To create and provide training and thus contribute to the development of the country's human resources. Students are to acquire knowledge and to receive training so as to become academicians, administrators or researchers equipped with high knowledge, skills, expertise, and an overall ability to innovate as well as a solid moral background;
2. To conduct and promote, alongside regular curriculum, research so as to buttress the country's economic and social development;
3. To disseminate research findings and provide academic and technical services to society in an efficient way; and
4. To preserve and expand the arts, culture and traditions of our multi-ethnic nation, while acknowledging and respecting world culture.

Brief description of main activities: n/a

Staff: 7 Professors, 133 Associate Professors, 58 Lecturers, 6 Lecturer Assistants with the following distribution of academic degrees: 129 PhDs, 803 master's degrees, 9 Post Bachelor's degrees, and 920 bachelor's degrees.

Distributions of the Faculties and Departments: (1) Faculty of Letters; (2) Faculty of Education; (3) Faculty of Social Science; (4) Faculty of Natural Sciences; (5) Faculty of Environment science; (6) Faculty of Forestry Science; (7) Faculty of Agriculture; (8) Faculty of Architecture; (9) Faculty of Engineering; (10) Faculty of Law and Political; (11) Department of Communication and (12) Department of Electronics.

The university is part of the following regional networks: (a) ASEAN University Network (AUN); (b) ASEAN University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-NET); (c) *Agence Universitaire de la Francophonie* (AUF) and (d) Greater Mekong Sub-Region Academic and Research Network (GMSARN).

Historical notes: NUOL was established by merging the higher education institutes which were under the supervision of several ministries into one university under the Ministry of Education in accordance to the Decree Number 50/PM of the Prime Minister of the Lao PDR dated 9 June 1995.

NUOL is a multi-campus structure, with eight campuses including Done Koy campus (Sethathiraj Hospital) scattered within a 30-km radius of Vientiane. NUOL has eleven faculties, a School of Foundation Studies, a Central Library, six Centres and a small hospital.

NUOL has played a role in providing higher education in areas required for the socio-economic development of Lao PDR; performing research in natural and social sciences; preserving the arts, culture and traditions of the nation; and providing academic services to society. It is known for its diversity: bachelor's degrees in all and some master's degree programs in some of its academic disciplines are available, and it is preparing to offer Doctoral degree programs.

Since the opening of its first academic year on 5 November 1996, the number of students has increased from 8,053 (including 2,170 women) to more than 26,000 in the academic years of 2005–2006. At present, NUOL is recognized as one of the main and most important public organizations in the Lao PDR; it employs 1,884 teaching and administrative staff (862 are women).

The IT Centre of NUOL was upgrading its ICT system in line with the First Development Plan, in academic year 2004–2005. Achieving the goals of the next Development Plan (2005–2010) is under preparation, which includes issues such as the development of the network; Internet services; the application of ICT technology in the teaching-learning activities, research activity as well as the planning and management of NUOL.

Staff: 7 Professors, 133 Associate Professors, 58 Lecturers, 6 Lecturer Assistants with the following distribution of academic degrees: 129 PhDs, 803 master's degrees, 9 post-bachelor's degrees, and 920 bachelor's degrees.

Outputs: n/a

BANKEUN TEACHER TRAINING COLLEGE

Address: Road No.10, Ban Keunnua, Toulakom district, Vientiane Province, Lao PDR
Telephone: +856-23 241032
Fax: + 856-23 241032
E-mail: ttcbankeun@gmail.com
URL: http://www.bankeun-ttc.edu.la/

Mandate: Bankeun Teacher Training College plays a role to create teachers with good skills and quality to support the need of Vientiane and Borikhamxay provinces. Bankeun Teacher Training College is an educational institution that promotes learning to develop creative thinking as well as provides advanced education, research, and advances students to a high level of the technical quality standards through excellence in biology and Lao language learning for the domestic and international community.

Vision: To develop creative thinking for the modernization and to conduct research to high quality standards in association with the domestic and international community

Mission: Create and train teachers for all levels with good quality based on 3 characteristics and 5 principles of education. Be an excellent human resource provider in vocational education and to meet the needs of market.

Historical notes: This institution was established in 1968 as a teacher training school. Between 1968 and 1975 there was a short-term training course for primary school teachers; then between 1975 and 1988, teacher training for primary and secondary school teachers was established.

Brief description of main activities: training for vocational teachers

Staff: In 2016 the institution had 120 teachers (56 women); 24 administrators (14 women). The total staff was 144 (68 women).

Outputs: Bachelor course: Mathematics, Physics, Chemistry, Biology, English (12+4 system); Diploma course: Kindergarten, Letters and Literature (12+2 system) Since 2005–2016. The total number of graduates is 12 101 persons, of whom 6 390 are women.

University structure: The College consists of 7 offices: Programme Offices (covering English, Science and Mathematics, Social Science, and Kindergarten-primary School), the Administration and Finance Office, the Teacher development Office, Student Affairs, and Monitoring and Evaluation Office.

Description of the research centres: 1. Experimental study on Mastery learning model in Teaching Chemistry and 2. Experiment Study on Teaching Sciences through Inquiry Based on lesson Integrated with Questioning Method in Secondary School.

University structure: n/a

CHAMPASACK UNIVERSITY

Address: Km 7, Ban Chatsanh, Pakse District, P.O. Box 81, Champasack Province, Lao PDR
Telephone: +856-31 260158
Fax: +856-31 260158
Email: cu.piu@hotmail.com or Scienctific456.Uni@gmail.com or kychu77@yahoo.com
URL: http://www.cu.edu.la/

Mandate: n/a

Vision: To be a centre of education, scientific, researcher and academic services.

Mission: (1) Improving education quality and relevance; (2) promoting scientific research and academic service to meet the national and local socio-economic development plan; (3) promoting disadvantages to access higher education; (4) promoting sport, preserve magnificent national arts, culture and tradition and (5) enhance international and national academic cooperation.

Brief description of main activities: (1) Providing Teaching-learning at the higher education level; (2) developing scientific, interdisciplinary and applied research; (3) providing capacity building and academic services base on communities-base in accordance to government policy for better well-being of its people.

Historical notes: In 2002, National University of Laos set up its branch in Champasack Province with the Prime Minister's decree number 214/PM, dated 28/11/2002. In 2004 that branch was upgraded and call name as Champasack University according to the Prime Minister's decree number 95/PM, 5/7/2004.

Strategic Planning: (1) Improve the organization to be entire, strong and suitable with current need; (2) upgrade staff, teachers on professional in management and administration with standard and good morality; (3) develop learning-teaching materials to meet the standard, aligned to current socio-economic development and international integration; (4) improve infrastructure, equipment and other facility for learning and teaching activities; (5) encourage the research in natural and social sciences, (6) develop a research centre; (7) create and maintain the data and information system; (8) create and maintain the quality administration; (9) improve security system; (10) extend the national and international cooperation and (10) encourage the social activities.

Curriculum: Bachelor's degree has a 4-year course and 27 programmes. The Associate degree has a 3-year course and 7 programmes. The Continuing programme for bachelor's degree has a 2-year course and 13 programmes.

Description of Research Centres: Champasck University has focussed on agriculture and will be a centre of excellence in Agriculture. Importantly, it also has 3 demonstration centres for agricultural experiments with a total land area of 65.8 hectares. Up to now, CU's researchers have experimented in relation to:

- *Cattle:* Improved breeding; nutrition; multi-nutrients; pasture and foliage;
- *Pigs:* Improved breeding; nutrition;
- *Goat:* Improved breeding; nutrition; multi-nutrients; pasture and foliage
- *Poultry:* Improved breeding; nutrition.
- *Agronomy:* Seeds, plants breeding (rice), organic and chemical fertilizer;
- *Wild-life:* a survey in the triangle of Cambodia-Lao PDR- Thailand borders.

Furthermore, the Centre Laboratory of the University is playing a vital role for scientific examination on food contaminations as well as agricultural product contaminations, for instances pesticide residues and chemical residues. Interestingly, the Faculty of Economics is also famous for the evaluation of environmental and recreational services.

Outputs/Publications: Since its establishment, the University has published its research only in own journal called "Scientific Journal" and its 2nd edition was to be issued in July 2017.

Staff: administration personnel (52 men and 13 women), researchers (105 men and 30 women) and students (2 617 men and 2 158 women)

LAO-AMERICAN COLLEGE (LAC)

Address: Kaisone Phomvihane Road, Saysettha District, P.O. Box 327, Vientiane Capital
Telephone: +856-21 900454
Fax: +856-21 900453
E-mail: thelaoameriancollege.com
URL: http://lac.edu.la/index.html

Mandate: n/a

Vision: n/a

Mission: LAC's mission is to promote quality education and standards of active learning to develop Lao human resource potential, and to help develop productive citizens to eradicate poverty and develop leadership by using its slogan "Think globally, study locally."

Historical notes: LAC was started as LALC (the Lao-American Language Centre) and opened on NongBone Road January 15, 1993. It was a wholly foreign-owned enterprise, and this represented the first license for a school granted to an American citizen. Then initial enrolment was 60 students and rapidly began to increase. LALC moved to Phonekheng Road and remodelled a much larger building in use by Soutsaka Institute until recently. In 1997, LALC became the Lao-American College and awarded its first bachelor's degree when for the first time the Lao Ministry of Education granted this privilege to a private college. Shortly thereafter, LAC became a partnership, American and Lao, with Virginia Van Ostrand (Ginny) and Thongsone Phoutsavath. Ginny wanted the college to become an integral part of Laos, not just a foreign entity. A new campus was formally dedicated and opened in 2001. Later on a Bachelor of Arts degree and IT coursework + computer labs were added. In 2003, LAC added the first Microsoft Unlimited Potential Centre in Laos. Two more centres opened in the provinces in 2006 and 2007, to help develop Lao human resource potential through promotion of computer skills and use. Successful students receive a Microsoft diploma. In 2005, LAC also opened the first Cisco Academy in Laos, to help develop networking skills among our people. The Lao-American Centre, a library provided by the US Embassy, became the first such Centre in Asia in 2004. It was expanded in 2006 and has promoted reading habits in English, study, and programs of public interest. It is a very popular place with a warm and welcoming atmosphere and is never empty. Both LAC students and the public at large are welcome to use this facility.

Brief description of main activities: Currently, LAC is working on a proposal for a third major field of studies, and a possible fourth. There are also two special projects underway that will be announced in the near future. A passing grade at LAC requires a minimum grade of 70% out of a possible 100%. This is also

being implemented in the Chansavanh Division. A bachelor's degree requires a grade point average of 75 % minimum.

Staff: n/a

Outputs: n/a

University structure: n/a

Description of the research centres: n/a

LAO-TOP COLLEGE

Address: Phonpapao Village, Sisattanak District, Vientiane Capital
Telephone: +856-21 353900
Fax: +856-21 353901
URL: http://laotop.net/

Vision: To become the nation's leading educator by setting the standards of excellence in innovative curriculum design, teaching, professional development, and cross-cultural understanding, ensuring that our students are prepared to face the challenges and opportunities that await them in the world.

Mission: Prepare the next generation of leaders and young professionals to meet the demands of a new world, a complex global-society of understanding relationships which will bring a needed change for a future of peace and prosperity. This is done through the support of a core base of highly educated instructors who hold a passion for education and development and have the ability to touch the hearts of our eager students.

Staff: 19 persons (8 women)

Description of the research centres: Lao-Top Research Centre was created for the college research; including planning training for teachers and staff and making some books for a college use and society.

LUANG PRABANG TEACHER TRAINING COLLEGE

Address: n/a
Telephone: +856-71 212058
Fax: n/a
URL: http://luangprabang-ttc.edu.la/lp2013/

Mandate: The Luang Prabang Teacher Training College has a role to develop and retrain teachers at a good quality level for 6 Northern provinces. It aligns with the new education policy and strategy of the Ministry of Education and Sport of Lao PDR.

Vision: To create excellent professional teachers with virtue, who promote traditional local culture, develop good learning environments and are prepared to meet the international level standards.

Mission: n/a

Historical notes:

- 1959: established
- 1961–62: Ecole normal Section 1-year
- 1964–65: Ecole normal Luang Prabang
- 1975–83: 2nd Ecole normal Luang Prabang
- 1984–92: Branche of Teacher University Luang Prabang

- 1993–2000: Teacher College
- 2000–present: Teacher Training College

Brief description of main activities: n/a

Staff: n/a

Outputs: n/a

University structure: n/a

Description of the research centres: n/a

LUANGNAMTHA TEACHER TRAINING COLLEGE

Address: n/a
Telephone: +856-30 9214000
Fax: n/a
URL: http://luangnamtha-ttc.edu.la/

Mandate: Luangnamtha Teacher Training College established in 1968 and has a mandate to create teachers for 4 northern provinces.

Vision: Create LTTC to be a good quality teacher school with fruitful skill and upgrade ethnic teacher to local and region level.

Mission: n/a

Historical notes: In 1968 was established and located in So vieng village, Luangnamtha district.

Between 1968–79 it was transformed into a teacher school

Brief description of main activities: n/a

Staff: n/a

Outputs: n/a

University structure: n/a

Description of the research centres: n/a

NORTHERN AGRICULTURE AND FORESTRY COLLEGE

Address: P.O. Bo 154, Luang Prabang
Telephone: +856-71 219 036
Fax: +856-71 219 034
URL: https://nafclao.org/

Mandate: The Northern Agriculture and Forestry College (NAFC) in Luang Prabang offers practice oriented-training to educate Lao students in technical fields including agronomy, livestock, fisheries, forestry and agribusiness. The college uses a skills-based approach which puts the student at the centre of the learning process and emphasizes on the practical application of knowledge and skills.

Historical notes: The college is located in Pakseuang, 25 kilometres North of Luang Prabang. The campus covers a total area of 51 hectares which used to be the Royal Gardens from the Lao King's Family until 1975. The college was officially established on 20 November 1989 by the government of Luang Prabang and the Ministry of Agriculture and Forestry and was called Northern Agricultural School. Mid diploma courses were

offered in Agronomy and Livestock & Fisheries. In 1999, the Northern Agricultural School merged with the Northern Agriculture and Forestry Training Center in Xieng Nguen District and changed its name to Luang Prabang Agriculture and Forestry College with a mid-diploma status. By 2010 the college changed its status to the Northern Agriculture and Forestry College, offering High-Diploma courses in upland agriculture and forestry. The 3-year courses are offered in 4 majors: Agronomy, Livestock & Fisheries, Forestry, and Agribusiness. Additional upgrading courses of 1.5 years were offered in the 3 majors Agronomy, Livestock & Fisheries and Forestry.

PAKSE TEACHER TRAINING COLLEGE

Address: Road No 13 South, Ban Xok am nua, Pakse district, Champasak Province, Lao PDR
Telephone: +856-21 212262
Fax: +856-21 212262
URL: http://www.pakse-ttc.edu.la/

Mandate: Pakse Teacher Training College is responsible for training fully skilled teachers for primary and secondary schools, and also for kindergartens.

Vision: Train professional teachers who can use Indigenous Knowledge and Technology, and care for the Natural Environment and Social Development.

Staff: 66 persons (women 34)

RATTANA BUSINESS ADMINISTRATION COLLEGE (RBAC)

Address: Suphangthong Nuer Village, Sisattanak District, Vientiane Capital.
Telephone number/Fax: +856-21 413871/413820
Email: contact@rbac.info

Name of the executive head: Dr Somphet Rattanasin
Website: www.rbac.edu.la

Mandate: Educate students according to the three characteristics and five educational principles. Train qualified teachers with real experience in business. Support educational research and provide services to the community.

Vision: To become a qualified institution with superior standards in business administration to serve society.

Mission: To educate students to be able to apply skills and knowledge effectively in real practice by training qualified teachers in business administration

Brief description of main activities:

RBAC conducts the curriculum according to the MOE approval in 5 majors: management, finance and banking, marketing, accounting and business English

Staff: administration personnel (54 men and 37 women), researchers (3 men and 2 women) and students (651 men and 897 women)

Description of the research centres: n/a

Historical notes: The establishment date is the 2nd March 1974 as a vocational school. In 1994, it was upgraded to RBAC. In 2002 was recognized by the Ministry of Education (MOE) to teach a bachelor's degree and in 2006 was approved by the MOE to teach master's degree.

Table 36: Distribution of personnel and students by sex and level of education at the Rattana Business Administration College, 2014–2016

Level of education	2014				2015				2016			
	Personnel [HC]		Student Enrolment [HC]		Personnel [HC]		Student Enrolment [HC]		Personnel [HC]		Student Enrolment [HC]	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
PhD	5	1			4	1			4	1		
Master	45	25			32	25			29	25		
Bachelor	34	25	925	661	28	15	261	367	22	12		
Diploma			518	638			643	860			819	1 074
Total	**135**		**2 746**		**105**		**2 131**		**93**		**1 893**	

SARAVAN TEACHER TRAINING COLLEGE

Address: Road 15A and 15B, Ban Na Don, Saravan district, Saravan Province
Telephone: +856-34 211 227
Fax: +856-34 211 227
URL: http://salavan-ttc.edu.la/

Mandate: Select students with sufficient requirement and provide teaching-learning process to meet local needs, upgrade skill and experiences of teachers through range of efforts, built capacity of administrative staff and ensure to provide good quality education at the college, develop suitable curriculums with aligned to formal school, monitor and evaluate the encouragement of professional development.

Staff: In the period 2007/08 there were 56 administrative staff (24 women) and 18 teachers (10 women).

SAVANNAKHET TEACHER TRAINING COLLEGE

Address: Road No 9, P.O. Box. 809, Oudomvilay Village, Kaisonphomvihan District, Sannakhet Province, Lao PDR
Telephone: +856-41 212180
Fax: +856-41 213667
E-mail: sananttc@yahoo.com
URL: http://183.182.99.92/

Mandate: STTC has a role to create and develop high quality teachers.

Vision: Savannakhet Teacher Training College is the Centre of professional development with high quality and ethic teachers, research-oriented, and international cooperation.

Mission: n/a

Historical notes: STTC was established in 1966 with the name *"Ecole Normale Savannakhet"*

Brief description of main activities: n/a

Staff: n/a

Outputs: n/a

University structure: n/a

Description of the research centres: n/a

SAVANNAKHET UNIVERSITY

Address: Naxeng Campus, Naxeng Village, Kaisonephomvihane District, Savannakhet Province, Lao PDR, P. O. Box: 14
Telephone: +856-41 253286
Fax: +856-41 253286
Email: info.usavannakhet@skulao.org
URL: http://skulao.org/

Mandate: Savannakhet University (SKU) is one of four universities in Lao PDR. The Prime Minister of Lao PDR promulgated the decree No 091/PM officially authorizing the establishment of Savannakhet University on 27 March 2009. This date is therefore considered the date the University was founded.

