

# Technology Needs Assessment for the Kingdom of Bhutan



Kingdom of Bhutan



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UNITED NATIONS TECHNOLOGY BANK  
FOR LEAST DEVELOPED COUNTRIES

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## Acronyms and Abbreviations

<b>ADB</b>	Asian Development Bank	<b>IPR</b>	Intellectual Property Rights
<b>AEC</b>	Advanced Entrepreneurship Course	<b>ISF</b>	Institute for Sustainable Futures
<b>AeHIN</b>	Asia eHealth Information Network AI Artificial Intelligence	<b>ISP</b>	Internet Service Provider
<b>AR</b>	Augmented Reality	<b>IT/ITES</b>	Information Technology/Information Technology Enabled Services
<b>ATP</b>	Apprenticeship Training Programme	<b>IZC</b>	Institutes for Zorig Chusum (Bhutanese traditional arts institute)
<b>BAC</b>	Bhutan Accreditation Council	<b>KGUMSB</b>	Khesar Gyalpo University of Medical Sciences of Bhutan
<b>BAFRA</b>	Bhutan Agriculture and Food Regulatory Authority	<b>KPI</b>	Key Performance Indicators
<b>BCCI</b>	Bhutan Chamber of Commerce & Industry	<b>LDC</b>	Least Developed Country
<b>BEC</b>	Basic Entrepreneurship Course	<b>LIMS</b>	Laboratory Information Management System
<b>BES</b>	Bhutan Ecological Society	<b>MECRIT</b>	Medical Education Centre for Research, Innovation and Training
<b>BITC</b>	Bhutan Innovation and Technology Centre	<b>MIT</b>	Massachusetts Institute of Technology
<b>CARLEP</b>	Commercial Agriculture and Resilient Livelihoods Enhancement Programme	<b>MoAF</b>	Ministry of Agriculture and Forests
<b>CEFE</b>	Competency based Economies through Formation of Enterprise	<b>MVP</b>	Minimum Viable Product
<b>CNC</b>	Computer Numerical Control	<b>NBC</b>	National Biodiversity Centre
<b>CNR</b>	College of Natural Resources	<b>NCHM</b>	National Centre for Hydrology and Meteorology
<b>CSI</b>	Cottage and Small Industry DGPC Druk Green Power Corporation	<b>NIS</b>	National Innovation System
<b>DRER</b>	Department of Research and External Relations	<b>NITM</b>	National Institute of Traditional Medicine
<b>DrukREN</b>	Druk Research & Education Network	<b>NKRA</b>	National Key Result Areas
<b>DTE</b>	Department of Technical Education	<b>NML</b>	National Metrology Laboratory
<b>EDP</b>	Economic Development Policy	<b>NPPC</b>	National Plant Protection Centre
<b>EPC</b>	Entrepreneurship Promotion Centre	<b>NRIC</b>	National Research and Innovation Council
<b>FAO</b>	Food and Agriculture Organization of the United Nations	<b>NTMH</b>	National Traditional Medicine Hospital
<b>FDI</b>	Foreign Direct Investment	<b>Nu.</b>	Bhutanese ngultrum
<b>GDP</b>	Gross Domestic Product	<b>ODA</b>	Official Development Assistance
<b>GNH</b>	Gross National Happiness	<b>PCR</b>	Polymerase Chain Reaction
<b>GNHC</b>	GNH Commission	<b>PCT</b>	Patent Cooperation Treaty
<b>GNI</b>	Gross National Income	<b>R&amp;D</b>	Research and Development
<b>GO-SPIN</b>	Global Observatory of Science, Technology and Innovation Policy Instruments	<b>REC</b>	Royal Education Council
<b>ICT</b>	Information and Communication Technologies	<b>REDCL</b>	Rural Enterprise Development Corporation Ltd
<b>IFAD</b>	International Fund For Agricultural Development	<b>REF</b>	National Research Endowment Fund
<b>IoT</b>	Internet of Things	<b>RNR</b>	Renewable Natural Resource
<b>IP</b>	Intellectual Property	<b>RUB</b>	Royal University of Bhutan
		<b>SME</b>	Small and Medium-Sized Enterprise
		<b>STEM</b>	Science, Technology, Engineering, and Mathematics

<b>STI</b>	Science, Technology and Innovation	<b>TVET</b>	Technical and Vocational Education and Training
<b>SWOT</b>	Strengths, Weaknesses, Opportunities and Threats	<b>UN</b>	United Nations
<b>TEI</b>	Tertiary Education Institute	<b>UNCDF</b>	United Nations Capital Development Fund
<b>TISC</b>	Technology and Innovation Support Centre	<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>TISCs</b>	Technology and Innovation Support Centres	<b>USD</b>	United States Dollar
<b>TNA</b>	Technology Needs Assessment	<b>UTS</b>	University Technology of Sydney
<b>TOT</b>	Training of Trainer	<b>VR</b>	Virtual Reality
<b>TTI</b>	Technical Training Institution	<b>WEF</b>	World Economic Forum
<b>TTO</b>	Technology Transfer Office	<b>WIPO</b>	World Intellectual Property Organisation

## Executive Summary

This report presents the Science, Technology and Innovation (STI) review and technology needs assessment (TNA) for the Kingdom of Bhutan conducted by UNESCO for the UN Technology Bank for Least Developed Countries (LDCs). The review mainly draws on the UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN) methodology, a tool developed to analyse national STI systems.

The overarching objective of the Technology Bank is to help the LDCs build the STI capacity that they need to promote the structural transformation of their economies, eradicate poverty and foster sustainable development.

Bhutan is among the five LDCs (the only country in Asia) for which the STI review and TNA study was launched in 2019 by the Technology Bank.

## Background

Bhutan is a landlocked country nestled in the eastern Himalayas between China and India. It has a population of 735,553<sup>1</sup> dispersed over 38,394 square kilometres. Its population is young, with the median age stands at 26.9 years as of 2017, and 37.8% of the population lives in urban areas<sup>2</sup>.

The country is characterised by deep valleys, snow-fed rivers, steep mountains as well as glacial lakes and glaciers. Guided by its Gross National Happiness (GNH) philosophy, the Constitution of Bhutan requires that “a minimum of 60% of the country’s total land is maintained under forest cover for all time”. Currently, with 71% of the total area covered by forests, Bhutan is the only carbon-negative country in the world. The abundant water resources create considerable hydropower generation potential that is exploited to fuel economic growth. However, Bhutan is highly vulnerable both to climate change and natural disasters. Added to this are the challenging geographical conditions and insufficient road networks, which make it difficult to deliver public services to widely dispersed population in the rural and remote areas.

Since the early 1980s, the average annual growth of Gross Domestic Product (GDP) has been 7.5%, making Bhutan one of the fastest growing economies in the world. The Gross National Income (GNI) per capita was at \$3,080 in 2018, three times the threshold for lower middle-income countries and only 10% below the threshold for upper-middle income economies. It is also one of the most successful countries in mitigating poverty and increasing the quality of life of its people. Furthermore, Bhutan achieved remarkable progress in education and health: school enrolment has reached nearly 100% with gender parity at secondary level, and life expectancy has increased from 46 years in 1977 to 68 years in 2018.<sup>3</sup>

The GNH framework strongly lines up with the global development agendas including Agenda 2030 for Sustainable Development, Addis Ababa Action Agenda and Paris Agreement. As such, the SDGs are considered of very high importance in Bhutan, and are integrated in the country policies and plans.

Bhutan is prepared to graduate from the LDC category in December 2023, after going through a five-year preparatory phase. This period corresponds to the time span of the Twelfth Five Year Plan (2018-2023) with the help of which the government aims to address the challenges facing the country and achieve a smooth and sustainable graduation process.

1 National Statistics Bureau of Bhutan (2018) Population & Housing Census of Bhutan [http://www.nsb.gov.bt/publication/files/PHCB2017\\_national.pdf](http://www.nsb.gov.bt/publication/files/PHCB2017_national.pdf)

2 [http://www.nsb.gov.bt/news/news\\_detail.php?id=263](http://www.nsb.gov.bt/news/news_detail.php?id=263)

3 Royal Government of Bhutan (2018) Sustainable Development and Happiness: Bhutan’s Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development [https://sustainabledevelopment.un.org/content/documents/19369Bhutan\\_NSDGR\\_Bhutan\\_2018.pdf](https://sustainabledevelopment.un.org/content/documents/19369Bhutan_NSDGR_Bhutan_2018.pdf) and Planning Commission (1999) Bhutan 2020: Vision for Peace, Prosperity and Happiness

## Challenges and Opportunities

In Bhutan, youth unemployment is a major issue (estimated at 15.7% in 2017)<sup>4</sup> and is especially high among educated young population. The economy is dominated by the hydropower and agriculture sectors, which are highly sensitive to climate change. The hydropower contributes approximately 25% of total annual GDP, accounts for 32% of exports, and generates about 25% of the government's total domestic revenue. However, massive scale of hydropower projects with high import content creates large external imbalance and high external debt, and fails to generate employment opportunities.<sup>5</sup> Agriculture accounts for 54% of employment but produces only 10% of the GDP. About 66% of poor household heads work in agriculture.<sup>6</sup>

The government seeks to diversify the economy, develop the private sector, and achieve more inclusive and broad-based growth. For this purpose, reforms are implemented to improve business and investment climate, and measures are taken to develop entrepreneurship and Cottage and Small Industry (CSI) sector. Main improvements include the new licensing policy; digitisation of registering properties; revisions of foreign direct investment (FDI) regulations and facilitation of access to finance. However, several impediments, such as skills shortages, inadequate physical and ICT connectivity, small size of the country and the domestic market and limited access to foreign markets create barriers for the development of a competitive private sector.

The Economic Development Policy of Bhutan sets out the strategies such as development of 'Brand Bhutan' and industrial cluster approach to promote the development of the priority sectors. It identifies five priority sectors (the so-called "Five Jewels") considering their economic potential and impact:<sup>7</sup> Hydropower, CSI, Mining, Tourism and Agriculture.

## STI Policy Framework and System

Bhutan does not have an explicit STI policy and its national innovation system (NIS) is at a nascent stage. Until recently, the STI investments have competed with basic infrastructure investments and other pressing priorities, such as education, health care and poverty reduction. Nevertheless, there is now a high commitment and increased interest among all stakeholders in investing in the STI. Research and innovation is regarded not only as a means for contributing to the GNH and addressing challenges facing the country but also for sustainable graduation from the LDC group.

The data do not exist about STI activities in Bhutan, including basic statistics, such as the expenditure on R&D and human resources in R&D. The WEF's Global Competitiveness Report, the only source of information about the innovation performance of Bhutan ranks the country the 79th among 137 countries in the innovation pillar of the competitiveness assessment in the period covering 2017-2018.<sup>8</sup>

Overall, R&D activities, number of researchers and funding for research and innovation are highly limited in the country. R&D is mainly conducted by the higher education institutes and research centres of the Ministry of Agriculture and Forests. These activities are confined to applied research aiming to solve problems, rather than development of innovative products, processes and services.

The absence of a stand-alone science, technology and innovation policy prohibits not only the take-up of research and innovation activities but also effective integration of the STI as a cross-cutting area in the other policies. Nevertheless, there are direct and indirect references to research, technology and

4 National Statistics Bureau of Bhutan (2018) 16th Labour Force Survey Report [http://www.nsb.gov.bt/news/news\\_detail.php?id=302&task=view](http://www.nsb.gov.bt/news/news_detail.php?id=302&task=view)

5 ADB (2019) Bhutan The World Bank In Bhutan, 2019–2023 –Fostering Diversification and Reducing Disparities <https://www.adb.org/sites/default/files/institutional-document/526656/cps-bhu-2019-2023.pdf>

6 The World Bank In Bhutan, country overview <https://www.worldbank.org/en/country/bhutan/overview>

7 Royal Government of Bhutan (2016) Economic Development Policy <https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf>

8 WEF, World Competitiveness Report 2019 [http://www3.weforum.org/docs/WEF\\_GlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport2019.pdf)

innovation in the majority of the national policy and strategy documents.

The STI system of Bhutan has not yet been fully formed. The country does not have an oversight body for STI policy making and implementation. Although included both in the Tertiary Education Policy in 2010 and in the Tertiary Education Roadmap in 2017 as an action item, the “National Council for Research and Innovation” has not been created so far. The STI related roles are distributed across different ministries and other government agencies.

There are several STI policy instruments, such as the Research Endowment Fund, which is under the responsibility of the Royal University of Bhutan (RUB) and the entrepreneurship programme implemented by the Ministry of Labour and Human Resources. The fiscal incentives also exist in the form of tax holidays applied to the sectors such as ICT as well as for the procurement of technology. However, the resources available for direct policy measures are highly limited. For instance, in the period 2017-2018, some 84 proposals were submitted by the research centres of the RUB which secured a total research grant of Nu. 49 million (USD 690,247). In the same period, the Khesar Gyalpo University of Medical Sciences of Bhutan could only fund 12 research projects with the available budget of Nu. 1.5 million (USD 21,239). Currently, the Master’s programmes at universities are limited and there are not any PhD programmes to raise researchers, although there is an effort to launch a doctorate programme in climate studies in the RUB.

Bhutan has a number of STI infrastructures, such as a Fab Lab, a TechPark, Start-up Centre, R&D centres of universities. The majority of these infrastructures are located in Thimphu. Among them, the Bhutan Fab Lab is turning into a success story with the quality and impact of its projects and activities that use emerging technologies to develop innovative solutions, and create skills and awareness of innovation especially among young people.

The Twelfth Five Year Plan identified the “Flagship Programmes”, with STI components, to address high priority national challenges that require multi-sectoral collaboration and coordination in a concerted manner. In addition, the Twelfth Five Year Plan for the Renewable Natural Resources (RNR) Sector (2018-2023) of the Ministry of Agriculture and Forests introduces specific programmes with STI elements for the development of the RNR sector.

## Assessment of Technology Needs

The technologies<sup>9</sup> needed in Bhutan in the short and medium term were identified through primary and secondary research.

All together 91 technologies were proposed for seven sectors which are of strategic importance to the country. The majority of them are in the agriculture and food sector (20 technologies). It is followed by conservation and environment, and health sectors (14 technologies each). The transportation, construction, education and energy are the other sectors for which technology transfer needs were expressed in the study. In almost all sectors, the requirement for adoption of emerging and modern technologies, capacity building and knowledge transfer were highlighted by the stakeholders (the technology lists are provided in Section 5). Furthermore, the need for strengthening the innovation infrastructure by assisting the establishment of the National Metrology Laboratory for the Bhutan Standards Bureau (BSB) as well as the creation of a Mobile Fab Lab to extend the learning and capacities of the Stationary Fab Lab to remote areas and a larger audience of users in other cities was identified.

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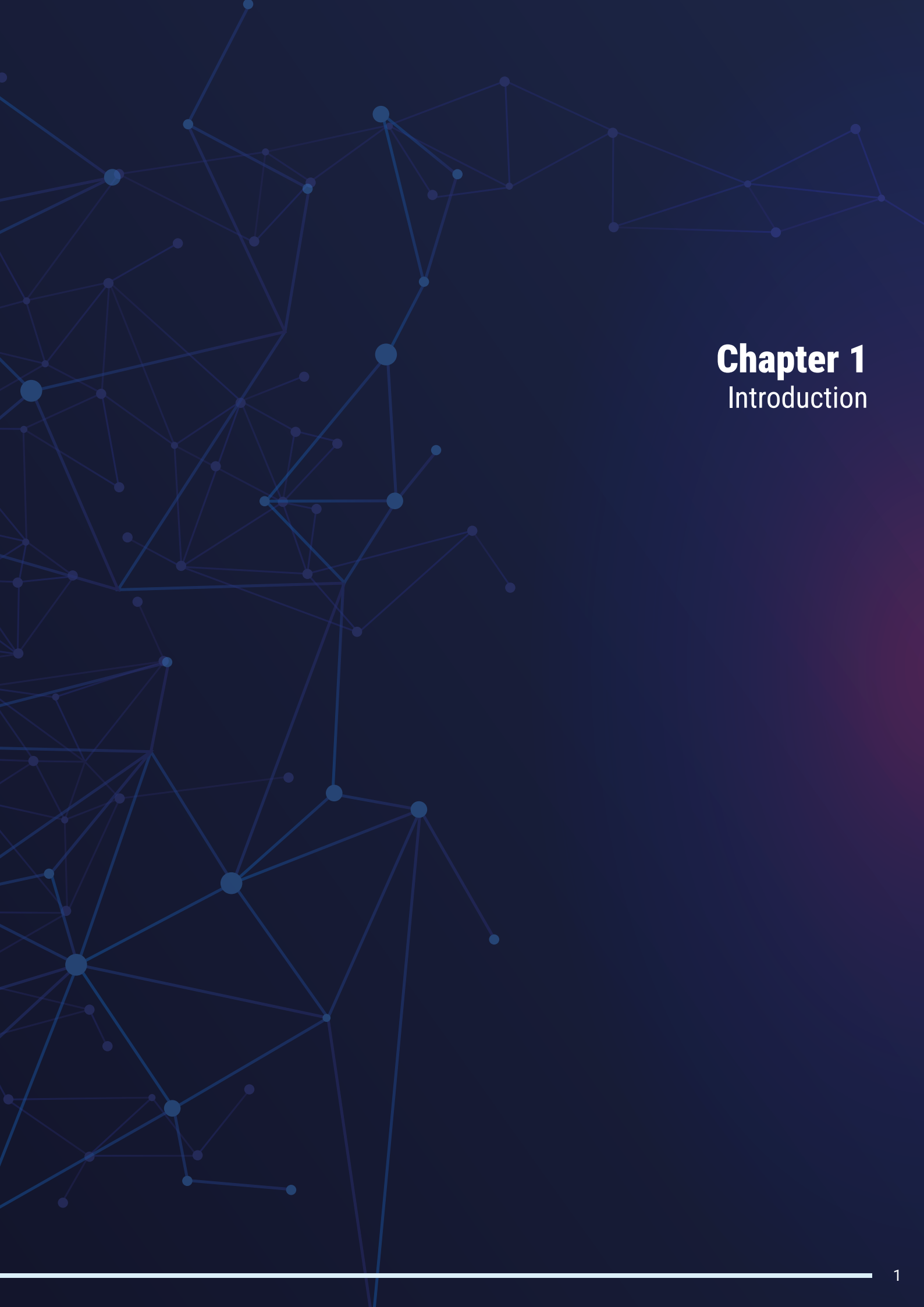
<sup>9</sup> Technology in this context is defined both as a physical component, such as products, equipment, devices, blueprints and processes, etc., and as an informational component such as know-how and technical knowledge.

## Conclusions and Recommendations

As noted above, Bhutan is strongly committed to STI as a vital tool for achieving sustainable socio-economic developments and attaining SDGs. The country is in the process of developing its innovation system, and designing and implementing projects that will enable the transformation of its economy and facilitate sustainable graduation from LDC category. It has aspirations to become a knowledge based and self-reliant society, and aims to create a “Just, Harmonious and Sustainable Society through enhanced Decentralisation” by implementing its Twelfth Five Year plan until 2023. The efforts to overcome the challenges and vulnerabilities of the country are guided by the King who emphasises the importance of investment in STI through STEM, TVET, and high and emerging technologies. The country’s renowned GNH philosophy forms a strong foundation for the realisation of its aspirations.

At this stage, it is indispensable for Bhutan to approach STI policy-making and implementation in a systematic way by putting in place all necessary elements so that it can bring lasting benefits to the country. To help the country leapfrog its constraints to growth and development through STI, a set of recommendations was proposed to the Royal Government of Bhutan in Section 6.2. They focus on strengthening STI policymaking and governance, and setting up a dynamic NIS; creating a forceful and balanced mix of STI policy instruments; improving and enhancing the research and innovation infrastructure, and developing STI human capital.

Another group of recommendations were developed for the UN Technology Bank which are presented in Section 6.2.2. The same section also includes the consolidated lists of technology needs identified under the study. It is recommended that priority is given to technologies in the agro-food, health, conservation and environment, and education sectors taking into account the challenges and opportunities for accelerating inclusive sustainable development of Bhutan. It is also suggested that the Technology Bank assists the country in the establishment of the National Metrology Laboratory as well as the creation a Mobile Fab Lab.



# Chapter 1

## Introduction

## 1.1 Introduction

This report presents the Science, Technology and Innovation (STI) review and technology needs assessment (TNA) for the Kingdom of Bhutan conducted by UNESCO for the UN Technology Bank for Least Developed Countries (LDCs). The STI review mainly draws on the UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN) methodology, a tool developed to analyse national STI systems (see Box 1 under Section 1.2).

The overarching objective of the Technology Bank is to help the LDCs build the STI capacity that they need to promote the structural transformation of their economies, eradicate poverty and foster sustainable development. Its specific objectives as outlined in its Charter are to:

- Strengthen the STI capacity of LDCs, including the capacity to identify, absorb, develop, integrate and scale-up the deployment of technologies and innovations, including indigenous ones, as well as the capacity to address and manage Intellectual Property Rights issues;
- Promote the development and implementation of national and regional STI strategies;
- Strengthen partnerships among STI-related public entities and with the private sector;
- Promote cooperation among all stakeholders involved in STI, including, researchers, research institutions, public entities within and between LDCs, as well as with their counterparts in other countries;
- Promote and facilitate the identification, utilisation and access of appropriate technologies by LDCs, as well as their transfer to the LDCs, while respecting intellectual property rights and fostering the national and regional capacity of LDCs for the effective utilisation of technology in order to bring about transformative change.<sup>10</sup>

Technology Bank projects and activities that are directly implemented, as well as those that are promoted and catalysed through its work, aim to help LDCs build STI capacities, ecosystems and regulatory frameworks that can harness the

benefits of newly available technologies by:

1. Attracting outside technology and facilitating technology transfer on voluntary and mutually agreed terms and conditions;
2. Supporting homegrown innovation and research; and
3. Bringing imported and indigenous technologies to market

Bhutan is among the five LDCs (the only country in Asia) for which the STI review and TNA study was launched in 2019 by the Technology Bank.

This report includes six sections: After a brief introduction of the background and methodology of the study in this section, an overview of the contextual background that shapes the framework in which STI policies and interventions will be formulated and implemented is given in the second section. The third section describes the current status of STI system and policy framework in the country. An analysis of the STI-related Strengths, Weaknesses, Opportunities and Threats (SWOT) for Bhutan is given in the fourth section. The assessment of the technology needs of the country as expressed by the stakeholders through field research and identified by desk study is presented in the fifth section. The last section provides a brief summary of conclusions as well as the recommendations formulated both for the Government of Bhutan and the Technology Bank. A glossary of STI related terminology is given at the end of the report based on the definitions used by UNESCO and other international organisations.

## 1.2 Background

The Kingdom of Bhutan is one of the fastest growing economies in Asia. It is also one of the most successful countries in mitigating poverty and increasing the quality of life of its people. The country is prepared to graduate from LDC category by 2023.

Over the past four decades, Bhutan's annual economic growth has averaged 7.5% and the portion of the population living in extreme poverty has decreased from 5.9% in 2007 to 1.6% in 2017.

<sup>10</sup> Technology Bank (2016) Supporting the operationalization of the Technology Bank for the Least Developed Countries: A 3 year Strategic Plan

The poverty rate has fallen from 12% in 2012 to 8.2% in 2017.<sup>11</sup> It has also achieved remarkable progress in education and health: school enrolment has reached nearly 100% with gender parity at secondary level, and life expectancy has increased from 46 years in 1977 to 68 years in 2018.<sup>12</sup>

Guided by its Gross National Happiness philosophy, Bhutan is the only carbon-negative country in the world with over 70% of forest cover. However, it faces a serious climate crisis. Its primary sectors (notably, agriculture, hydro-power and tourism) are climate-vulnerable and are not sustainable. Youth unemployment is a major issue (estimated at 15.7% in 2017)<sup>13</sup> and is especially high among educated young population. To this end, the government seeks to diversify the economy, develop the private sector and achieve more inclusive and broad-based growth. The Twelfth Five Year Plan (2018–2023) aims to address the challenges confronted by the country and guide it to a successful transition to middle-income status by 2023.

The SDGs are considered of very high importance in Bhutan, and are integrated in the country policies and plans. Equally important is the STI which is regarded as a tool to address the development challenges, achieving the SDGs and

realising national objectives. There is an ongoing debate and increased commitment among all stakeholders to create a well-functioning national research and innovation system and to put in place STI policies and policy instruments.

### 1.3 Methodology

The main tool used in this study is UNESCO's GO-SPIN (Global Observatory of Science, Technology and Innovation Policy Instruments) Report methodology. GO-SPIN is used to analyse STI systems in different national contexts. For this purpose, it maps STI landscapes and reviews STI policies and their implementation through stocktaking exercises that precede policy development. Considering the limitations as well as the fact that the STI system in Bhutan is at its nascent stage, a simplified version of the GO-SPIN methodology was used in this study.

GO-SPIN draws on a comprehensive stocktaking process through which primary and secondary data and information are collected. The techniques used in the primary research included interactive and participatory approaches, and comprised interviews, a national workshop and an online survey.

Interviews with 35 stakeholders in the Bhutan STI system were conducted between 14 and 18

#### Box 1: GO-SPIN methodology of UNESCO

GO-SPIN (<https://en.unesco.org/go-spin>) is a methodological tool to map national science, technology and innovation (STI) landscapes and analyse STI policies and their implementation. GO-SPIN Country Profiles in Science, Technology and Innovation Policy is a series of reports published by UNESCO. The GO-SPIN programme is run by UNESCO's Division of Science Policy and Capacity Building. The aim is to generate reliable, relevant information about the different landscapes of STI 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. The open-access platform of GO-SPIN<sup>14</sup> offers innovative databases with powerful graphic and analytical tools for the use of decision-makers, parliamentarians, universities, knowledge brokers, companies, specialists and the general public, with a complete set of diverse information on STI policies.

11 ADB (2018) Asian Development Bank Member Fact Sheet: Bhutan <https://www.adb.org/sites/default/files/publication/27755/bhu-2018.pdf> and National Statistics Bureau of Bhutan (2017) Bhutan Poverty Analysis Report [http://www.nsb.gov.bt/publication/files/2017\\_PAR\\_Report.pdf](http://www.nsb.gov.bt/publication/files/2017_PAR_Report.pdf)

12 [https://sustainabledevelopment.un.org/content/documents/19369Bhutan\\_NSDGR\\_Bhutan\\_2018.pdf](https://sustainabledevelopment.un.org/content/documents/19369Bhutan_NSDGR_Bhutan_2018.pdf) and Planning Commission (1999) Bhutan 2020: Vision for Peace, Prosperity and Happiness

13 [http://www.nsb.gov.bt/news/news\\_detail.php?id=302&task=view](http://www.nsb.gov.bt/news/news_detail.php?id=302&task=view)

14 <https://gospin.unesco.org/>

October 2019. The list of interviewees is given in Annex 1. In addition, 9 entrepreneurs participated in the Entrepreneurship Festival were interviewed. The workshop organised with the GNH Commission on 17 October 2019 attracted some 50 participants. The online survey, which was implemented between 22 November and 13 December 2019 in collaboration with the GNH Commission aimed to collect information on technology needs in key sectors, and was

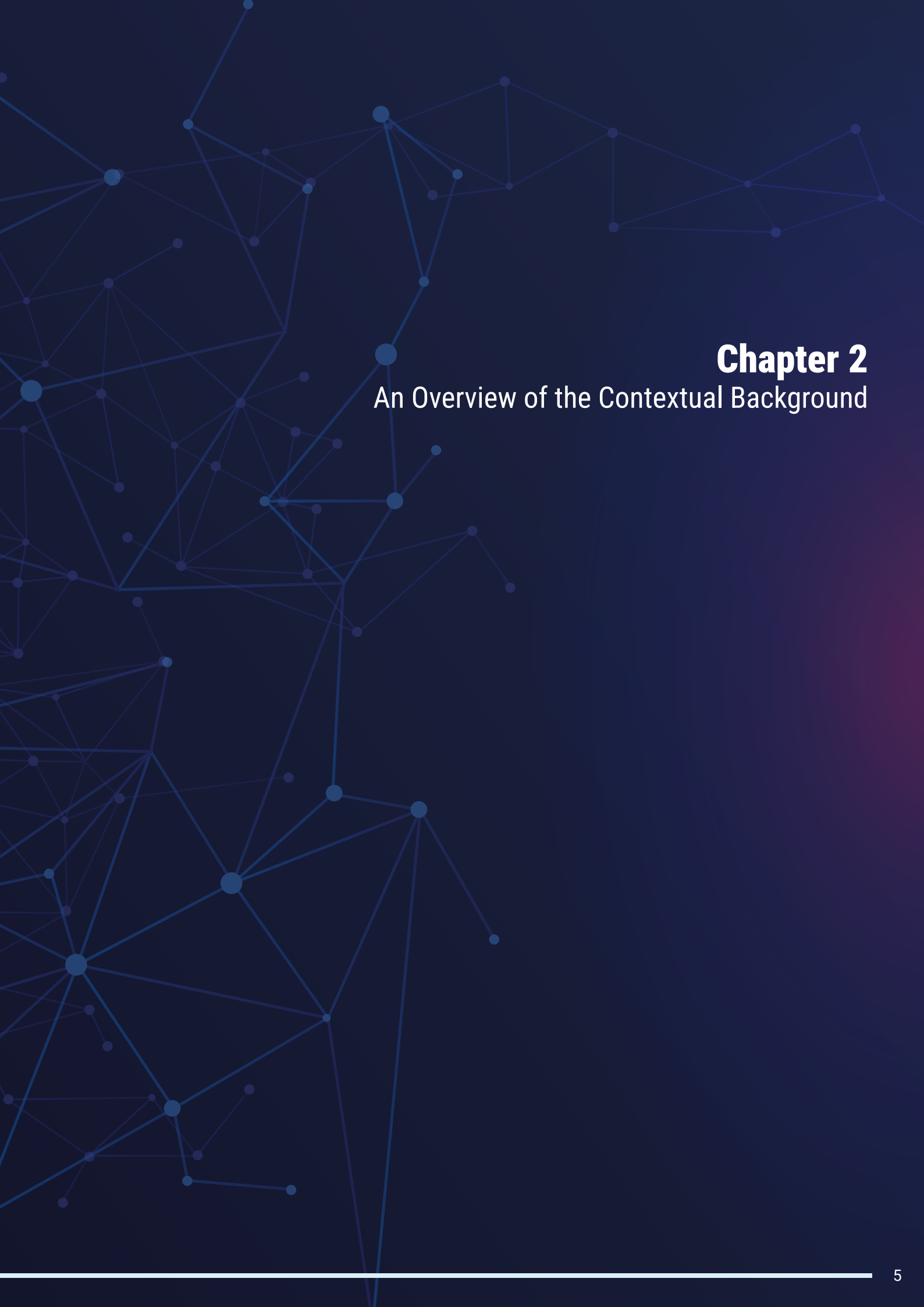
answered by 32 participants. The secondary data and information sources reviewed included the documentation

published by national and international organisations. The study benefited from the input by the Working Group created and led by the GNH Commission.<sup>15</sup>

The cutoff date for the data and information used in this report was 16 December 2019.

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<sup>15</sup> Working group members include Royal University of Bhutan, Ministry of Education, Ministry of Economic Affairs, Ministry of Information and Communication, KGUMSB, RIGGS, Ministry of Agriculture and Forests, Ministry of Health, National Statistical Bureau, GNHC (Lead/focal).



## **Chapter 2**

### An Overview of the Contextual Background

Bhutan is a landlocked country nestled in the eastern Himalayas between China and India. It has a population of 735,553<sup>16</sup> dispersed over 38,394 square kilometres. Bhutan's population is young, with the median age stands at 26.9 years as of 2017. Some 37.8% of the population lives in urban areas.<sup>17</sup>

The country is characterised by deep valleys, snow-fed rivers, steep mountains as well as glacial lakes and glaciers. The Constitution of Bhutan requires that "a minimum of 60% of the country's total land is maintained under forest cover for all time". Currently, 71% of the total area of Bhutan is under forest cover, 51.4% of which is maintained as protected areas and 8.6% as ecological corridors. Another 0.1% is protected as the royal botanical parks. The abundant water resources create considerable hydropower generation potential that is exploited to fuel economic growth.

The ecosystem of Bhutan is fragile and exposed to environmental problems. Its rich biodiversity, water resources and the livelihoods of its people are threatened by climate change. The country is also vulnerable to natural disasters, including floods, earthquake, landslide, drought, windstorm and forest fires. Added to this are the difficult geographical conditions and insufficient road networks, which make it difficult to deliver public services to widely dispersed population in the rural and remote areas. Accessibility for passenger and freight transport and logistics are among the issues that need to be addressed.

Since the early 1980s, the average annual growth of Gross Domestic Product (GDP) has been 7.5%, making Bhutan one of the fastest growing economies in the world. The Gross National Income (GNI) per capita was at \$3,080 in 2018, three times the threshold for lower middle-income countries and only 10% below the threshold for upper-middle income economies. At this stage of development, it is of vital importance to create a vibrant private sector as well as a dynamic innovation and entrepreneurship ecosystem to

diversify the economy with value-added goods and services, and develop the export base.

## 2.1 Development Agenda

The development agenda of Bhutan is shaped by the Gross National Happiness (GNH) vision and seeks to maintain a balance between development and conservation of its environment. The idea of happiness as a guiding principle for the government is deep-rooted in Bhutan. The 1729 legal code of the country states: "The purpose of the government is to provide happiness to its people. If it cannot provide happiness, there is no reason for the government to exist." During the mid-1970s, Bhutan's King Jigme Singye Wangchuck introduced the GNH concept, stating that GDP is less important because it could not deliver happiness and well-being.<sup>18</sup> The Constitution also mandates the government to promote the conditions for GNH.

The GNH is a multi-dimensional development framework that places people at the centre of development. It is translated into a practical guideline for development through the identification of strategic thematic areas, the so-called "the four pillars of GNH". These pillars are (i) sustainable and equitable socio-economic development; (ii) preservation and promotion of culture; (iii) conservation and sustainable utilisation and management of environment; and (iv) promotion of good governance.<sup>19</sup> These are further broken down into nine domains to measure GNH values:<sup>20</sup>

1. Psychological well-being
2. Health
3. Time use
4. Education
5. Cultural diversity and resilience
6. Community vitality
7. Good governance
8. Ecological diversity and resilience
9. Living standards

The GNH lays the foundation for the socio-economic development priorities and programmes

<sup>16</sup> [http://www.nsb.gov.bt/publication/files/PHCB2017\\_national.pdf](http://www.nsb.gov.bt/publication/files/PHCB2017_national.pdf)

<sup>17</sup> [http://www.nsb.gov.bt/news/news\\_detail.php?id=263](http://www.nsb.gov.bt/news/news_detail.php?id=263)

<sup>18</sup> <https://www.adb.org/news/features/gross-national-happiness-bhutan-12-things-know>

<sup>19</sup> <http://www.lldc2conference.org/custom-content/uploads/2018/12/Bhutan-Eng.pdf>

<sup>20</sup> [https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/GNH\\_9DOMAINS-AND-INDICATORS.pdf](https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/GNH_9DOMAINS-AND-INDICATORS.pdf)

**Table 1: Overview of the Five-Year Plans of Bhutan**

Plan	Main goals
1st FYP (1961-66)	Development of basic infrastructure
2nd FYP (1966-71)	Build on the foundations laid in the first plan
3rd FYP (1971-76)	Improvement of agriculture and livestock production, social services Balanced regional development Setting up small and medium scale industries
4th FYP (1976-81)	Concentration on growth of agriculture, livestock, forests and small industries
5th FYP (1981-86)	Economic self-reliance Sustained rate of growth Greater distributional equity among regions Participatory planning
6th FYP (1987-92)	Achieve economic self-reliance Improve governance through organisational development programmes Rural development Consolidation of development programmes
7th FYP (1992-97)	GNH based development Economic development and self-reliance Living standard and quality of life Decentralisation
8th FYP (1997-02)	Balanced and sustainable development Decentralisation Institutional strengthening
9th FYP (2002-08)	Improve the quality of life and income Enhance good governance Promote private sector growth Preserve and promote culture Environmental conservation Accelerate economic growth
10th FYP (2008-13)	Poverty Reduction
11th FYP (2013-18)	Self-reliance and inclusive green socio-economic development
12th FYP (2018-23)	Just, harmonious and sustainable society through enhanced decentralisation

Source: Gross National Happiness Commission (2019) Twelfth Five Year Plan Document (<https://www.gnhc.gov.bt/en/wp-content/uploads/2019/05/TWELVE-FIVE-YEAR-WEB-VERSION.pdf>)

of Bhutan outlined in the five-year plans. The plans have been prepared since 1961, the year which marks the beginning of significant reforms.<sup>21</sup> Until the 1960s, the country lacked telephones, airport, hospitals, postal service and national currency. Starting from the first plan period, it has gone through considerable modernisation and transformation.<sup>22</sup> The main goals of each plan, as indicated in Table 1 provide a historical perspective of the country's development process.

The GNH pillars and domains are translated into concrete actions in the National Key Result Areas (NKRA) of the plans. The latest (twelfth) five-year Plan covering the period 2018-2023 identifies 17 NKRA:

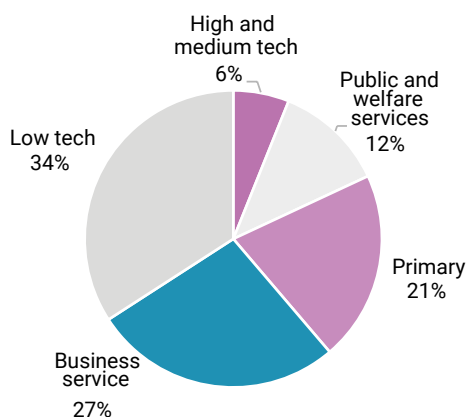
1. Macroeconomic stability
2. Economic diversification
3. Reducing poverty and inequality

4. Preservation of culture
5. Healthy ecosystem
6. Carbon neutrality, climate and disaster resilient
7. Quality education and skills
8. Food and nutrition security
9. Infrastructure, communication and public services
10. Gender equality
11. Productive and gainful employment
12. Corruption reduced
13. Vibrant democracy and decentralisation
14. Healthy and caring society
15. Sustainable human settlements
16. Effective justice services
17. Sustainable water

The GNH framework strongly lines up with the global development agendas including Agenda 2030 for Sustainable Development, Addis Ababa

<sup>21</sup> <https://www.gnhc.gov.bt/en/wp-content/uploads/2019/05/TWELVE-FIVE-YEAR-WEB-VERSION.pdf>

<sup>22</sup> <https://www.adb.org/countries/bhutan/overview>

**Figure 1: GDP Product Share by 5-Sector Aggregation, 2017 (%)**

Source: ADB (2018) *Economic Indicators for South and Central Asia: Input-Output Tables* <https://www.adb.org/sites/default/files/publication/470111/south-and-central-asia-input-output-tables.pdf>

Action Agenda and Paris Agreement. Thanks to GNH, Bhutan achieved most of the Millennium Development Goals by 2015. A UN assessment conducted in 2015 revealed high level of integration of the SDG targets into Bhutan's Eleventh Five Year Plan which was issued in 2013: a total of 134 out of 143 SDG targets relevant to Bhutan were included in the Plan, except SDG 14 Life below Water.<sup>23</sup>

As noted before, Bhutan plans to graduate from the UN's list of LDCs in December 2023, after going through a five-year preparatory phase. This period corresponds to the time span of the Twelfth Five Year Plan with the help of which the government aims to address the challenges in all sectors for ensuring sustainable graduation.

## 2.2 Political and Economic Environment

Bhutan has a stable political environment. Its political system evolved since mid-2000s from an absolute monarchy into a democratic constitutional monarchy. The fourth King, Jigme Singye Wangchuck, lifted the ban on television and the Internet in 1999. He introduced a new constitution in 2005 and voluntarily abdicated in favour of his son, Jigme Khesar Namgyel Wangchuck in 2008. In the same year, the first national elections were held and the democratic

constitutional monarchy was established.<sup>24</sup> The third parliamentary elections were successfully held in 2018 after which the Twelfth Five Year Plan was endorsed by the new government.

Bhutan attracts significant international financial assistance. The net official development assistance (ODA) flows have been over USD 120 million per year over the period 2013-2015. India is the main economic and strategic partner of the country. It is a source of foreign aid (about 70% of the external grants were from India during 2015-2018) and a financier and buyer of hydropower. Also, nearly 80% of Bhutan's imports are from India. A one-to-one peg of Bhutanese currency Ngultrum is maintained with the Indian Rupee and the exchange rate is mostly determined by the exchange rate of Rupee. The other major funding providers are the Asian Development Bank (ADB) and the World Bank. The bilateral donors of the country include Australia, Austria, Japan, Norway and Switzerland.<sup>25</sup> As one of the least corrupted countries in the world,<sup>26</sup> Bhutan uses financial assistance and technical support effectively.

According to the ADB data, the economy in Bhutan is dominated by low-tech and primary sectors and the share of high and medium technology sectors accounts only for 6% of the economy (Figure 1).

<sup>23</sup> <http://www.lldc2conference.org/custom-content/uploads/2018/12/Bhutan-Eng.pdf>

<sup>24</sup> <http://documents.worldbank.org/curated/en/612871468205491416/pdf/885970CPS0P148000Box385310B000U0090.pdf>

<sup>25</sup> <https://rtm.gnhc.gov.bt/wp-content/uploads/2019/01/ImpactAssessment-Bhutan-2018.pdf>

<sup>26</sup> [https://www.transparency.org/files/content/pages/2018\\_CPI\\_Executive\\_Summary.pdf](https://www.transparency.org/files/content/pages/2018_CPI_Executive_Summary.pdf)

Several impediments, such as skills shortages, inadequate physical and ICT connectivity, small size of the country and the domestic market and limited access to foreign markets are the barriers for the development of a competitive private sector. In order to change this situation, the government implements reforms to improve business and investment climate, and takes measures to develop entrepreneurship and Cottage and Small Industry (CSI) sector. Main reforms include the new licensing policy; digitisation of registering properties; revisions of FDI regulations and improvements in the access to finance. These reforms helped Bhutan to achieve a higher rank in the World Bank's Doing Business in 2017 among all other South Asian economies. However, it dropped from 73th in 2017 to 81th in 2019 due to the slower pace of reforms compared to the other countries.<sup>27,28</sup>

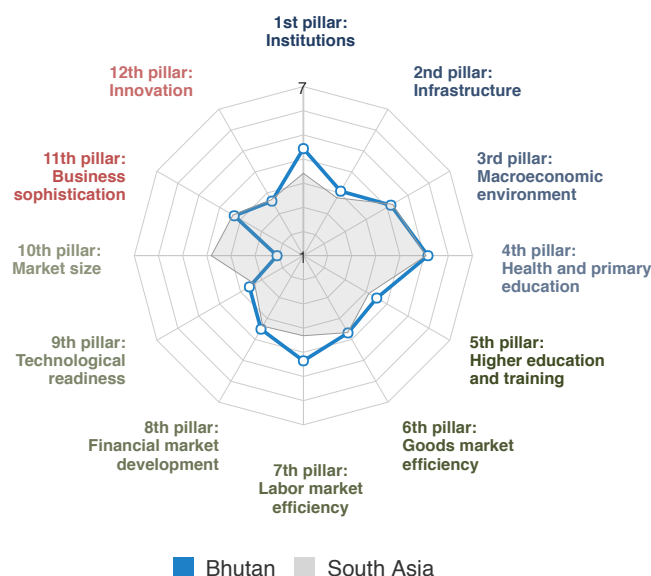
The narrow resource base and the limited opportunities for trade logistics have resulted in foreign trade imbalance in Bhutan. In 2018, exports accounted for 58% of imports. India received about 78% of Bhutan's total exports, while about 84% of Bhutan's imports originated from India.<sup>29</sup>

On the other hand, with the improvement in the ICT infrastructure and introduction of e-payment gateway, e-commerce is developing. As a result of this development, several online portals (such as <https://druksell.com>) started to operate to sell Bhutanese products.

However, there are still major obstacles in entering foreign markets. For example, the share of Bhutanese firms with internationally recognised quality certification is significantly low (less than 5%), according to the World Bank.<sup>30</sup> The reasons are explained as the low level of awareness of the benefits of certification and the high cost of obtaining them due to the underdeveloped quality infrastructure and limited supply of certification services in the country. This situation inhibits access to high-value markets which presents remarkable opportunity for Bhutan considering its highly positive international reputation and image as a country.

The World Competitiveness Report 2017-2018 gives a snapshot of the challenges facing Bhutan in creating a competitive economy (Figure 2).<sup>31</sup> While the country's ranking has improved in

**Figure 2. Bhutan's assessment in the Global Competitiveness Index 2017-2018**



Source: WEF, World Competitiveness Report 2017-2018

27 <https://www.worldbank.org/en/news/press-release/2018/10/31/bhutan-second-doing-business-south-asia-reform-slowdown>

28 <https://www.doingbusiness.org/content/dam/doingBusiness/country/b/bhutan/BTN.pdf>

29 <https://www.adb.org/sites/default/files/institutional-document/526656/cps-bhu-2019-2023.pdf>

30 <http://documents.worldbank.org/curated/en/673381506689928071/pdf/120144-ICA-PUBLIC-P153221-Bhutan-Competitiveness-Policy-Note-Web.pdf>

31 <http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017-2018.pdf>

2017-2018 (82nd in 137 economies) compared to 2016-2017 period, improvements are needed in access to financing, labour regulations, supply of infrastructure, work ethic in national labour force and foreign currency regulations. Among the issues identified for the country, inadequately educated workforce and insufficient capacity to innovate are the two challenges that directly concern STI performance of Bhutan.

## 2.3 Priority Sectors

The Economic Development Policy of Bhutan sets out the strategies such as the diversification of exports and economic base, development of 'Brand Bhutan' and industrial cluster approach to promote the development of the priority sectors. It identifies five priority sectors (the so-called "Five Jewels") considering their potential and impact on the society at large.<sup>32</sup>

- Hydropower
- Cottage and Small Industries
- Mining
- Tourism
- Agriculture

Agriculture is further classified into the following sub-sectors: organic farming, agro- processing, biotechnology, forest based products, poultry, fisheries, floriculture, health food, animal feed, apiculture, horticulture and dairy.

The hydropower sector contributes approximately 25% of total annual GDP, accounts for 32% of exports, and generates about 25% of the government's total domestic revenue. However, massive scale of hydropower projects with high import content creates large external imbalance and high external debt, and fails to generate

employment opportunities in the country.<sup>33</sup>

Agriculture accounts for 54% of employment but produces only 10% of the GDP. About 66% of poor household heads work in agriculture, and the increase in agricultural exports and productivity has been helping reduce poverty in recent years.<sup>34</sup> Tourism is seen as a sector that could contribute to job creation and income growth, especially among the rural poor and low-skilled.<sup>35</sup>

The manufacturing accounts for only about one-fifth of the industrial sector. It is dominated by a small number of major operators and a larger number of CSI firms mainly operating in the food processing and low value-added products. The CSI is seen as a strategic sector due to its potential to enhance domestic production, diversify and promote inclusive growth, boost employment, reduce inequality and promote innovation and entrepreneurial skills. The sector is defined using two criteria: cottage industries are companies with an investment of less than Nu.1 million (USD 14,000) and employing up to 4 people whereas small industries are firms employing between 5 and 19 people and having an investment between Nu.1 million to Nu.10 million (USD 14,000–USD 143,000).