Vision: n/a

Mission: (1) SKU Development is aligned with the socio-economic development strategy of the three provinces (Savannakhet, Khammouane and Bolikhamxay); (2) provide equal access to higher education for both the urban and rural people, in particular, underprivileged people from rural and remote area; (3) development of SKU must be closely related to national strategy of education development so as to gradually approach the national and international standard and (4) Centre for human resources development, in the central region.

Historical notes: n/a

Brief description of main activities: n/a

Staff: Academic and administration staff: 321 persons (148 women) and training staff: 43 persons (20 women). The distribution according to the educational level and gender is the following: 4 persons with Ph.D. (0 women); 23 persons with M.S. 23 (8 women); 133 persons with B.S. (44 women); 53 persons with Diploma (43 women), 16 persons with Middle Diploma (15 women) and 7 persons with First state levels (6 women).

Total number of students: 3 442 persons (1 820 women)

University structure: To fulfil the instructional process the University has 6 faculties (Agriculture; Business Administration; Linguistics; Food Science; Natural Sciences, and Education), one Information Technology Centre and a Secondary School for Ethnic and Talent Students.

Description of the research centres: The University has one Office of Research and Science Management and one Research Centre.

SOUPHANOUVONG UNIVERSITY

Address: 13th North street, Donmai Village, Luangprabang city, Luangprabang province, Lao PDR.
Telephone: +856-71 254931
Fax: +856-71 254934
URL: http://su.edu.la/

Mandate: According to the Prime Minister Decree on the Organization and Activities of Souphanouvong University, No. 099/PM, dated 3 April 2009, SU is a public national educational and cultural institution under the Ministry of Education. The University carries out the educational functions of preparing specialists, researchers and multidisciplinary scientific scholars; organizing scientific research; protecting and promoting Lao's unique national and multi ethnic arts and culture; and delivering academic services to society.

Vision: n/a

Mission: n/a

Historical notes: It was established in accordance with the Prime Minister Decree, No. 169/PM, dated 4 November 2003, and inaugurated on the following day. The University is named after Prince Souphanouvong, who was the first President of the Lao PDR.

Brief description of main activities:

Staff: 400 persons and 4 000 students

Outputs: n/a

Description of the careers, degrees, post-graduate degrees: Souphanouvong University currently runs 20 undergraduate bachelor's degrees, each of 4-year duration. The Faculty of Education offers three degree-programmes: Lao language and literacy, English, and mathematics. The Faculty of Economics and Tourism has six programmes: economics, general business management, tourism management, IT business management, international business management, and finance and banking. The Faculty of Agriculture and Forest Resources offers four programmes: plant science, animal science, forest resources, and food science and technology. The Faculty of Engineering has three programmes: electrical engineering, computer engineering, and civil engineering. The Faculty of Architecture offers two programmes: architecture and interior design. The Faculty of Languages has two programmes and two centres: Lao language, general English language, Korean Language Centre and the Chinese Language Centre.

Description of the research centres in the university: Souphanouvong University has established academic relations and cooperation with 33 universities and organizations in neighbouring countries such as Vietnam, China, Cambodia, Thailand and the Republic of Korea. The main cooperation activities are focused on scholar and student exchanges, library book and computer supply, as well as co-organizing international seminars, workshops and meetings.

SOUTSAKA COLLEGE

Address: P. O. Box 390, Phonepanoa-Phonetong Road, Phonpanoa Village, Saythany District, Vientiane Capital, Lao PDR
Telephone: +856-21 900 337, 261 140
Fax: +856-21 900 338, 261 141
URL: https://www.scmt.edu.la/story.html

Mandate: Soutsaka College is a higher education institution established in 2002. Its role is to develop human resource in business administration and information technology fields to support the need of national socio and economic devilment.

Vision: Soutsaka College aims to become a first-rate higher education institution in Lao PDR with international quality standards, and to provide education, research and training for society and encourage international cooperation and student exchange in all its technical areas.

Mission: n/a

Historical notes: n/a

Brief description of main activities: n/a

Staff: n/a

Outputs: n/a

University structure: The Soutsake College promotes human resources at post diploma level, offering bachelor's degrees in business administration, accounting, IT and computer engineering.

Description of the research centres: n/a

UNIVERSITY OF HEALTH SCIENCES

Address: Samsenthai Road, Phivat Camps, Sisattanak District 1001, Vientiane Capital, Lao PDR
Telephone: +856-21 222883
Fax: +856-21 210455
E-mail: contact@uhs.edu.la
URL: http://www.uhs.edu.la/

Name of the executive head: Dr Phouthone Vangkonevilay, Acting President.

Mandate: The University of Health Sciences (UHS) is a unique health institution that produces health professionals at higher level (bachelor's degree) in Lao PDR. The University has three main functioning roles: training, service and research.

Mission: The mission of the University is "working together to improve the health of all the people of Lao PDR through contribution to education, research and service to the community".

Vision: The vision of the UHS is to be recognised in the region as an institute of high learning that is contributing to the production of knowledge and education of high quality, training health personnel who are motivated to serve the people of Lao PDR and committed to lifelong learning.

Historical notes: The University of Health Sciences (UHS) was founded in 1969 as the Royal School of Medicine in Vientiane and re-named in 1975. There are about 1 000 students enrolled in three programs staffed with about 50 full-time and 50 part-time teachers. General medicine is the largest faculty with about 700 of the students enrolled in a 6-year course. Pharmacy has about 200 of the students enrolled in a 5-year course, and dentistry has about 100 of the students enrolled in a 4-year course. Programme completion rates are 85% for general medicine, 79% for pharmacy, and 92% for dentistry.

Brief description of main activities: Training, service and research

Staff: administration personnel (88 men and 156 women), researchers (20 men and 15 women) and lecturers (93 men and 106 women)

University structure: The University of Health Science consists of the Cabinet Office, 7 faculties and one centre namely, (1) Faculty of Medicine; (2) Faculty of basic Science; (3) Faculty of Dentistry; (4) Faculty of Pharmacy; (5) Faculty of Medical Technology; (6) Faculty of Nursing; (7) Faculty of Post Graduate Studies and (8) the Centre of Education Development

Outputs: Publications (incl. international): 312 published papers in peer-review journals since 1998 (72 in 2016).

Description of the research centres in the university: n/a

VIENTIANE-HANOI FRIENDSHIP TECHNICAL VOCATIONAL COLLEGE

Address: Nongbone Road, Naxay Village, Saysettha District, Vientiane Capital
Telephone: +856-21 412461
Fax: +856-21 453126

Name of the executive head: 1) Mr Bounphom Keomiphit, 2) Mr Sonexay Phanthavong
E-mail: vihatec@yahoo.com
URL: http://business-computer-department.blogspot.com/ or www.vihatec.edu.la

Mandate: Vientiane-Hanoi Friendship Technical Vocational College has a mandate to develop human resources in the fields of computer engineering, office management, accounting and electronics and train technical staff in those areas. Moreover, VIHATEC has the role to research and develop efficiently applications of information technology, so as to meet needs of the country.

Vision: By 2025, Teachers and Students will have advanced knowledge in the field of science and technology equal with some ASEAN countries.

Mission: Developing knowledge-learning ability and stronger teaching. Train teachers to able use and produce teaching and learning materials. Improving laboratories, training room and other facilities to be able to provide services for private sectors. Promote cooperation in research and development with all local and international enterprises.

Brief description of main activities: Teaching students in the field of computer engineering, business management, and accounting and information technology. Carry out research and development in information technologies. Provide training courses for technical staff of enterprises.

Outputs: Attend the 8th ASEAN Skill Competition in 2010 in Bangkok, Thailand, won the 4th place. Participation of the ASEAN Student Competition in 2014 and 2015, in Thailand.

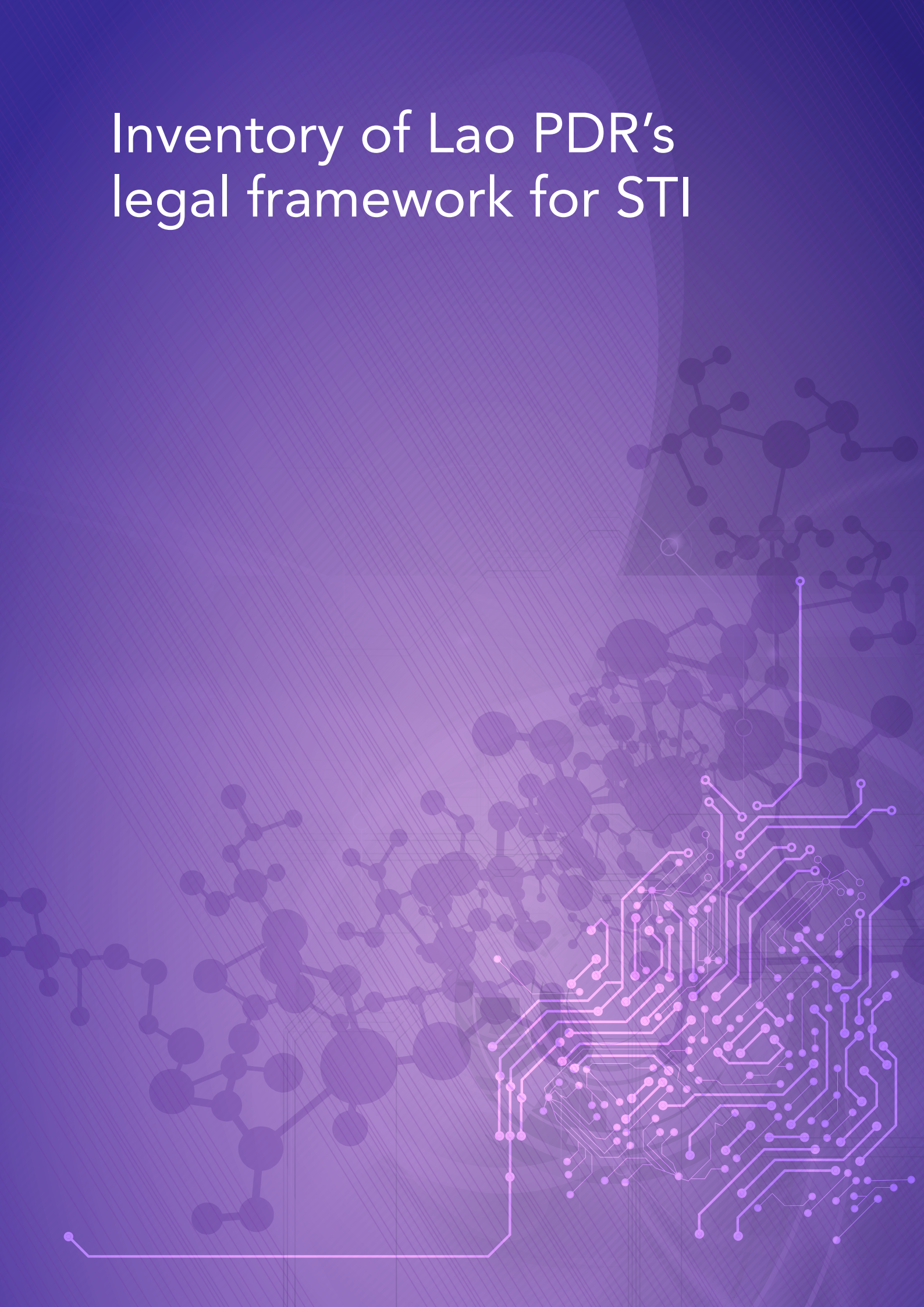
University structure: There are five fields of study, such as (1) computer engineering; (2) business administration; (3) office management; (4) electronics and (5) accounting.

Historical notes: The school was established in 2004 and upgraded to become a technical vocational college in 2014.

Table 37: Distribution of personnel and students by sex and level of education at the Vientiane-Hanoi Friendship Technical Vocational College, 2014–2016

Level of education	2014				2015				2016			
	Personnel (HC)		Student Enrolment (HC)		Personnel (HC)		Student Enrolment (HC)		Personnel (HC)		Student Enrolment (HC)	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
PhD					0	1						
Master	3	2							2	0		
Bachelor	0	1	124	107	0	1			3	3		
Diploma			213	138			243	173			280	195
Certificate			61	55	1	0	54	39			79	91
Total	**6**		**698**		**3**		**509**		**8**		**645**	

Inventory of Lao PDR's legal framework for STI



A country's legal framework represents a collection of legal processes and legal instruments, which embody a given policy or parts of it in the form of a law, decree or policy regulating an area of activity. Formal agreements, contracts and international STI co-operation treaties may also be included in this category. A legal instrument elaborates a policy by stipulating obligations, rights, rewards and penalties connected with its observance. The STI legal framework of the Republic of Lao PDR is presented hereafter.

NATIONAL LAWS AND ACTS

Laws pertaining to higher education and scientific research

LAW ON SCIENCE AND TECHNOLOGY No. 30–13

Date of Enactment: 19 August 2013

Description: This Law determines the principles, rules and measures relating to the management and monitoring of scientific and technological activities to enable such activities to develop in a systematic manner with an aim to enhance and promote scientific research, application of science, transfer of technology, invention, innovation and new advanced technology services that contribute to industrialization and modernization as well as socio-economic development and national protection and regional and international integration.

URL: http://www.laoofficialgazette.gov.la/

Laws pertaining to intellectual property rights

LAW ON INTELLECTUAL PROPERTY, No. 01/NA

Date of Enactment: 20 December 2011

Description: The law on intellectual Property determines the principles, regulation and measure relating to the promotion inventions, creativities, knowledge- based economy, management and protection of intellectual property right, in order to ensure the legitimate interest of the owner of intellectual property and interest of states, social, encourage the research and develop science and technology, transfer of technology within the country and from abroad, effectively aiming to promote trade, investment and the competitiveness for the national economy in the era of globalization, contribute in the gradual industrialization and modernization of the country. Intellectual property is the work of the human mind through inventions and creations.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=13482
or http://www.laoofficialgazette.gov.la/

LAW ON ENTERPRISES No. 11/NA

Date of Enactment: 9 November 2005

Description: For provisions relating to intellectual property, see: Chapter 3 'Name of enterprise', Article 21 'Selection of name of enterprise', Article 22 'Forbidden names', Article 23 'Allowing other persons to use name or license of enterprise', Article 24 'Liability for allowing other persons to use name or license of enterprise', Article 25 'Transfer and restrictions on transfer of name'.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5970
or http://www.laoofficialgazette.gov.la/

LAW ON THE PROMOTION OF FOREIGN INVESTMENT

Date of Enactment: 15 November 2005

Description: The Law on the Promotion of Foreign Investment defines the principles, regulations and measures regarding the promotion, protection and management of foreign investment in the Lao People's Democratic Republic, with the aim of enhancing relationships and economic cooperation with foreign countries, [enhancing] the utilisation of financial resources and knowledge to increase production capacity for the purpose of industrialisation and progressive modernisation as well as to contribute to gradually improving the people's living conditions and to strengthen and to develop the country.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5904
or http://www.laoofficialgazette.gov.la/

LAW ON NATIONAL HERITAGE No. 08/NA

Date of Enactment: 9 January 1995

Description: The Law on National Heritage determines the principles, regulations and measures for the administration, use, protection, conservation, restoration, [and] rehabilitation of the national heritage, and also determines the rights and duties of the State, social organisations and individuals to preserve the value of the national cultural, historical and natural heritage, with the aims of educating citizens to hold a conscious love for their nation and its fine national traditions that is deeply embedded in their hearts and can assure the elements for sustainable national prosperity.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5955

Laws pertaining to standardization

LAW ON METROLOGY, No. 07–10

Date of Enactment: 20 December 2010

Description: This Metrology Law determines the principles, rules and measures regarding the management and inspection of metrology activities in order to ensure that such work is carried out uniformly, properly and clearly, ensuring the justice and rights for business people and consumers in order to create conditions to facilitate production, services, exchange and trade, to ensure public safety and a just society, and to contribute to national socio-economic growth and environmental protection. Metrology is the science of measurement, and includes the functions required to ensure the uniformity of measurements within the Lao PDR and traceability to the International System of Units (SI), and to improve the quality of products and services to support domestic and international trade.

URL: http://www.laoofficialgazette.gov.la/

LAW ON STANDARDS (REVISED), No. 49–14

Date of Enactment: 18 July 2014

Description: The Standards Law determines principles, rules, measures regarding the establishment, activities, management, and inspection of standards and technical regulations for products, goods, services, processes, and the environment, in order to encourage, improve and ensure the production, services, social economic and environment protection in order to have the quality, efficiency, justice and rights, and the legitimate interests and safety of consumers in manufacturing, and will be a factor in managing the nation's economy and development. A standard is determined specific characteristics of products, goods,

services, processes, the environment, and other matters relating to standards, which are established for the valuation, classification, and quality ratings of these things. Technical regulation is determined ratings, scope, and specific technical characteristics of products, goods, services, processes, the environment, and other matters relating to technical regulation, which are established for use in regulation and inspection to ensure safety, sanitation, health, consumer interests, environmental protection, and the interest and security of the nation.

URL: http://www.laoofficialgazette.gov.la/

Laws pertaining to environmental protection

LAW ON ENVIRONMENTAL PROTECTION, No. 29–12

Date of Enactment: 18 December 2012

Description: The Environmental Protection Law defines principles, regulations and measures related to environmental management, monitoring of protection, control, preservation and rehabilitation, with quality, of mitigating impacts and pollution created by anthropogenic loads or by nature, aiming to provide balance between social and natural environment, to sustain and to protect natural resources and public health; and contribution into the national socio-economic development and reduction of global warming. Environment means any organic or inorganic features, existing naturally or created by mankind, and its surroundings [such as]: people, animals, plants and others, that have positive and negative interactions with and impact on each other, whether detrimental or favourable to the life, sustainability and development of humans and nature. Environment includes soil, water, forests, plants, animals, bacteria, mountains, cliffs, minerals, [and] air, which constitute the balance of the ecosystem. Archaeological artefacts, historical heritage, urban and rural settlements, buildings, vibrations, radiation, colours, and odours that are created by mankind are important elements of the environment.

URL: http://www.laoofficialgazette.gov.la/

LAW ON WATER AND WATER RESOURCE No. 02–96

Date of Enactment: 11 October 1996

Description: This Law on Water and Water Resources determines the necessary principles, regulations, and measures relating to the administration, exploitation, use and development of water and water resources in the Lao People's Democratic Republic, in order to preserve the sustainability of water and water resources, to ensure [that water is available in the] volume and quality necessary for the people's living requirements, to promote agriculture, forestry, and industry, to develop the national economy, and to ensure that no damage is caused to the environment.