Finally, the construction industry plays an important role in the economy of Bhutan. In 2017, the contribution of the sector to the GDP was 10.33%. While it creates jobs, these are taken up by foreign workers due to limited number of skilled work force in the country.<sup>36</sup>

The Economic Development Policy lists six more sectors which have the highest potential to generate wealth, employment and sustainable growth within the framework of GNH (Table 2).

32 <https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf>

33 <https://www.adb.org/sites/default/files/institutional-document/526656/cps-bhu-2019-2023.pdf>

34 <https://www.worldbank.org/en/country/bhutan/overview>

35 Ibid.

36 <https://www.mowhs.gov.bt/wp-content/uploads/2018/04/Revised-First-Draft.pdf>

**Table 2: Sectors with the highest potential**

Sector	Sub-sectors
High Quality Green Services	Education Health services and traditional medicines ICT (BPOs, KPOs, green data centres, software development, animation) Financial services R&D Professional services Waste Management Services
Energy	Solar and wind energy Other sources of renewable energy
Information, Media and Cultural Industry	Film and Creative Arts Handicrafts Textiles Fine art including the performing arts Publishing Festivals, spiritual centres, etc.
Transportation and Related Services	Green and non-fossil fuel based modes of transportation Mass transportation Railways, rope ways, cable cars and riverine transport
Construction	Mechanisation Green technology
Manufacturing	Electronics Electric vehicles and transport Electrical transformers, equipment, gadgets, fittings Computer hardware Building materials Power intensive industries Pharmaceuticals Traditional and herbal medicines Mineral processing Water based products Wood based industries

Source: Government of Bhutan (2016) *Economic Development Policy* <https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf>

## 2.4 Education, Employment and Skills

Investing in the development of human capital is among the top priorities of the government. The share of education investments in the GDP increased from 5.1% in 2013 to 6.7% in 2016. Investments in the Technical and Vocational Education and Training (TVET) have also grown. There are 18 Tertiary Education Institutes (TEIs) offering undergraduate and postgraduate courses in healthcare, medical, law, language, management, natural resource, education, and technology in the country. The science curricula in Bhutan have improved as well and teachers' training was conducted.

On the other hand, the majority of population are still employed in agriculture. According to the 2017 Population and Housing Census,<sup>37</sup> amongst the employed, 43.9% work in the agriculture sector, 11% in the construction sector, 10.8% in

public administration and 5.6% in the wholesale/retail trade. The census results indicate that the number of people employed in agriculture has increased by 37,074 persons in 2017 from 108,617 persons in 2005. Around 59% of this population is female and nearly 63% live in the rural areas.

Out of the total labour force of 340,236 persons, 8,137 persons are unemployed, leading to an unemployment rate of 2.4%. The unemployment rate increases with increasing levels of education, and reaches 6.7% for those having above secondary degrees. The youth unemployment rate is high at 10.6%. The unemployment rate amongst young women is especially high (12.9%), according to 2017 census findings.<sup>38</sup> The insufficient investment in TVET, and the poor quality of training are among the issues that lead to youth unemployment.<sup>39</sup> The mismatch between the educational system and the demand of the job market is also often cited as a major issue.

37 [http://www.nsb.gov.bt/publication/files/PHCB2017\\_national.pdf](http://www.nsb.gov.bt/publication/files/PHCB2017_national.pdf)

38 Ibid.

39 <https://www.adb.org/sites/default/files/institutional-document/526656/cps-bhu-2019-2023.pdf>

According to the Enterprise Survey (2015) of the World Bank,<sup>40</sup> specialised and soft skills are scarce in the labour force. In addition, nearly 40% of firms consider that their employees' job-specific skills are lower than required, according to the Bhutan's Labour Market study.<sup>41</sup> The same study indicates that approximately 60% of employers say their workers have insufficient computer skills. The employers also think that workers at 35 to 40% of firms have insufficient problem solving, critical thinking or leadership skills. Furthermore, employees at one-fourth of firms have teamwork skills that are below their employers' requirements.

Another issue is the skills shortages, which is not only caused by low levels of education but also by the recruitment of skilled human resources by the public sector, which absorbs some two-thirds of the labour force with tertiary education. This situation limits the development of a vibrant private sector as well as well-paying private sector jobs.

However, the public sector job opportunities are diminishing due to the saturation in that

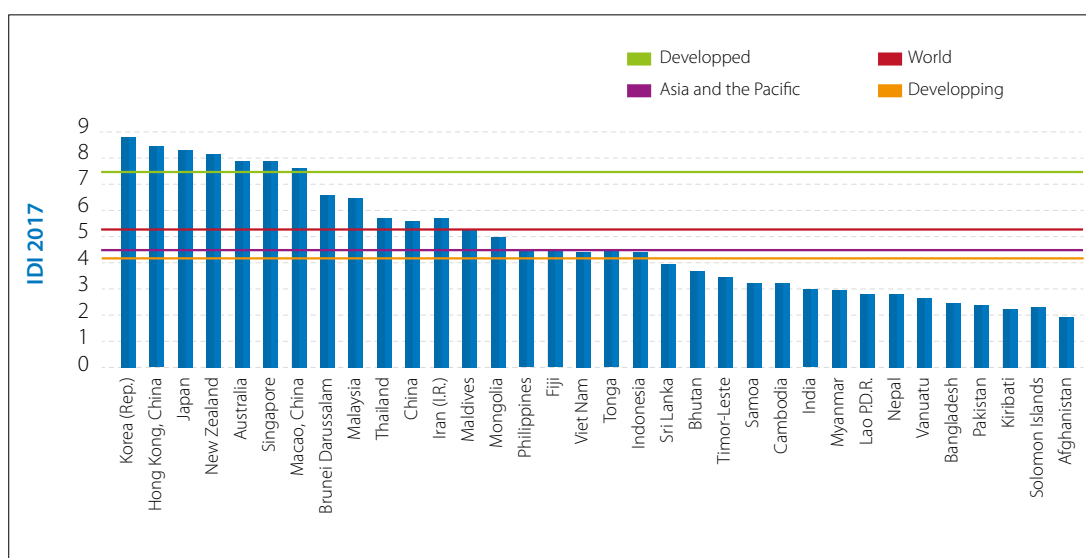
jobs market. More importantly, Bhutan faces a shortage of specialised human capital such as doctors, teachers and engineers. For instance, there are only 2 doctors and 8 nurses per 10,000 populations. It is estimated that the country needs at least another 150 doctors to reach the minimum desired level of doctor to population ratio.<sup>42</sup> In other occupations and mainly in the construction and production sectors, Bhutan imports the majority of skilled labour force mainly from India.

## 2.5 ICT Infrastructure

A comparison of the Asia-Pacific countries in terms of ICT development indicates that Bhutan is approaching to the level of developing countries (Figure 3). The ranking of Bhutan has dropped slightly, from 119 in 2016 to 121 in 2017 among 176 countries. Increasing ICT access, ICT use and ICT skills are required to improve the country's position, and to harness the opportunities presented through the digital revolution.<sup>43</sup>

According to the data provided by the Ministry of Information and Communications, the total

**Figure 3: ICT Development Index values in the Asia-Pacific region (2017)**



Source: International Telecommunication Union in UNESCO (2017) *Beyond Access: ICT-enhances Innovative Pedagogy in TVET in the Asia-Pacific*

40 <https://www.enterprisesurveys.org/en/data>

41 <https://www.molhr.gov.bt/molhr/wp-content/uploads/2017/07/Bhutans-Labor-Market-Towards-Gainful-Quality-Employment-for-All.pdf>

42 [https://www.kgumsb.edu.bt/?page\\_id=21](https://www.kgumsb.edu.bt/?page_id=21)

43 See for example, [https://www.weforum.org/agenda/2019/12/technology-digital-revolution-africa/?utm\\_source=sfmc&utm\\_medium=email&utm\\_campaign=2709001\\_Agenda\\_weekly-FinalTemplate-3.January2020-20200101\\_090548&utm\\_term=&emailType=Newsletter](https://www.weforum.org/agenda/2019/12/technology-digital-revolution-africa/?utm_source=sfmc&utm_medium=email&utm_campaign=2709001_Agenda_weekly-FinalTemplate-3.January2020-20200101_090548&utm_term=&emailType=Newsletter)

number of mobile cellular subscribers in Bhutan was 715,872 as of the 2nd Quarter of 2019 and the number of Internet subscribers was 694,249 in the same period. Broadband Internet services were introduced in the country in 2008. There are four Internet Service Providers (ISPs) offering fixed broadband services. In 2018, the fixed broadband subscriptions were 9,211 with a decrease by 40.59% as compared to 2017. In 2019, fixed broadband subscribers were even lower, at 1.3 per 100 inhabitants. The mobile broadband subscriptions in 2018 were 766,768.<sup>44</sup>

According to the interviews, the reason for low penetration rate of fixed high-speed Internet services is its high cost. In a World Bank study<sup>45</sup> where a comparison is made for the cost of Internet access with the neighbourhood countries indicated that the unsubsidized monthly Internet lease line tariff provided by Bhutan Telecom (at up to 30 Mbps or more) was Nu. 252,626 (Bhutan Telecom Ltd. 2017), or more than USD3,000. On the other hand, monthly prices for broadband services (at speeds of at least 60 Mbps) in Dhaka (Bangladesh) and Bangalore (India) were USD24.46 and USD18.39, respectively. The same study notes that according to the key tenant of the Thimphu TechPark, even with subsidies, the cost of Internet access is twice as high as in neighbouring countries.

## 2.6 Environment, Climate Change and Natural Disasters

As noted before, Bhutan has always maintained a balance between development activities and conservation of the environment, which is also one of the pillars of the GNH. It is not only carbon neutral, but is also the only carbon negative country in the world.

However, it is highly vulnerable to climate-related

risks and natural disasters. The climate change is not only a threat to its hydropower sector but also to agriculture and tourism. Bhutan's Voluntary National Review Report for 2030 Agenda highlights the need for developing the national capacity to understand the climate change pathways among the sectors and building innovative capacities to provide local solutions. The report also emphasises the massive scale of investments required to deal with impacts of climate change and to remain carbon neutral.<sup>46</sup>

There are attempts to use different solutions to cope with the environmental problems, such as the utilisation of plastic waste to build roads. However, the reintroduction of plastics into the environment could lead to negative consequences in the medium and long term, such as microplastic pollution in soil and water.<sup>47</sup>

The Twelfth Five Year Plan identifies the major disaster risks as increased forest fires, glacial lake outburst floods, drying up of water sources, crop diseases, windstorm and erratic and high intensity rainfall. In addition, earthquakes are cited as a serious threat.

Bhutan is located in one of most seismically active zones in the world and has already experienced earthquakes over 7.0 in magnitude.

Resilience to the effects of natural disasters and climate change is crucial considering the rapid urbanisation experienced in Bhutan today. Poor construction practices, inadequate enforcement of building by-laws and low awareness on disaster risk reduction are often cited as the major weaknesses. The other challenges that increase vulnerability include the remote and isolated rural communities that could become inaccessible during major disasters and emergencies, the lack of emergency communication facilities and procedures, as well as the fragile road network and transportation system.<sup>48</sup>

44 Annual Info-Comm and Transport Statistical Bulletin (10th Edition, 2019) Ministry of Information and Communications, Policy and Planning Division.

45 <http://documents.worldbank.org/curated/en/673381506689928071/pdf/120144-ICA-PUBLIC-P153221-Bhutan-Competitiveness-Policy-Note-Web.pdf>

46 Royal Government of Bhutan, July 2018, Sustainable Development and Happiness: Bhutan's Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development [https://sustainabledevelopment.un.org/content/documents/19369Bhutan\\_NSDGR\\_Bhutan\\_2018.pdf](https://sustainabledevelopment.un.org/content/documents/19369Bhutan_NSDGR_Bhutan_2018.pdf)

47 See for example <https://www.ciel.org/wp-content/uploads/2019/02/Plastic-and-Health-The-Hidden-Costs-of-a-Plastic-Planet-February-2019.pdf>

48 [http://www.ddm.gov.bt/download/Bhutan\\_DRM\\_Status\\_Review.pdf](http://www.ddm.gov.bt/download/Bhutan_DRM_Status_Review.pdf)



## **Chapter 3**

### STI System and Policy Framework

Bhutan does not have an explicit STI policy and its national research and innovation system is at a nascent stage. Until recently, the STI investments have competed with basic infrastructure investments and other pressing priorities, such as education, health care and poverty reduction.

There is now a high commitment and increased interest among all stakeholders in investing in the STI. Research and innovation is regarded not only as a means for contributing to the GNH and addressing challenges facing the country but also for sustainable graduation from the LDC group. As such, there is an ongoing debate among the stakeholders about the steps to be taken for mainstreaming STI in the development process. For instance, a conference organised in February 2019 by the Royal University of Bhutan (RUB) under the theme of ‘Promoting Research and Innovation in Bhutan’<sup>49</sup> identified the major challenges as the lack of national research policy, absence of a nodal or central agency and the lack of a dedicated fund from the Government. The conference also underlined that “there is an opportunity for the government and organisations to support research and innovation to give sustainable development direction for the nation, develop human capital and recognise their contributions in research and innovation, and invest in research that assist policy decision making.”

### 3.1 STI Performance

The data do not exist about STI activities in Bhutan. The basic STI statistics, such as the

expenditure on R&D and human resources in R&D, are not collected in the country.

The only source of information about the innovation performance of Bhutan is the WEF’s Global Competitiveness Report<sup>50</sup> which ranks Bhutan the 79th among 137 countries in the innovation pillar of the competitiveness assessment in the period covering 2017-2018 (Table 3).

Owing to the highly limited number of human resources in R&D as well as low levels of research and innovation investments in the country, the weakest areas according to the assessment are the quality of scientific research institutions, PCT patent applications and availability of scientists and engineers. Interviews also revealed that becoming a researcher is not one of the first career choices, and the incentives and opportunities to develop career as researcher is limited.

Overall, R&D activities and funding are highly limited in the country, and are mainly carried out by the higher education institutes and research centres of the Ministry of Agriculture and Forests. These activities are in general confined to applied research aiming to solve problems, rather than development of innovative products, processes and services.

### 3.2 STI Policies

The absence of a stand-alone science, technology and innovation policy prohibits not only the take-up of research and innovation activities but also effective integration of the STI as a

**Table 3: Innovation pillar assessment of Bhutan in the Global Competitiveness Index 2017-2018 (Ranking in 137 countries)**

12th pillar: Innovation		79
12.01	Capacity for innovation	78
12.02	Quality of scientific research institutions	103
12.03	Company spending on R&D	58
12.04	University-industry collaboration in R&D	92
12.05	Gov’t procurement of advanced technology products	28
12.06	Availability of scientists and engineers	115
12.07	PCT patents (applications/million pop.)	119

Source: WEF, *Global Competitiveness Report (2017-2018)*

<sup>49</sup> [http://www.rub.edu.bt/images/rub/news\\_events/Events/2019-promoting-research-and-innovation.pdf](http://www.rub.edu.bt/images/rub/news_events/Events/2019-promoting-research-and-innovation.pdf)

<sup>50</sup> [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf)

cross-cutting area in the other policies in Bhutan.

Nevertheless, there are direct and indirect references to research, technology and innovation in the majority of the national policy and strategy documents. A brief summary of high-level documents with STI elements are given below in order to provide an overview of the current policy framework in the country:

**“Bhutan 2020: Vision for Peace, Prosperity and Happiness”**: Issued in 1999 by the government, the document identifies the main development objectives in the areas such as human development, culture and development, balanced and equitable development, governance and environmental conservation which have since guided the five-year plans.

The document makes clear references to the innovation-driven development and the importance of innovation and technology in achieving the national objectives. Some examples include the emphasis made on the need for creating “clean industries” as well as “high technology enterprises which are engaged in the production of high value/low volume products that place the nation in the vanguard of technological advance and innovation”; building “an environment that encourages and rewards entrepreneurship and innovation”; ensuring that health and education “take full advantage of advances in technology”; and using the rich biodiversity of the country to develop “high tech industries, such as bioengineering and gene technology”.

**“Twelfth Five Year Plan (2018-2023)”**: As being the national plan which paves the way for the graduation from the LDC category, the current five year plan includes STI strategies such as:

- Enhancing research, innovation and scholarship, and promoting innovation and entrepreneurship (to be implemented by the RUB);
- Enhancing quality of medical and health education and skills through the development of infrastructure, expansion of programmes, capacity development for faculty members, promotion of research, and updating existing curriculum to international standard (to be implemented by the Khesar Gyalpo University

- of Medical Sciences of Bhutan (KGUMSB));
- Offering research and extension service in the areas of soil fertility, plant protection, postharvest and market linkages to develop targeted Renewable Natural Resources (RNR) products and services (implemented by the Ministry of Agriculture and Forests (MoAF));
- Enabling digital transformation and innovation in the use of ICT and Media to enhance access, reliability and security of ICT systems and infrastructure, and enhance digital and media literacy (implemented by the Ministry of Information and Communications (MoIC));

The plan also sets out concrete programmes (the so-called “flagship programmes”) which would enhance the STI capacity in the country (see Section 3.5.2).

**“Cottage and Small Industry Policy”**: The policy document prepared by the Ministry of Economic Affairs in 2019 includes six strategic domains for the development of the CSI sector:

1. Policy and legislative framework
2. Entrepreneurship culture and human capital
3. Business development support and infrastructure
4. Enhancing access to finance and incentives
5. Innovation and technology adoption
6. Access to market

Under the “Innovation and technology adoption” domain, the following strategies are envisaged:

- Fostering collaboration between the incubation units and entrepreneurship development cells of Technical Training Institutions (TTIs) and Institutes for Zorig Chusum (IZCs)<sup>51</sup> and tertiary institutions with Start-up Centres, financial institutions and CSIs to encourage innovation;
- Developing database for up-to-date information on appropriate technologies for CSIs;
- Fostering greater Intellectual Property adoption among CSIs through enhanced awareness activities and capacity building programs;
- Providing CSIs with access to global patents, design and brand databases and related services through the Technology and Innovation Support Centres;

<sup>51</sup> Institutes providing training in Bhutan’s traditional arts

- Providing advisory services and related assistance in franchising and licensing of intellectual property rights (IPR) in permissible areas, which offer potential for rapid business development and employment generation;
- Allowing foreign direct investment (FDI) in select small scale industry sector;
- Encouraging innovation and creativity through an Innovation Voucher Scheme;
- Promoting R&D in TVET and tertiary institutions.

Other strategic domains also include STI related actions such as

- “Developing e-commerce regulatory framework and providing necessary support to the use e-commerce platforms by CSIs” under the “Policy and legislative framework”;
- “Supporting the winning ideas of various entrepreneurship competitions” under the “Entrepreneurship culture and human capital”;
- “Setting up business incubation centres, start-up centres, fab labs to facilitate the growth of CSIs” under the “Business development support and infrastructure”;
- “Facilitating industries to improve the quality of products and services through promotion of standards, facilitation of conformity assessment services including calibration” under the “Access to market”.

**“Sustainable Development and Happiness: Bhutan’s Voluntary National Review Report on the Implementation of the 2030 Agenda for Sustainable Development”**:<sup>52</sup> Bhutan participated in review at the 2018 High Level Political Forum in line with its commitment to the implementation of the SDGs. The document refers to the need for diversification, technological innovation, entrepreneurship and technology transfer as well as developing the capacity to harness benefits of S&T, and investing in human resources.

**“The Economic Development Policy (EDP)”**:

<sup>53</sup>Issued by the government in 2016, the EDP includes STI related strategies under different policy reforms planned. The notable ones are the following:

- Establishing a dedicated institution by 2017 (which could be also an existing institution) with adequate funds to promote and support R&D;
- Ensuring that foreign service providers conducting in major works engage local firms for the transfer of technology/skills;
- Encouraging R&D in energy storage technology;
- Developing a large talent pool of technically educated human resource to attract investments;
- Identifying and establishing networks with relevant multilateral and regional agencies to promote culture of entrepreneurship, innovation and creativity amongst CSIs; and recognising and incentivising the recipients of the various awards schemes;
- Encouraging and promoting innovation in the development of the film, media and creative art sector;
- Giving priority to STEM education.

**“National Intellectual Property Policy”**:<sup>54</sup> The government published the IP policy in 2018 with the objective “to develop an IP system consistent with international best practices that encourage creativity, innovation and inventiveness, and provide protection through appropriate legislations”. The strategies were identified as:

- Developing balanced and development-oriented IP laws and regulations;
- Establishing an effective institutional framework;
- Increasing strategic use of IP assets and greater use of IP system for the protection of Traditional Knowledge, Genetic Resources and Traditional Cultural Expressions;
- Facilitating the transfer of technology;
- Improving access to the results of innovation and creativity;
- Strategic participation in the international IP system;
- Incentives to encourage innovation and creativity.

The strategies regarding the facilitation of technology transfer underlines the need for increased

<sup>52</sup> [https://sustainabledevelopment.un.org/content/documents/19369Bhutan\\_NSDGR\\_Bhutan\\_2018.pdf](https://sustainabledevelopment.un.org/content/documents/19369Bhutan_NSDGR_Bhutan_2018.pdf)

<sup>53</sup> <https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf>

<sup>54</sup> [https://www.gnhc.gov.bt/en/wp-content/uploads/2018/05/National\\_Intellectual\\_Property\\_Policy\\_2018\\_Web1\\_Final-1.pdf](https://www.gnhc.gov.bt/en/wp-content/uploads/2018/05/National_Intellectual_Property_Policy_2018_Web1_Final-1.pdf)

transfer of appropriate technologies and putting in place a stimulating IP framework. Specific policies envisaged for this purpose include the following:

- Establishing Technology and Innovation Support Centres (TISCs) in relevant institutions to provide access to:
  - Online patent and non-patent (scientific and technical) information;
  - Industrial property-related publications;
  - Information on technology commercialisation.
- Promoting the development of collaboration or networks of enterprises with the RUB and other institutions to engage in R&D and innovative activities;
- Assisting and encouraging the public research institutions to collect and disseminate appropriate technologies;
- Collaborating with international and national agencies to explore and introduce appropriate technologies.

**National Education Policy (Draft):**<sup>55</sup> Prepared by the Ministry of Education in 2018, the document covers policies planned at all levels of education. The notable STI-related elements include “strengthening STEM education to promote creativity and innovation through school curriculum” and “promoting ICT in schools through the provision of ICT-based resources and ICT-aided teaching and learning”.

**“Tertiary Education Policy 2010 (TEP)”:**<sup>56</sup> The objective of the policy is defined as to “build and advance a tertiary education system in the country that will support and strengthen Bhutan’s goal to create an enlightened citizenry in a knowledge-based society worthy of its rich heritage and aspirations for a dynamic, forward-looking and confident future.” It led to the creation of the Tertiary Education Board (TEB) and Bhutan Accreditation Council (BAC) as oversight bodies of the sector. The TEB is the highest executive decision-making body formulating policies for tertiary education development, while the BAC

is responsible for the accreditation, quality assurance, and interpretation and recognition of qualifications to establish an international level of tertiary education standards.

The policy document highlights research and innovation as a strategic objective for Bhutan<sup>57</sup> and foresees the establishment of the National Council for Research and Innovation (NCRI). The functions of the NCRI are listed as:

- Setting national research policies,
- Determining national research priorities,
- Co-ordinating research activity,
- Encouraging, stimulating and supporting research and funding research,
- Fostering a culture of enquiry, curiosity and investigation among the institutions of tertiary education,
- Serving as a clearing house for the transmission and dissemination of information and research in Bhutan, or acting as the stimulus for the establishment for such an information management centre, in cooperation with the National Library,
- Formulating policies to improve the public understanding of science and research,
- Advising the TEB on the national research priorities and hence the funding of research in the tertiary education sector,
- Devising mechanisms whereby private institutions devoting significant part of their budget to research activities are granted higher rate of tax rebate,
- Developing an infrastructure for research,
- Setting guidelines for universities to follow on ethics in research as well as intellectual property rights.

The development of R&D infrastructure, assessment of research performance, establishment of an enabling environment for research are among the other STI-focused strategies covered in the document.

55 <https://www.gnhc.gov.bt/en/wp-content/uploads/2018/06/National-Education-Policy-v13.pdf>

56 <http://www.dahe.gov.bt/images/pdf/Tertiary%20Education%20Policy%20of%20the%20Kingdom%20of%20Bhutan%202010.pdf>

57 “A strategic objective for Bhutan shall be to increase research, innovation and the use of new knowledge in all aspects of the country’s work; to improve the system for the dissemination of information and the provision of relevant information to persons in need of that information; and to develop a culture of enquiry and investigation in the society”.

**“Tertiary Education Roadmap for Bhutan: 2017-2027 - Towards Bringing Positive Reforms in the Tertiary Education System”**:<sup>58</sup> Published by the Higher Education Planning Division of the Ministry of Education in 2017, the roadmap envisages “realising the aspirations of Tertiary Education Policy and building Bhutan into a knowledge-based society”. It underlines the need for providing adequate funding to tertiary education institutes (TEIs) for carrying out research and innovation activities and includes “promoting research and innovation in TEIs” in the strategies.

The establishment of the “National Council for Research and Innovation” (NCRI) is again stated as a requirement. It also foresees the allocation of research funds to TEIs on a competitive basis. Although contemplated both in TEP 2010 and in Tertiary Education Roadmap of 2017, the NCRI has still not been created.

Other STI related strategies in the Roadmap are:

- promoting entrepreneurship culture among students and exploring setting up business incubation units and innovation centres in order to encourage graduates to become job creators rather than job seekers;
- strengthening STEM programmes;
- increasing expenditures in tertiary education as a percentage of GDP to support core areas of tertiary education such as professional development programmes of faculty as well as research and innovation activities.

**Bhutan Education Blueprint (2014-2024)**<sup>59</sup> and **TVET Blueprint (2016-2026)**:<sup>60</sup> Both documents make reference to STI-related aspects for human capital development. In the Education Blueprint, notable strategies include fostering 21st century skills of innovation, creativity, enterprise and universal human values; developing TVET education pathways; and developing teachers such a way that STEM competency and ICT innovation in teaching are improved.

The TVET Blueprint covers the following strategies in relation to STI:

- Setting up a TVET Resource Centre to facilitate

innovation and equipping them with state of the art industry ready technology (i.e., CNC machines, total station IT and filmmaking studios, SME related production and manufacturing equipment, etc.) and highly competent staff capable of delivering new services;

- Developing employability soft skills (creativity/innovativeness, teamwork skills, passion/commitment/attitude, interpersonal and communication skills, leadership skills, knowledge of industry, emotional intelligence, entrepreneurship skills, and analytical skills) among young people;
- Ensuring that the private sector plays a key role in improving quality and responsiveness of the TVET system and participating both in the planning or implementation process.

**Gender Equality Policy of Bhutan (Draft) 2017:**

The document states that in Bhutan there are much lower numbers of girls in the inter-disciplinary and applied STEM subjects, which is traditionally seen as a domain for boys. It foresees several strategies such as increasing the number of girls and their performance in STEM subjects and supporting women’s entrepreneurship by providing access to finance, skills development, knowledge of markets, business development and communication and negotiation skills.

**Twelfth Five-Year Plan: Renewable Natural Resources Sector (2018–2023):**

Published by the Ministry of Agriculture and Forests, the document underlines the importance of research, innovation and technology development to address the challenges such as climate change, increased disasters and rapid urbanisation. Key strategies in the plan include, inter alia, strengthening research, innovation and training institutions for increased efficiency, enhancing commercialisation, value addition and RNR enterprise development, and applying new and climate smart irrigation/water harvesting technologies.

**Strategy for GNH:** Formulated in 2008, it is a comprehensive development strategy that provides broad based national development trajectory building on the opportunities and

58 [http://www.dahe.gov.bt/images/pdf/Tertiary-Education-Roadmap-for-Bhutan-2017-2027\\_compressed.pdf](http://www.dahe.gov.bt/images/pdf/Tertiary-Education-Roadmap-for-Bhutan-2017-2027_compressed.pdf)

59 [https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/bhutan\\_education\\_blueprint\\_2014-2024.pdf](https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/bhutan_education_blueprint_2014-2024.pdf)

60 <https://www.molhr.gov.bt/molhr/wp-content/uploads/2017/07/TVET-Blueprint-Inside-Page.pdf>

anticipating the challenges for the following 20 years. While many of the initiatives under the strategy have been completed, some of them are still ongoing, such as the actions related to “high-value manufacturing and service industries” under the pillar “Innovation, Creativity and Enterprise”.

**National Energy Efficiency & Conservation Policy:**<sup>61</sup> Issued in 2017 by the Department of Renewable Energy of the Ministry of Economic Affairs, the document underscores the importance of energy efficient production processes and technologies to improve productivity, profitability and competitiveness of industries by lowering operating costs, enhancing worker skills and disseminating knowledge and best practices. The energy efficiency measures mainly focus on transferring technologies from abroad and establishing value chains for energy-efficient goods and services.

**Bhutan e-RNR Master Plan:** Prepared in 2016 by the Ministry of Agriculture and Forests with the technical assistance and funding from the Food and Agriculture Organization of the United Nations (FAO), the master plan aims to harness the ICT potential of Bhutan in achieving its RNR goals until 2023. It also seeks to strengthen the role of ICT in accelerating the growth of the RNR sector in a sustainable and equitable manner.

The master plan highlights 36 independent ICT solutions for RNR sector, out of which six solutions have been accorded high priority and are considered for implementation starting from 2016. The progress achieved in the implementation of them as of October 2019 is the following:

- Integrated Natural Resource Management Information System: The Forest Information Reporting and Monitoring System under the Department of Forest and Park Services was developed and put in use; the Spatially Enabled Decision Support System under the same department is at the stage of implementation (tendering and evaluation process is ongoing).
- e-RNR Extension and Advisory System: The e-RNR crop advisory mobile application is

under development.

- Online RNR marketplace and supply chain management information system: Agricultural Market Price Information System is being revamped. The new system along with a mobile app is planned to be launched at the end of 2019.
- M-banking / online transaction for agricultural services were developed by the banks including the Central Bank.
- RNR Helplines were developed by the Bhutan Agriculture and Food Regulatory Authority (BAFRA), Department of Agricultural Marketing and Cooperatives, Research and Development Centres Wengkhari and National Centre for Animal Health.
- Agromet Decision Support System was developed under the Department of Agriculture. Furthermore, the e-Pest Surveillance system was developed and put in use under the National Plant Protection Centre.

**iSherig-2:**<sup>62</sup> **Education ICT Master Plan 2019-2023:**<sup>63</sup> Issued by the Ministry of Education in cooperation with UNESCO, the document provides the framework and strategies for motivation for lifelong learning, effective teaching and learning, and efficient administration system using the ICT. The budget estimate for the implementation of the master plan is Nu 1.729 billion. The following programmes are envisaged under each strategic thrust elaborated in the document:

- Thrust 1 “iAble”: Enhancing the ICT competency of educators, learners and support staff.
  - Programme 1.1 ICT Capacity Development of Educators
  - Programme 1.2 ICT Capacity Development of Learners
  - Programme 1.3 ICT Capacity Development for Learning Support
- Thrust 2 “iBuild”: Enhancing the use of ICT-integrated teaching and learning resources by learners, teachers, non-formal education instructors and Community Learning Centre managers.
  - Programme 2.1 Pervasive Use of Digital Educational Resources

61 <https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/EEC-Final-Draft-Policy-2017-Final-1.pdf>

62 “Education ICT Master Plan is named iSherig, which translates to ICT in education. The “i” alludes to innovation and integration that the master plan intends to promote through use of ICT in education.”

63 [https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/bhutan\\_isherig-2-education-ict-masterplan-2019-2023.pdf](https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/bhutan_isherig-2-education-ict-masterplan-2019-2023.pdf)

- Thrust 3 “iConnect”: Strengthening the ICT infrastructure and connectivity for better learning and educational services.
  - Programme 3.1 ICT Infrastructure Development
  - Programme 3.2 Administration and Learning Systems Development

### 3.3 Policy-Making Practices and Policy Cycle

The national policies and plans in Bhutan are prepared in a participatory manner with the involvement of relevant stakeholders. Their implementation are usually monitored and assessed against pre-defined indicators and targets.

In 2015, the government issued the “Protocol for Policy Formulation” as the binding framework for the design, revision, approval and adoption of all public policies in Bhutan.<sup>64</sup> The Protocol requires that the policies be designed in two stages: (i) conception stage and (ii) formulation and approval stage. All draft policies require public consultation.

The policy-making practices have improved in time. It is observed that the Twelfth Five Year Plan was prepared following international good practices: the process involved a comprehensive review of the previous five-year plan and a series of consultative meetings with the stakeholders. Furthermore, central agencies and local governments were provided with the flexibility to formulate their sectoral and local key result areas and key performance indicators (KPI) based on the NKRAs of the plan. Governance issues were given high consideration for the implementation. Also, emphasis was put on the monitoring process with effective data collection and analysis. A similar participatory approach was followed while formulating the flagship programmes, and a process for monitoring the implementation of these programmes was defined in the plan document.

The Cabinet was identified as the body to follow up the implementation of the plans and to provide

strategic direction, guidance and support. The Secretariat of the GNH Commission (GNHC) is responsible for monitoring and reviewing the plans and policies. The findings from the monitoring and review process are reported to the Prime Minister. For this purpose a National Monitoring and Evaluation System was created. In addition, the GNHC Secretariat was given the responsibility for making strategic and timely intervention to provide guidance and direction to the sectors either in compliance to the Cabinet directives or on its own accord. Encouraging citizen monitoring of the plan was also introduced as a new feature of the plan to ensure social accountability.

Evaluation is an area given increasing attention in the policy cycle in Bhutan. The GNHC drafted the “Evaluation Protocol and Guidelines” in 2015 and the “Development Evaluation Policy of Bhutan” in 2017.<sup>65</sup> Furthermore, policy governance through the creation of synergies and achievement of policy coordination and collaboration between central agencies and local governments is considered essential in the policy cycle.

On the other hand, evaluation activities are still limited and evaluation reports are not available for policies and programmes. The need for improving the implementation of plans is often underlined. The Twelfth Five Year Plan Guideline, for example, makes a reference to the following quote of the King’s National Day Address in 2013:<sup>66</sup> *“We Bhutanese are good at writing plans, speaking well and expounding ideas. But implementation fall short of commitments. There is gap between commitments made and output delivered. We are not able to deliver results of expected quality in a timely manner”.*

### 3.4 STI System

The STI system of Bhutan has not yet been fully formed. The country does not have an oversight body for STI policy making and implementation. As noted before, although included both in the Tertiary Education Policy in 2010 and in the Tertiary Education Roadmap in 2017 as an action item, the National Council for Research and

64 <https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/policy0001.pdf>

65 <https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/Evaluation-Policy-March-2017.pdf>

66 <https://www.gnhc.gov.bt/en/wp-content/uploads/2017/05/gnh.pdf>

Innovation has not been created. The STI related roles are distributed across different ministries and other government agencies.

The following organisations are the key actors of the national research and innovation system:

### 3.4.1 Policy Makers

**GNH Commission:** Chaired by the Prime Minister, the GNH Commission is the high level body responsible for steering national socio-economic development guided by the principles of GNH. The members of the Commission include the Minister of Finance (Vice Chair), the Cabinet Secretary, all Secretaries to Ministries, the Head of the National Environment Commission Secretariat and the GNHC Secretary (Member Secretary). Other public officials can also participate in the discussions based on the decision of the Commission which meets at least once every quarter. The Secretariat of the GNHC, reporting to the Prime Minister, is the apex agency for central planning and coordination of plans and programmes. It is also responsible for the coordination, advice, monitoring, evaluating and reporting progress on the implementation of the SDGs in Bhutan. A dedicated SDG Working Committee, established within the Secretariat and led by its Director, works to achieve smooth implementation and seamless coordination of actions related to the SDGs. The Secretariat also implements the GNH Surveys and collects climate change and environment statistics.

**Tertiary Education Board (TEB):** It is the highest executive decision making body in managing the Tertiary Education System in Bhutan. The Board's responsibilities include planning and funding, quality assurance, and registration and licensing of both public and private tertiary education institutions. It is chaired by the Minister for Education. The Department of Adult and Higher Education acts as the Secretariat to the TEB. Members include the Secretary and the Joint Secretary of the Ministry of Finance, the Directors of the Department of Human Resources, Ministry of Labour and Human Resources, the Department of Industries, Ministry of Economic Affairs, the GNH Commission Secretariat, the Commissioner of the Royal Civil Service Commission and the Director General of the Department of Adult and Higher Education (Member Secretary).

**Royal Education Council (REC):** The REC's mandate includes education innovation and transformation. It is responsible for the determination of the national school curricula and teachers' professional development programmes, and improvement of the overall mainstream education system. The Council is chaired by the Prime Minister and the members include the Minister of Education (Vice Chairperson),

Secretary of Ministry of Education, Vice Chancellor of the Royal University of Bhutan, the President of the Khesar Gyalpo University of Medical Sciences of Bhutan, the Commissioner of the Royal Civil Service Commission, the Director General of the Department of School Education, the Secretary of the Bhutan Council for School Examinations and Assessment, and Director General of the Royal Education Council (Member Secretary).

**National Environment Commission (NEC):** It is the agency responsible for the issues related to environment in Bhutan. The NEC monitors the impact of development on the environment and aims to put in place the necessary controls, regulations and incentives for the private and public sectors to achieve sustainable development. It also coordinates the inter-sectoral programmes, and the policies and legislation regarding the environment.

**Ministry of Economic Affairs:** The Ministry is a major player in the innovation system as the organisation responsible for the development of economic sectors such as industry, CSI and renewable energy, as well as the protection and enforcement of IPR. The Intellectual Property Department of the Ministry implements the process of copyright registration and patenting. It consists three divisions: (i) Industrial Property Division involving the Trademarks Unit, Patents, Industrial Designs and Geographical Indications Units; (ii) the Copyright Division comprising of Voluntary Copyright Registration and Public Outreach Units; and (iii) the Legal & ICT Unit. Bhutan has enacted two IP specific laws in 2001: the Copyright Act of the Kingdom of Bhutan, and the Industrial Property Act of the Kingdom of Bhutan.

**Ministry of Education:** It is accountable for all levels of education in Bhutan including the tertiary education and lifelong learning. With the increased emphasis on STEM and TVET on the policy agenda, the Ministry assumes wider role in STI (such as the organisation of the National STEM Olympiad and offering scholarships for TVET).

**Ministry of Labour and Human Resources:** It plays a critical role in the development of human capital in the country as well as in the promotion and support of entrepreneurship in Bhutan. The Department of Technical Education (DTE) of the Ministry is responsible for overseeing all aspects of TVET and the human resources development for the private and corporate sector in the country. There are six Technical Training Institutes and two Institutes for Zorig Chusum under the DTE. The Entrepreneurship Promotion Centre (EPC) of the Ministry works “to promote entrepreneurship and encourage the youth to take up self-employment as a preferred career option”. Its main tasks include promoting creativity, innovation and entrepreneurial culture through training programmes and entrepreneurship education in schools and colleges; developing business incubation centres; supporting new start-ups for job creation and developing critical skill development for the entrepreneurs (see Section 3.5).

**Ministry of Information and Communications:** The Ministry’s mandate cover a number of areas within the domain of STI policy, such as digital transformation, e- government, satellite/ space policy and strategy, eco-friendly surface transport through electric vehicles and ICT accessibility.

**Ministry of Agriculture and Forests:** The Ministry has various research centres as well as specialised institutions, such as the BAFRA, the National Biodiversity Centre, Agriculture Machinery Centre, Research & Development Centre – Yusipang, Research & Development Centre – Bajo, National Seed Centre and National Dairy Research & Development Centre-Yusipang. The Ministry implements a comprehensive five-plan for the sector in parallel with the national five-year plan (see Section 3.2).

**Ministry of Finance:** The Ministry, through its Department of Revenue & Customs, implements fiscal incentives to stimulate the growth of economic sectors and encourage investment in new technologies (see Section 3.5).

**Ministry of Health:** It plays an important role in the national STI system with the initiatives on the digitisation of health care services as well as in traditional medicine and healing which has significant innovation potential for the country.

### 3.4.2 Organisations for Policy Implementation

**National Statistics Bureau (NSB):** The NSB is the central authority for the collection and release of official data and statistics. It is mandated to conduct national surveys and censuses, publish statistical reports, validate and maintain a national data repository, ensure statistical uniformity and standards, and provide technical supports to streamline and strengthen national statistical system. In addition, in line with the National Strategy for the Development of Statistics, the NSB implements the statistical coordination mechanisms, and develops statistical legislations and statistical standards for quality assurance, among other things. One of the actions taken by the NSB under the Twelfth Five Year Plan is the use of new technologies for data collection and dissemination.<sup>67</sup>

**Bhutan Standards Bureau (BSB):** Established as an autonomous entity in 2010 after the enactment of the Bhutan Standards Act, the BSB coordinates and oversees all standardisation and conformity assessment activities in the country. It was formerly known as the Standards and Quality Control Authority created under the Ministry of Communications in 2000. In addition to standardisation and certification, the BSB is responsible for metrology and laboratory services as well as national accreditation. The calibration services are currently carried out for mass and length. ISO 9001 standard is the most widely known and used standard in the country. The accreditation function is not yet operational and the accreditation services are received from India. The BSB made a proposal to the government for the creation of an accreditation body.

<sup>67</sup> [http://www.nsb.gov.bt/main/apa/12th\\_FYP.pdf](http://www.nsb.gov.bt/main/apa/12th_FYP.pdf)

The entity has 10 technical committees however it is difficult to attract potential members to the committees due to low levels of awareness on the subject. Lead auditors are hired from Malaysia as they carry out the tasks for free provided that their travel and accommodation are paid.

**Bhutan Agriculture & Food Regulatory Authority (BAFRA):** Affiliated to the Ministry of Agriculture and Forests, BAFRA is the entity responsible for biosecurity and food safety systems to promote the quality and safety of food and agricultural products. It was established in 2000 as the Quality Control and Regulatory Services. BAFRA carries out inspection and certification of food and agricultural goods and products to ensure quality and safety and to facilitate trade and increase market access. For any import or export of food and agricultural goods and products, sanitary and phytosanitary permits are obtained from BAFRA. Similarly, for the movement of plants, animals and their products within the country, an in-country movement permit is received from the BAFRA offices. The organisation has two main divisions: The Quality Control and Quarantine Division, and the Analytical and Certification Division.<sup>68</sup>

**National Centre for Hydrology and Meteorology (NCHM):** It was established in 2016 as an autonomous scientific and technical organisation responsible for the generation of information and provision of products and services on weather, climate, cryosphere and water resources in Bhutan. It is also the designated national focal point for the international scientific organisations such as the World Meteorological Organization and International Panel for Climate Change.<sup>69</sup>

**Rural Enterprise Development Corporation Ltd (REDCL):** Established in 2016, the REDCL aims to generate employment, substitute imports and encourage exports by promoting non-formal rural activities through business support. It manages a revolving fund that supports the projects of start-ups and CSIs engaged in production and non-formal rural activities. The finance is provided with a low interest rate of 4% and does

not require collaterals. In 2018, some 7,716 applications were received and 3,964 of them were approved for which a budget of Nu.485.782 million was made available.<sup>70</sup>

### 3.4.3 Research Performers

**Royal University of Bhutan (RUB):** RUB is the first tertiary education institution in Bhutan established in 2003. Its mandate includes all three main tasks of universities: teaching, research and transfer of knowledge and research results of relevance to the country. As of April 2019, there were 14,059 students studying at different colleges of the university. Only about 23% of these students study at the bachelors' or diploma programmes on STEM subjects. The masters' programmes are highly limited. In addition to a few masters' degree programmes in social sciences, there exist only two programmes in the College of Natural Resources (CNR): the Master's in Development Practices and in Natural Resources Management. These programmes have 12 and 5 students, respectively.

The university does not have any PhD programmes yet; however, the CNR is in the process of developing a 3-year PhD programme in Climate Studies. A research capacity development project of five years amounting approximately to USD 4 million was developed and submitted to the UNDP for this purpose. The outputs of the projects are planned as having in place a climate science laboratory and field equipment; publishing at least 20 climate related scientific articles; having about 20 PhD graduates and 3 faculty members with PhD degrees as well as 5 post-docs; and developing a transdisciplinary research programme with the Institute for Sustainable Futures (ISF) of the University Technology of Sydney (UTS), Australia.

The research mandate of the RUB is articulated in Article 2.2 of its Royal Charter as "to promote and conduct research, to contribute to the creation of knowledge in an international context and to promote the transfer of knowledge of relevance to Bhutan". The university published its Research Policies in January 2014 that define

<sup>68</sup> <http://www.bafra.gov.bt>

<sup>69</sup> <http://www.nchm.gov.bt>

<sup>70</sup> Rural Enterprise Development Corporation Limited Annual Report 2018

the official policies, procedures, and structures for all aspects of research. The policies seek to encourage and enable collaboration amongst university colleges on research.

The Department of Research and External Relations in the Office of the Vice Chancellor provides the linkage between the Academic Board's policies and the research activities of colleges. Within colleges, research is managed by the Directors, Deans of Research and Industrial Linkages, and Research Centre Coordinators with the approval and monitoring of the College Research Committees. The research is promoted through the provisions of fund, allocation of resources, capacity development, networking and scholarships.

The university has 16 research centres conducting research in social and natural sciences. The majority of them which are engaged in natural sciences aim to carry out research in climate, environment and energy related fields (such as the Centre for Science & Environmental Research, the Centre for Environment and Climate Research, Centre for Lighting and Energy Efficiency Studies, Centre for Renewable and Sustainable Energy Development, Disaster Risk Reduction and Community Development Centre, and Centre for Climate Change and Spatial Information). According to the Annual Report published the Department of Research and External Relations, in the period 2017-2018, some 84 research proposals were received from the research centres which secured a total research grant of Nu. 49 million (around USD 690,247). About 90 scientific articles were published in various journals within and outside Bhutan in the same period.

**Khesar Gyalpo University of Medical Science of Bhutan (KGUMSB):** Established in 2013, the university focuses mainly on medical education, research and science to provide quality health-care. The departments and centres of the university include the Faculty of Nursing and Public Health, Faculty of Traditional Medicine, Faculty of Postgraduate Medicine, and the Medical

Education Centre for Research, Innovation and Training (MECRIT). Although it was initially planned to establish the Bachelor of Medicine and Bachelor of Surgery (MBBS) programmes, it has to be postponed mainly due to inadequate manpower.

In the period 2017-2018, there were 551 students studying at different degree programmes of the three faculties of the university. Only four of them were those enrolled in the masters' programme of the Faculty of Traditional Medicine.<sup>71</sup> The university does not have any other graduate degree programmes. However, discussions are going on for creating a master's programme in public health and nursing science.