URL: http://www.laoofficialgazette.gov.la/

LAW ON AGRICULTURE No. 01–98

Date of Enactment: 10 October 1998

Description: The Law on Agriculture determines principles, rules, and measures regarding the organisation and activities of agricultural production which is the basis of the country's economy. This includes management and preservation of agricultural activities and production with the following aims: to encourage, promote, and expand agricultural production; to guarantee the food supply; and [to guarantee] commodity production; to create favourable conditions for building and expanding agro-industrial processing; to contribute to national economic growth; to improve people's incomes; to strengthen the nation; and to avoid damaging and endangering the environment. Agriculture cultivation, animal husbandry and fishery for consumption and [for producing] food for the public, raw materials to supply industrial processing factories, and commodities for domestic consumption and export are all covered.

URL: http://www.laoofficialgazette.gov.la/

Laws pertaining to public health and bioethics

LAW ON BIOTECHNOLOGY SAFETY, No. 39–13

Date of Enactment: 18 December 2013

Description: This law defines the principles, regulations and measures on management and monitoring of biotechnology safety to ensure safety in research, development, handling, movement, and the use of Genetic Modified Organisms (GMOs) resulting from the use of biotechnology, which may result in having negative impacts on conservation and sustainable use of biodiversity, with a focus on the limitation and reduction of risks to the life and health of human beings, animals, plants and the environment that can be linked at the regional and international levels, and which contribute to national socio-economic development. Biotechnology safety guarantees the limitation and reduction of risks caused by GMOs to the life and health of human beings, animals, plants, the environment, and socio-economic development according to the results of biotechnological science-based risk analysis.

URL: http://www.laoofficialgazette.gov.la/

LAW ON DRUGS AND MEDICAL PRODUCTS, No. 01–00

Date of Enactment: 8 April 2000

Description: The Law on Drugs and Medical Products defines principles, rules and measures relating to the management of the cultivation, growing, preservation, exploitation, production, export, import, distribution, possession and use of drugs and medical products with the aim to ensure the supply of drugs and medical products that are of good quality, safe and appropriately priced, in order to prevent disease and provide treatment, ensuring the good health of the population.

URL: http://www.laoofficialgazette.gov.la/

BOX 20 – HEALTH POLICIES AND POLICY INSTRUMENTS IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

During the past two decades, Lao PDR has developed and adopted some 30 health policies, decrees and laws in the field of health (Jönsson *et al.*, 2015). The first systematic study on policies and policy instruments in Lao PDR was carried out with regards to pharmaceutical regulations (Stenson *et al.,* 1997 and Syhakhang, 2002). This is a good example providing a methodological approach which can be used for the analysis of other public policies related to science, technology and innovation at large.

Several studies showed that although knowledge about research is increasing among policymakers, the use of research in policymaking, particularly within the health public policies, is still very limited (Jönsson *et al.*, 2007).

After the establishment of Lao PDR in 1975, a cooperative-based health system was established but in less than a decade it collapsed. The failure of these policies paved the way for new reforms, resulting in the introduction of new economic policies in 1985–1986. These changes influenced health policies and led to rapid privatization of pharmaceutical distribution. Regulation of private pharmacies has been introduced gradually from 1988 and a National Drug Policy was adopted in 1993. The latter was the first ever comprehensive national health policy in the country. Until 1995 health care was free of charge in Lao PDR.

The Council of Medical Sciences (CMS) was established as an advisory body for health research to the Ministry of Health. The first five-year (1992-1996) master plan on health research priorities was established, followed by the second five-year (1997-2001) master plan, together with the development of legal instruments for public health. Health research activities became one of the nine work plans of the Ministry of Health. There was a skill development in research for its 156-health staff, including 95 from the central level and 61 from the provincial level, with training in research methodology in cooperation with international organizations such as IDRC, WHO, and SIDA (Ministry of Health, 2014).

In 1995, Prime Minister's Decree 52 aimed to provide fair and equal access of health care for the citizens and to enhance the quality of the services by introducing revolving funds for pharmaceutical drugs and a cost recovery system with user fees (Jönsson *et al.*, 2015).

In 2005, Decree 52 was revised and supplemented by the New Health Care Law. In 2013, the Decree 349 replaced Decree 52. In recent years, the Health Care Law has been reviewed in collaboration with the World Health Organization in order to identify the gaps so as to meet the on-going health sector reform strategy. The Ministry of Health of Lao PDR has identified a number of implementation challenges: targeting the poor, determining benefits, managing service delivery coverage and quality, accommodating the needs of ethnic minorities, developing administrative and payment mechanisms, among others (Annear *et al.*, 2008).

In the period 2000–2010, there was systematic cooperation at the international level, in particular with Karolinska Institute of Sweden (funding provided by SIDA) for developing Lao researchers under the national drug policy project, which training ranged from training in writing the research project proposals, to training in research implementation and in writing the research results for publication in various international journals. Through these activities, outstanding staff were selected to present the health research findings at an international forum and to upgrade their master's degrees and doctorate degrees in Thailand and Sweden. Research has been promoted by efforts to create a favourable research environment to support research culture in the health sector, including by introducing methodology of research in the curriculum of the community health subject for medical students who will write their final thesis before graduating with their bachelor's degrees at the University of Health Sciences. In 2009, a total of 453 health researchers graduated both in the country and abroad. Of these, 410 received master's degrees, 12 received post-graduate master's degrees and 31 received doctorate degrees (Ministry of Health, 2014).

While the Government has made significant investments in the rollout of free maternal, neonatal and child health care, health sector financing and domestic resource allocation need to be increased to achieve universal health coverage. Both the child mortality rate and maternal mortality rate reflect the low coverage and inadequate quality of the health services (United Nations, 2016).

According to Jönsson *et al.* (2015), "…the National Drug Policy was formulated and adopted in a short period of time in a resource-scarce setting, but with dedicated policy entrepreneurs and support of concerned international collaborators. Timely introduction of operational health systems research played a crucial role to support the implementation, as well as the subsequent revision of the policy. The development of the Health Care Law took several years and once adopted, the implementation was delayed by institutional legacies and issues concerning the choice of institutional design and financing, despite strong support of the law among the policymakers. Among many factors, timing of the implementation appeared to be of crucial importance, in combination with strong leadership."

The Ministry of Health (2014) established the Department of Training and Research to enhance promotion and macro management of health research. Meanwhile, the Law on Science and Technology was endorsed by the National Assembly, No. 03/NA dated 19 July 2013, and by the Presidential Decree, No. 169/P, dated 20 August 2013. A strategy on health research by the World Health Organization, published in 2012, was an additional basis to encourage and strengthen the promotion and management of health research. Another legal development relevant to health research is a Decree on the Science and Technology Development Fund endorsed by the government, No. 174/GOV, dated 23 May 2014.

NATIONAL DECREES

DECREE FOR THE SCIENCE AND TECHNOLOGY DEVELOPMENT FUND, No. 174/GOV

Date of Enactment: 23 May 2014

Description: This decree creates a funding mechanism for science and technology activities in Lao PDR

URL: https://www.most.gov.la/

DECREE ON IMPORT AND EXPORT OF GOODS, No. 114/GOV

Date of Enactment: 6 April 2011

Description: This Decree determines principles, rules and measures on import and export of goods in order to facilitate promote and administer the import and export, aiming at developing and strengthening socio-economy and contributing to the improvement of people's standard of living. Import and export means to bring goods into or export of goods out of Lao PDR, including temporary import and temporary export; and transhipment as set out under this Decree.

URL: http://www.laotradeportal.gov.la/

DECREE ON THE PROMULGATION OF THE AMENDED LAW ON INTELLECTUAL PROPERTY No. 054/PO

Date of Enactment: 16 January 2012

Description: Decree of the President of the Lao People's Democratic Republic on the Promulgation of the Amended Law on Intellectual Property Copyright and related rights (neighbouring rights), industrial property.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=13481

DECREE ON THE PROMULGATION OF THE INTELLECTUAL PROPERTY LAW No. 06/PO

Date of Enactment: 14 January 2008

Description: Decree of the President Lao People's Democratic Republic on the promulgation of the Intellectual Property Law. Copyright and related rights (neighbouring rights), geographical indications, industrial designs, layout designs of integrated circuits, patents (inventions), trademarks, utility models

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5900

DECREE ON PATENT, PETTY PATENT AND INDUSTRIAL DESIGNS No. 01/PM

Date of Enactment: 17 January 2002

Description: Lao PDR became a member of the ASEAN Common Filing System on Patents in 2000, but lacks qualified patent examiners. This Decree is the first one on the protection of patents, petty patents, and industrial designs. Enforcement of IP and related laws, industrial designs, patents (inventions), utility models are covered.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5787

DECREE ON IMPORT AND EXPORT MANAGEMENT No. 205/PM

Date of Enactment: 11 October 2001

Description: The Decree defines that any exported and imported goods require an authorization and all relevant documents certifying the origin of the goods and their quality. The decree also contains provisions relating to the punishment of violators.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=6028

DECREE ON THE PROMULGATION OF THE LAW ON AGRICULTURE No. 105/PO

Date of Enactment: 6 November 1998

Description: Decree of the President of the Lao People's Democratic Republic on the Promulgation of the Law on Agriculture which includes plant variety protection.

URL: http://www.wipo.int/wipolex/en/details.jsp?id=13640

DECREE ON THE PRESERVATION OF CULTURAL, HISTORICAL AND NATURAL HERITAGE No. 03/PR

Date of Enactment: 20 June 1997

Description: n/a

URL: http://www.micat.gov.la/images/document/pdf/provision001.pdf

DECREE ON TRADEMARKS REGISTRATION No. 06/PM

Date of Enactment: 1998

Description: n/a

URL: https://www.most.gov.la/index.php?option=com_content&view=article&id=173&Itemid=112&lang=en

NATIONAL REGULATIONS AND OTHER POLICIES

RENEWABLE ENERGY DEVELOPMENT STRATEGY IN LAO PDR

Date of Enactment: October 2011

Description: This strategy aims to develop new renewable energy resources which are not yet widely explored in Lao PDR to replace resources that will be exhausted in the future, also known as "non-renewable energy" (fossil fuels, coal, natural gas etc). These renewable energy resources comprise biomass energy (biofuels, biogas, ...); solar energy; wind; small hydropower. Energy is essential for meeting the peoples' basic needs as well as vital in fuelling economic development. The increase in population and economic growth have resulted in increase of energy consumption. Reserves of non-renewable energy, being the dominant traded energy commodity, are declining. In particular, liquid fossil fuels are estimated to be depleted within the next few decades. Many countries in the world have recognized the importance of renewable energies, and therefore have undertaken technology research and development, and have set up goals for the development and effective use of their Renewable energy resources.

URL: https://es.scribd.com/document/154710417/LIRE-Renewable-Energy-Development-Strategy-in-Lao-PDR

LAO PDR NATIONAL AGRO-BIODIVERSITY PROGRAM AND ACTION PLAN II (2015–2025)

Date of Enactment: December 2016

Description: The overall aim in preparing the Lao PDR National Agro-Biodiversity Programme (NABP-II) is to develop a strategic approach and framework for the sustainable use, development and conservation of agrobiodiversity in support of national priorities on food security, poverty-reduction and socio-economic development of the country. Agro-biodiversity is a subset of biodiversity and that can very simply be defined as the variety and variability of animals, plants, fungi and micro-organisms that are used directly or indirectly for food and agriculture. It includes crop, livestock, forest and fish resources and comprises the diversity of genetic material (species, varieties landraces and / breeds) used for food, fodder, fibre, fuel and medicine.

URL: http://www.monre.gov.la/home/

NOTIFICATION ON PROHIBITED GOOD ON IMPORT OR EXPORT, No. 0973/MOIC. DIMEX

Date of Enactment: 25 May 2011

Description: The Minister of the Ministry of Industry and Commerce restricts trade on a specific list of goods in this notification as follows: I. A list of prohibited goods for import and export are specified in Annex 1, and thes Prohibited Goods on import or export are types of goods subject to prohibition to import and export pursuant to measures for the protection of national security; public order; public morals; human, animal or plant life or health; national treasures or natural resources or for compliance with treaties to which Lao PDR is a party. . II. Goods which are in the list of prohibited goods for import or export may not be imported or exported unless otherwise authorized by the Government of Lao PDR on a case by case basis. The importer or exporter may file an application along with documents justifying why import or export is considered necessity, applying to the relevant authority as specified in the notification so as to get approval from the Government of Lao PDR. With regard to procedures and the necessary documentation, the regulations of relevant authorities shall apply. III. Provincial and Vientiane Capital Office of the Industry and Commerce, other relevant authorities and all concerned parties shall strictly comply with this Notification. IV. This Notification is effective after 30 days of its date of signature and replaces Notification No. 2151/MoIC.DIMEX, dated 30 October 2009. Any notifications or provisions which are incompatible with this Notification shall be hereby repealed.

URL: http://www.laotradeportal.gov.la/

REGULATION No. 22/STEA-PMO ON THE IMPLEMENTATION OF DECREE ON PATENT, PETTY PATENT AND INDUSTRIAL DESIGNS

Date of Enactment: 18 February 2003

Description: Industrial designs, industrial property, patents (inventions), utility models

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5926

REGULATION No. 466/STEA-PMO OF THE PRIME MINISTER ON THE REGISTRATION OF TRADEMARKS

Date of Enactment: 7 March 2002

Description: The Regulation delineates the enforcement of the protection of Trademarks in Laos. Alternative Dispute Resolution (ADR), enforcement of IP and related laws, trade names, trademarks

URL: http://www.wipo.int/wipolex/en/details.jsp?id=5930

INTERNATIONAL AGREEMENTS ON STI MATTERS

Table 38: List of international agreements related with scientific and technological activities in Lao PDR

Instrument	Signed	Ratified/ Acceded	In force
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal		21 September 2010	20 December 2010
Biological and Toxin Weapons Convention (BWC)	10 April 1972	20 March 1973	26 March 1975
Cartagena Protocol on Biosafety to the Convention on Biological Diversity		3 August 2004	1 November 2004
Chemical Weapons Convention (CWC)	13 May 1993	25 February 1997	29 April 1997
Comprehensive Nuclear Test-Ban Treaty (CTBT)	30 July 1997	5 October 2000	
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (ASSIST)		10 May 2013	9 June 2013
Convention on Biological Diversity		20 September 1996	19 December 1996
Convention on Early Notification of a Nuclear Accident (NOT)		10 May 2013	9 June 2013
Convention on the Physical Protection of Nuclear Material (CPPNM). Lao PDR has not ratified the 2005 Amendment to the CPPNM		29 September 2010	29 October 2010
International Convention for the Suppression of Terrorist Bombings		22 August 2002	21 September 2002
International Convention for the Suppression of the Financing of Terrorism		29 September 2008	29 October 2008
Montreal Protocol on Substances that Deplete the Ozone Layer		21 August 1998	21 November 1998
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade		9 October 2010	7 January 2011
Stockholm Convention on Persistent Organic Pollutants	5 March 2002	20 April 2006	26 September 2006
Treaty on the Non-Proliferation of Nuclear Weapons (NPT)	1 July 1968	20 February 1970	5 March 1970
Treaty on the Southeast Asia Nuclear-Weapon Free Zone (Bangkok Treaty)	15 December 1995	16 July 1996	27 March 1997
United Nations Convention against Transnational Organized Crime		26 September 2003	26 October 2003
United Nations Framework Convention on Climate Change		4 January 1995	4 April 1995
Vienna Convention for the Protection of the Ozone Layer		21 August 1998	21 November 1998
Convention for the Suppression of the Illicit Trafficking in Dangerous Drugs, Geneva, 26 June 1936 and Lake Success, New York		13 July 1951	
Convention of the Prohibition of Military or any other hostile use of Environmental Modification Techniques, New York, 10 December 1976	13 April 1978	5 October 1978	
Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, Paris, 13 January 1993	13 May 1993	25 February 1997	
Convention on the simplification and harmonization of customs procedures (Kyoto Protocol)		16 July 2017	

Source: GO→SPIN Survey and Ministry of Science and Technology of Lao PDR

WIPO-Administered Treaties

- Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks (7 March 2016)
- Berne Convention for the Protection of Literary and Artistic Works (14 March 2012)
- Patent Cooperation Treaty (14 June 2006)
- Paris Convention for the Protection of Industrial Property (8 October 1998)
- Convention Establishing the World Intellectual Property Organization (17 January 1995)

IP-related Multilateral Treaties

- Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (22 March 2016)
- Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (12 October 2014)
- Agreement establishing the World Trade Organization (WTO) (2 February 2013)
- World Trade Organization (WTO) - Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) (1994) (2 February 2013)
- Convention for the Safeguarding of the Intangible Cultural Heritage (26 February 2010)
- Convention on the Rights of Persons with Disabilities (25 October 2009)
- International Convention on the Harmonization of Frontier Controls of Goods (29 December 2008)
- Convention on the Protection and Promotion of the Diversity of Cultural Expressions 2005 (5 February 2008)
- International Covenant on Economic, Social and Cultural Rights (13 May 2007)
- WHO Framework Convention on Tobacco Control (5 December 2006)
- Stockholm Convention on Persistent Organic Pollutants (26 September 2006)
- International Treaty on Plant Genetic Resources for Food and Agriculture (12 June 2006)
- International Plant Protection Convention (2 October 2005)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (16 February 2005)
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity (1 November 2004)
- United Nations Convention on the Law of the Sea (5 July 1998)
- United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (26 December 1996)
- Convention on Biological Diversity (19 December 1996)
- United Nations Framework Convention on Climate Change (4 April 1995)
- Convention concerning the Protection of the World Cultural and Natural Heritage (20 June 1987)
- Protocol (I) Additional to the Geneva Conventions of 12 August 1949, and relating to the protection of victims of international armed conflicts (18 May 1981)
- Protocol (II) Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of Non-International Armed Conflicts (18 May 1981)
- Convention on Transit Trade of Land-locked States (28 January 1968)
- Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field (29 April 1957)
- Convention (II) for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea (29 April 1957)
- Convention (III) relative to the Treatment of Prisoners of War (29 April 1957)
- Convention (IV) relative to the Protection of Civilian Persons in Time of War (29 April 1957)

- Protocol 1 annexed to the Universal Copyright Convention as signed at Geneva on 6 September 1952 concerning the application of that Convention to works of stateless persons and refugees (16 September 1955)
- Protocol 2 annexed to the Universal Copyright Convention as signed at Geneva on 6 September 1952 concerning the application of that Convention the works of certain international organizations (16 September 1955)
- Universal Copyright Convention of 6 September 1952, with Appendix Declaration relating to Article XVII and Resolution concerning Article XI (16 September 1955)
- Convention on International Civil Aviation (13 July 1955)
- Protocol 3 annexed to the Universal Copyright Convention as signed at Geneva on 6 September 1952 concerning the effective date of instruments of ratification or acceptance of or accession to that Convention (19 August 1954)
- Convention and Statute on Freedom of Transit (22 October 1953)
- Agreement on the Importation of Educational, Scientific and Cultural Materials (21 May 1952)

Regional Economic Integration Treaties

AGREEMENT ESTABLISHING THE ASEAN-AUSTRALIA-NEW ZEALAND FREE TRADE AREA

Date of Enactment: 1 January 2011

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=421

ASEAN TRADE IN GOODS AGREEMENT

Date of Enactment: 17 May 2010

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=315

AGREEMENT ON THE COMMON EFFECTIVE PREFERENTIAL TARIFF SCHEME FOR THE ASEAN FREE TRADE AREA

Date of Enactment: 28 January 1992

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=441

AGREEMENT ON PROMOTION AND PROTECTION OF INVESTMENT IN ASEAN

Date of Enactment: 2 August 1988

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=444

FIRST AGREEMENT ON TRADE NEGOTIATIONS AMONG DEVELOPING MEMBER COUNTRIES OF THE ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Date of Enactment: June 17, 1976

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=24&treaty_id=373

IP-relevant Bilateral Treaties

AGREEMENT ON COMPREHENSIVE ECONOMIC PARTNERSHIP AMONG JAPAN AND MEMBER STATES OF THE ASSOCIATION OF SOUTHEAST ASIAN NATIONS

Date of Enactment: 1 January 2009

Description: The objectives of this Agreement are to: (a) progressively liberalise and facilitate trade in goods and services among the Parties; (b) improve investment opportunities and ensure protection for investments and investment activities in the Parties; and (c) establish a framework for the enhancement of economic cooperation among the Parties with a view to supporting ASEAN economic integration, bridging the development gap among ASEAN Member States, and enhancing trade and investment among the Parties.