Besides providing tertiary education on medical science, the university promotes research and capacity building activities (see Section 3.5). It also organises international workshops and conferences on medical and health science, and publishes Bhutan Health Journal biannually. A recent example is the "Health Big Data and Enterprise Architecture Convergence Workshop" on 27-29 October 2019 in Thimphu organised in collaboration with the Ministry of Health, the Massachusetts Institute of Technology's Critical Data Team, Asia eHealth Information Network (AeHIN), and Bhutan Foundation.<sup>72</sup>

**National Institute of Traditional Medicine (NITM):** Established in 1978, the NITM supplies traditional medicines and medical services, offers training to doctors, and conducts research on traditional medicinal plants to identify the ingredients and develop new products. Its library dates back to circa 1616. Today, the institute functions as a part of the Faculty of Traditional Medicine under the KGUMSB. It also implements a five-year bachelor's degree programme for physicians, and a three-year diploma programme for compounders who develop medicines. The pharmaceutical research unit, created in 1997, produces some 103 essential compounds in traditional medicine, coordinates the cultivation of the medicinal plants, conducts research to develop new products, authenticates species, measures effectiveness, controls quality and

71 <https://www.kgumsb.edu.bt/wp-content/uploads/2019/03/annual-report-2017-2018.pdf>

72 <http://www.health.gov.bt/health-big-data-and-ea-convergence-workshop/>

standardises the production processes.<sup>73 74</sup>

**Druk Green Power Corporation (DGPC):** The Druk Green Power Corporation Limited was created in 2009 through a merger of three hydropower corporations of Bhutan to manage projects and operations in the sector. It has capabilities in the design and engineering, construction, automation and consultancy services. The corporation also conducts research in its field of activity in order to reduce dependence on imported skills and technology. However, it is constrained by a lack of national research policy and dedicated research fund as well as insufficient or inadequate site data, access to international journals and standards.<sup>75</sup>

**Centres of Ministry of Agriculture and Forests:**

The centres of the Ministry are responsible for research and innovation in their fields of activity. Among them are the (a) R&D Centre Yusipang, coordinating R&D activities in the areas such as organic agriculture, high altitude crops and vegetable, quinoa adaption; (b) Renewable Natural Resources Research and Development Centre Bajo Wangduephodrang, implementing research in the field crops research, horticulture crops, forest research programme, among other activities; (c) Agricultural Machinery Centre, developing and innovating agricultural technologies and farming practices which are appropriate to the Bhutanese farm terrain and ecological conditions; (d) National Biodiversity Centre responsible for strengthening conservation initiatives and coordinating biodiversity conservation and sustainable utilisation programmes; (e) National Centre for Animal Health which coordinates and implements research and training in animal health in liaison with the relevant institutes, (f) National Dairy Research and Development Centre at Yusipang which, inter alia, conducts need based research and coordinates the implementation of dairy development programmes including sourcing and production of required inputs. Some of these centres are quite small and have limited research budget and human resources. For example, the National Dairy Research and Development Centre,

which started research activities in 2016, has a research budget of Nu. 80,000 for the financial year 2019-20 and employs three R&D personnel. As the scientific outputs of the centre, five papers were published between 2017 and 2018 in the Bhutan Journal of Animal Science (BJAS) and three more papers are ready for publication.

There are also two entities conducting research in social sciences: the Royal Institute of Management provides education and conducts research in social sciences (mainly in governance, public administration, entrepreneurship and innovation, culture and law). The Centre for Bhutan and GNH Studies carries out research on Bhutanese society, history, culture, and GNH.

### 3.4.4 Innovation Infrastructures

**Fab Lab Bhutan:** The FabLab in Bhutan was established in 2017 with the donations of MIT's Center for Bits and Atoms, and SolidWorks. It was created as a part of the Global Fab Lab Network that provides open-access high-tech workshop to develop custom-made products not accessible by conventional industrial technologies. The Keio University of Japan was also collaborated in the process. The initiative was led by the Fab Lab team together with a Bhutanese expert in Denmark and implemented in collaboration with the Ministry of Labour and Human Resources.

The Fab Lab offers the possibility of digital fabrication and rapid prototyping for hands-on projects in various fields. It is planned that 10 Fab Labs are established across the country until 2023. The lab possesses the infrastructure needed, including but not limited to Precision Milling Machines, Laser Cutter (80 W), 3D Printer and CNC Machine. It also implements a pilot "Fab4Fab programme" (Fab 2.0) that enables the production of as many parts as possible locally to create new Fab Labs in the country, thus focusing on import replacement and the development of a more resilient ecosystem around decentralised fabrication.

The Fab Lab is in the process of establishing a

73 [https://en.wikipedia.org/wiki/Institute\\_of\\_Traditional\\_Medicine\\_Services\\_\(Bhutan\)](https://en.wikipedia.org/wiki/Institute_of_Traditional_Medicine_Services_(Bhutan))

74 <http://www.hsprj.com/health-maintanance/introduction-development-and-present-status-of-traditional-medicine-in-bhutan.php?aid=19601>

75 Proceedings of the conference 'Promoting Research and Innovation in Bhutan', RUB, 2019

'Royal Super Fab Lab' under the auspices of the King with a more sophisticated infrastructure. The project secured USD 2 million finance and will be completed in 36 months starting from December 2019.

The existing Lab has implemented a number of projects so far to help different sectors and producers; such as the "beehive monitoring assistant" project where artificial intelligence is used to inspect hive's health and report updates to the mobile application continually throughout the day. There are also R&D projects conducted by the Lab such as the "Karma farmBot-Open tool for farming", a platform constitutes robotic tools, research, data and shared documentation, and aims to help farming communities increase their production and improve their working conditions. In addition, it included Bhutan in the Fab City Global Initiative, which creates a network of cities, regions and countries that have pledged to work towards producing everything they consume by 2054. A project called "Virtual 3D city Thimphu" is carried out to exploit new data sources to plan the infrastructure and amenities for the city through the ability to model, analyse, simulate, visualise and experience the entire city in a virtual environment. The Lab team is also developing the National Database Centre for CSI in Bhutan as requested by the Ministry of Economic Affairs and ESCAP.

The Lab together with the Japan International Cooperation Agency in Bhutan conducted the training programmes and workshops, and also managed to have a Fab Lab donated by the Japan Government for College of Science and Technology of the RUB. This new lab will be established in March 2020. There is one more flagship Fab Lab to be established by Nepal by January 2020. Furthermore, the Lab team has been working on establishing the 'Fab Lab Bhutan Association', which will have 2 members from all Fab Labs in the country nominated for its Board. The Board will be selected by the General Assembly for three years. The association will ensure that all Fab Labs in Bhutan collaborate and share their skills and experiences to make a positive impact in the country.

The Fab Lab Bhutan works towards a financially sustainable model by generating income through

membership fees, consultancy services, training and workshops and local productions to cover direct expenses such as salaries, internet, rent, etc. While 40% of the resources are used for income generating activities, the rest is used to offer free access to the Bhutanese citizens for the use of Lab facilities.

The Lab will host the global Fab Summit FAB17 in Thimphu in 2021 that will attract some 2,500 makers, researchers and innovators from world-wide Fab Labs for an 8-days event.

**Thimphu TechPark:** As the only technology park of Bhutan, the Thimphu TechPark was established in 2012. It was promoted by the Department of Information Technology & Telecom of the Ministry of Information & Communications, and supported by the World Bank. The TechPark was developed jointly by Assetz Property Group of Singapore and Druk Holding & Investments as a 250,000 square feet IT-focused mixed-use development over 18 acres. The parks mission is defined as "attracting respected IT and Information Technology Enabled Services companies from both within Bhutan and around the world to work in a stimulating environment which provides opportunities for technology-based collaboration, learning and innovation".

As of 2019, there are 11 tenant companies 10 of which are foreign firms operating in different areas such as software development for financial sector and telecom as well as image processing, machine learning and artificial intelligence. The tenants employ around 600 people in two buildings. The second building was completed in August 2019 at a total cost of Nu. 71.13 million. The data on export volume of the companies is not available but it is known that they offer all their services to international clients. Spillovers from international companies do not exist and there is not a policy in that respect.

The TechPark offers infrastructure, amenities and services to tenant companies, such as stable green power supply at less than 30% of the cost in other parts of the region, Internet and telecom infrastructure, 24 hours security, back up, and other basic infrastructure, as well as services like investment facilitation. The rent of the offices is twice higher than the market rates

due to the features of the building as well as the services offered.

A company can be 100% foreign owned if established at the TechPark. Outside of the park, it is necessary to have a Bhutanese partner. There are also tax exemptions applied to the tenants (see Section 3.5). These incentives were valid for 10 years for any company when the TechPark was first established but decreased to 5 years by the new government.

The current management company of the TechPark is working under a contract with the government. It also operating as a software development company and has 25 software developers in addition to 18 people engaged in park management. The TechPark is financially sustainable thanks to the operating profit it makes.

**Bhutan Innovation and Technology Centre (BITC):** Located on a 10,000 sq. ft. space on the ground floor of the Thimphu TechPark, the BITC operates as a Bbusiness incubator, a shared technology centre and a data centre.

The mixed-use incubator provides rental space and business services to incubatees for a period of three years. It also offers furnished workspace for foreign firms planning to invest in Bhutan to pilot their operations. The incubator is not currently full and hosts 7-8 companies since it is not preferred by start-ups due to its location, which is not easily accessible. The shared technology centre provides facilities such as meeting and conference rooms for training and networking events as well as for product launches. Designed and built to Tier II Data Centre specifications as classified by Uptime Institute, the data centre is a data storage and management service provider for the government, tenants of the TechPark and other users.

The BITC runs an Overseas Expert Programme where overseas experts work at the centre for a period of 1 to 6 months and provide training, mentoring and coaching to Bhutanese entrepreneurs. The Centre's programme 'Business Idea Competition of Bhutan' aims to stimulate innovation and entrepreneurship in the country

and is organised annually in collaboration with the Ministry of Labour and Human Resources.

**Start-up Centre:** Established in 2018 in Thimphu by the Department of Cottage and Small Industry of the Ministry of Economic Affairs, the centre provides incubation infrastructure and services (mentoring, training, marketing, product designing and development, linkages to financial institutions and other business development services) to the CSI entrepreneurs. The building was constructed with financial assistance of the Government of India and also hosts the Fab Lab Bhutan. The centre has 28 units for start-ups, two training rooms, a resource room, a cafeteria and a management office.

**Druk Research & Education Network (DrukREN):** Started as a project funded by Asian Development Bank (ADB) in 2014, DrukREN is the dedicated high speed network for research and education community in Bhutan with its point of presence in 11 out of 20 districts. It is operated and managed by the Department of Information Technology & Telecom of the Ministry of Information and Communications. The network interconnects 25 research institutes including higher educational institutes and hospital, and plans to further extend high-speed connectivity to all other research and education institutes in the country. It also provides international commercial transit for its members. The international connection to global research and education network is operational since February 2019.<sup>76</sup>

### 3.4.5 Innovation Intermediaries and Service Providers

**Bhutan Chamber of Commerce & Industry (BCCI):** Established in 1980, the BCCI is the non-profit organisation representing the business community in Bhutan. The BCCI Secretariat delivers services through three departments: the Business Support Department, General Affairs Department, and Research and Policy Department. It also has five regional offices. The business support services include training related services for the private sector (such as needs assessment, training of the trainers, etc.), planning and delivery of business support services particularly to CSIs (such as micro credit,

<sup>76</sup> <https://drukren.bt/about/>

business idea development, assistance in preparing business plans and providing procedural guidance, business certification services, and facilitation, promotion and business networking with bilateral and multilateral organisations). The Chamber's Research and Policy Department coordinates public-private sector dialogue, undertakes research and participates in policy development activities, among other things. The BCCI is also partnering with funding organisations to provide microfinance for agro-based industries.

**Loden Foundation:** The foundation is a civil society organisation which designs and implements programmes and projects in economic, social and cultural fields. As one of the leading organisations empowering entrepreneurs through training, financing and mentoring, Loden supported 175 entrepreneurs so far.

The Loden Entrepreneurship Programme (LEP) offers interest and collateral free loans that are repayable over three years with a grace period between 6 months and one year. Selected business ideas receive soft loans up to maximum of Nu. 1.5 million. The calls for business proposals are launched twice a year and applications are evaluated through two-phase assessment process by a panel comprising of Bhutanese and international business experts.

The foundation also implements the Loden SEED Programme (Student Empowerment through Entrepreneurship Development) where entrepreneurial education is provided to college and school students. Loden collaborates with seven university colleges including the College of Science and Technology.

**Technology and Innovation Support Centres (TISCs):** The Ministry of Economic Affairs started to create the TISCs with the agreements signed by the Department of Intellectual Property in 2018 with three institutions, namely College of Science and Technology, Jigme Namgyel Engineering College and the Thimphu TechPark. The centres are created following the model of the World Intellectual Property Organisation (WIPO) in accordance with the agreement signed with the Organisation.

The TISCs will provide access to about 70 million global patent documents on technological fields as well as to locally based high quality technology information and related services. It is expected to help the innovators further innovate and develop products and services, and to create, protect and manage their IPRs. The TISCs are also expected to strengthen the institutional capacity of universities and R&D institutions to conduct patent search, patent drafting, and to assist in patent prosecution.

**Bhutan Ecological Society (BES):** The BES is a civil society organisation aiming to contribute to sustainable development to create jobs, increase self-sufficiency, build resilient communities, proactively adapt to climate change and ensure the persistence of biodiversity. It was conceptualised by the Ugyen Wangchuck Institute for Conservation and Environmental Research. Its activities include, inter alia, landscape, enterprise, agriculture and forests development, for example by enhancing and empowering natural resource-based entrepreneurs; conducting research on water and climate science; energy and sustainable architecture through initiatives such as smart rural-urban development, and science, outreach and advocacy.

**Bhutan Foundation:** Co-chaired by the Queen Mother and Michael Philipp, a Managing Partner of US-based Ambata Capital Partners, the Bhutan Foundation serves the Bhutan society in living and sharing the principles of GNH.<sup>77</sup> The foundation contributes to the strategies of conservation of the environment, equitable and sustainable development, good governance, and preservation of culture, and implements and supports projects in the areas such as economic development, education, and health and medicine.

There are also other organisations that have roles in the value chains of strategic sectors, such as the Agency for Promotion of Indigenous Crafts and the Tourism Council of Bhutan.

<sup>77</sup> <https://bhutanfound.org/>

## 3.5 Operational STI Policy Instruments

### 3.5.1 Public Programmes for STI

#### **Research grants and scholarships of the RUB:**

The RUB is responsible for the implementation of the National Research Endowment Fund (REF) to promote research activities. The Governing Board of the Fund functions under the RUB. The budget of the REF was Nu.10 million in the period 2017-18. According to the guidelines provided by the Ministry of Finance, 70% of the fund should be invested for research activities. In 2019, the Governing Board decided to save 90% and utilise only 10% of the fund until a formal national council is established.<sup>78</sup>

The RUB accepts research project proposals through annual calls. The research is sponsored through three broad mechanisms: university-wide sponsored research, college sponsored research and external grant sponsored research. The proposals of researchers are accepted under one of the following categories: Beginning Career Researcher Category, Mid-Career Researcher Category and Advanced-Career Researcher Category.

In the period 2017-2018, a total of 88 project proposals were submitted to various agencies to finance research activities and a total of Nu.49 Million was secured by the university to support research from various sources, including international students' fees from different study abroad programme modalities.<sup>79</sup>

The Department of Research and External Relations (DRER) facilitates scholarships to strengthen research capacity of the academics. During 2017-2018, the DRER received 46 applications for university research grants, out of which 21 applications were selected through competitive basis.

**National STEM Olympiads:** Organised by the Ministry of Education in collaboration with Royal Education Council (REC) since 2017, the Olympiads provide a platform to showcase the

talent, innovation and creativity among students. Selected middle and higher secondary schools participate in this annual event and are awarded with seed money to develop their model or prototype. In 2019, a total of No. 310,000 made available to 16 participating schools in different award categories. The theme in 2019 edition was identified as "Artificial Intelligence for sustainable farming" and it hosted for the first time the National STEM Robotics Competition led by the Fab Lab.

There are also scholarship programmes implemented with international donors, which mainly focus on offering training and education abroad for a small number of university graduates, such as the Australian Award Fellowship and the Japanese Grant Aid (JDS) that provides two-year master degree opportunities.

**Research Grants of the KGUMSB:** The Medical Education Centre for Research, Innovation and Training (MECRIT) of the university in collaboration with Bhutan Foundation offers grants to researchers with the objectives of promoting and strengthening research culture and capacity among health professionals.<sup>80</sup> In 2017- 2018, grants were provided to 12 research proposals out of 29 applications. The research results are published in journals and shared with the relevant agencies. The budget available for research in the university is limited (Nu. 1.5 million) and hence, there is a need to benefit the funding from the REF, according to the interviews. Moreover, access to the DrukREN is not possible at the university and poor Internet connection is an issue for research activities.

**Fiscal Incentives:** According to the 2017 Fiscal Incentives Act of Bhutan, direct and indirect tax incentives are provided for investments in Bhutan.<sup>81</sup> The direct incentives are further divided into two: General Incentives and Sector Specific Incentives. The General Incentives are applicable to all sectors of the economy while Sector Specific Incentives are applicable to the priority sectors ("five jewels") identified under the Economic Development Policy. The

78 <http://www.rub.edu.bt/images/rub/meeting/ric/Minutes-of-the-Meeting-26th-RIC.pdf>

79 RUB - DRER, *State of Research and Institutional Linkages 2017-2018*

80 <https://www.kgumsb.edu.bt/wp-content/uploads/2019/03/annual-report-2017-2018.pdf>

81 [https://www.mof.gov.bt/wp-content/uploads/2014/07/Rules\\_FI2017.pdf](https://www.mof.gov.bt/wp-content/uploads/2014/07/Rules_FI2017.pdf)

incentives are provided, inter alia, for (a) adopting modern environmentally friendly technologies, (b) the procurement of R&D equipment, and (d) buying computers and related hardware and software for IT-enabled service providers. They are also applied to newly established Information Technology/Information Technology Enabled Services (IT/ITES) businesses as well as IT park developers and newly established infrastructure developers within industrial estates, IT Parks, dry ports, warehousing and cold storages. The incentives are applicable in the period between 8 May 2017 and 31 December 2020.

The fiscal incentives for IT/ITES companies at Thimphu TechPark include:<sup>82</sup>

- A tax holiday is available to the IT/ITES firms operating within the TechPark and exporting 80% of their products/services.
- Import of capital goods forming direct inputs for the IT/ITES companies in the TechPark is exempted from customs duty and sales tax.
- IT/ITES businesses/companies as defined within the TechPark is exempt from Tax Deducted at Source for the duration of the tax holiday.
- 100% foreign equity participation is permitted for the IT/ITES companies in the TechPark.
- Flexibility to obtain investment capital globally after obtaining prior permission of the authorities concerned.
- Export earnings in convertible currency by IT business/companies operating from the park is exempted from tax for the duration of tax holiday.

**Entrepreneurship Development Programme:** Implemented by the Ministry of Labour and Human Resources, the programme aims at promoting entrepreneurship and encouraging the youth to take up self employment as a preferred career option.<sup>83</sup> The programme includes several sub-programmes:

1. *Basic and Advanced Entrepreneurship Development Training:* The programme offers regular training programmes called the Basic Entrepreneurship Course (BEC) and the Advanced Entrepreneurship Course (AEC).

The BEC is a 120- hour programme delivered over 15 days and is offered to jobseekers between 18 and 29 years of age. The AEC is conducted for 160 hours over 21 days targeting young people with bachelor's degree. During the programme, the participants are taught on basic entrepreneurship concepts, ecosystems, following the 'Competency-based Economies through Formation of Enterprise' (CEFE) methodology. At the end of the programme, the trainees are required to develop viable business plans for further execution.

2. *Student Business Seedling Programme:* The programme was initiated by the Royal Monetary Authority in collaboration with Ministry of Labour and Human Resources, and was piloted in Desi High School, Thimphu in 2018. It aims to foster entrepreneurial spirit among students.
3. *Training of Trainer (TOT) on New Business Creation:* The programme targets entrepreneurship promotion focal officers in various agencies/institutions. It is delivered for TVET instructors, tertiary education lecturers, curriculum developers, and other relevant individuals. Along with the TOT training, beneficiaries are also provided with BEC and AEC curriculum. The programme is a part of entrepreneurship integration in school and different learning institutions.
4. *Start-up Innovation Tech Week:* Organised as a one-week innovative technology idea generation event to get hands-on experiences, and test innovative ideas, it starts with idea pitches by participating teams. On subsequent days, teams focus on market validation, building a Minimum Viable Product (MVP), demonstrate their prototypes, and receive feedback from a panel of experts. The programme is open to anyone, interested in exploring her/his innovative ideas.
5. *Business Acceleration Programme:* It provides additional training and support to entrepreneurs having viable business ideas. The programme is lasts 3 months with a weeklong training in first weeks of every month. The participants are matched with experienced

<sup>82</sup> [http://thimphutechpark.com/downloads/Web\\_TTPL\\_Brochure\\_Final%2026.6.14.pdf](http://thimphutechpark.com/downloads/Web_TTPL_Brochure_Final%2026.6.14.pdf)

<sup>83</sup> [https://www.molhr.gov.bt/molhr/?page\\_id=834](https://www.molhr.gov.bt/molhr/?page_id=834)

mentors in their relevant field to be guided and provided with support to develop their ideas. At the end of the programme, the participants are expected to develop and launch their products. The beneficiaries of the programme are selected from cohorts of those who attended other programmes of the Ministry.

6. *Start-up Weekend*: It is a 54-hours event providing a platform for aspiring entrepreneurs to develop their business ideas, conduct market validation and pitch their ideas. During the event, mentors, volunteers and organisers help the participants to work on their ideas, and teams are formed to turn the ideas into working prototypes. The programme is carried out in collaboration with the Thimphu TechPark.
7. *Entrepreneurship Awareness Programme*: It is implemented in technical training institutes, schools and colleges to create awareness of entrepreneurship culture and ecosystem in the country.
8. *Global Entrepreneurship Week (GEW)*: Implemented as a part of the worldwide event led by the Global Entrepreneurship Network (GEN), the one-day event seeks to inspire those interested in exploring her/his potential as an entrepreneur, fostering connections and increasing collaboration within the entrepreneurship ecosystems. The event includes various sessions and workshops, and the best entrepreneur is awarded with a prize and a certificate.
9. *Business Idea Competition of Bhutan (BICOB)*: Conducted annually in collaboration with the Thimphu Techpark and other key stakeholders to promote innovation and entrepreneurship in the country, the competition is open to all citizens. It involves submission of business ideas that are assessed by a panel of judges. The shortlisted participants go through final prototype development and pitching. The winners of the competition are awarded with cash prizes and certificates, and are given incubation space to further develop their ideas.
10. *Setup of Digital Fabrication Labs*: As part of a flagship programme under the five-year

plan, Fab Labs are envisaged to be created in the training and education institutes. For this purpose, it is planned to open two pilot Fab Labs in the Jigme Wangchuck Power Training Institute (JWPTI) and Sherubtse College.

11. *Micro-works and online freelancing*: To provide opportunities for college students and job seekers, micro-work and online freelancing is planned to be promoted in colleges. The first phase will involve the organisation of awareness raising activities and training programmes for 200-300 students at the RUB colleges.

Since the initiation of the Twelfth Five Year Plan in 2018, the Ministry delivered entrepreneurship training to 92 participants. Of them two have established their start-ups. Between 2013 and 2018 (the period covered by the Eleventh Five Year Plan), 3,645 participants were trained out of which 447 have established their businesses. Nearly half of the total number of participants were the students of six TTIs and two IZCs who were trained as part of their curriculum. The remaining half received short-term training organised by the Department of Employment and Human Resources. Another 1,144 participants were trained between 2008 and 2013 (the period covered by the Tenth Five Year Plan) out of which 72 established their start-ups.

In addition to these 4,881 individuals who were trained in entrepreneurship, 20 people participated in one time Start-up Innovation Tech Week and 9 participated in one time Business Acceleration Programme. Moreover, 10 Start-up Weekends (with 842 participants), 10 Entrepreneurship Programmes and 7 Business Idea Competitions were organised.

In addition to the above programmes, the Ministry implements the Apprenticeship Training Programme (ATP) where job seekers are placed to the companies to gain knowledge, skills and experience. The ATP covers both occupation related instruction and on-the-job skills training.<sup>84</sup> Under this programme 1,767 young people were trained in the fields of construction, hospitality, IT and automobile industries.

Although planned in the TVET Blueprint, the

84 [https://www.molhr.gov.bt/molhr/wp-content/uploads/2017/07/ATp\\_guidelines\\_22.pdf](https://www.molhr.gov.bt/molhr/wp-content/uploads/2017/07/ATp_guidelines_22.pdf)

Ministry could not establish the TVET Resource Centres due to budget constraints. These centres were expected to be equipped with state of the art industry ready technologies and highly competent staff capable of delivering new services. The business incubation units established in TTIs and IZCs have not been successful due to the lack of qualified human resources.