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=23&treaty_id=413

AGREEMENT BETWEEN JAPAN AND THE LAO PEOPLE'S DEMOCRATIC REPUBLIC FOR THE LIBERALIZATION, PROMOTION AND PROTECTION OF INVESTMENT

Date of Enactment: 3 August 2008

Description: promote investment in order to strengthen the economic relationship between the two countries and create favourable conditions for greater investment by investors of one country in the area of the other country.

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=23&treaty_id=868

AGREEMENT BETWEEN THE GOVERNMENT OF THE RUSSIAN FEDERATION AND THE GOVERNMENT OF THE LAO PEOPLE'S DEMOCRATIC REPUBLIC ON THE PROMOTION AND RECIPROCAL PROTECTION OF INVESTMENTS

Date of Enactment: 9 February 2006

Description: n/a

URL: http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=23&treaty_id=910

Inventory of STI operational policy instruments in Lao PDR

The STI operational instruments are the levers, or actual means, by which the organizational structure ultimately implements the decisions on a day-to-day basis and attempts to produce the desired effect on the variables the policy has set out to influence. Throughout the analysis of an instrument it is important to keep in mind the "actors" or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own and responds to the will of the policy-makers and decision-makers using it.

By July 2017, only two different STI operational policy instruments had been identified in Lao PDR. These are presented in the tables overleaf. In general, each individual STI operational policy instruments has either one or several specific objectives and goals, which correspond to the standard categories adopted within the GO→SPIN methodological approach. Figure 49 shows the distribution of STI operational policy instruments by strategic objectives and goals in Lao PDR which are now in operation.

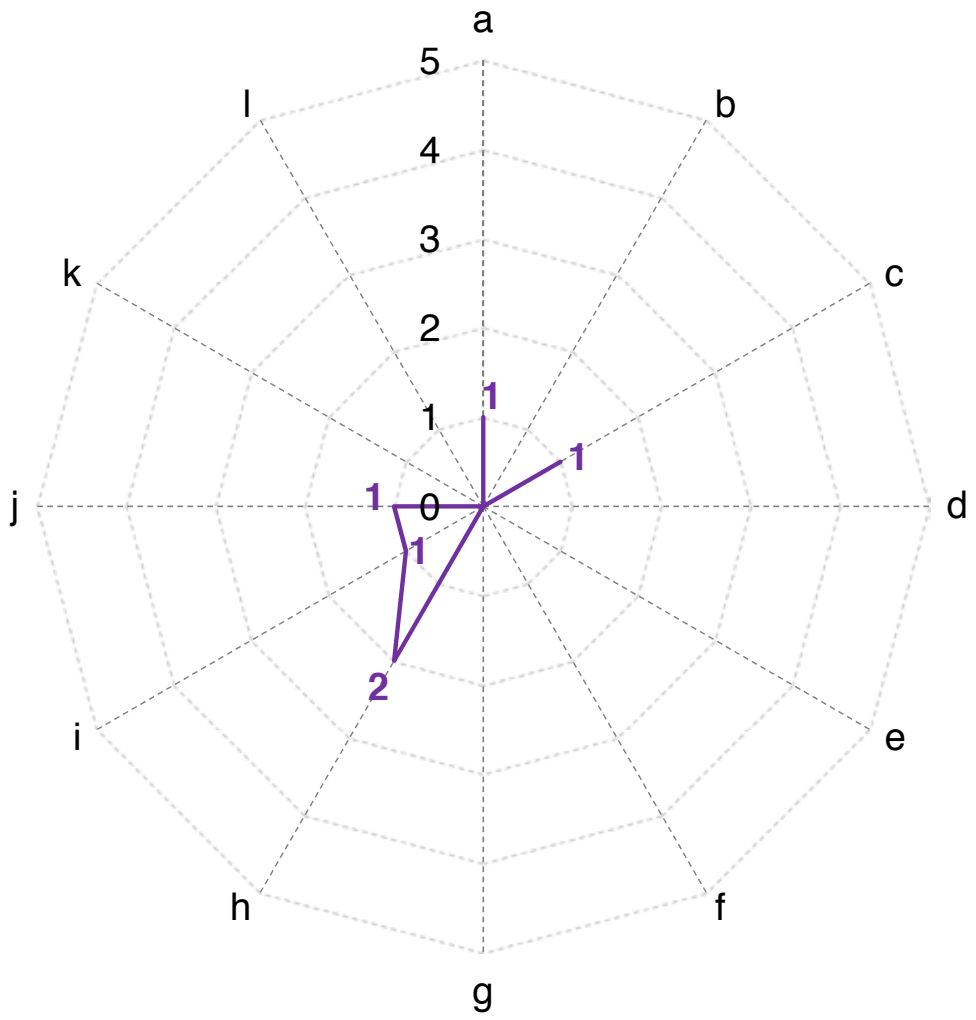


Figure 49: Distribution of STI operational policy instruments in Lao PDR according to the GO→SPIN categories of objectives and goals.
Source: UNESCO

Key

a. Strengthening the production of new endogenous scientific knowledge
b. Strengthening the infrastructure of research laboratories in the public and private sectors
c. Human resources for research innovation and strategic planning. Capacity building education and training of specialized human capital for (1) the production of new scientific knowledge (2) development of new technologies (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society

d. Strengthening gender equality for research and innovation
e. Strengthening the social appropriation of scientific knowledge and new technologies
f. Development of strategic technological areas and new niche products and services with high-added value. Promotion and development of innovation in the production of goods and services. Promotion of start-ups in areas of high technology
g. Strengthening programmes on science education at all levels (from primary school to postgraduate)
h. Promotion of the development of green technologies and social-inclusion technologies.
i. Promotion of indigenous knowledge systems
j. Research and innovation eco-system: strengthening co-ordination networking and integration processes which promote synergies among the different actors of the national scientific technological and productive innovation system (i.e. government university and productive sectors)
k. Strengthening the quality of technology foresight studies to: assess the potential of high-value markets; develop business plans for high-tech companies; construct and analyse long-term scenarios and; provide consulting services and strategic intelligence
l. Strengthening regional and international co-operation networking and promotion of STI activities.

STI OPERATIONAL POLICY INSTRUMENT 1

- **Title of the STI operational policy instrument:** Environmental Protection Fund (EPF)
- **Keywords:** environment, protection, funding mechanisms
- **Overview:** The Environmental Protection Fund was established in 2005 as a financially autonomous organization to strengthen environmental protection, sustainable natural resources management, biodiversity conservation and community development in Lao PDR.
- **Objectives of the plan (or the STI policy) to which the instrument relates:** Strengthen environmental protection, sustainable natural resources management, biodiversity conservation and community development in Lao PDR.
- **Specific objectives:** (h) promotion of the development of green technologies and social-inclusion technologies; (i) promotion of indigenous knowledge systems; (l) strengthening regional and international co-operation, networking and promotion of SETI activities
- **Sectoral and horizontal approach of the instrument:** Sectoral
- **Mode of support/Type of mechanism:** Non-refundable grants, preferential loans, interest rate subsidies, or a combination of these.
- **Conditions to apply for the instrument:** n/a
- **Target groups/Beneficiaries:** Any person, commercial entities, government organizations or civil society entities are eligible to apply for EPF financial support.
- **Eligibility/Selection criteria:** n/a
- **Eligible costs:** The resources of the EPF shall only be used to finance regular and recurrent expenses of ministries, departments, agencies and any other public or private organizations and entities receiving financial support from the EPF, where these expenses relate directly to the implementation of eligible activities determined by the national Decree. EPF shall not provide any forms of support to any project developers towards the financing of costs for mitigating or compensating environmental and social impacts of that project, unless where it is explicitly indicated as an eligible activity.
- **Source of funding:** Grants and loans from domestic and foreign entities, government budget, development projects and other activities, contributions from business entities and individuals, interest or benefits accrued from investing the EPF endowment.
- **Mode of disbursement of financial resources:** n/a
- **Annual budget:** n/a
- **Continuity of the instrument in time:** 2005–on
- **Geographical coverage:** b. national

- **Results, outcomes and evidence of success of a given measure:** The EPF ensures proper dissemination of information pertaining to its activities and operations, list of projects and activities that have received EPF financial support and annual reports of the annual financial statements in both Lao and English through appropriate information technology systems.
- **URL:** http://laoepf.org.la/

STI OPERATIONAL POLICY INSTRUMENT 2

- **Title of the STI operational policy instrument:** Science and Technology Development Fund
- **Keywords:** Research fund, innovation, funding mechanisms
- **Overview:** The Science and Technology Development Fund (STDF) was established on 23 May 2014. It was designed as a self-financed organization with the role to raise funds, support and promote research and development, encourage innovation, technology transfer, and science and technology services. It focuses on students, young scientists, and talented researchers whose research and development activities may contribute to addressing the country's social, economic and environment challenges.
- **Objectives of the plan (or the STI policy) to which the instrument relates:** To provide core financial resources for scientific research and technology development, technology transfer and promotion of innovation, with particular focus on 1) the promotion of scientific research and technology development; 2) the promotion of innovation, and 3) the provision of awards to recognize excellence in the work of scientists, technologists and young researchers.
- **Specific objectives:** (a) Strengthening the production of new endogenous scientific knowledge; (c) human resources for research innovation and strategic planning; capacity building education and training of specialized human capital for (1) the production of new scientific knowledge (2) development of new technologies (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society; and (h) promotion of the development of green technologies and social-inclusion technologies.
- **Sectoral and horizontal approach of the instrument:** Horizontal.
- **Mode of support/Type of mechanism:** Grants
- **Conditions to apply for the instrument:** 1) The research project or scientific activities must meet eligibility criteria; 2) the research project must be approved by the Council of Sciences of sectors and approved by the National Council of Sciences; 3) the proposed budget should be appropriate and efficient; 4) the project should be aligned to the socio-economic development plan and promote the sustainability of natural resources and environment, and 5) the budget disbursement period is October-December of each year, although some ongoing projects may receive continued funding, based on the timing and impact of the project after its evaluation;
- **Target groups/Beneficiaries:** research institutes of government, universities and others government agencies.
- **Eligibility/Selection criteria:** Projects may 1) Support the research and development priorities of science, technology and innovation of the various economic sectors; 2) support the government's urgenty needed research program; 3) support participation by researchers in national and international scientific seminars; or recognize excellence among researchers, scientists, talent students for having a great impact on scientific, technological and innovation research; 4) strengthen the STDF's activities such as human resources development, legislation, hiring experts, holding seminars/workshops or meetings for appraisal of research projects, monitoring and evaluation of research projects, and Fund Management (this is approximately 5% of the approved annual budget of the STDF); 5) support science communications, including dissemination of results of scientific research or related to applications of technology and innovation; and 6) co-fund research and development.
- **Eligible costs:** Defined by the ministerial Decree of Ministry of Finance.

- **Source of funding:** 1) Governmental budget allocation; 2) technical services; 3) contribution of entrepreneurs; 4) intellectual property, research finding and services; 5) grant, donations and contribution from both inside and outside the country.
- **Mode of disbursement of financial resources:** n/a
- **Annual budget:** 1% of public investment annual budget.
- **Continuity of the instrument in time:** 2014
- **Geographical coverage:** b. national
- **Results, outcomes and evidence of success of a given measure:** In period 2011–2013, STDF funded 120 research projects.
- **URL:** www.most.gov.la

SWOT analysis of Lao PDR's research and innovation system

This section focuses on the strengths, weaknesses, opportunities and threats (SWOT) which characterize Lao PDR's research and innovation system. These characteristics are summarised in Table 39 on page 200. The analysis, which follows, is based on and organized according to the information and data presented in preceding sections. The sequence of items in each of the four individual dimensions of the SWOT analysis follows the order of the different chapters, starting with the contextual factors – which influence the implementation on any policy – and continues with more specific items associated with STI policies.

Strengths

- **Positive long-term trends in human development indicators.** Life expectancy at birth has increased from 47.7 years in 1975 to 66.5 years in 2015 (see Figure 5, page 16). The Human Development Index has progressed in a parabolic fashion over decades increasing their value from 0.37 in 1985 to 0.586 in 2015 (see Figure 4, page 15). The under-5 mortality rate had fallen to 66.7 per 1 000 live births in 2015, improving the MDG's target of 70 (see Figure 3, page 14).
- **Lao PDR has political stability, security and peace.** Since 2012, the country reached positive values of Political stability/Absence of violence and Terrorism (see Figure 12, page 30). The values of government effectiveness for policy implementation as well as the corruption perception index also improved in recent years (see Figure 13, page 30). However, these values place Lao PDR within the lowest global ranks.
- **Sustained economic growth.** The gross domestic product (GDP) of Lao PDR, measured in constant 2015 US$ (1984–2016) and measured in constant 2011 PPP international $ (1990–2016), has been growing exponentially at an annual rate of 6.4% and 6.7% respectively (see Figure 6, page 21). On the other hand, the GDP per capita experienced a growth following a mathematical cubic curve, with annual growth-rates of 4.4% and 5% respectively (see Figure 7, page 21).
- **New STI legal framework and research infrastructure established.** The National Assembly has recently approved eight new public laws for the promotion of STI activities (see pages 176–182) and allocated 1% of annual public investment budget to promote research activities (see pages 137–139). With the creation of the Ministry of Science and Technology (MOST) in 2011, four new research institutes as well as the Office of National Science Council were founded under MOST (see pages 148–151).
- **Special Economic Zones (SEZs) as policy instruments for the promotion of industrial sectors.** The government has created specific and special legislation as a foundation to develop SEZs, promote investment and a favourable environment. At present, there are 13 SEZs in Lao PDR, four of which are SEZs and nine of which are specific economic zones. Of the total 13 established SEZs, seven have been upgraded from general concession investments (see page 46). By 2016, there were 249 companies that have invested in these zones, including: 180 foreign companies, 48 domestic companies and 21 joint venture domestic and foreign companies. These companies have invested 49.4% in the service sector, 34.6% in the commercial sector and 16% in the industrial sector.
- **Hydropower and renewable energy as a sustainable development tool.** The Ministry of Energy and Mines is fostering the creation of different policy instruments (mechanisms and incentives) for investment by expanding the renewable energy market to attract more private sector investment in the development of renewable energy projects (see pages 41 and 183). The Ministry of Science and Technology is fostering R&D and innovation activities within this sector (see page 150). As per the provision under the Investment Promotion Law of Lao PDR, the government provides both financial and non-financial incentives to investors according to their sector and zone. Among them we find: (i) Tax holidays of up to 10 years; (ii) exemptions from export duties on export products; (iii) exemptions from land lease or concession fees for up to 15 years; (iv) exemptions from import duties and taxes on raw materials and capital equipment used in production, and (v) additional tax holidays are negotiated for large concession projects. Foreign investments that are subject to the Foreign Investment Law pay a favourable annual profit tax at a rate of 10%, 15%, and 20% depending on their zone (other investments are taxed at 35%).

- **Strong regional integration policies.** Since 1997, Lao PDR became a member of the Association of Southeast Asian Nations (ASEAN) and started aligning its national STI policies to the regional ones (see Box 16, page 124). FDI is concentrated in a small group of neighbour countries, such as China, Thailand, Malaysia, Viet Nam and the Republic of Korea (see Table 4, page 27). During the past two decades, Lao PDR concluded and acceded to a series of bilateral and multilateral international agreements, and enacted new national legislation for the protection of intellectual property rights as well as concluding co-operation agreements on STI (see pages 185–188). While Viet Nam, Thailand, China and Japan are the countries with the highest numbers of Lao students conducting graduate and post graduate studies (Table 10, page 67), Thailand is the principal partner in the co-authorship of scientific publications (Table 28, page 107).
- **Expansion of the tertiary education system.** Enrolment in tertiary education has been expanding exponentially at an annual rate of 13% (see Figure 20, page 62) from 26 students in 1955 to more than 130 000 in 2015. The total enrolment per 100 000 inhabitants remained very low (approx. 130 students per 100 000 inhabitants) from 1984 to 1996. After 1997 this number expanded exponentially to reach 2083 in 2013 (see Figure 21, page 63). These facts are consistent with the creation of the National University of Laos, in 1996, and the growing number of tertiary and higher education institutions in the country since then (see pages 62–65).