### 3.5.2 Flagship Programmes under the Twelfth Five Year Plan

The Twelfth Five Year Plan identified the “Flagship Programmes” to address high priority national challenges that require multi-sectoral collaboration and coordination in a concerted manner. They are regarded as key means to achieve the NKRA through the implementation of high impactful activities. A summary of these programmes are given below:

1. *Start-up & Cottage and Small Industries (CSI) Development Flagship Programme*: It aims to foster job creation and enhance income generation by enabling the creation of new CSIs and improving the competitiveness of the existing ones. It focuses on building entrepreneurship and innovation culture and promoting start-ups. A total of 1,050 CSIs are provided with targeted support to help generate additional 4,700 jobs. The programme activities include the establishment of business incubation centres and Fab Labs in colleges and TTIs; development of platforms to showcase and identify creative business ideas; and strengthening the existing Start-up Centre to provide end-to-end services ranging from business idea generation, mentoring, skills development, product design, production enhancement and marketing; streamlining legal and policy frameworks; improving access and explore alternative financing mechanisms; building human capital; and improving business development services to create enabling ecosystem for Startup and CSI growth, It is planned that targeted support is offered through product standardisation, packaging, certification and branding to produce and market 20 different products that have market potential. An indicative budget of Nu. 1.2 billion has been earmarked for the

programme, and implementation is led by the Ministry of Economic Affairs in collaboration with the Ministry of Labour and Human Resources, the Ministry of Agriculture and Forests, Royal Monetary Authority, Bhutan Standard Bureau, Bhutan Chambers for Commerce and Industries, local governments and the private sector.

2. *Sustainable Tourism Development Flagship Programme*: This programme aims to increase contribution of tourism to national economy and rural livelihood through balanced regional development and seasonal spread of tourism while providing an enhanced visitor experience of Bhutan as an exclusive destination. The activities cover creating the necessary policy and regulatory frameworks to support an enabling environment, institutional strengthening, and the adoption of safeguards and safety standards. The programme will identify and implement selected projects to develop diverse tourism packages and a specific component on allied waste management across the country. It will undertake focused end-to-end activities in five strategically placed Dzongkhags<sup>85</sup> for accelerated tourism development. The programme targets to increase tourism gross receipts from Nu.10 billion to Nu. 39 billion and direct revenue contribution from Nu.1.6 billion to Nu. 5.5 billion in the next five years. It is expected to create 15,000 additional jobs. An indicative outlay of Nu.1.566 billion has been earmarked for the programme, and the implementation will be led by Tourism Council of Bhutan in collaboration with the local governments, the Ministry of Economic Affairs and the private sector.
3. *Organic Flagship Programme*: This programme aims to commercialise organic production. It will provide access to bio-inputs and organic seeds, develop an organic value chain and market system, and develop and operationalize organic certification systems. The programme will target the organic production of 8 selected commodities for exports and 4 for domestic consumption. It aims to produce approximately 254,000 metric tonnes of bio-inputs within five years.

<sup>85</sup> The administrative and judicial districts of Bhutan.

The target is to generate approximately 1,500 new jobs and engage around 33,000 farmers across the country. An indicative outlay of Nu.1.0 billion has been earmarked for the programme, and the implementation will be led by the Ministry of Agriculture and Forests in collaboration with the local governments, the Ministry of Economic Affairs and other relevant agencies.

4. **Digital Druknyul Flagship Programme:** This programme aims to leverage ICT for delivering health care, education, business licensing and other critical public services efficiently. An electronic patient information system to centrally manage patient records of all health centres will be developed and about 1,000 schools, hospitals and offices will be provided with broadband Internet connection. The issuance of business licenses of all categories, clearances for export and import, and most commonly used public services such as birth and death registration, pension services, marriage certificate, vehicle services, issuance of various permits, construction approvals and utility services will be streamlined and facilitated by enabling government agencies to interact and coordinate more efficiently. An indicative budget of Nu. 2.5 billion has been earmarked for the programme, and implementation will be led by the Ministry of Information and Communications in collaboration with the Cabinet Secretariat, the Ministry of Health, the Ministry of Economic Affairs, the Ministry of Finance and other relevant agencies including the private sector.
5. **Water Flagship Programme:** This programme aims to provide access to safe drinking water to both rural and urban households. For this purpose, new water supply schemes will be developed; existing ones will be improved, and water source protection and water quality testing and surveillance will be implemented. The programme will also ensure the availability of adequate irrigation water. In addition it foresees the exploration of the creation of an agency for water supply services. An indicative outlay of Nu. 3 billion has been earmarked for the programme. The National Environment Commission Secretariat and the Ministry of Works and Human Settlement are responsible for the implementation and

they collaborate with local governments, the Ministry of Health, the Ministry of Agriculture and Forest, and the Ministry of Finance.

There are also other flagship programmes in the areas of health, rural economy, education and waste. The capital outlay for all programmes is Nu. 15,000 million.

### 3.5.3 Programmes under the RNR Twelfth Five Year Plan

The Twelfth Five Year Plan for the Renewable Natural Resources Sector (2018-2023) issued by the Ministry of Agriculture and Forests introduces specific programmes for the development of the sector. There are seven programmes identified and they are summarised below:

1. **Food Self-Sufficiency and Nutrition Security Programme:** It aims to enhance self-sufficiency in rice, vegetable, meat, eggs, chicken and dairy products by increasing the area under assured irrigation and reduce fallow land, strengthening animal and plant bio-security and safety, enhancing food safety and strengthening organic agriculture production. The programme activities include the adaptation of improved postharvest technologies for grain, legumes and oil seed; strengthening of laboratory facilities and equipment, and promotion of effective microorganisms technology for organic farming. The programme budget is Nu. 1357.36 million and the implementing organisation is the Department of Agriculture, Department of Livestock and BAFRA.
2. **Value Chain and Enterprise Development Programme:** It includes measures such as developing enhanced market information and infrastructure facilities; product processing and value addition facilities as well as enterprise development. The programme activities are identified as supporting quality standards formulation and compliance to the standards, supporting and establishing agro-based enterprises, and support to private sector, enterprises and NGOs for product development. The budget allocated is Nu. 353.73 million and responsible organisation is the Department of Agriculture, Department of Livestock and Department of Agricultural Marketing and Cooperatives.

3. *Sustainable Natural Resources Management and Biodiversity Utilisation Programme:* The programme is designed to address the challenges facing Bhutan in resources management and biodiversity, and enable continued provision of critical ecosystem services to social, economic, cultural and environmental functions of the country. The programme activities cover developing waste management plans, implementing waste management plan in parks and territorial divisions, conducting biodiversity inventory to update flora and fauna of Bhutan, generating biodiversity information, and strengthening biodiversity portal and improving access. The budget is Nu. 706.97 million and the implementing organisations are the Department of Forests and Park Services and the National Biodiversity Centre.
4. *Research and Extension Services Programme:* The programme aims to adopt organic agriculture technologies; farm mechanisation technologies; plant protection technologies on rice and maize, vegetable, potato, citrus, fruits and nuts, and soil fertility and nutrient management technologies on rice and maize, vegetable, potato, citrus, fruits and nuts. Implemented by the Department of Agriculture, Department of Livestock and the Department of Forests and Park Services, it has a budget of Nu. 443.58 million.
5. *Climate Smart and Disaster Resilient Development Programme:* It focuses on climate change responsive policies, technologies, pests and disease management, information management and disaster management. The programme activities include conducting capacity building on biogas technology for relevant stakeholders, promoting water efficient irrigation technologies, promoting pressurized irrigation systems, releasing and promoting climate resilient agriculture technologies, and functional e-pest surveillance system. The budget is Nu. 655.68 million and implementation is under the responsibility of the Department of Agriculture, the Department of Livestock and the Department of Forests and Park Services.
6. *Highland Development Programme:* It aims to promote sustainable livelihood of the highland communities, promote and preserve the socio-cultural traditions of the highlanders in consistence with GNH principles, ensure equitable access, sustainable management and utilization of natural resources, and promote traditional knowledge and generate technological innovations to enhance income generation and employment opportunities. Programme activities include promotion of yak, sheep and bee-based enterprises through product diversification strategies and exploration of potential areas. It also foresees supporting medicinal and aromatic enterprise establishment. Implemented by the Department of Agriculture, the Department of Livestock and the Department of Forests and Park Services, it has a budget of Nu. 86.54 million.
7. *Coordination and Support Service Programme:* Activities of this programme is identified as having in place the Laboratory Information Management system for effective service delivery, developing Forestry ICT and Government to Citizen services, designing GIS maps of important quarantine pest and diseases severity zoning and spatial and temporal mapping). It is implemented by the Department of Agriculture, the Department of Livestock and Department of Forests and Park Services, the Department of Agricultural Marketing and Cooperatives, and has a budget of Nu. 70.73 million.

In this section, an analysis of the STI-related strengths, weaknesses, opportunities and threats (SWOT) for Bhutan is presented. The summary of the SWOT is given in Table 4.

The STI SWOT analysis of Bhutan based on the findings of the National Consultation Workshop conducted in Thimphu on 17 October 2019 using a participatory approach. It is also draws on the findings from the information and data presented in the preceding sections.



# Chapter 4

## STI SWOT Analysis

## 4.1 Strengths

**Strong leadership and commitment in Bhutan on STI and SDGs:** The King and the government of Bhutan consider STI as a key tool for development and attaining the SDGs. The thematic and sectoral policy documents and the national plan have already include a significant amount of action items regarding STI, which –if implemented successfully without any delay- help the country leapfrog its constraints to growth and development.

**GNH vision that corresponds with and supports STI-based development:** Bhutan's GNH vision, structures, policies and initiatives is an incomparable comparative advantage for the country to achieve STI-driven development.

**Unique brand value, reputation and image of Bhutan at global arena:** Bhutan's strong image and distinctive characteristics such carbon neutrality, GNH philosophy, uncorrupted system, cultural values, etc. place it in a special position in the world which attracts attention and support from across the globe.

**Existence of main stakeholders of the National Innovation System:** Bhutan has the main stakeholders that form the backbone of its National Innovation System.

**Existence of policy instruments and infrastructures to stimulate STI:** Over the past few years, Bhutan has been creating STI related policy instruments and infrastructures, such as the Fab Lab, Start-up Centre and TechPark, and is gaining experiences in managing STI measures.

## 4.2 Weaknesses

**Need to design and implement an explicit national STI policy:** Not having an explicit, fully-fledged STI policy cross-cutting all sectors and policy areas in Bhutan is a major weakness of the country. The need for the national STI policy is recognised by all stakeholders and is highlighted in different forums.

**Need to establish an oversight body and develop the STI governance system:** Bhutan needs to create/assign an oversight body for the coordination of STI policy-making and implementation. Such an institution is also inevitable to enhance

the communication, coordination and cooperation between the organisations responsible for different aspects of STI, and to eliminate duplications and overlaps of roles and responsibilities among different institutions. Although the government is aware of this need and planned to create a national STI council two decades ago, it could not yet accomplish it.

**Need to create a national STI funding agency and provide sufficient resources to finance STI projects:** The absence of a dedicated national agency to design and implement support programmes and the lack of adequate funds to finance STI are major weaknesses prohibiting the accelerated sustainable development of the country.

**Need to create a balanced policy mix by designing direct and indirect STI policy instruments:** Bhutan requires to have a diverse STI policy instruments addressing to encourage different groups of research and innovation performers to invest in STI and its commercialisation.

**Need to develop STI human resources:** There is a need to increase both the number and the qualifications of the human resources to create and maintain a critical mass of researchers and STEM graduates who can carry out research and innovation activities on an ongoing basis, and create and grow innovation-driven enterprises.

**Need for developing skills and capabilities for STI policy, programme and project design and implementation:** The stakeholders in Bhutan require enhanced knowledge, skills and capabilities on STI policy making and programme design and implementation. In addition, the competencies and skills of the researchers and entrepreneurs should be developed on research and innovation project design and implementation.

**Need to improve policy and programme monitoring and evaluation practices:** Bhutan should create necessary systems and build capabilities to collect and publish internationally comparable STI statistics. In addition, systematic monitoring and evaluation practices should become an integral part of the policy cycle. Steps are required to be taken to evaluate the relevance, efficiency, effectiveness, impact and sustainability of the

existing policy instruments, including the innovation infrastructures, and to take necessary measures to improve them.

**Need to increase awareness and create a common understanding of STI among all stakeholders in the country:** There is a need to create awareness and common understanding of STI among different players of the NIS in Bhutan both to develop supply and demand for research, innovation and innovative products and services, and to implement policies and policy instruments effectively.

### 4.3 Opportunities

**The process of graduation from LDC category:** The process through which Bhutan is prepared to graduate from LDC group accelerates the efforts, investments and external assistance for transformation of the country into a knowledge society.

**Attracting international funding and technical assistance for STI:** The unique brand and image of Bhutan at global level makes it possible to attract more funding and technical assistance support from donor organisations and international financial institutions. It is possible to use this funding and support for STI related investments.

**Mobilising skilled human capital available in diaspora:** The Bhutanese researchers, entrepreneurs and other highly skilled human resources living and working in other countries could actively participate in the STI-driven transformation of Bhutan. There are already success stories of such diaspora linkages, as in the case of Fab Lab Bhutan. Therefore, it is important to establish a dynamic network of diaspora and engage

them in the STI-focused activities in the country.

**The availability and accessibility of emerging technologies:** The developments and access to emerging technologies, such as Artificial Intelligence, Internet of Things, Virtual Reality, Augmented Reality, drones and 3D printing offers the greatest opportunities to create new businesses and revenues as well as to address societal and environmental challenges.

### 4.4 Threats

**Climate change and natural disasters:** Climate change and natural disaster threats create major risks for all sectors of the economy. It is often cited as the single greatest risk of derailing decades of development gains achieved in Bhutan. On the other hand, effective use of STI provides the country with opportunities for disaster risk reduction, climate change adaptation and resilience.

**Difficult geographical terrain and dispersed population settlements:** Communities living in rural locations in Bhutan face challenges in access to public services and are less likely to benefit from STI investments and measures unless they are defined as one of the priority target groups for STI policy and policy instruments. Furthermore, the use STI is essential to overcome the challenges presented by the unfavourable geography and settlements.

**Failure to prioritise investment in STI:** There is a risk of choosing to invest in the areas which are still of priority to the country, such as adequate provision of basic education and healthcare services, or sectors for short term returns, such as hydropower, instead of STI which has medium to long term returns.

**Table 4: STI SWOT analysis of Bhutan**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>- Strong leadership and commitment among the stakeholders on STI and SDGs</li> <li>- GNH vision that corresponds with and supports STI-based development</li> <li>- Unique brand value, reputation and image of Bhutan at global arena</li> <li>- Existence of main players of the National Innovation System</li> <li>- Existence of policy instruments and infrastructures to stimulate STI</li> </ul>	<ul style="list-style-type: none"> <li>- Need to design and implement an explicit national STI policy</li> <li>- Need to establish an oversight body for STI and develop the STI governance system</li> <li>- Need to create a national STI funding agency and provide sufficient resources to finance STI projects</li> <li>- Need to create a balanced policy mix by designing direct and indirect STI policy instruments</li> <li>- Need to develop human resources for STI</li> <li>- Need for developing skills and capabilities for STI policy, programme and project design and implementation</li> <li>- Need to improve policy and programme monitoring and evaluation practices</li> <li>- Need to increase awareness and create a common understanding of STI among all stakeholders in the country</li> </ul>
Strengths	Weaknesses
<ul style="list-style-type: none"> <li>- The process of graduation from LDC category</li> <li>- Attracting international funding and technical assistance support for STI</li> <li>- Mobilising skilled human capital available in diaspora</li> <li>- The availability and accessibility of emerging technologies</li> </ul>	<ul style="list-style-type: none"> <li>- Climate change and natural disasters</li> <li>- Difficult geographical terrain and dispersed population settlements</li> <li>- Failure to prioritise investment in STI</li> </ul>



## **Chapter 5**

### Assessment of Technology Needs

In the light of the findings of the primary and secondary research, the technologies needed in Bhutan in the short and medium term are presented below.

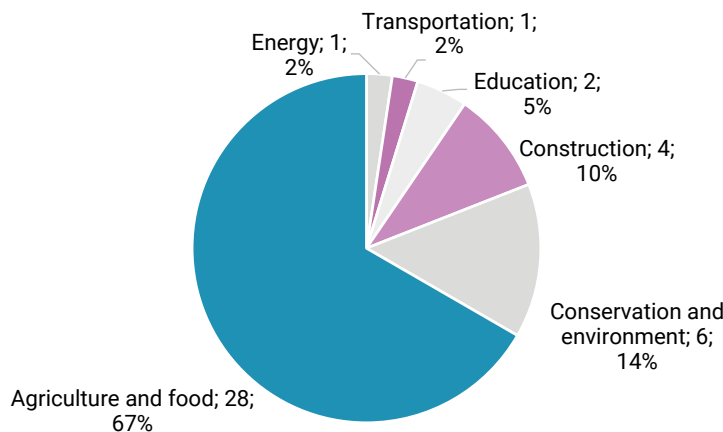
Technology in this context is defined both as a physical component, such as products, equipment, devices, blueprints and processes, etc., and as an informational component such as know-how and technical knowledge.

### 5.1 The Results of Technology Needs Assessment Survey

The Technology Needs Assessment (TNA) survey implemented in Bhutan was answered by 32 participants. They identified 42 issues facing the priority sectors that should be addressed through the transfer of technology and knowledge. The technology needs expressed by the respondents are given in Section 5.2 below.

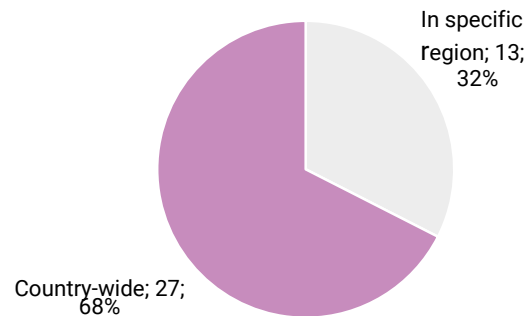
The majority of respondents (67%) identified issues and needs for the agriculture and food sector (involving organic farming, agro-processing, biotechnology, forest based products, poultry, fisheries, floriculture, health food, animal feed, apiculture, horticulture, dairy, etc.). It is followed by conservation and environment (wildlife, land, water and forestry management, water and air quality, waste management, pollution control, etc.), construction (buildings, construction materials, design, renovations, etc.) and education (STEM, TVET, higher education, etc.) (Figure 4).

**Figure 4: The sectors for which the survey respondents identified issues and technology needs**

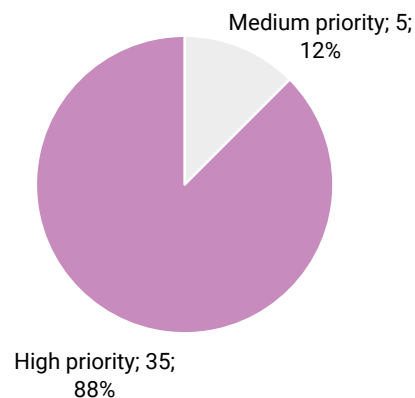


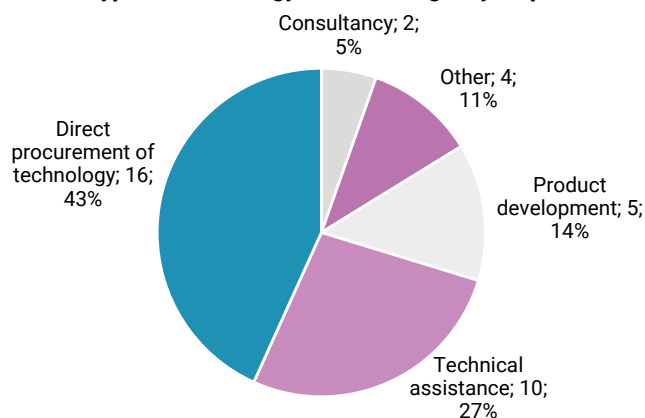
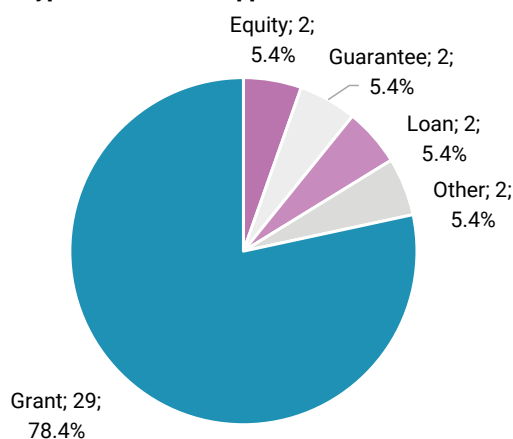
The survey findings indicate that the majority of the issues listed concern the whole country (68%) and rest are specific to certain regions or organisations. Nearly 90% of the respondents consider that the issues reported are of high priority to the country.

**Figure 5: The geographical location(s) for the deployment of the technology**



**Figure 6: The level of priority for the acquisition of this technology**



**Figure 7: The types of technology transfer sought by respondents****Figure 8. The types of financial support needed for the transfer of the technology**

While slightly more than half of the respondents (55%) are of the opinion that the technologies needed should be internationally procured, the rest believes that they can be developed locally. This indicates the importance of investing in STI in the country.

Almost 65% of the survey respondents reported that they have already identified the source(s) of these technologies, and 58% of them declare that the regulations are in place for the deployment of the technologies identified.

The main type of technology transfer sought by the respondents is direct procurement of technology (equipment, machinery, software, etc.) (43%). It is followed by technical assistance (27%) and product development (contract R&D or joint R&D) (14%) (Figure 7)

The primary type of financial support needed for the transfer of technology is expressed as grants (78%) (Figure 8). Almost all of the respondents

explained that training support is also required for successful acquisition/adoption of the technology. Assistance in negotiating license agreements is also cited as an area of support needed in the procurement of technologies.

## 5.2 Sectoral Technology Needs

The technologies needed for the priority sectors of Bhutan are given below based on the findings of the TNA survey as well as the interviews, consultation workshop and desk research conducted under this study.

### 5.2.1 Agriculture and Food Sector

The technology needs expressed in the TNA survey for the agriculture and food sector (organic farming, agro-processing, biotechnology, forest based products, poultry, fisheries, floriculture, health food, animal feed, apiculture, horticulture, dairy, etc.) are summarised below in Table 5.