Weaknesses

- **Poor overall economic and innovation infrastructure system.** Lao PDR's exposure to economic vulnerability remains high due to over-dependence on the agriculture and natural resource sectors (see pages 35 – 37). A majority of the labour force has remained in the agriculture sector but with very low productivity due to limited capacity to shift to modern technological production, and there is limited coordination with the service sector, which caused a weak foundation for shifting into industrialization and modernization. Lao PDR is still reliant on external financing for development such as FDI, loans and grants (see pages 22 –27), and has a weak private sector.
- **Low labour productivity and inadequately educated workforce**. The country requires the development of better skills, for example by providing training to the local workforce. Improving skills is a necessary condition for diversifying the economy, and for shifting the type of investment inflows to the country away from those that rely on unskilled labour and away from activities that make intensive use of natural resources, toward those that use skilled labour and capital-intensive production processes. Human resource development has been very little promoted by either the private and public sectors. Labour lacks necessary skills. Human resource development may be essential to the demand-driven socio-economic development, especially for SMEs that confront changing conditions due to Lao PDR's integrating into the ASEAN Economic Integration and joining WTO.
- **A small pool of researchers**. Research and innovation are dependent on having the requisite stock of human capital, defined as the knowledge, skills, competencies and attributes that facilitate the creation of personal, social and economic wellbeing. Per million inhabitants, Lao PDR has an estimated 76 head counts (HC) or 19 full-time equivalent (FTE) researchers (see Figure 29, page 88). From a global perspective, the critical mass, which triggers innovation on a national scale, is at least 1 200 FTE researchers per million inhabitants (i.e. China, Malaysia, Singapore, etc.). For Lao PDR, this critical value is 63 times the present one. Developed countries have between 263 and 368 times more FTE researchers per million inhabitants than Lao PDR. No formal system of government scholarships is in place for completing PhDs in science and engineering, nor any other incentive or policy instrument guaranteeing the career promotion by performing research and innovation activities (see Chapter on STI operational policy instruments). The 8th NSEDP proposed to "train 11 researchers per 10 000 of the population by 2020." Assuming the text is referring to HC numbers, this particular target is 14 times the number available in 2012. With the present lack of adequate policy instruments (e.g. scholarships, local PhDs programmes, new research infrastructure, new permanent posts for researchers, etc.) there is no

possibility that this target will be reached by 2020. The small pool of researchers is the most serious weakness of the research and innovation system of Lao PDR.

- **Absence of an STI gender policy**. There is no single mention to any gender issue neither within the 8th National Socio-Economic Development Plan on the strategies designed for science, technology and innovation, neither there is a formal human-resources plan to foster participation of women in science and engineering. There is a lack of recent statistics on the distribution of women among researchers and technicians in Lao PDR, the last 2002 survey showed 23% of these employees in S&T were women. By 2014, only 35% of those working at the Ministry of Science and Technology were women (see Table 16, page 87). There are no existing or planned operational policy instruments of any sort that aim to promote gender equality within scientific and technological research activities, nor are there any incentives specific to encouraging girls and women (i.e. scholarships). In 2015, the female tertiary enrolment at ISCED 5 level was only 31.7% of the whole (see Figure 22, page 63) and women made up only 29.3% of the teachers at the same educational level institutions (Figure 24, page 66). In 2015, women represented only 32.8% of the graduates (see Figure 23, page 65) and 40.1% of the academic staff (see Figure 28, page 80) of all ISCED levels taken together.
- **Absence of any explicit human resources policy for science and engineering**. There are neither specific reliable strategies nor any operational policy instruments in place for increasing the number of scientists and engineers to achieve the target of 11 researchers per 10 000 inhabitants in 2020 (8th NSEDP). The university system in Lao PDR does not have adequate PhD programmes on science and engineering or infrastructure to conduct research in the key national strategic areas. Evaluation and accreditation standards for postgraduate programmes and a system of full-time scholarships at PhD level are also lacking. In absence of these critical conditions, it will be very difficult to expand the number of FTE researchers in the country during the next decade. The design, implementation and substantial financing in series of new STI operational policy instruments is a necessary minimum requirement to expand the number of researchers. Policy measures can be designed to ensure a healthy supply of human resources to STI, for example incentives such as fellowships aiming to rapidly increase rates of student enrolment and completion of scientific, technological and engineering education and training at undergraduate and postgraduate levels.
- **Low research and innovation productivity.** Although Lao PDR researchers published 173 scientific articles in mainstream journals in 2016, this represents just one scientific article per HC researcher every 2.8 years, or 0.35 scientific articles per HC researcher annually. The number of articles per million inhabitants has been increasing in a parabolic way since 1997 reaching 25.9 articles per million population in 2016 (see Figures 35 and 36, page 105). This is around 100 times smaller than the productivity of Switzerland or Singapore. The past decade has seen a positive trend: an extraordinary increase in the number of co-publications with foreign countries, which now represent 90–100% of all Lao PDR scientific articles listed at the Web of Science (see Figure 38, page 106). In the past decade, 52.3% of publications have been in medical sciences (public environmental and occupational health; tropical medicine, infectious diseases and parasitology), 11% in agricultural sciences, and the rest distributed mainly within the biosciences (see Table 31). In comparison, in emerging economies like China, Singapore or the Republic of Korea, where there are linkages between research and innovation, 80% of all publications are in natural sciences and/or engineering. As for patents, during the past five decades the number of applications by residents (and non-residents) was extremely low (see Figure 43, page 115) even compared to sub-Saharan countries (UNESCO, 2013, 2014a, 2014b).
- **A small STI demand pull.** Macro-economic conditions today hamper research and innovation demand in the business and industry sector. In developed and emerging economies, the business sector provides between 50% and 70% of GERD. In other words, the STI demand-side tracks the type of research done by governmental research centres and higher education institutions (the STI supply side). Businesses also typically need to adapt technologies and innovate in order to meet needs of the customers at local and international levels and to remain competitive; this implies that businesses will address firm-level constraints by investing in human resources, technology and R&D. Despite that the 8th NSEDP sought to promote public–private partnerships, there is no operational policy instrument in place to foster networking among the business, government and university sectors (see pages 46 – 47). While it may be that R&D activities exist in the garment industry (see Box 7, page 52), Lao PDR never

performed an innovation survey (following the Oslo Manual standards) sto track R&D and innovation within the business-enterprise sector.

- **Low participation of the business/enterprise sector in R&D.** In emerging economies such as China the Republic of Korea, Malaysia or Singapore, the business sector employs more than 60% of national researchers and provides the funding for conducting R&D and innovation activities. In Israel the private sector provides 80% of GERD. Linkages between universities, R&D centres and the business/enterprise sector are generally absent in Lao PDR. There is also an absence of appropriate policy instruments to stimulate strong interaction between the STI supply and demand sides. There is a need for capacity-building and a stronger human capital policy to support innovation and entrepreneurship in the business sector. Linkages and coordinated policy interventions among the Ministry of Science and Technology, Ministry of Industry and Commerce, Ministry of Energy and Mines, Ministry Agriculture and Forestry and Ministry of Health to promote the participation of business/enterprise sector in R&D and innovation, are very weak and not explicitly established. Policies to promote innovation, and to strengthen start-ups with limited access to financial support, are also lacking.
- **Inadequate set of STI operational policy instruments and funding mechanisms.** The GO→SPIN survey has identified only two operational policy instruments in Lao PDR (see pages 189–193). A country the size of Lao PDR should have between 10 and 20 times more, of a diverse nature and adequately funded. The absence of some operational policy instruments impinges on research and innovation. There are no policy instruments in place promoting linkages between the STI demand and supply, nor any funding mechanism addressing the research priorities set by 8th NSEDP.
- **Absence of reliable system for R&D and higher education statistics.** There is no reliable information on the number of graduates (at all ISCED levels) against the six major fields of science (exact and natural sciences, engineering and technology, agricultural sciences, social sciences, medicine and health sciences and humanities). The absence of this information prevents adequate human resources planning for STI. The last R&D survey was conducted on 2002 and the information generated did not follow the standards of the Frascati Manual (OECD 2015, UIS 2014). Its results were incomplete and at times contradictory to the results of the ASTI-IPFRI R&D surveys for the agriculture sciences sector conducted since 1998 (see Chapter on R&D indicators, pages 83–97).
- **Indigenous knowledge remains largely disregarded.** Knowledge is the key input to innovation. It can come from a formal process, such as R&D, but also in the form of indigenous knowledge developed over centuries of learning from the environment. Indigenous knowledge can play a central role in transforming and modifying technologies to suit local conditions and the local context, as well as in developing indigenous home-grown technologies. To play these roles, indigenous knowledge needs to be documented, protected, developed and efficiently managed. Lao PDR needs to incorporate these actions with regard to indigenous knowledge in the formulation of its R&D strategies. There is scant treatment of indigenous knowledge in existing STI strategies and research programmes.

Opportunities

- **Improving FDI and technology transfer within AEC.** The creation of the ASEAN Economic Community (AEC) in 2015 marked a milestone in regional economic integration in Southeast Asia. The AEC has since established a highly integrated market consisting of 625 million consumers with a combined purchasing power of US$ 2.3 trillion. For a small, landlocked country like Lao PDR, the ASEAN market and production base offers great economic potential by opening up more opportunities to participate in regional value chains. Indeed, ASEAN Member States already account for more than half of Laos' total foreign trade (see page 49–50) and the majority share of its FDI (see Table 4, page 27). The reduction of import duties is also a significant step which enhances opportunities in the manufacturing sector and facilitates technology transfer within the region. The membership to WTO and AEC will enhance opportunities to bring more investments, trade and services to Lao PDR as well as to learn from experiences and lessons in technology and culture which will generate advantages for further socio-economic development of the country in the medium and long-terms.

- **STI networking at national, regional and international levels.** Lao PDR has a long tradition of successful international scientific collaboration (mainly in the health and agribusiness sectors) and in business (energy and ICTs). Based on this experience, appropriate policy instruments and special mechanisms can be designed to promote synergies and networking among national laboratories, universities and the manufacture sector. Other policy instruments should improve the participation of the diaspora in strategic research and innovation projects in Lao PDR, while enhancing networking between public and private research institutions and enterprises in the country. There are many Lao PDR PhD holders working in Lao PDR and abroad in leading research institutions. Collaboration and networking in research and innovation oriented toward national development projects (i.e. ICTs, mining, health, environment, energy, agribusiness, etc.) among people both within and outside Lao PDR can lead to a better higher education system, greater scientific productivity and stronger linkages between STI supply and demand.
- **Human capital development in science and engineering**. A large share of Lao PDR's population is youth (34% of the population is less than 14 years old) who will study and develop their potential (see Figure 1, page 13). Lao PDR has the youngest labour force in the region and is expected to benefit from a demographic transition as they enter the productive years of mid-life. The share of the population of working age (aged 15–64 years) in Lao PDR is projected to increase to 69% by 2050, compared with 68% in Myanmar, 65% in Cambodia and 62% in Viet Nam. To help Lao PDR toward its target of 11 researchers per 10 000 inhabitants by 2020 (as announced in the 8th NSEDP), there is an opportunity to immediately expand the training of young people in science and engineering. An explicit human resources policy to expand the number of scientists and engineers and promote research and innovation is indispensable. For this, adequate STI policy instruments to provide incentives are required, such as: scholarship programmes to encourage students to embark on PhDs, and a system of competitive grants for young researchers in fields that national policies prioritize. STI research programmes designed to develop human capital should be associated with the portfolio of strategic areas, which the 8th NSEDP identified as: hydropower, renewable energy, ICTs, agriculture and health. STI human capital development should thus be tailored to these development projects.
- **STI regional co-operation to foster capacity building.** Recent regional agreements within the framework of the ASEAN Plan of Action on Science, Technology and Innovation (APASTI) for the period 2016–2025 (see Box 16, page 124) open opportunities for Lao PDR to enhance the quality of education through exchange and twinning arrangements with high-standard educational institutions in advanced ASEAN countries such as Singapore and Malaysia.
- **Improve gender equality in science and engineering.** Gender equality is one of the United Nations Sustainable Development Goals. It will be possible to improve the participation of women in science and engineering by introducing appropriate STI policy instruments and incentives in both the education system (from primary school to postgraduate studies) and in the terms of reference of advertised posts or calls for research and innovation proposals. A specific policy for gender equality within the higher education sector and the research and innovation system should be established, setting out specific targets, and then activities should be implemented. Specific operational policy instruments must be in place to guarantee the implementation of these strategies. Implementation can contribute to achieving existing targets in the 8th NSEDP, and targets that explicitly aim to achieve gender equality should be part of next (9th) NSEDP.
- **R&D and value-addition.** Despite that a portfolio of strategic areas has been identified in which to promote FDI in Lao PDR (see page 27), value-addition across all sectors in Lao PDR remains low. Lao PDR is still a net exporter of raw materials. There is a wide margin of manoeuvre for using STI to add value across sectors and for using innovation to add value to Lao PDR's agribusiness, tourism, renewable energy industries and to other uses of natural resources.
- **Legal instruments to protect indigenous knowledge.** The 8th NSEDP does not address the strategic value of indigenous knowledge systems and their need for protection. The indigenous knowledge basis for traditional medicine, for example, needs to be understood, preserved, further developed and protected for the country's benefit. A large group of traditional medicines, based on natural local flora, can be an important source of innovation. Intellectual property rights law, which adequately covers the body of knowledge that may generally be classified as 'Western' today in Lao PDR is weak

when it comes to protecting indigenous knowledge, in part because the latter is owned collectively (by extended families, clans and communities) and because substantial parts of indigenous knowledge are transmitted orally. Lao PDR can follow the example of Botswana (UNESCO, 2013), which already has a legislative instrument to protect traditional knowledge and handicrafts. In Botswana, the IP law has been changed. Under this law, traditional knowledge may give rise to intellectual property that can be owned by a group of people or by a community. This is not possible with other forms of intellectual property or intellectual property rights. The terms of protection in Botswana expire only when the traditional knowledge has (a) lost its value as an element of cultural identification; (b) been abandoned as a result of wilful and express non-use by its owner(s); or (c) been disowned as a result of non-use by owners and use in a distorted manner by third parties of which the owner(s) are aware. This type of good practice can be easily implemented in Lao PDR. WIPO is also developing a set of adequate IP policy instruments to guarantee the protection of indigenous knowledge.

Threats

- **Adverse effects of climate change**. Exposure to climatic extreme events and trends in socio-economic development that influence the country's adaptive capacity suggest that Lao PDR's vulnerability will increase most rapidly between now and 2050. However, socio-economic development may begin to offset the country's growing exposure to climate change in the second quarter of the century. This implies an urgent need for international assistance to finance climate change adaptation. Policy interventions are needed to mitigate potential disasters by building STI capacity and by promoting the use of appropriate technologies.
- **Regional and international competition will place a limit on STI growth**. The external environment, especially world economic development, and natural disasters, is a barrier to socio-economic development of the country. Lao PDR is likely to face more intense competition from other labour surplus countries, especially in a more globalized economy. The inflow of talented workers can present a threat for local workers who lack competitive capacities (see page 44 – 50). WTO membership comes with challenges including severe trade competition, as well as business and technology development competition, thus calling for internal improvement by all sectors to deal with the future challenges. Other nations are developing more aggressive STI policies and research infrastructure draining the most qualified national researchers.
- **Strong dependence on mining and hydroelectricity sectors**. In order to maintain its growth and make the country more sustainable, Lao PDR must diversify its productive system and develop its industries to move towards higher-value production by improving its innovation system. At present, policies focus on developing STI management capacity without a comprehensive view of industry or R&D. Each line ministry has been pursuing its goals individually, which has created inconsistencies in overall planning. The main goal of this project is to increase the absorptive capacity of Lao PDR and its stakeholders using collective priority setting.
- **Scarce R&D resources are over-allocated to administrative functions.** Lao PDR's GERD represents approximately 0.04% GDP (or 37 times smaller than the share of GDP that R&D needs to start influencing the national economy, which is 1.5% GDP). The public funding allocation for STI has been approximately 1% of the national public budget and the 8th NSEDP proposes taking that number to 2%. Even if this target is met, this figure remains very low. Meanwhile, international comparisons suggest it would be typical for administration costs (mostly personnel) to require 10-15% of the total S&T budget. In Lao PDR, data suggests that research receives fewer resources than its administration. For example, the Ministry of Science and Technology has a staff with 1199 persons (see Table 16, page 87), while the total number of researchers in the country has been estimated at only 490 HC (see page 88).
- **Lack of an entrepreneurship and innovation culture within the business/enterprise sector.** To be competitive, stakeholders must be able to add value through their productive activities. Increasing added value requires innovation which is missing at present. Firms are dependent on imported technology and imported skilled human resources. Despite that R&D is an important component to

maintain competitiveness and value, no evidence was yet found showing R&D conducted within the Lao PDR business enterprise sector. Even in manufacturing and processing, capital is imported at a premium. The supply chain is also weak because there are few providers that can be found in the system. Similarly, competitive financing is typically unavailable in the country. R&D capacity found in the research institutes and university is limited and does not meet the needs of industry.

Table 39: SWOT analysis of Lao PDR's research and innovation system

Strengths	Weaknesses
• Positive long-term trends in human development indicators • Lao PDR has political stability, security and peace • Sustainable economic growth • New STI legal framework and research infrastructure established • Special Economic Zones (SEZ) as policy instruments for the promotion of the industrial sector • Hydropower and renewable energy as a sustainable development tool • Strong regional integration policies • Expansion of the tertiary education system	• Poor overall economic and innovation infrastructure system • Low labour productivity and inadequately educated workforce • A small pool of researchers • Absence of an STI gender policy • Absence of any explicit human resources policy for science and engineering • Low research and innovation productivity • A small STI demand pull • Low participation of the business/ enterprise sector in R&D • Inadequate set of STI operational policy instruments and funding mechanisms • Absence of reliable system for R&D and higher education statistics • Indigenous knowledge remains largely disregarded
Opportunities	**Threats**
• Improving FDI and technology transfer within AEC • STI networking at national, regional and international levels • Human capital development in science and engineering • STI regional co-operation to foster capacity building. • Improve gender equality in science and engineering • R&D and value-addition • Legal instruments to protect indigenous knowledge	• Adverse effects of climate change. • Regional and international competition will place a limit on STI growth • Strong dependence on mining and hydroelectricity sectors • Scarce R&D resources are over-allocated to administrative functions • Lack of an entrepreneurship and innovation culture within the business /enterprise sector

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Glossary

I. Glossary of main terms used in R&D surveys

Sectors covered by R&D surveys

Business enterprise sector: (a) all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, including both public and private enterprises; (b) the private non-profit institutions mainly serving them.

Government sector: (a) all departments, offices and other bodies which furnish, but normally do not sell to, the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the community's economic and social policy; (b) public enterprises mainly engaged in market production and the sale of goods and services are included in the business enterprise sector; (c) non-profit institutions controlled and mainly financed by government, not administered by the higher education sector.

Higher education sector: (a) all universities, colleges of technology and other institutions providing tertiary education (see below for details), whatever their source of finance or legal status; (b) all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, higher education institutions.

Private non-profit sector: (a) Non-market, private non-profit institutions serving households (i.e. the general public) and (b) private individuals or households.

Definition of research and experimental development

Research and experimental development (R&D): comprises creative work undertaken on a systematic basis, in order to increase the stock of knowledge, including knowledge of humanity, culture and society, and the use of this stock of knowledge to devise new applications. The term R&D covers three activities: basic research, applied research and experimental development.

Basic (or fundamental) research: is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied research: is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development: is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed towards producing new materials, products or devices, towards installing new processes, systems and services, or towards improving substantially those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D in other units.

Definition of personnel

R&D personnel: all persons employed directly in R&D, as well as those providing direct services such as R&D managers, administrators and clerical staff. Persons providing an indirect service, such as canteen and security staff, should be excluded.

Head count: data reflect the total number of persons employed in R&D, independently of the focus of their work. These data allow links to be made with other data series, such as education and employment data, or the results of population censuses. They also serve as the foundation for calculating indicators which analyse the characteristics of the R&D labour force, with respect to age, gender or national origin.

Full-time equivalent (FTE): may be thought of as one person-year. Thus, a person who normally spends 30% of his/her time on R&D and the rest on other activities (such as teaching, university administration and student counselling) should be considered as 0.3 FTE. Similarly, if a fulltime R&D worker is employed at an R&D unit for only six months, this results in an FTE of 0.5. However, for reporting purposes, the total sum of FTEs should be rounded to the next integer to avoid the reporting of decimals.

Researchers: are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in managing the projects concerned. Postgraduate students at the PhD level engaged in R&D should be considered as researchers.

Technicians: and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences (technicians) or social sciences and humanities (equivalent staff). They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.

Support staff: includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects (or providing services to researchers involved therein).

II. Glossary on intellectual property rights

Applicant: An individual or other legal entity that files an application for a patent, utility model, trademark or industrial design. There may be more than one applicant in an application. For the statistics presented in the present publication, the name of the first-named applicant is used to determine the owner of the application.

Application abroad: For statistical purposes, an application filed by a resident of a given state/jurisdiction with an IP office of another state/jurisdiction. For example, an application filed by an applicant domiciled in France with the Japan Patent Office (JPO) is considered an 'application abroad' from France's perspective. This differs from a 'non-resident application', which describes an application filed by a resident of a foreign state/jurisdiction from the perspective of the office receiving the application.

Industrial design: applies to a wide variety of industrial products and handicrafts. It refers to the ornamental or aesthetic aspects of a useful article, including compositions of lines or colours or any three-dimensional form that gives a special appearance to a product or handicraft. The holder of a registered industrial design has exclusive rights concerning unauthorised copying or imitation of the design by third parties. Industrial design registrations are valid for a limited period. The term of protection is usually 15 years for most jurisdictions. However, differences

in legislation do exist, notably in China (which provides for a 10-year term from the application date) and the USA (which provides for a 14-year term from the date of registration).

Intellectual property (IP): refers to creations of the mind: inventions, literary and artistic works, symbols, names, images and designs used in commerce. IP is divided into two categories: industrial property, which includes patents, utility models, trademarks, industrial designs and geographical indications of source; and copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs, sculptures and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings and those of broadcasters in their radio and television programmes.

Invention: a new solution to a technical problem. To obtain patent rights, the invention must be novel, involve an inventive step and be industrially applicable, as judged by a person skilled in the art.

Non-resident: for statistical purposes, a 'non-resident' application refers to an application filed with the IP office of, or acting for, a state/jurisdiction in which the first-named applicant in the application is not domiciled. For example, an application filed with the JPO by an applicant residing in France is considered a non-resident application from the perspective of this office. Non-resident applications are sometimes referred to as foreign applications. A non-resident grant or registration is an IP right issued on the basis of a non-resident application.

Patent: a set of exclusive rights granted by law to applicants for inventions that are new, nonobvious and commercially applicable. It is valid for a limited period of time (generally 20 years), during which patent holders can commercially exploit their inventions on an exclusive basis. In return, applicants are obliged to disclose their inventions to the public in a manner that enables others, skilled in the art, to replicate the invention. The patent system is designed to encourage innovation by providing innovators with time-limited exclusive legal rights, thus enabling innovators to appropriate a return on their innovative activity.

Patent Co-operation Treaty (PCT): an international treaty administered by WIPO. The PCT system facilitates the filing of patent applications worldwide and makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by first filing a single 'international' patent application. The granting of patents, which remains under the control of the national or regional patent offices, is carried out in what is called the 'national phase' or 'regional phase'.

Registration: a set of exclusive rights legally accorded to the applicant when an industrial design or trademark is 'registered' or 'issued'. (See also Industrial design or Trademark.) Registrations are issued to applicants so that they can make use of, and exploit, their industrial design or trademark for a limited period of time; in some cases, registration can be renewed indefinitely, particularly in the case of trademarks.

Resident: for statistical purposes, a 'resident' application refers to an application filed with the IP office of, or acting for, the state/jurisdiction in which the first-named applicant in the application has residence. For example, an application filed with the JPO by a resident of Japan is considered a resident application from the perspective of the JPO. Resident applications are sometimes referred to as domestic applications. A resident grant/registration is an IP right issued on the basis of a resident application.

Trademark: a distinctive sign that identifies certain goods or services as those produced or provided by a specific person or enterprise. The holder of a registered trademark has the legal right to exclusive use of the mark in relation to the products or services for which it is registered. The owner can prevent unauthorised use of the trademark, or a confusingly similar mark, so as to prevent consumers in particular and the public in general from being misled. Unlike patents, trademarks can be maintained indefinitely by paying renewal fees. The procedures for registering trademarks are governed by the rules and regulations of national and regional

IP offices. Trademark rights are limited to the jurisdiction of the authority that registers the trademark. Trademarks can be registered by filing an application at the relevant national or regional office(s), or by filing an international application through the Madrid system.

Utility model: a special form of patent right granted by a state/jurisdiction to an inventor or the inventor's assignee for a fixed period of time. The terms and conditions for granting a utility model differ slightly from those for normal patents (including a shorter term of protection and less stringent patentability requirements). The term 'utility model' can also describe what are known in some countries as 'petty patents', 'short-term patents' or 'innovation patents'.

Annex 1: The methodological framework for this series

GO→SPIN Country Profiles in Science, Technology and Innovation Policy is a series of reports published by UNESCO within its Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN). The GO→SPIN programme is run by UNESCO's Division of Science Policy and Capacity-Building.

The aim of this new series is to generate reliable, relevant information about the different landscapes of science, engineering, technology and innovation (SETI) policies around the world. The published information is based on replies to the GO→SPIN surveys, combined with government reports and statistical data from the UNESCO Institute for Statistics and other international sources.

Each country profile represents a comprehensive study of all the SETI policies, which include:

1. a long-term description of the political, economic, social, cultural and educational contextual factors;
2. a description of women in science and engineering;
3. a standard content analysis of the explicit SETI policies, including those research and innovation policies implemented in other sectors, such as the agricultural, energy, health, industrial and mining sectors;
4. a study of R&D and innovation indicators;
5. a long-term scientometric analysis of scientific publications, patents, trademarks and utility models;
6. a historical description of the long-term evolution of STI policies and institutions;
7. a description of the SETI policy cycle;
8. a complete analysis of the SETI organizational chart at five different levels (policy-making level; promotion level; research and innovation execution level; scientific and technological services level and evaluation level);
9. an inventory of all the SETI government bodies and organizations related both to research and innovation and to science and technology services;
10. an inventory of the SETI legal framework, including acts, bills, regulations and international agreements on SETI issues;
11. a standard inventory with 18 different analytic dimensions of all the SETI operational policy instruments in place;
12. a SWOT analysis of the country's research and innovation landscape.

THE GO→SPIN APPROACH

The strategy of the GO→SPIN programme is four-fold:

- **Capacity-building:** training high-ranking national officials in the design, implementation and evaluation of a variety of SETI policy instruments at national and regional levels;

- **Standard-setter:** providing a standard practice for surveys on SETI policies and operational policy instruments through the *Paris Manual*[1]
- **Data collection:** worldwide distribution of the GO→SPIN surveys, prioritizing Africa, Arab States, Asia–Pacific and Latin American and the Caribbean.
- **GO→SPIN platform:** creation of an online, open access platform for decision-makers, knowledge-brokers, specialists and general public, with a complete set of various information on SETI policies.

The online platform will provide an innovative cluster of databases equipped with powerful graphic and analytical tools. The platform has been devized for political leaders, planners, directors and administrators of S&T in government, parliament, universities, research institutions, productive enterprises concerned with innovation, international organizations working for development; research personnel and specialists whose field of study embraces S&T policies.

The platform will also be a useful tool for the democratization of decision-making and public accountability of SETI policies.

The GO→SPIN survey and the information generated are primarily intended for the use of specialists and governmental bodies responsible for national SETI policies. It is their function to analyse the results of the survey and draw appropriate conclusions when they are required to prepare decisions by political bodies in the field of science, engineering, technology and innovation. The survey is also of interest to national bureaux of statistics and international organizations for promoting scientific and technological cooperation among their member states. Collectively, these users are:

- the national developing planning agencies, more particularly the government bodies responsible for formulating and co-ordinating national SETI policies and other national bodies involved in the application of science and technology (S&T) to sustainable development;
- parliamentary groups especially concerned with STI policies;
- SETI information brokers, consulting groups and advisory bodies;
- teaching and research departments engaged in SETI policy studies;
- The governing bodies of R&D institutes and S&T services;
- The boards of management of productive enterprises heavily reliant on R&D or engaged in the transfer of technology and innovation;
- International governmental and non-governmental organizations concerned with SETI and their application to sustainable development;
- Other more peripheral users, such as university departments of political science, economics and social sciences and national and international documentation and information services;
- The mass media.

At individual level, the main groupings are:

- **Decision-makers:** i.e. those responsible for national SETI policies and the management of R&D (ministries of R&D or S&T, directors of bodies responsible for formulating national S&T policies, directors of R&D institutes, heads of productive enterprises heavily reliant on R&D, etc.)
- **Intermediate users:** i.e. those who serve as the link between decision makers referred to above and researchers in S&T policy; their function is to prepare decisions by the former using theories and methods put forward by the latter, this category is made up of experts, consultants, advisers, liaison officers, the staff of ministerial offices and of parliamentary committees, etc., and they usually require rapid access to factual data.
- **Researchers in SETI policies:** i.e. those who develop the theories and methods on which S&T policy is based (researchers in the philosophy, history, sociology and economics of science, engineering and innovation, in the transfer of technology and in the management of R&D.
- **The general public:** by making SETI information more accessible, the GO→SPIN approach introduces a new dimension to the democratization of SETI.

1 The *Paris Manual* is being drafted by an international committee of experts put together by UNESCO in 2011. Once completed, the manual will define the ontological and epistemological bases of a common paradigm for evaluating STI policies and policy instruments worldwide.

THE METHODOLOGICAL FRAMEWORK

Science, engineering, technology and innovation (SETI) are becoming increasingly important for socio-economic and sustainable development. During the past 60 years, both developed and developing countries have recognized this fact by increasing the number of SETI government bodies, establishing new SETI legal frameworks and implementing a diverse set of new SETI policy instruments. This has driven investment in scientific research, technological development and innovation (STI), led to an increase in the number of scientists and engineers and fostered exponential growth in the number of new scientific articles and patents worldwide (UNESCO, 2010a).

The information economy is one of the key concepts invented to explain structural changes to the modern economy (Godin, 2008). The infrastructure to manage SETI information has been largely considered the core resource of national competitiveness in research and innovation (Neelameghan and Tocatlian, 1985). With the globalization of SETI information infrastructure has come a need to implement comprehensive strategies to connect, share and trade both domestic and foreign information at the national level (Lee and Kim, 2009).

The formulation of adequate SETI policies is critical to tackling contemporary challenges that include mitigating the consequences of global climate change; exploring new energy sources; generating innovation to foster social inclusion; promoting the sustainable management and conservation of freshwater, terrestrial resources and biodiversity; disaster resilience; and fostering the eradication of extreme poverty and hunger. These policies also need to be designed to achieve the UN Millennium Development Goals.

Over the past five decades, operational definitions have been elaborated within the framework of multilateral organizations to measure R&D and the broader concept of S&T. Statistical techniques have been developed to estimate private and public resources invested in these areas. For the former the OECD has laid down a methodological framework in the *Frascati Manual*, the sixth edition of which was published in 2002 (OECD, 2002). For the latter, the Member States of UNESCO have adopted the *Recommendations concerning the International Standardisation of Statistics on Science and Technology* (UNESCO, 1978; 1982; 1984a; 1984b). Methodologies for generating data about R&D investment and human resources have been constantly upgraded and extended.

During the first African Ministerial Conference on Science and Technology[2] (AMCOST I), in 2003, countries committed themselves to developing and adopting a common sets of STI indicators. The New Partnership for African Development (NEPAD) established the African Science, Technology and Innovation Indicators Initiative (ASTII) with the objective of building Africa's capacity to develop and use STI indicators. More specifically, NEPAD aims to: (a) develop and promote the adoption of internationally compatible STI indicators; (b) build human and institutional capacities for STI indicators and related surveys; (c) enable African countries to participate in international programmes on STI indicators; and (d) Inform African countries on the state of STI in Africa. The first *African Innovation Outlook* was published in 2011, while the second volume is being published in 2013. The methodology employed – that suggested by ASTII officials – follows the recommendations of the *Frascati Manual* for R&D indicators and the *Oslo Manual* (OECD, 2005) for innovation indicators.

In 2009, the UNESCO Institute for Statistics organized an Expert Meeting on Measuring R&D in Developing Countries, in Windhoek (Namibia). During the meeting, the experts identified the difficulties and challenges faced by the majority of developing countries, which were not explicitly addressed in the *Frascati Manual* (UNESCO Institute for Statistics, 2010; see Box 21). The UNESCO Institute for Statistics is working towards a global standardization of STI statistics, including those items which are not taken into account in the *Frascati Manual*.

2 The final declaration of the AMCOST meeting in 2012 recommended coordination between the African Observatory on STI (AOSTI), ASTII and UNESCO's GOSPIN. An agreement between UNESCO and AOSTI in February 2013 assigned AOSTI with responsability for following up GO→SPIN surveys with a group of West African countries.

BOX 21 – MEASURING R&D: CHALLENGES FACED BY DEVELOPING COUNTRIES

The methodology for measuring R&D is detailed in the *Frascati Manual* (OECD, 2002), which has been in use for more than 50 years. A revised edition is due out in 2015. Despite the manual's longevity, developing countries still face problems when trying to apply its standards to measuring the situation in their particular country.

The UNESO Institute for Statistics conducts a biennial data collection of R&D statistics and produces a methodology tailored to the needs of developing countries; it also holds training workshops and builds capacity through other means in developing countries.

In 2014, the UNESCO Institute for Statistics published a *Guide to Conducting an R&D Survey: for Countries starting to Measure R&D*. This guide presents the relevant R&D indicators, discusses the main issues facing each of the major sectors of performance, provides a simple project management template and proposes generic model questionnaires for the government, higher education, business and private non-profit sectors which countries can use and adapt to suit their needs.

In 2010, the UNESCO Institute for Statistics produced a technical paper on *Measuring R&D: Challenges faced by Developing Countries*. The OECD Working Party of National Experts on Science and Technology Indicators subsequently suggested that the paper serve as the basis for an annex to the *Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development (6th edition)*. This annex was adopted as an online adjunct to the *Frascati Manual* in March 2012 (OECD, 2012).

Measuring R&D: Challenges faced by Developing Countries provides guidance on a number of challenges that are relevant to developing countries and which may not be elaborated on clearly enough in the *Frascati Manual*. The following situations are addressed in the document, among others:

- Despite the increasing presence of developing countries in global R&D, there is still a marked lack of demand for science, technology and innovation (STI) indicators from policy-makers in developing countries. Even if the demand does exist, there are often significant problems with compiling the data due to a lack of coordination at the national level, a lack of cooperation by research institutions, universities and businesses, and a generally weak statistical system in the country.
- R&D used to be largely funded by the government but new sources of funds are emerging. Foundations, scientific associations, NGOs and particularly foreign organizations already play an important role. In addition, the contribution of private business is becoming more important and gaining more recognition in a wider range of developing countries. Many of these new sources of funding go directly to individuals and groups rather than to institutions and therefore remain unaccounted for, including for statistical purposes.
- Although the *Frascati Manual* recommends the collection of primary data through direct surveys, the use of secondary data from national budgets and budgetary records of public R&D performing units has been a widely adopted practice to obtain a rough estimate of gross expenditure on R&D (GERD). However, there is often a discrepancy between voted and allocated budgets. Furthermore, national research systems have a limited absorption capacity, which may leave funds unused in central accounts instead of being transferred to institutions performing R&D. Moreover, care needs to be taken to ensure that such transfers are not 'double counted' as expenditure of both the funding body and the institution performing R&D.
- The definitions used by finance ministries and other government institutions to establish S&T budgets may be *ad hoc* and fail to distinguish between broad S&T and narrower R&D activities. Furthermore, many institutions (universities in particular) do not compile a separate R&D budget, especially where research is a low institutional priority.
- R&D components in the national budget, especially capital expenditure, can be difficult to identify and may be aggregated under different headings. In addition, when R&D activities

stretch over more than one financial year, it may not be easy to estimate the amount of resources used each year. For example, work done to develop land and buildings used for research in a given year should be clearly earmarked and not recorded in subsequent years.

- A concentration of innovation activities by sector or in a small set of institutes may lead to volatility and inconsistencies in statistics. There is generally lower emphasis on R&D in the business sector, in part due to reduced competitive pressure in local markets.
- In the higher education sector, the increasing number of private universities makes it useful to distinguish between public and private higher education and to further break up private higher education into government-dependent and independent private institutions. Further disaggregation into private-for-profit and private-not-for-profit higher education institutions should also be considered to track where most research is carried out.
- Surveys that cover all R&D performers should in principle all report for the same period. This is difficult to achieve since, in many countries, higher education institutions and businesses do not necessarily report on the same period – the business sector's calendar tends to be the most problematic. Also, not all countries follow the same calendar. As a solution, the recommendation that R&D performers report on the financial year closest to the survey period may have to suffice.
- Information systems in government and higher education are often not set up to enable the extraction of data on R&D personnel and expenditure. Thus, accurate information on financial expenditure only becomes available a long time after completion of an activity. Unfortunately, ad hoc IT solutions to address these issues may also lead to errors and inconsistencies.
- The collection of data in full-time equivalents (FTE) for researchers provides useful information on the true volume of human resources devoted to R&D. This information is also essential for estimating R&D labour costs. Tallying the number of researchers in a given country presents further challenges. In some developing countries, salaried researchers may not have research budgets or unpaid researchers may undertake research. In other scenarios, academic staff may hold part-time contracts at more than one university. Even if academic staff have contracts that specify the amount of time to be spent on conducting research, it is difficult to enforce especially where there is a lack of resources. Estimating the time spent on research and hence the calculation of the FTE for research staff – particularly in the higher education sector – is fraught with difficulties. This directly impacts the calculation of R&D expenditure.