**Table 5. Technology needs according to the TNA survey for the agriculture and food sector**

No.	Technology need	Responsible organisation	Remarks
1	Large scale farm yard waste recycling and organic fertilizer making (mechanised compost)	Ministry of Agriculture and Forest	Can be locally developed and financed by the Climate Fund
2	New farming technology such as intensive Farming using modern technology	Ministry of Agriculture and Forest	Can be internationally procured
3	Development of qualified human resources in the field of Biosecurity, Food Safety and Quality	Royal Civil Service Commission and Finance Ministry	An urgent need for monitoring and inspection
4	- Easy access to organic manures and pesticides. - Incentives to go for organic farming - Support in marketing of organic products	Ministry of Agriculture and Forests and other relevant agencies	Planned under the National Organic Programme. Organic manure, pesticides and weedicides are not readily available.
5	Quantification of genetically modified organisms using Real-time polymerase chain reaction (PCR) and Laboratory Information Management System (LIMS) - Adequate laboratory capacity for detection, identification and quantification of the genetically modified element - Laboratory Information Management System - Knowledge on the technology advancements taking place in the similar field - Development of technical expertise and transfer of knowledge	Bhutan Agriculture and Food Regulatory Authority	Needs to be Internationally procured. Can be financed by the Government or International Donor Agencies. Additional support is needed for negotiating license agreements training.
6	Biotechnology and food technology laboratories	Bhutan Agriculture and Food Regulatory Authority	Donor funding is needed. There are technically qualified human resources working in different ministries who could be engaged in this project.
7	Development of RNR enterprises (agriculture and livestock) by providing required technologies and enabling product development (contract R&D or joint R&D) and offering training	Department of Agricultural Marketing and Cooperatives, Department of Agriculture and Livestock	Potential resources can be international donors (notably CARLEP) and the Government (Department of Agricultural Marketing and Cooperatives, Mongar)). A budget amounting to \$60,000 is planned.
8	Transfer of modern farming techniques	Department Agriculture and Livestock	International donors (CARLEP)
9	- Farm mechanization, introduction of labour saving devices and gender friendly technologies; electric fencing schemes, automated irrigation systems, climate resilient farming technologies, sustainable land management practices, crop compensation, cost sharing mechanisms etc. - Trainings and capacity development in these areas.	Ministry of Agriculture and Forests	Can be funded by international donors such as IFAD, FAO, World Bank, European Union, India, Japan, UN, and the government.
10	Stable electronic database to prevent loss of data due to frequent system break down	Bhutan Agriculture and Food Regulatory Authority	Should be internationally procured. Capacities are needed for programming and operation
11	Computer technology and mobile technology for e-traceability system for product certification (locally and internationally) of agricultural produce	Ministry of Information and Communication	Technical assistance and grants are needed.
12	- Simple cost effective food processing equipment - Simple packaging materials - Efficient/multiple land utilisation techniques to address the issues such as farm labour shortage, difficulty of farm mechanisation due to the rugged terrain, cheaper imports, high cost of food production and processing in the country, and limited knowledge and skills in food processing industry.	All departments of the Ministry of Agriculture and Forests	Can be funded by international donors, such as UN, FAO, EU, IFAD, India, and Japan. Training to the farmers, youths, cooperatives, study visits to learn from international good practices are needed.

No.	Technology need	Responsible organisation	Remarks
13	Food technologies - to produce more food products in the country, - to increase the quality and safety of food - technical knowledge on good farming systems.	Bhutan Agriculture and Food Regulatory	Can be funded by international donors.
14	Supplying of farm equipment that can be used on sloping land (at present the Ministry is focusing only on supply of power tiller to general public, which work only in plain areas like Paro, Bumthang).	Ministry of Agriculture and Forests and other relevant organisations such as Agricultural Machinery Centre and Farm Machinery Corporation Limited	Technology is needed in specific regions, mainly Zhemgang, Trashigang, Mongar, Haa, Samtshé, Pemagatshel, Trashiyangtshé etc.
15	Technologies and training for increasing farm product quality	Ministry of Agriculture and Forests	Technology is needed in specific regions, mainly Zhemgang, Trashigang, Mongar, Haa, Samtshé, Pemagatshel, Trashiyangtshé etc.
16	RNR technologies their dissemination and awareness raising among users (A dedicated TV channel is needed to broadcast regularly the RNR related technologies. Local cable operators could also be involved. A properly managed Technology Forum in FaceBook would be useful as well to reach the technologies to the users in much faster way.)	Information & Communication Technology Division of the Ministry of Agriculture and Forests, Ministry of the Information & Communications	There are too many training programmes organised for farmers and existing programmes are proved to be ineffective and costly considering the limited impact obtained, as they are not put into practice.
17	- Supplying micro irrigation technologies and smart irrigation systems - Developing irrigation designers	Ministry of Agriculture and Forests	
18	RNR technologies to attract youth to farming. (Currently, the population engaged in farming is aging. Young generation need comfort while in farm and make profit.)	Ministry of Labour and Human Resources; the Ministry of Agriculture and Forests, and the Ministry of Economic Affairs	Direct procurement of technology (equipment, machinery, software, etc.), grants and training are needed.
19	Technologies for the analysis of hormones and pesticides (GC-MS/MS, LC-MS/MS, ICP-MS) to be used in the National Food Testing Laboratory of BAFRA and training	Bhutan Agriculture & Food Regulatory Authority	Direct procurement of technology (equipment, machinery, software, etc.) through donor funding
20	- Technologies that replace the processed agro-products imported from neighbouring countries - Technologies for food security - Providing incentives and finance with low interest rate to attract investments in agro-processing and to encourage local farmers in going into commercial farming of such agro-produce.	Ministry of Finance in collaboration with the Royal Monetary Authority should come up with plans and policies to create enabling environment for upcoming entrepreneurs.	
21	- Intensive skill development in social and scientific research among the extension agents to transfer technologies to farmers to understand the issues and address them accordingly - Technologies to increase productivity from livestock which is currently quite low due to poor nutrition as well as the inability of farmers to adopt the technologies	Department of Livestock/ Animal Nutrition Division/ National Research & Development Centre for Animal Nutrition	
22	X-Ray machine and relevant technologies for food safety, animal bio-safety and plant bio-safety.	Bhutan Agriculture & Food Regulatory Authority	Can be financed by international donors such as FAO and EU
23	Web-based and smart mobile application, which is simple and easy to use for getting timely and reliable market information (both for the domestic and export markets) and making it available so that the farmers can make informed decision on their marketing and production plans so that they are motivated enough by getting good returns from agriculture on their investment.	Department of Agricultural Marketing and Cooperatives	The department at the moment is upgrading its information system but will still be constrained on data collection and inputting them into the system. Sources of support can be the EU through the International Trade Centre.

No.	Technology need	Responsible organisation	Remarks
24	- Value addition technologies that will reduce drudgery, improve the shelf life of the products, assist product diversification and improve packaging - Capacity building for ensuring International quality standards; meeting the requirements of the international packaging standards and marketing - Technical assistance in post harvest	Department of Agricultural Marketing and Cooperatives; National Post Harvest Centre, Farm Machinery Centre Ltd., Agricultural Machinery Centre, Livestock Development Centres	Direct procurement of technology (equipment, machinery, software, etc.) and training are needed.
25	- Rain water harvesting technologies - Water pumping machines - Topographically suitable farm mechanization (The county lacks adequate farm mechanisation and faces both drinking and irrigation water supply problems.)	Ministry of Agriculture and Forest, City Office and Ministry of Work and Human Settlement	Potential users will be all citizens but specifically the farmers.
26	Food hygiene and safety (Food hygiene cannot be implemented due to lack of financial resources.)	Bhutan Agriculture and Food Regulatory Authority	<i>Expressed by two different respondents.</i>
27	Online market accessibility to the farmers to sell their product	Bhutan Agriculture and Food Regulatory Authority	

Other technology and knowledge transfer needs for the sector are the following:

- Building capacities to develop high-value/ niche premium products in agro-food sector and to market them high-value external markets using the international reputation of Bhutan
- The use of emerging technologies in the agro-food value chain, such as the agricultural and smart farming drones; digital agricultural solutions to optimize farming practices to increase yields, crop quality, and income in a sustainable way; the use of AI in areas of decision making, variable needs of plants and animals, to maximise productivity and yields; the use of 3D printing to develop low cost new machinery parts; the use of satellite technologies for gathering soil and crop condition information, etc.
- Capacity building and technology transfer for climate smart agriculture and irrigation, and water efficient technologies in food processing
- Technical assistance, technologies and materials (bio-fertilizers, bio-pesticides, etc.) to move into full organic production as well as the capacities to develop and produce them locally
- Technical assistance for complying to international standards and obtaining certifications, including but not limited to internationally recognised organic certification
- Development of R&D capabilities and infrastructure to improve seed quality, develop drought tolerant crops, insect-resistant crop varieties
- Adoption of technologies for value-added agriculture and processing (including the use of emerging food processing technologies to produce nutritionally rich products for domestic consumption (particularly for children) such applications as non-thermal plasma, refractance window drying, extrusion, enzyme immobilisation, and dry fractionation which is a sustainable alternative to wet processes for producing protein concentrates from legumes<sup>86</sup>)
- Technical assistance for adopting innovative methods and technologies (such as AI) to make available affordable crop and livestock insurance for farmers which face problems by wild animals due to strong conservation policy
- Establishment of a biotech laboratory in the Start-up Centre
- Technical assistance to create an incubator for the food and agriculture sector

## 5.2.2 Conservation and Environment

The technology needs expressed in the TNA survey for the conservation and environment (wildlife, land, water and forestry management, water and air quality, waste management, pollution control, etc.) are given in the following table 6.

<sup>86</sup> See Sankar Chandra Deka, et al (2019) Technologies for Value Addition in Food Products and Processes

**Table 6: Technology needs according to the TNA survey for conservation and environment**

No.	Technology need	Responsible organisation	Remarks
1	Capacity building and awareness raising in the field of conservation to be able to implement conservation plan	National Environment Commission and Forestry Department	To be implemented in the Southern belt border town to India
2	Setting up a simple PCR extraction and DNA sequences lab, and training of experts on DNA based identification for mushroom specimens of Bhutan that are of unique value (So far, about 1,500 plus wild mushroom specimens were preserved but it is considered that this is just 2% of what is assumed in the forests of the country.)	National Mushroom Centre	Once lab is set up, measures should be taken to prevent that none of the materials go out of the country to conserve natural resources.
3	- Advance mushroom cultivation technology: Mushroom cultivation in saw dust, instead of billets; optimum use of raw materials - Furnished mushroom shed such as those in Japan with control environment in the shed.	National Mushroom Centre	To be used by every individual mushroom growers of the country; especially the unemployed youth, who will then go back to their villages to work in mushroom farm and set up maximised income generating enterprises.
4	Efficient computers, server and a power stabiliser for the National Biodiversity Centre including its laboratories (Currently, good computers are rare in the organisation, and the server is full and ten years old. No maintenance budget and power stabiliser available for the lab.)	Ministry of Agriculture and Forests	For computer and lab equipment India is the preferred source. Whilst the quality is not excellent, the import taxes are lower so the prices much lower than elsewhere. The cost would be in the range of US\$50,000
5	- IT developers and map developers are needed for the Bhutan Biodiversity Portal (www.biodiversity.bt) (It currently depends on the agents in India. The developers need to be based in Bhutan to support any updates and advancement to the portal functions.) - DNA barcoding and sequencing facilities (Research in biodiversity taxonomy exploration for conservation would be greatly enhanced with the DNA sequencing and barcoding facilities.)	National Biodiversity Centre, Royal University of Bhutan, and other agencies under the Ministry of Agriculture and Forests	Portal and DNA barcoding facilities could be based in Thimphu as there exist established basic infrastructures already. Sources: 1. Portal developers: Local developers to built capacity on development through Strand Life Sciences, Bangaluru, India, the current developers. 2. Procurement of DNA technologies and capacity building through Naturalis Biodiversity Center in the Netherlands or other reasonable sources Estimated budget: 1. The portal (developers, software; and communication with portal users both registered users and potentially new users): \$70,000 2. DNA technologies and laboratory, and local capacity: \$250,000
6	Specimen digitisation equipment such as different cameras for different biodiversity groups. (Insects digitisation requires special camera and the best would be Stacking Microscope Photography and mounts, while plants require different camera stands or mounts.)	National Biodiversity Centre (NBC; including programmes such as Royal Botanical Garden, National Herbarium, National Invertebrates Repository Centre, and Gene Bank under NBC), National Plant Protection Centre (NPPC)	A possible source is the Naturalis Biodiversity Centre, in the Netherlands. The cost is roughly \$45,000.

Other technology and knowledge transfer needs for the sector are the following:

- Technologies to improve water quality in and around the urban areas
- Technologies to improve water quality air quality in urban centres, industrial area and along the southern border of the country
- Circular economy technologies and waste management systems such as the clean development mechanism for municipal solid waste,

source reduction, etc.

- Adoption of new technologies for flood forecasting, monitoring and early warning for landslides
- Capacity development and infrastructure to generate and use climate information to cope with the threat of hydro-meteorological and geological disasters
- Laboratory and treatment plants for water quality analysis, monitoring and improvement

### 5.2.3 Construction

The technologies needed for the construction sector (buildings, construction materials, design, renovations, etc.) are given in the following table.

**Table 7: Technology needs according to the TNA survey for the construction sector**

No.	Technology need	Responsible organisation	Remarks
1	Specialised knowledge and skills to build the most energy efficient/green buildings: - Specialised long term courses for key professionals - Training of professionals and artisans - Information dissemination through workshops/ other platforms - Construction material and methodology apt to Bhutan and tested in Bhutan	The Ministry of Works and Human Settlement	Direct procurement of technology both soft and hard component but adapted and tested for Bhutan with focus on sustainability
2	Centralised database accessible at least by relevant government employees for the data on buildings, including material, waste, water and energy, and climate. (lack of such a centralised database makes it difficult for professionals to accurately simulate and predict impact areas/most apt/significant potential interventions.)	- Ministry of Works and Human Settlement (all building-related) - National Centre for Hydrology and Meteorology (climate-related) - Thromdes (for respective municipalities)	Can be locally developed. Additionally, technical assistance and funds for development of database would be needed.
3	- Transfer of knowledge on construction (including material and methodology) and maintenance of energy efficient and green buildings and its components - Pilot construction in order to validate and test applicability to Bhutan and its environment. (Bhutan needs focussed building projects which also aims at validating key recommendations/research. For instance, the Bhutan Energy Baseline for building sector was developed, however still requires validation of its recommendations of new and refurbished buildings. Without the validation and test of applicability to Bhutan, all works and recommendations remain theoretical.)	Ministry of Works and Human Settlement	The Ministry may receive fund for retrofitting in one climatic condition in the near future (budget not committed yet). However, there are no financial resources available for application of new construction recommendations. The new construction which is envisaged will not only incorporates recommendations of the baseline (i.e. the future code of practice) in its design and construction but will also function as the one stop centre for energy efficient and green building.
4	- Design, construction and management of sustainable infrastructures - Capacity development for professionals involved in the use and management of technologies	Whole construction sector	Needed for the south and east of country Rules, guidelines, technical assistance, regulations and grants are required.

In addition, the following needs are identified for the sector:

- Capacity building on integrated and sustainable urban planning
- The use of advanced technologies for delivering reliable wastewater treatment, water supply, geographic information systems, and hydraulic modelling
- Building Information Modelling, on-site energy production and smart building technologies
- and new building materials
- The use of new construction technologies such as specialised drones for survey work to improve productivity and higher measurement precision
- The use of space technology for early warnings about natural disasters
- The use of water efficient technologies in construction

## 5.2.4 Education

The technologies needed for education sector (STEM, TVET, higher education, etc.) is given in the following table.

**Table 8: Technology needs according to the TNA survey for the education sector**

No.	Technology need	Responsible organisation	Remarks
1	- Integration of emerging technologies (AI, IoT, VR, AR, etc.) in STEM subjects - Knowledge on emerging trends in technology	Royal Education Council	Guidelines to use emerging trends in technology in STEM subjects are needed. Consultancy and training are required.
2	- Supply of technology such as computers, and IT based teaching learning materials - Good internet connectivity in all schools and universities - Capacity building for: a) trainers b) technicians who will ensure that there will be no disruption due to technology breakdown c) policy makers to ensure it is featured in the country's plans and programmes d) curriculum developers for IT learning in schools	Ministry of Education	

Additionally, the following needs are identified for the sector:

- Integration of ICT in TVET and development of capacities for the creation of innovative models of work-based learning
- Adoption of digital and interactive learning and teaching methods
- Capacity building and access to technology for the digitalisation of textbooks
- Technical assistance and training programmes, hardware and software for the development of creative industries, including animation, graphic design, application and game development
- Capacity building for the enhancement of the quality of teachers
- Development of education programmes and infrastructure for space technologies
- Education technologies and innovative learning methods to encourage youth to advance in mathematics (the majority of children drop math courses at the age of 9-10 and a large portion of those attend engineering faculties fail in this subject, according to the interviews)
- Establishment of interactive science centres, museums, and other forms of public science outreach for general public and students
- Establishment of TVET Resource Centres with required infrastructure and training of staff who will operate these centres:
  - Acquiring advanced technology (i.e., CNC machines, total station IT and filmmaking studios, SME related production and manufacturing equipment etc.)
  - Development of skills in high demand through the delivery of short term courses
  - Facilitating the delivery of higher-level TVET programmes at TTIs and supporting the move towards internationally recognised standards for TVET
  - Expanding the delivery of skills through the use of electronic media and innovative distance learning techniques
- Capacity building and technical assistance on the design and management of incubators to revamp the business incubation units established in Technical Training Institutes and Institutes of Zorig Chusum.

## 5.2.5 Energy

The technologies needed for energy sector (hydropower, solar, wind and other sources of renewable energy) are given in the following table.

**Table 9: Technology needs according to the TNA survey for the energy sector**

No.	Technology need	Responsible organisation	Remarks
1	<ul style="list-style-type: none"> <li>- Projects on low cost localised production of alternative sources of energy like, solar, wind and biogas.</li> <li>- Efficient technologies for hydropower generation (currently the projects are implemented by using machines and turbines from India which are not efficient or reliable (eg. Mangdechu Hydropower Project already needs maintenance).)</li> <li>- Knowledge transfer and capacity building to ensure that experience gained from the hydropower projects are retained in the country</li> </ul>	Ministry of Economic Affairs	Diversification is needed as hydropower based energy generation has become costly and risky.

Additional areas for technology and knowledge transfer in the field include

- Capacity building for the development of renewable energy sector
- Adoption of energy efficiency technologies
- Developing energy auditors to inspect and improve the energy efficiency of both residential and commercial buildings

## 5.2.6 Transportation

The technologies needed for transportation (roads, green modes of transportation, railways, rope ways, cable cars and riverine transport, logistics, etc.) are given in the following table.

**Table 10: Technology needs according to the TNA survey for the transportation sector**

No.	Technology need	Responsible organisation	Remarks
1	<ul style="list-style-type: none"> <li>- Use of new technologies and eco friendly materials on road construction</li> <li>- Measures for strict check of emission from the vehicles</li> <li>- Environmental clearance to be stringent</li> <li>- Use of eco friendly materials and electric cars</li> <li>- Capacity building of policy makers to develop knowledge on these matters</li> </ul>	Road Safety and Transport Authority, Ministry of Finance, NEC and financial institutions	

The following technologies are also identified during the study:

- Use of smart transport technologies such as real-time user information, smart power grids, early warning systems in case of natural disasters and better transport infrastructure
- Application of advanced and emerging technologies (computers, sensors, controls, communications and electronic devices) in transportation systems
- Advanced intelligent transport systems
- IoT-powered smart logistics solutions
- Adoption of electric scooters and light-electric vehicles
- Development of capabilities and skills for maintenance and repair of electric vehicles' components
- Technical assistance on understanding the value chain of electric vehicles and identifying components which can be developed and produced in Bhutan
- Charging stations for electric vehicles

### 5.2.7 Health

Traditional medicine is an area where Bhutan can develop a comparative advantage. The country has a significant potential to create a niche sector by developing and exporting products and investing in health tourism depending on traditional medicine. Introduced formally to the national health care system in 1967, it is implemented in the hospitals in the country in addition to the specialised National Traditional Medicine Hospital

(NTMH). The followings are identified as the needs of the sector based on the field and desk research:<sup>87</sup>

- Developing capacities and adoption of techniques for proper collection and sustainable harvesting to protect the medicinal plants
- Technical assistance and technology for the creation of a database of the Medicinal and Aromatic Plants and taking measures to protect the most vulnerable medicinal herbs found in fragile ecosystems of the Himalayas as well as those grow exclusively in Bhutan
- Developing infrastructure and capabilities for conducting R&D for new drugs using traditional medicine
- Documentation of scientific evidence of therapeutic claims including the properties of many formulations used in the system (there is a difficulty in defining quality and efficacy of traditional remedies due to their complex and multiingredient nature. This required research to improve scientific evidence.)
- Conducting, capacity building and support for patenting of traditional medicine knowledge
- Policy instruments to encourage R&D and innovation in traditional medicine
- Strengthening the research infrastructure and capacity of the National Institute of Traditional Medicine and the NTMH and adoption of scientific methods for systematic R&D
- Transfer of knowledge for the manufacturing and production of traditional medicines in accordance with the Good Manufacturing

Practices

- Capacity building in drug research and bio-assay for scientific validation
- Incentives to encourage farmers to produce herbs needed

Other areas where transfer of knowledge and technology is needed in the other domains of health sector are the following:

- Capacity development and technical assistance for the improvement of the quality of health data collected through electronic health records, the process of data collection,<sup>88</sup> and the analysis and use of data collected by the Ministry of Health
- Use of big data and artificial intelligence in healthcare
- Establishment of a Medical Fab Lab and building capabilities for development of medical oriented products, 3D print surgical guides, clinical aids and applications
- Use of Virtual Reality in medical students education as well as the training of surgeons, nurses and physicians

## 5.3 Technology Needs of Innovation Infrastructures

### 5.3.1 Bhutan Standards Bureau (BSB)

The BSB is financially supported by the government considering the importance of quality infrastructure, which encompasses standardisation, metrology and accreditation, for the health and safety of people and the conservation of the environment as well as the development of the economy. However, the resources for the enhancement of human resource and infrastructure are highly limited due to budgetary constraints.

- The needs are expressed for the BSB are the following:
- Constructing a special separate building for the National Metrology Laboratory (NML) to be able to obtain international accreditation

<sup>87</sup> Scope and Challenges of Bhutanese Traditional Medicine “Ancient Science of Healing for 21st Century Healthcare Needs” Ugyen Dendup & Kinga Jamphel, PRU, ITMS, DMS, MoH)

<sup>88</sup> “Concerns have been reported regarding the use of electronic health records (i) prolonging working hours because of the time spent on tasks such as data entry; and (ii) reducing professional satisfaction because of issues such as time directed away from patient interaction and the inflexibility of using templates for notes.” ([http://www.who-seajph.org/temp/WHOSouth-EastAsiaJPublicHealth8277-3965428\\_110054.pdf](http://www.who-seajph.org/temp/WHOSouth-EastAsiaJPublicHealth8277-3965428_110054.pdf))

(currently it is located on the first floor of the BSB office building and as the product testing laboratory, which is on the ground floor, produces vibration while the tests are being conducted it affects NML's operations.)

- Provision of special climatisation system for the NML to obtain reproducible and comparable test results
- Capacity building of the NML personnel on the topics both to perform calibration and product testing services more effectively and to obtain accreditation in more parameters and for product testing laboratory:
  - Provision of metrology services under mass, length, volume, pressure and temperatures
  - Legal metrology services
  - Provision of product testing services

includes the suite of machines, and materials and equipment found in a stationary lab:<sup>89</sup>

- 3 D printers
- Laser Cutters
- Filtration
- Shopbot
- MDX-20 Mini Mill
- Computers
- Software (Sketch Up, Rhino, Corel Draw)
- Large format printer
- Electronics Workbench
- Small tools/molding & casting
- Silk Screening materials
- Documentation (camera+ accessories)
- Power and Internet Cables
- Books
- Truck
- Trailer

The financial needs estimated are as follows:

Item	Estimated cost (Nu.)
Construction of laboratory building	15 million
Procurement and installation of vital Equipment	5 million
Construction of Product Testing Laboratory	15 million
Professional Capacity Development	5 million
<b>TOTAL</b>	<b>40 million</b>

The estimated cost of a Mobile Fab Lab is USD 298,000.

The process to build of a mobile lab takes around 6-18 months, depending on the project and the capacity of the network, and includes the following phases: Design, Procurement, Construction, and Preparation & Training.

In addition to the above needs regarding metrology, capacity building and training courses are needed to develop Bhutanese certified lead auditors for quality management systems.

### 5.3.2 Fab Lab Bhutan

Although the current Stationary Fab Lab has required infrastructure and there is a project to create a Super Fab Lab in Thimphu, the Mobile Fab Lab project had to be abandoned due to lack of resources.