A number of special types of activity warrant attention when measuring R&D, as they are on the border of what is considered R&D. Three examples follow from the technical paper:

- In the case of traditional knowledge, it is important to set boundaries. Activities which establish an interface between traditional knowledge and R&D are considered R&D. However, the storage and communication of traditional knowledge in traditional ways is excluded.
- Clinical trials are an area of growth in some developing countries. Identifying research personnel in the extended clinical trials value chain may be difficult, as their involvement is occasional and harbours a risk of double counting (i.e. as personnel in the trial and as academic staff).
- Reverse engineering is important in many developing countries. However, this generally falls outside the scope of R&D. Only if reverse engineering is carried out within the framework of an R&D project to develop a new (and different) product, should it be considered R&D.

STI statistical systems are often weak in developing countries. To help strengthen these systems, the paper recommends that countries institutionalize R&D statistics, establish registers of R&D performers and document survey procedures and estimations.

Countries interested in embarking on R&D measurement are encouraged to contact the UNESCO Institute for Statistics.

The availability of input and output R&D indicators alone does not suffice to evaluate SETI policies. Much more important than the particular value of one specific indicator at a given time is the long-term rate of change that long temporal series of indicators show (Lemarchand, 2010: 27–28). For that reason, long-term temporal series of indicators are necessary to analyse the impact of specific public policies. Improving the reliability of this analysis requires new ways of standardizing information about public policies and the policy instruments designed to implement them. Owing to the complexity of these issues, the 'science of science policy' has emerged in recent years as a new discipline where new analytic paradigms can be tested.

Better ways of measuring evidence-based policies

SETI policy debates are not yet dominated by a thoughtful, evidence-based analysis of the likely merits of different investment options and policy decisions. The latter are strongly influenced by past practice or data trends that may be out of date (Husbands Fealing *et al.*, 2011). The evolution of new policies has been accompanied by more difficult challenges related to planning and evaluating these policies (see Box 22); this indicates a need to improve the theoretical frameworks for policy formulation (Steinmueller, 2010).

Unfortunately, a number of factors prevent countries from reaching most of the objectives established by their own development plans: the lack of reliable information on SETI national potentialities; difficulties in coordinating the various SETI stakeholders; an absence of mechanisms for promoting a strong interaction between the *supply* and *demand* sectors in SETI, and; the absence of any explicit industrialization policy promoting endogenous innovation.

BOX 22 – THE POLICY-MAKING CYCLE

A stylized presentation of the policy-making cycle typically involves five stages:

- *Agenda-setting*: refers to the process by which problems related to SETI and the linkages between SETI and both society and the economy come to the government's attention;
- *Policy formulation*: refers to the process by which SETI policy options are formulated by the government;
- *Decision-making*: refers to the process by which governments adopt a particular course of action or non-action;
- *Policy Implementation*: refers to the process by which governments put SETI policies into effect and;
- *Policy evaluation*: refers to the process by which the results of SETI policies are monitored by both the State and societal actors. The result may be a re-conceptualization of policy problems and solutions, in which the effectiveness, efficiency and continuing appropriateness of policies and policy instruments are assessed and the results fed back into another round of agenda-setting.

Responsible and accountable SETI governance entails developing capabilities at each of these five stages.

These difficulties mostly appear in small economies. For example, Flanagan *et al.* (2011) have explored the ways in which innovation policy studies treat actors, instruments, institutions and interactions, in order to arrive at a more useful conceptualization of the policy mix for innovation. They stress the need for a genuinely dynamic view of policy formulation and policy interaction. They conclude that 'despite the importance attached to "strategic policy intelligence" in recent innovation policy analysis, little empirical attention has been devoted to actual processes of policy learning.' In developing and exploiting technological opportunities, institutional competencies – namely, the governance of SETI decision-making bodies – are just as important as the SETI incentive instruments they promote (Pavitt,

1996). Path dependency emerges, as the cost of institutional changes to SETI is often higher than that of accommodating new instruments and policies in existing structures (Van der Meulen, 1998). For this reason, the design, analysis and monitoring of any national SETI policy will strongly depend on the adequate mapping of: the structure of the SETI governing bodies; the SETI national legal framework and; of the implicit and explicit operational SETI policy instruments which are implemented (Herrera, 1971; 1972; Sagasti and Aráoz, 1976).

WHY TALK ABOUT SETI POLICIES?

The term 'science policy' was coined following publication in 1945 of Vannevar Bush's seminal article *Science – the Endless Frontier*, which laid the foundations for the first social contract for science. By 1950, UNESCO had initiated the first systematic studies on science policies in a dozen developed countries. Originally, this term referred to public policies related to scientific and technological research, experimental development, scientific and technological services and innovation. *Science policy* as a discipline evolved over the coming decades. Today, it is possible to distinguish specific operational policy instruments according to the different needs established by science policies, engineering policies, technology policies and innovation policies. As these four distinct types of public policy require different skills, major universities around the world have recently introduced specific postgraduate programmes targeting each of the four types of policy:

Science policy: relates to those policies needed to: promote scientific research, determine and select scientific objectives and goals consistent with national plans or strategies, exercise judgment in fixing norms to govern the ways and means by which science is developed, transferred and applied; gather, organize and deploy resources required to pursue the selective objectives and; monitor and evaluate the results obtained from applying the policy. The following are therefore among the most important questions dealt with by policy-makers in the field of science policy: (a) establishing and strengthening government structures and mechanisms for planning, budgeting, co-ordinating, managing and promoting scientific research; (b) gathering, processing and analysing basic data concerning the national scientific potential, including data on ongoing research, monitoring national scientific development and ensuring the smooth growth of the institutional infrastructure for scientific research; (c) maintaining a proper balance between the various types of research (fundamental, applied, experimental development), supporting the development of a creative national scientific community and setting standards for the status of scientific researchers in conformity with their responsibilities and rights; (d) optimizing human, financial, institutional and informational resources to achieve the objectives established by the national SETI policy; (e) assessing and promoting productivity, relevance, quality effectiveness of national research and scientific and technological services in various sectors of performance (higher education, government institutions, business enterprise, private non-profit) and removing organizational and managerial difficulties encountered in the execution of scientific research; (f) initiating appropriate legislative action in relation to the impact on the individual, society as a whole or the natural environment of the application of discoveries and inventions; evaluating the economic profitability and social utility (or harmful effects) of the said discoveries and inventions. Although the aforementioned list is not exhaustive, it indicates the key areas for which government policy-makers are primarily responsible. Each individual issue requires the design of a particular operational policy instrument.

Engineering policy: the role of engineers in public policy can be seen as a two-fold endeavour: (1) to help create public policy related to the utilization of technology to solve public problems as well as monitor and ensure compliance with such policies; and (2) to use engineering knowledge to assist in the construction of policy directives to help solve social problems. In many cases, the development and implementation of such regulations and laws requires both a technical understanding of the functioning of these artefacts and an understanding of how this technology interacts with social and natural systems and would benefit from the involvement of a technical expert. The issues addressed by engineering policies are vast and global in nature and include water conservation, energy, transportation, communication, food production, habitat

protection, disaster risk reduction, technology assessment and the deterioration of infrastructure systems. These issues need to be addressed while respecting the rights and meeting the needs and desires of a growing world population [for a detailed list of issues and challenges addressed by engineering policies, see UNESCO (2010c).

Technology policy: the fundamental premise of technological policies is that it is possible for governments to implement public policies to improve social welfare by influencing the rate and direction of technological change. The conventional entry point for economic analysis is to identify the conditions needed for such influence to be superior to the outcome of ordinary market competition. These conditions, in turn, direct further examination of the feasibility and methods for such intervention, including the question of whether government intervention is necessary to improve social welfare. Succinctly stated, government intervention would be necessary if profit-seeking actors underperformed or performed poorly in producing or exchanging technological knowledge from the perspective of social welfare.

Innovation policy: innovation policy can be characterized in various ways, such as by distinguishing between 'supply-side' and 'demand-side' policy, or between 'mission-oriented' and 'diffusion oriented' policy. Policy instruments include financial instruments (e.g. R&D tax credits, export incentives, soft loans, etc.) and regulatory instruments such as laws and binding regulations (e.g. the use of safety equipment for children in cars). Innovation policy encompasses many types of innovation. Innovation may be characterized, *inter alia*, by: the type of innovation – technological (product and process) or non-technological (organizational and marketing); the mode of innovation – novel innovator (strategic and intermittent), technology modifier and technology adopters and; the socio-economic impact – incremental, disruptive or radical. The effectiveness of innovation policies requires a sufficiently stable framework, institutions and policies. Stability and predictability are particularly important for risky activities with a long time horizon such as R&D and innovation. Excessive instability may inhibit innovation by increasing uncertainty for innovators. It may lessen the effectiveness of policy instruments by weakening the incentives they provide. In addition, it reduces opportunities for learning and developing evidence-based policy practices. Whereas there are manifold sources of unwarranted discontinuities, political instability and fiscal problems – often related to policy cycles – are a common cause. In an increasingly complex innovation landscape, developing effective governance requires better co-ordination at, and among, the local, regional, national and international levels.

SETI projects normally occur within a larger temporal framework administered by an organization or a government policy-making body. The early stages of a new SETI policy usually appear as successive expansions of the group of agents and stakeholders whose endorsement is needed to launch the initiative, whereas the latter stages focus on programme management, with feedback as to its success or failure at the policy level (Marburger III, 2011). Consequently, in order to provide an accurate landscape of the SETI policies and policy instruments in a specific national context, it is imperative to understand the long-term evolution of the SETI organizational chart, SETI infrastructure and legal framework (i.e. explicit policies), as well as the type of funding mechanisms implemented. The latter dimensions must be contrasted with detailed analyses of the long-term behaviour of political, educational, economic, productive and social macrovariables (i.e. implicit policies).

It is impossible to describe the current status of SETI without accurate data. Moreover, these data should be presented in such a way as to allow decision-makers and experts to estimate whether the status of SETI meets societal needs or expectations. Policy-makers benefit from additional policy tools to assist them in deciding about budget allocations or in the design of new SETI policy instruments, especially if these are real-time tools or new innovative prospective methodologies. Recent empirical studies show the relevance and long-term impact of appropriate SETI information services on SETI policies designed to improve national competitiveness (Lee and Kim, 2009).

It is also important to note the availability of a large group of public and private databases. These can be most useful tools for evaluating the performance of the SETI policies and providing adequate technology intelligence studies. There are robust, accessible systems designed to make rapid analyses and apply mathematical models to identify critical points or levers triggered by policy changes that can directly affect

the performance of innovation activities. For example, Zucker and Darby (2011) present a comprehensive survey of all available databases that may be used to analyse the impact of SETI policies (see Box 23).

BOX 23 – USING NEW MATHEMATICAL THEORIES TO PROMOTE STRATEGIC NATIONAL INNOVATION

Recent developments in the mathematical theory of networks can be applied to formulating new SETI policies, in order to promote strategic innovation within national economies.

Hidalgo *et al.* (2007) found that 'economies grow by upgrading the products they produce and export. The technology, capital, institutions and skills needed to make newer products are more easily adapted from some products than from others. The study of this network of relatedness between products, or 'product space,' shows that more-sophisticated products are located in a densely connected core, whereas less sophisticated products occupy a less connected periphery. Empirically, countries move through the product space by developing goods close to those they currently produce. Most countries can reach the core only by traversing empirically infrequent distances, which may help to explain why poor countries have trouble developing more competitive exports and fail to converge to the income levels of rich countries.'

This type of analysis can be applied directly to formulating customized SETI policy instruments to foster the development of specific technologies, where the country has detected a potential new technological niche. The availability of access to new electronic international databases (Zucker and Darby, 2011), combined with the appropriate analytic software, might transform this type of analysis into a standard procedure for selecting national SETI priorities.

Access to appropriate, reliable data is also a prerequisite for responsible and accountable governance, which demands informed decision-making at the planning stage of SETI policy and foresight as to the possible short and long-term impact of policy decisions. Therefore, policy-makers not only need a clear picture of the national, regional and global situation. They also need to be able to estimate the impact of current SETI policies and plan on future policies. The analysis of any national or regional SETI policy strongly depends on the adequate mapping of the structure of SETI governing bodies, SETI national legal frameworks and the implicit and explicit operational SETI policy instruments. Gaps or blind spots in information can cause a specific field to be neglected, which can result in missed opportunities for socio-economic development.

POLICY INSTRUMENTS: LEVERS FOR IMPLEMENTING DECISIONS

A policy may remain a mere rhetorical statement if no means are provided for its implementation or to realize its potential effect. To do this, a number of things may be needed, which we will incorporate under the term of policy instrument. A policy instrument constitutes the set of ways and means used when putting a given policy into practice. It can be considered as the vehicle through which those in charge of formulating and implementing policies actualize their capability to influence decisions taken by others.

The study of public policy instruments in national settings has contributed significantly to the understanding of policy, political systems and relations between State and citizen. Research on policy implementation usually focuses principally on the effects of a specific instrument, within a wider reflection on whether the correct instrument has been chosen for the purpose. As far as new governance models is concerned, the search for suitable instruments is above all governed by pragmatism (Kassim and Le Gales, 2010).

Figure 50: Instruments for ensuring a policy obtains the desired effect. Adapted from Sagasti and Aráoz (1976).

SETI operational policy instruments are the levers by which the organizational structure ultimately implements the decisions on a day-to-day basis and attempts to produce the desired effect on the variables the policy has set out to influence. Throughout the analysis of an instrument's effectiveness, it is important to bear in mind the 'actors' or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own accord. Rather, it responds to the will of the policy-makers and decision-makers using it.

A related concept can be found in the problem of *Ordnungspolitik* stressed by the German Freiburg School in the 1930s. Here, the focus was how to devise a framework or set of rules (*Ordnungsrahmen*) for an economy that would define the operating space for individual and private activities. The challenge for SETI policy instruments can be interpreted as a problem of transformation, namely the question of choosing the best policy instrument in order to reach the set target.

A policy instrument attempts to make individuals and institutions take decisions following the rationality dictated by the collective objectives established by those in power. It is the connecting link between the purpose expressed in a policy and the effect that is sought in practice. An SETI policy instrument includes, as a significant component, the manipulation of SETI variables.

One of the first and more relevant studies on SETI policy instruments was conducted in the 1970s by the International Development Research Centre. The principal objective of the study was to devise ways and means of understanding how a country's investment in S&T could be most effectively related to its objectives for industrial development. Sagasti and Aráoz (1976) developed an interesting methodological framework for making a survey and analysing the policy instruments of ten countries in Latin America, the Middle East, Southern Europe and Asia.

UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments[3] (GO→SPIN) has adapted and expanded the theoretical framework of Sagasti and Aráoz (1976), in order to implement a systematic survey in Africa, Arab States, Asia and the Pacific and in Latin America and the Caribbean. The information in the present country profile has been organized according to this methodological approach. Figure 50 presents the basic analytical units around which the present report is organized.

All national SETI policies, be they *implicit* or *explicit* (Herrera, 1971; 1972), attempt to harness a country's creative potential to its socio-economic, environmental and cultural objectives. An *explicit* SETI policy is a statement by a high-level government official or institution, such as a ministry or the planning secretariat, that deals with activities related to STI. The policy expresses a purpose (effects according to SETI variables) and may set objectives, define desired outcomes and establish quantitative goals. Policies also contain criteria for choosing from among several alternatives to guide decision-makers as to how SETI works. SETI policies might also be formulated by representatives of the private sector. A number of factors impinge on the efficiency of SETI governance, namely, the extent to which policy processes have the greatest effect with a given use of resources. It must be acknowledged that overall efficiency is not easily defined and measured in a multi-objective, multi-actor world.

THE KEY ROLE OF THE SETI ORGANIZATIONAL STRUCTURE IN POLICY IMPLEMENTATION

The SETI organizational structure or chart usually shows the distribution of responsibility for implementing a given policy. Under the term 'organizational structure,' it is possible to distinguish at least five different levels: (1) policy planning level (policy design); (2) promotional level (i.e. funding and co-ordination of R&D, innovation and scientific and technological services); (3) implementation level (execution of R&D and innovation); (4) scientific and technological services and; (5) assessment or evaluation level.

3 See www.unesco.org/new/en/natural-sciences/science-technology/sti-policy/global-observatory-on-policy-instruments

1. *Policy planning level*: includes policy planning, budgeting, decision-making, interministerial co-ordination. The responsibility for the formulation of SETI policies generally rests with a special government department, ministry or statutory body, in some cases assisted by national councils of research and innovation. SETI policy formulation normally includes the preparation of the national development plan or strategy relating to SETI; it also includes the annual preparation of the functional state budget for SETI activities (mainly research, innovation and scientific and technological services). The decision-making function usually falls to the government, or to a committee of ministers more specifically concerned with SETI; it mainly involves the approval of the national SETI plan (or strategy), as well as the assignment of funding mechanisms. The interministerial co-ordination takes place during the formulation of policies and preparation of plans and budgets then at the various stages of the implementation of these policy documents, once approved by the government.
2. *Promotional level*: the promotion, financing and co-ordination of research, innovation and scientific and technological services in the various sectors of the economy and in society. The functions performed at this level begin with the policy decisions taken by the government and continue with the various government departments or ministries through traditional budgetary procedures along administrative budget lines or through programme budget procedures, as applied to the so-called management by objectives. Several funding mechanisms and SETI operational policy instruments of various kinds have been implemented over the years (i.e. research funds, innovation funds, sectorial funds, tax-incentives; competitive grants, scholarships, etc.). Most countries apply a combination of operational policy instruments to handle the financing of research, innovation and scientific and technological services according to well-defined programmes. The latter can be achieved either by responding to requests for the funding of specific projects submitted by external institutions, laboratories, research units, individual research scientists and high-tech enterprises, or by providing incentives for innovation, or by selectively entrusting the external bodies mentioned above with the execution of specific projects called for by certain development objectives according to the national SETI plan or strategy (normative method). At this particular level, several countries have special institutions (i.e. national research councils) which promote the advancement of scientific research and technological development with a view to improving the quantity and quality of new scientific knowledge to expand the country's potentialities, particularly through support for post-graduate education and research at universities and polytechnics.
3. *Implementation level*: this operational level concerns the actual performance of scientific research, technological development and innovation.
4. *Scientific and technological services (STS) level*: this represents a mixed group, including the institutions in charge of: (a) SETI information and documentation, (b) museums of science and technology, botanical and zoological parks and other SETI collections (anthropological, archaeological, geological, etc.), (c) general purpose data collections: all the activities comprising the routine systematic collection of data in all fields of SETI, such as topographical, geological and hydrological surveys, routine astronomical, meteorological and seismological observations, surveying of soils and plants, fish and wildlife resources, atmosphere and water testing, monitoring of radioactivity, UV and CO_2 levels, prospecting and related activities designed to locate and identify oil and mineral resources, gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics; testing, standardization, metrology and quality control, activities related to patents and licenses, as well as the production of scientific publications.
5. *Assessment or evaluation level*: this consists in government sectors and institutions monitoring the implementation of policy goals and measuring the societal impact of those policies. Their function also encompasses the conduct of an ongoing survey of a country's SETI potential at the level of research, innovation and scientific and technological service units, including ongoing research results and their practical application.

The GO→SPIN methodological approach introduced a normalized way of encoding the different types of organization and their functions. By representing each national SETI organizational chart and by using the same set of coding tools (Lemarchand, 2010: 310), it will be possible in future to associate these charts and tools with specific topological metrics to identify patterns in performance. The latter will be very useful for

defining a new set of SETI policy indicators able to reveal the level of complexity and functionality of each STI organizational chart. Table 40 shows examples of how different countries structure SETI policy design.

Since its purpose is to guide decisions about the future that must be taken now, a SETI watch cannot seek to identify future developments in S&T independently of past and current developments, or independently of the material and human resources devoted to research and innovation. The prerequisites for any future is: knowledge of the present, knowledge of the current trends observed in a real world composed of different nations and institutions, and knowledge of the strength and weaknesses of the national SETI system in which the decisions informed by the GO→SPIN survey's methodological approach have to be taken.

Table 40: Models of governing bodies heading SETI policy design

Argentina	Scientific and Technological Cabinet (GACTEC) Ministry of Science, Technology and Productive Innovation
Australia	Prime Minister's Science Engineering and Innovation Council Commonwealth State and Territory Advisory Council on Innovation Coordination Committee on Innovation
Chile	Inter-ministerial Committee for Innovation National Corporation for the Promotion of Production (Ministry of Economy) National Commission for Scientific and Technological Research (Ministry of Education)
Croatia	Ministry of Science, Education and Sports National Council for Science National Council for Higher Education
Czech Republic	Ministry of Industry and Trade Council for Research, Development and Innovation Ministry of Education, Youth and Sports
Finland	Research and Innovation Council Ministry of Employment and the Economy Ministry of Education and Culture
Ireland	Inter-Departmental Committee on STI Department of Jobs, Enterprise and Innovation
Malaysia	Ministry of International Trade and Industry Ministry of Science, Technology and Innovation Economic Planning Unit
Republic of Korea	National Science and Technology Council Ministry of Science and Technology
Singapore	Economic Development Board Research, Innovation and Enterprise Council National Research Foundation
South Africa	Department of Science and Technology Department of Trade and Industry Department of Higher Education and Training

Source: UNESCO

The diversity of institutions at the promotion level (funding) in a given country seems to be one of the most fundamental indicators of good practices. The GO→SPIN global database will provide empirical evidence to confirm or refute this and other hypotheses.

The so-called *legal framework* can also be considered as a set of legal instruments. This embodies the policy, or parts thereof, in the form of a law, decree or regulation. Formal agreements, contracts and international STI cooperation treaties may also be included in this category. A legal instrument goes one step beyond a policy by stipulating obligations, rights, rewards and penalties. The GO→SPIN systemic approach has developed a friendly platform offering direct access to the entire SETI legal framework,

description and the full text of laws, acts, decrees and agreements adopted by each country. Table 41 shows different examples of the most important types of legal instrument.

Table 41: Examples of SETI legal instruments

A law for the creation of national research labs, universities, national research councils, ministry of S&T, R&D Funds, etc., or a legal framework to regulate the organization of the national innovation system.
A law to regulate the imports/exports of high-tech products.
A law to regulate tax incentives to promote innovation within the private sector.
A law to regulate foreign direct investments promoting the establishment of new high-tech enterprises.
A law to regulate the protection of the national biodiversity and to establish norms on how foreign companies exploit the active substances available within each national territory (new rules for the protection of indigenous knowledge).
Laws to foster R&D activities within the private sector and the creation of technological funds associated with the most strategic sectors of the economy (energy, mining, agriculture, industry, communication, fishing, tourism, etc.).
National regulations and decrees to establish new national policies, creation of new funding mechanisms, import/export tariffs, etc.
Bilateral, regional and international agreements on SETI activities.
Contracts on technology transfer.

Source: UNESCO

GO→SPIN also includes a complete description of SETI operational policy instruments; these are the levers, or actual means, through which the organizational structure ultimately implements the decisions on a day to day basis and attempts to influence the behaviour of the various stakeholders targeted by the policy. Throughout the analysis of an instrument, it is important to keep in mind the actors or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own accord. Rather, it responds to the will of the policy-makers and decision-makers using it. Table 42 shows different types of operational policy instrument, whereas Figure 51 shows various instruments that can be employed to effect at the different stages leading to market penetration of an innovation. Table 43 presents the taxonomic classification of SETI operational policy instruments employed by GO→SPIN according to its methodological approach, by objective and goal; the type of mechanism/mode of support and target groups/beneficiaries. By analysing the aggregated information for groups of countries employing these classification schemes, it is possible to detect development patterns.

Table 42: Examples of operational SETI policy instruments

Programmes and objectives	Policy instrument	Strategic objectives	Beneficiaries	Mechanisms for allocating funding
Scientific research and technological development	Competitive grants	Promote the endogenous production of new scientific knowledge in the exact and natural sciences. Promote regional networking.	Research groups at national universities and national research centres associated with similar research groups from other countries in the region, within formal partnership agreements	Competitive grants selected on a peer review basis; national research groups must be associated with similar groups from countries in the region which provide matching funding
Promotion of science education	Public subsidies for projects establishing science laboratories at public secondary schools	Improve scientific knowledge; methodological approach and critical thinking for secondary school pupils	Public secondary schools in less developed parts of the country	Public subsidies to mount new science cabinets and laboratories and new posts for science professors

Programmes and objectives	Policy instrument	Strategic objectives	Beneficiaries	Mechanisms for allocating funding
Promotion of gender equality in research and innovation	Scholarships	Promote the participation of women in high-tech research and innovation	Young women enrolled in a PhD programme in basic and engineering sciences	Scholarships of up to four years and small grants for participation in international conferences
Protection of indigenous knowledge	Intellectual property rights, public law–national legislation and public subsidies	Protection of traditional knowledge to confer exclusive ownership and rights on local communities when the object of protection is a product or domesticated animal, cultivated plant or any micro-organism, or a design or an object of a functional or aesthetic nature, including any element of handicrafts, the act prohibits third parties from making, using, stocking, offering for sale, selling, commercializing, importing, exporting or identifying the active substances for commercialization, without consent	A local traditional practitioner, a local community or its representative may apply to register traditional knowledge	Public subsidies and tax exemptions to defend the Intellectual property rights of holders of indigenous and traditional knowledge
Attraction and reinvestment of foreign direct investment	Public financing Tax incentives	Strategies vary from country to country, examples being: (a) an Industrial policy based on attracting export-oriented industries; (b) promotion of structural change; (c) capacity-building to improve competitiveness, focusing on sectors or market niches; (d) internationalization of enterprises, and promotion of innovation; (e) prioritizing the generation of higher-tech goods and services (f) attracting selective FDI oriented towards ICTs, biotechnology, nanotechnology and financial services; (g) improving the business climate by refining legislation and simplifying formalities to facilitate corporate operations.	National Infrastructure (buildings, technology corridors, technological cities) and training of labour and professionals for the industry in question SMEs with export capacity	Soft-loans, tax incentives, grants For specific periods: tax discounts, exemptions, preferential rates, rebates on machinery and equipment
	Attracting R&D firms		Endogenous entrepreneurs High-tech emerging sectors: biotechnology, nanotechnology, new materials, ICTs.	The same tax incentives plus special competitive funding
	Other services	Structural change within a large country offers more opportunities for the domestic market, small and medium-sized countries generally focus on schemes conducive to the development of exports	Strengthening exports of industries and services considered to have strong potential in the country	Creation of a "one-stop shop" with representatives from different ministries/ agencies to deal with problems concerning programmes, public regulations and post-investment services
Technological development	Non-repayable contributions	Increased competitiveness through innovation in products, services and processes	Micro-, small and medium-sized enterprises and broader enterprises certified as having attained international standards	By public competition; up to 50% of project cost
	Loans for technological development projects	Finance for middle-income technology production projects	Micro-, small and medium-sized enterprises with R&D departments or teams, collaborating groups and technical linkage units underwritten by the enterprise	Compulsorily repayable loans; up to 80% of the total cost, allocated on an open window basis, with a maximum of $... for three years
Technological modernization (improvement of products and processes, training)	Fiscal credit programme	Assistance in executing R&D	Physical or juridical persons who own enterprises producing goods and services	Subsidies through fiscal credit certificates obtained via public competition; up to 50% of the total cost of the project

Programmes and objectives	Policy instrument	Strategic objectives	Beneficiaries	Mechanisms for allocating funding
	Loans for modernization Projects	Technological adaptation and improvements to products and processes with a low level of technical and economic risk	Enterprises with R&D department or groups; collaboration groups, and technical linkage units underwritten by the enterprise	Special compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of $...in three years
	Loans to enterprises	To finance projects for the development of new production processes, products and modifications thereto	Enterprises, without any restriction on size or sector; no finance provided for projects with a rate of return of less than 12%	Compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of $...
Promotion of the technological services market (research institutes and business research centres)	Subsidies for projects to develop business plans	Finance for business development projects based on R&D	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to 50% of the total project cost, with a maximum of $..., for up to one year
	Loans to institutions	To promote the establishment and strengthening of structures for the provision of technological services to R&D enterprises and institutions	Public or private institutions providing services to the private productive sector; projects may be presented on an individual or associated basis	Obligatorily repayable subsidies allocated on an open window basis, up to a maximum of $...
Training and technical assistance	Subsidies for training and retraining projects	Subsidies to support activities for training and retraining human resources in new technologies	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or $... for up to six months
	Subsidies for project Formulation	Support for the formulation of R&D projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises whose projects are executed by technical linkage units	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or $... for up to six months
Technological advisory assistance programmes and those strengthening the performance of technical small and medium-sized enterprises	Technological advisory assistance programme	Support for the formulation of R&D projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises producing goods and services which incorporate technological added value	Subsidies allocated on an open window basis to individuals or groups, with a maximum of 50% of the total cost of the project, or $... and a maximum of $... per participating enterprise
Popularization and social appropriation of science	Competitive grants	Support for the organization of national exhibitions and science fairs	Science museums, educational institutions at primary, secondary and tertiary levels	Subsidies allocated on a competitive basis

Source: UNESCO, UN ECLAC, FONTAR (Argentina)

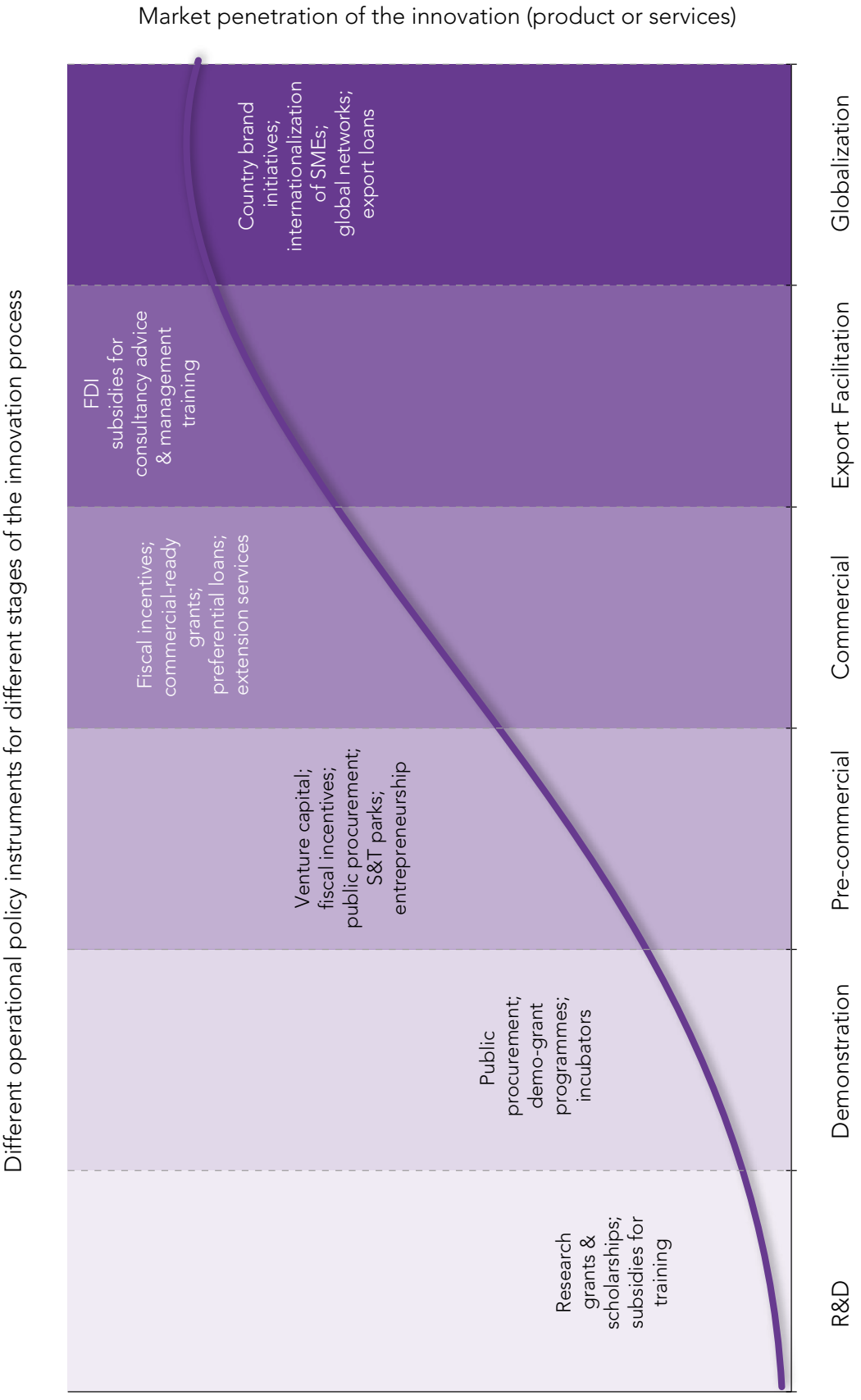

Figure 51: Policy instruments for different stages of the innovation process and market penetration.
Source: UNESCO

Table 43: Taxonomic classification of SETI operational policy instruments employed by GO→SPIN

Objectives and goals	Type of mechanism/ Mode of support	Target groups/ Beneficiaries
• Strengthen the production of new endogenous scientific knowledge • Strengthen the infrastructure of research laboratories in the public and private sectors • Human resources for research, innovation and strategic planning; capacity building, education and training of specialized human capital for (1) the production of new scientific knowledge, (2) development of new technologies, (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society • Strengthen gender equality for research and innovation • Strengthen the social appropriation of scientific knowledge and new technologies • Development of strategic technological areas and new niche products and services with high added value; promotion and development of innovation in the production of goods and services; promotion of start-ups in areas of high technology • Strengthen science education programmes at all levels (from primary school to postgraduate) • Promotion of the development of green technologies and social-inclusion technologies • Promotion of indigenous knowledge systems • Research and innovation eco-system: strengthening co-ordination, networking and integration processes which promote synergies among the different actors of the national scientific, technological and productive innovation system (i.e. government, university and productive sectors) • Strengthen the quality of technology foresight studies to: assess the potential of high-value markets; develop business plans for high-tech companies; construct and analyse long-term scenarios and; provide consulting services and strategic intelligence • Strengthen regional and international co-operation, networking and promotion of SETI activities	• Grants (grant funds) • Donations (individuals/ companies) • Loans • Creation of, and support for, technological poles and centres of excellence • Tax incentives • Technical assistance • Scholarships • Credit incentives and venture capital • Trust funds • Information services • Others	• Individual researchers or professionals, PhD holders, higher-education teachers. • Research groups • Technical and support staff for SETI activities • Graduate students • Universities, colleges, tertiary education institutions (public or private) • Secondary and primary schools (public or private) • Institutes and other research centres (public or private) • Technical training centres (public or private) • Business/enterprises (public or private) at different categories (corporations, SMEs, etc) • R&D non-profit organizations (public or private) • Foundations (public or private) • R&D Professional Associations • Ad hoc associations • Co-operatives related with SETI • Other

Source: UNESCO

Annex 2: Members of the GO→SPIN Survey Team in Lao PDR

Table 44: Members of the 'GO→SPIN Survey Team' in Lao PDR

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G. A. Lemarchand and A. Tash, eds. UNESCO (2018)

GO→SPIN Country Profiles in Science, Technology and Innovation Policy, vol. 7.

United Nations Educational, Scientific and Cultural Organization: Paris

The Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN) country profiles are designed to expose – through the rigorous application of an assessment lens—usable insights about science, technology, and innovation (STI) policies and their context. This is meant to encourage choices that harness research and innovation to achieve national goals.

While the availability and quality of data necessarily constrains the possibility to draw and to validate conclusions, in Lao People's Democratic Republic it is clear that sustained growth, a young population, the Association of South-East Asian Nations (ASEAN) dynamics, and global links that researchers have forged offer a foundation for turning the national economy and STI system toward a new model of growth with potential to speed improvements to the well-being of the population. This transition would involve diversifying the productive system and improving the innovation ecosystem in order to accompany and encourage industry's move toward higher-value production. Improving labour skills is a necessary condition.

The Lao PDR government has taken several measures to strengthen the STI system recently, including restructuring STI governance, making a commitment to reinforce its public funding, and bringing a focus to sustainable energy which may raise demand for research and development (R&D) in that area. Yet the ratio of researchers to inhabitants today is only 19 full-time equivalent (FTE) researchers per million inhabitants, a very low baseline, and supply and demand for these activities are weak. This country profile shows, among other things, that the Government has a limited number of operational policy instruments to encourage R&D and innovation activities.

Likewise, STI policy instruments could very efficiently strengthen human capital, for example if they were designed to incentivize people to complete PhD programmes, or to encourage women and girls toward science and engineering careers. The university system in Lao PDR may need to re-gear so as to offer adequate PhD programmes on natural sciences and engineering or on infrastructure, even while recent regional agreements within the framework of the ASEAN Plan of Action on Science, Technology and Innovation (APASTI) should open opportunities for Lao PDR to enhance the quality of its educational offering.

In this volume *Mapping Research and Innovation in Lao PDR*, the Ministry of Science and Technology of Lao People's Democratic Republic and UNESCO have collaborated to prepare an evidence-based policy analysis of Lao PDR's unique situation. The present profile has been produced within the Global Observatory of Science, Technology and Innovation Policy Instruments (GO→SPIN), a UNESCO initiative applying a new methodology to mapping research and innovation at country level.

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