The Mobile Fab Lab will extend the learning and capacities of the Stationary Fab Lab to remote areas as well as a larger audience of users in other cities. It has a standard platform which

## 5.4 Potential Technology Offers from Bhutan

In the TNA survey, the respondents were also asked to specify locally developed technologies that can be transferred from Bhutan to other countries. The answers provided include the following:

- Countries that do not have a citizen science-based online platform for documentation of biodiversity could transfer technology (Bhutan Biodiversity Portal) from Bhutan.
- Going organic
- Electric fencing using locally available materials;
- Automation of irrigation using scrap materials
- Lead farmer training
- Development of farmers knowledge

<sup>89</sup> <https://fabfoundation.org/getting-started/#mobile-fablab>



# Chapter 6

## Conclusions and Recommendations

## 6.1 Conclusions

As discussed in the previous sections, Bhutan is strongly committed to STI as a vital tool for achieving sustainable socio-economic developments and attaining SDGs. The country is in the process of developing its innovation system, and designing and implementing projects that will enable the transformation of its economy and facilitate sustainable graduation from LDC category. It has aspirations to become a knowledge based and self-reliant society, and aims to create a “Just, Harmonious and Sustainable Society through enhanced Decentralisation” by implementing its Twelfth Five Year plan until 2023. The efforts to overcome the challenges and vulnerabilities of the country are guided by the King who emphasises the importance of investment in STI through STEM, TVET and emerging technologies. The country’s renowned Gross National Happiness philosophy forms a strong foundation for the realisation of its aspirations.

There is also a range of initiatives funded by international organisations and donors to help Bhutan in the transformation process and tackle the challenges facing the country.

At this stage, it is indispensable for Bhutan to approach STI policy-making and implementation in a systematic way by putting in place all necessary elements so that it can bring lasting benefits to the country. The recommendations proposed to the government below in Section 6.2 seek to provide guidance in this process that presents an opportunity for leapfrogging in development.

With regards to the technology needs of the country, those needs that were identified through the field and desk research have been and listed in Section 6 are grouped and listed for the Technology Bank in Section 6.2.2 below.

## 6.2 Recommendations

### 6.2.1 Recommendations for the Government of Bhutan

#### A. STI policy making and governance

**a.** Establish the Bhutan National Research and Innovation Council (NRIC) as a high-level oversight body for the formulation and implementation of STI policies, establishment of

multi-stakeholder dialogue, design of a coherent STI policy mix, and integration of STI in other policy areas. Ensure that it is chaired by the Prime Minister and formed by the ministers and other high level representatives of the NIS in Bhutan. Consider assigning GNH Commission Secretariat as the Secretariat of the NRIC considering its role and capabilities.

**b.** Design a stand alone STI Policy for Bhutan, including goals and targets, priorities, as well as an ‘STI Policy Implementation Plan’, including the details such as the theory of change, major STI policy instruments, resource allocation, etc.

**c.** Ensure that internationally comparable STI statistics are collected regularly to set realistic targets for the STI Policy, monitor progress and benchmark performance. Collaborate with UNESCO Institute of Statistics for this purpose.

**d.** Include all NIS stakeholders (universities, companies, R&D centres, civil society, innovation infrastructures, etc.) actively in the policy-making and programme design process.

**e.** Create an autonomous agency for the design and implementation of STI policy instruments and to manage funds to be allocated for these instruments. Make sure to secure long-term and predictable funding for STI and allocate sufficient amount of finance every year to support STI projects of the main target groups (universities/ colleges and research centres, private sector, potential entrepreneurs and start-ups) under the policy instruments to be designed.

**f.** Establish and maintain a balanced policy mix, and evaluate and improve the existing STI instruments and STI infrastructures (R&D centres, TechPark, etc.) for greater and sustainable impact, and eliminate duplication and overlaps, if any.

**g.** Ensure that policy instruments are not confined to R&D performers or technology-based enterprises, but also target CSIs and grass-roots innovators.

**h.** Establish the National Academy of Sciences to advise the government on issues involving S&T and to promote S&T capacity and excellence in Bhutan.

**i.** Re-create the Research Council of the Ministry of Agriculture and Forests for effective coordination, monitoring and evaluation of R&D activities of its centres.

**j.** Separate the roles of the organisations to

avoid conflict of interest and create a well functioning NIS, e.g. RUB, as a research performer should not be responsible for the management of REF; regulatory bodies should not be engaged in certification activities, etc.

**k.** Diversify and increase the number of funding mechanisms to finance STI in different sectors. For this purpose (a) design and pilot crowdfunding and angel investment programmes to finance innovation-driven entrepreneurship also by attracting international community and investors; (b) partner with international organisations (such as the UNCDF) and funds (for example, innovation and seed funds in India) to invest in inclusive innovation in Bhutan.

**l.** Improve legislation and simplify administrative processes of public interventions for STI.

**m.** Facilitate the establishment of Research Ethics Boards in line with the international ethical standards.

**n.** Ensure that a monitoring and evaluation system for policies and policy measures becomes an integral part of the STI policy cycle following the international good practice (i.e. ex-ante, interim and ex-post evaluations to be conducted independently and regularly).

**o.** Introduce measures to create dynamic local and regional innovation ecosystems and integrate them with the national and global innovation systems by supporting partnerships, and collaborative and inter-disciplinary projects.

**p.** Establish a single window to make information and guidance available for research performers, entrepreneurs and the private sector about policies and support measures for STI.

**q.** Use public procurement to encourage R&D and innovation in the private sector and collaboration with the research performers to design and implement innovation-based solutions locally.

## B. STI policy instruments

**a.** Establish good practices in programme design for all policy instruments (i.e. develop problem tree, theory of change and indicators and SMART targets, monitoring and evaluation framework, process descriptions and rules and regulations, and put in place a complete set of programme documents).

**b.** Ensure that policy instruments put a clear and specific focus on social and inclusive innovation,

and define women and youth as the primary beneficiaries of the measures.

**c.** Create a policy instruments for cluster development in the integrated value chains of priority sectors and pilot it in agro-food, tourism and ICT sectors.

**d.** Introduce a brain gain programme by creating a diaspora network of Bhutanese researchers, entrepreneurs and other highly skilled human resources living and working in other countries. Encourage them to actively participate in the STI-driven transformation of Bhutan through different channels, such as direct investment, outsourcing, providing knowledge and mentoring, and offering finance by participating in angel network and crowdfunding, etc.

**e.** Design and implement awareness raising campaigns tailored to different target groups on STI related areas including but not limited to the importance of quality, standards and certification. Promote science journalism and cooperate with journalists, opinion leaders and influencers for better communication of STI. Identify and promote success stories of individuals with creativity, innovation and entrepreneurship mindset and achievements.

**f.** Introduce policy measures to encourage creative thinking, innovation and entrepreneurship culture in all regions and sectors, and among all target groups.

**g.** Develop and launch a linkage programme to ensure transfer of knowledge and technology from foreign investors and projects to local CSI, research centres and start-ups.

**h.** Introduce regular thematic idea generation challenges to develop innovative local solutions for major challenges.

**i.** Continuously invest in developing skills and capacities of project and programme management teams, and create a voluntary mentorship scheme for the transfer of knowledge and experience between researchers and businesses about project design, proposal writing and project implementation.

## C. STI infrastructure

**a.** Ensure that all public universities, education institutes, schools, research centres and innovation infrastructures become a part of the DrukREN and benefit from it free of charge.

**b.** Provide high-speed Internet throughout the

country at a low and affordable price. Take necessary measures to avoid cut outs and improve the reliability of Internet connection.

**c.** Improve roads and accessibility of the Thimphu TechPark by providing effective public transport alternatives, and take measures to turn it into a centre of attraction for ICT start-ups to achieve full occupancy.

**d.** Design and implement policy measures to create synergies and cooperation between the foreign and companies located in the TechPark and the incubator.

**e.** Consider establishing new ICT research centres, colleges, universities and TVET centres ICT nearby the TechPark and create strong linkages with it to be able to build a vibrant innovation ecosystem in the area that benefit from the spillover from the TechPark activities.

**f.** Improve the service portfolio of the TechPark by including value-added interventions such as building linkages and developing joint R&D projects between foreign and local enterprises as well as with the university researchers, and introducing mentorship schemes for incubatees.

**g.** Ensure that new technology and innovation infrastructures are established with close proximity to the universities, colleges and research centres to be able to develop local and regional innovation ecosystems.

**h.** Create a dynamic network and collaboration between all innovation infrastructures (Fab Labs, incubators, TechPark, R&D centres of universities/colleges and ministries, etc.) and encourage them to collaborate to learn from good practices and increase the impact of their activities.

**i.** Enhance the quality, metrology and standardisation infrastructure, and offer internationally recognised certification in all sectors.

**j.** Clearly define the mandates of universities and colleges as education, research and “third task”, i.e. knowledge transfer to society and commercialisation of research results for the economy.

**k.** Consolidate the research centres of the colleges working in the same and similar fields (such as different centres of RUB working on environment, energy and climate research) for effective use of limited resources, and strengthen the research infrastructure and human capital of the centres.

**l.** Create a national Technology Transfer Office

(TTO) to identify and commercialise research results from universities/colleges and research centres, transfer knowledge to the society and to initiate contract and joint R&D activities in the country.

**m.** Establish technology transfer units in the universities/colleges, and research centres, which employ sufficient number of qualified staff for acting as an interface between the researchers and the TTO, and coordinating the activities internally.

**n.** Ensure that the TTO creates a national inventory of STI capabilities and infrastructures (laboratories, equipment, devices, etc.) and make the information and access available to all NIS stakeholders.

**o.** Encourage the creation of non-governmental organisations to act as intermediary between the research community, private sector and the government, as well as service provider to the research performers and enterprises engaged in R&D and innovation activities.

#### D. Developing STI human capital

**a.** Review and revise the STEM curricula to develop high level of capabilities and skills among students. Ensure that mathematics is taught in a stimulating and engaging manner also using the possibilities offered by ICT. Develop innovative methods to help students in developing a growth mindset towards mathematics and other STEM subjects. Ensure that positive and encouraging messages are given through campaigns, and misperceptions are removed, such as ‘our children are not good at math’ and ‘there are no job opportunities in technology’.

**b. b)** Increase the attractiveness of teaching profession and encourage the most qualified candidates to take up careers as teachers at all levels of education.

**c. c)** Introduce special measures to attract girls to STEM subjects to increase the participation of women in research and STI-driven entrepreneurship. Encourage women to explore non-traditional career choices and increase women’s representation in decision-making positions as well as in leadership roles in business, politics, research and education.

**d.** Put in place an international graduate degree scholarship programme for STEM and Medicine to develop critical mass of MSc and PhD holders

to be employed in universities and research centres in Bhutan. At the same time, establish MSc and PhD programmes in STEM subjects and Medicine in cooperation with reputable international universities. Ensure that MSc and PhD degrees are seen as a prestige marker to attract more students to graduate education.

- e.** Implement awareness campaigns and policy measures to motivate students in all regions towards STEM careers from an early age. Engage students in meaningful real-life problem-solving situations through projects and programmes that promote creativity, innovation and entrepreneurship throughout the educational life-cycle.
- f.** Promote STI-based careers and employability. Introduce mobility initiatives to support placement of STEM teachers and university students in enterprises within the country and the region.
- g.** Create Innovation Hubs to link STEM education and TVET with businesses and civil society organisations at local and regional level.
- h.** Expand science education opportunities through science museums, centres, festivals and competitions for the citizens of all ages and in all regions.
- i.** Launch TVET programmes to raise sufficient number of intermediate-level employees (laboratory technicians, radiographers, renewable energy and energy efficiency experts, etc.) to be engaged in STI in the priority sectors.
- j.** Ensure that the promotion/performance regulations for researchers put less emphasis on publications, and promote patenting, result-oriented research and research commercialisation.
- k.** Improve employee benefits of researchers including salary levels, and take measures to make research careers attractive for young people.
- l.** Increase awareness on IPR protection, and design and implement measures to encourage patenting among firms and R&D centres and universities; develop capabilities of patent attorneys.
- m.** Introduce R&D staff mobility and exchange programmes at national, regional and international levels.

### 6.2.2 Recommendations for the UN Technology Bank for LDCs

- a.** Give priority to meeting technology needs

expressed for the agro-food, health conservation and environment, and education sectors taking into account the challenges and opportunities for accelerating inclusive sustainable development of Bhutan.

- b.** Consider addressing technology needs in other sectors when there are funding and/or technology supply opportunities for a specific sector.
- c.** Raise donor funding for the establishment of the National Metrology Laboratory for the BSB as well as a Mobile Fab Lab.
- d.** Assist policy-makers and public authorities in identifying and adopting the most suitable, sustainable and proven technologies.
- e.** Help Bhutan to develop technology development capabilities as well as technology transfer skills.
- f.** Continue supporting Bhutan after the graduation from LDC category to further strengthen the capacities and technology infrastructure of the country.

The regrouped lists of technology needs for Bhutan are given below:

#### 1. Technology needs for agriculture and food sector:

1. Technologies and capacity building for safety and quality in agriculture and food (food hygiene and safety, animal bio-safety and plant bio-safety)
2. Technologies for collecting and using marketing information, online market accessibility for farmers, capacity building on marketing, technologies for packaging
3. Smart irrigation technologies and design, rain water harvesting technologies
4. Modern farming techniques to increase productivity and mechanisation
5. Use of emerging technologies in agriculture and farming
6. Skills, materials and technologies for organic farming
7. Farm equipment that can be used on sloping land
8. Technologies for the analysis of hormones and pesticides
9. Technologies that replace the processed agro-products imported
10. Technologies and know-how to increase

productivity in livestock

11. Technologies and technical assistance on post harvest
12. Development of R&D capabilities and infrastructure to improve seed quality, develop drought tolerant crops and insect-resistant crop varieties
13. Technologies for value-added agriculture and processing
14. Technical assistance for adopting innovative methods and technologies (such as AI) to make available affordable crop and livestock insurance for farmers
15. Establishment of biotech and food technology laboratories in the Start-up Centre
16. Creating of an incubator for the agro-food sector
17. Laboratory facilities for GMO quantification
18. Technologies and technical assistance for the development of RNR enterprises
19. ICT infrastructure and databases for the BAFRA
20. Technologies for e-traceability of product certification

## **II. Technology needs for conservation and environment:**

1. Capacity building and awareness raising in the field of conservation to be able to implement the conservation plan
2. Setting up a simple PCR extraction and DNA sequences lab, and training experts on DNA based identification for mushroom specimens of Bhutan that are of unique value
3. Advance mushroom cultivation technology: mushroom cultivation in saw dust, instead of billets; optimum use of raw materials
4. Furnished mushroom shed, such as those in Japan with control environment in the shed.
5. Efficient computers, server and a power stabiliser for the National Biodiversity Centre and its laboratories
6. Development of IT developers and map developers for the Bhutan Biodiversity Portal
7. DNA barcoding and sequencing facilities
8. Specimen digitisation equipment such as different cameras for different biodiversity groups
9. Technologies to improve water quality in and around the urban areas
10. Technologies to improve water and air

quality in urban centres, industrial areas and along the southern border of the country

11. Circular economy technologies and waste management systems such as Clean Development Mechanism for Municipal Solid Waste, source reduction, etc.
12. Adoption of new technologies for flood forecasting, monitoring, and early warning for landslides
13. Capacity development and infrastructure to generate and use climate information to cope with the threat of hydro-meteorological and geological disasters
14. Laboratory and treatment plants for water quality analysis, monitoring and improvement

## **III. Technology needs for construction sector:**

1. Specialised knowledge and skills to build the highly energy efficient green buildings
2. Centralised database for the keeping and analysing data on buildings including those related to material, waste, water and energy, and climate
3. Transfer of knowledge (including material and methodology) on construction and maintenance of energy efficient green buildings and its components; piloting to validate and test applicability to Bhutan and its environment
4. Design, construction and management of sustainable infrastructures
5. Capacity development for professionals involved in the use and management of the technologies for sustainable infrastructures
6. Capacity building on integrated and sustainable urban planning
7. Advanced technologies for delivering reliable wastewater treatment, water supply, geographic information systems, and hydraulic modelling
8. Building Information Modelling, on-site energy production and smart building technologies and new building materials
9. New construction technologies such as specialised drones for survey work to improve productivity and higher measurement precision
10. Space technology for early warnings about natural disasters
11. Water efficient technologies in construction

#### IV. Technology needs for education sector:

1. Integration of emerging technologies (AI, IoT, VR, AR, etc.) in STEM subjects and knowledge transfer on emerging trends in technology
2. Supply of technologies such as computers
3. Integration of ICT in TVET and building capacities for the development of innovative models of work-based learning
4. Adoption of digital and interactive learning and teaching methods
5. Capacity building and access to technologies for the digitalisation of textbooks
6. Technical assistance and training programmes, and hardware and software for development of creative industries, including animation, graphic design, application and game development
7. Development of education programmes and infrastructure for space technologies
8. Capacity building for the enhancement of the quality of teachers
9. Education technologies and innovative learning methods to encourage youth to advance in mathematics
10. Establishment of interactive science centres, museums, and other forms of public science outreach for general public and students
11. Establishment of TVET Resource Centres with required infrastructure and training of staff for operating these centres
12. Capacity building and technical assistance on the design and management of incubators to revamp the business incubation units established in Technical Training Institutes and Institutes of Zorig Chusum.

#### V. Technology needs for energy sector:

1. Capacity building and technologies for implementing projects on low cost localised production of alternative sources of energy such as solar, wind and biogas
2. Efficient technologies for hydropower generation
3. Knowledge transfer and capacity building to ensure that experience gained from the hydropower projects are retained in the country
4. Capacity building for the development of renewable energy sector

5. Adoption of energy efficiency technologies
6. Developing energy auditors to inspect and improve the energy efficiency of both residential and commercial buildings

#### VI. Technology needs for transportation sector:

1. New technologies and eco-friendly materials on road construction
2. Measures for strict check of emission from the vehicles
3. Capacity building of policy makers on the sector
4. Use of smart transport technologies such as real-time user information, smart power grids, early warning systems in case of natural disasters and better transport infrastructure
5. Application of advanced and emerging technologies (computers, sensors, controls, communications and electronic devices) in transportation systems
6. Intelligent transport systems; advanced navigation and monitoring systems
7. IoT-powered smart logistics solutions
8. Adoption of electric scooters and light-electric vehicles
9. Development of capabilities and skills for maintenance and repair of electric vehicles' components
10. Technical assistance on understanding the value chain of electric vehicles and identifying components which can be developed and produced in Bhutan
11. Charging stations for electric vehicles

#### VII. Technology needs for health sector:

1. Developing capacities and adoption of techniques for proper collection and sustainable harvesting of medicinal plants
2. Technical assistance and technologies for creation of a database of Medicinal and Aromatic Plants and taking measures to protect the most vulnerable medicinal herbs found in fragile ecosystems of the Himalayas as well as those grow exclusively in Bhutan
3. Developing infrastructure and capabilities for conducting R&D for new drugs using traditional medicines
4. Documentation of scientific evidence of therapeutic claims including the properties of formulations used in the system
5. Capacity building and support for patenting

- of traditional medicine knowledge
6. Technical assistance in designing policy instruments to encourage R&D and innovation in traditional medicine
7. Strengthening the research infrastructure and capacity of the National Institute of Traditional Medicine and the NTMH and adoption of scientific methods for systematic R&D
8. Transfer of knowledge for the manufacturing and production of traditional medicines in accordance with the Good Manufacturing Practices
9. Capacity building in drug research and bio-assay for scientific validation
10. Incentives to encourage farmers to produce herbs needed
11. Capacity development and technical assistance for the improvement of the quality of health data collected through electronic health records, the process of data collection, and the analysis and use of data collected by the Ministry of Health
12. Use of big data and artificial intelligence in healthcare
13. Establishment of a Medical Fab Lab and building capabilities for development of medical oriented products, 3D print surgical guides, clinical aids and applications
14. Use of Virtual Reality in medical students education as well as the training of surgeons, nurses and physicians

## Glossary

### Evaluation

The systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipients and donors. Evaluation also refers to the process of determining the worth or significance of an activity, policy or program. (OECD definition)

### Ex-ante evaluation

An evaluation that is performed before implementation of a development intervention (OECD definition)

### Ex-post evaluation

Evaluation of a development intervention after it has been completed.

It may be undertaken directly after or long after completion. The intention is to identify the factors of success or failure, to assess the sustainability of results and impacts, and to draw conclusions that may inform other interventions. (OECD definition)

### External evaluation

The evaluation of a development intervention conducted by entities and/or individuals outside the donor and implementing organizations (OECD definition)

### Gender parity

Purely a numerical concept; for R&D statistics, gender parity is reached when women represent between 45% and 55% of the total number of researchers

Reaching gender parity in education implies that the same proportion of boys and girls – relative to their respective age groups – would enter the education system and participate in its different cycles

### Gross domestic product

The sum of gross value added by all resident producers in the economy, including distributive trades and transport, plus any product taxes and minus any subsidies not included in the value of the products

### Inclusive innovation

Any innovation that helps expand affordable access to quality products and services that create and increase livelihood opportunities for excluded populations (World Bank definition)

### Innovation

Deriving the benefits from a new or significantly improved product (good or service), or process (such as a new marketing method) or a new organizational method (such as in business practices, workplace organization or external relations).

A key point to differentiate innovation from improvement is that innovation derives significantly (as opposed to incrementally) more impact (economic, social and environmental) from existing products, processes and services or from a combination of proven and new science and technology to develop new products, processes or services. Innovation should be understood as something new to a local context. It may also include adapting imported technologies to local conditions.

*Social innovation* can similarly be defined with the addition that it simultaneously meets social needs while creating new social relationships or collaborations. In other words, they are innovations that change society and enhance its capacity to act.

An important type of innovation that predominantly concerns the least developed and STI lagging countries is inclusive innovation. It refers to any innovation that helps expand affordable access to quality products and services that create and increase livelihood opportunities for excluded populations – on a sustainable basis and with significant outreach. This type of innovation seeks to expand access to essential goods and services, thereby improving quality of life, and enhancing economic empowerment through knowledge creation, acquisition, adaption, absorption, and deployment efforts targeted directly at the needs of excluded populations, primarily at the ‘Base of the Pyramid’ - those earning less than two dollars a day.

#### Innovation policy

A set of policy instruments and appropriate institutions that assist in the local adoption of technologies and the introduction new products and services to the market

This may include adapting imported technologies to local conditions.

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.

#### 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.

#### Mid-term evaluation

Evaluation performed towards the middle of the period of implementation of the intervention (OECD definition)

#### Monitoring

A continuing function that uses systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds (OECD definition)

#### National Innovation Systems

Refers to the complex and interactive web of knowledge flows and relationships between industry, government and academia and making them work systematically to sustain innovation and science and technology development efforts. The innovative performance of a country depends to a large extent on how these NIS actors relate to each other as elements of collective system of knowledge creation and use, as well as the technologies they use. (OECD definition)

#### Patent

A set of exclusive rights granted by law to applicants for inventions that are new, non-obvious 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.

#### Policy mix

Refers to the combination of direct and indirect programmes through which financial and non-financial support is provided to target groups.

#### Programme, policy instrument and policy measure

The terms used interchangeably to describe an intervention, which is multi-annual and has a pre-defined budget, specific target group and objectives, implementation rules and regulations, as well as a monitoring and evaluation framework.

#### Research and experimental development (R&D)

Covers basic research, applied research and experimental development, both formal R&D in R&D units and informal or occasional R&D

#### Researchers

Professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of the projects concerned

#### Science

The systematic study of the physical or material world (natural science) and of society (social science) that generates, or creates, knowledge from which data and information is drawn

#### 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.

#### STI

An integrated life cycle where science leads to new technologies from which innovations develop. Innovative ways of doing things can change and influence the development of science and how and what technologies are brought forth which, in turn, also influence the innovation process.

#### Technology

The application of scientific knowledge to develop techniques to produce a product and/or deliver a service or as the application of scientific knowledge for practical ends

#### 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.

## Annex 1: List of Interviewees

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