Science, Technology and Innovation (STI) Gap Assessment of the SPECA Countries[1]

[1] Analytical study prepared by Rumen Dobrinsky, European Allaince for Innovation, in the context of the project "Strengthening innovation policies for SPECA countries in support of the 2030 Agenda for Sustainable Development" conducted by UNECE in partnership with ESCAP under the 12th tranche of the UN Development Account.

List of Acronyms

AFN	Afghan Afghani (currency)
AZN	Azerbaijani Manat (currency)
BOPIS	Buy Online, Pickup in Store
COVID-19	Coronavirus Disease of 2019
EBRD	European Bank for Reconstruction and Development
ESCAP	UN Economic and Social Commission for Asia and the Pacific
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GII	Global Innovation Index
ICT	Information and Communications Technology
IMF	International Monetary Fund
KZT	Kazakhstani Tenge (currency)
R&D	Research and Development
SD	Sustainable Development
SDG	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
SPECA	UN Special Programme for the Economies of Central Asia
STI	Science, Technology and Innovation
UN	United Nations
UNECE	United Nations Economic Commission for Europe
VAT	Value Added Tax
WIPO	World Intellectual Property Organization

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Introduction: objectives and scope of the study

The UN 2030 Agenda for Sustainable Development emphasized the role of science, technology and innovation (STI) as an important vehicle for pursuing the Sustainable Development Goals (SDGs). STI can be a powerful engine for economic development in general and can serve as a driver for structural transformation and economic diversification and hence for overall sustainable development (SD).

The capacity of countries to innovate and harness innovation to address existing challenges is thus a key ingredient in their future development. For less advanced economies, innovation is largely associated with their capability to adopt, absorb and adapt existing knowledge and technologies into their existing socio-economic structures and processes. For such countries, the opening up of their economies and embrace of international cooperation (both regional and global) becomes increasingly important with regard to development based on STI advances.

The countries in the UN Special Programme for the Economies of Central Asia (SPECA) sub-region have repeatedly reiterated their resolve to attain the goals and targets of the 2030 Agenda for Sustainable Development and assign high policy priority to employ STI in these efforts. These topicshave featured prominently at several high-level expert meetings (such as the SPECA Economic Forums in 2017 and 2019) and are reflected in the decisions of high-level intergovernmental meetings (such as the SPECA Governing Council in 2017, 2018 and 2019) as well as in a series of sessions of the SPECA Working Group on Innovation and Technology for Sustainable Development. As a result of these discussions, at the 14th session of the SPECA Government Council held in Ashgabat in November 2019, the council approved the SPECA Innovation Strategy for Sustainable Development and encouraged the SPECA countries, donors and partner organizations to support its implementation.

As reflected in this strategy, the ambition of the SPECA countries is to develop and consolidate their national capacities and capabilities to design and implement innovation policies for sustainable development taking into account not only their national contexts and existing constraints but also recognizing any possible transboundary effects created. In accordance with the SPECA Innovation Strategy for Sustainable Development, the SPECA countries aim to work together to strengthen their institutional frameworks for regional cooperation regarding the implementation of innovation policies for sustainable development with possible cross-border effects to achieve beneficial regional synergies.

The goals outlined in this strategy are ambitious but challenging. This is because it is widely acknowledged that the national innovation systems of the SPECA countries are still underdeveloped and their STI capabilities are limited in terms of the scientific capacities, the general level of technological development and ability to absorb STI products. Despite the declared ambitions of the SPECA countries, many of the policies, instruments, institutions, and processes that have been put in place to facilitate innovation are often ineffective and do not

always bring about the expected results. Therefore, these countries still face momentous challenges in matching outcomes with ambitions when it comes to STI goals.

The main purpose of this study is to reveal and analyse some of the main existing problems in the current state of STI development in the SPECA region and identify key gaps hindering the advancement of STI in these countries. Such an analysis will help to reveal some common STI development needs of the SPECA countries and this, in turn, can serve as a basis to formulate recommendations about possible long- and short-term solutions and policy measures to close or reduce existing STI gaps. Furthermore, such an analysis will highlight the existing opportunities provided by those economic sectors in each country with high potential for innovation and the ability to adopt good practices from around the region and the world.

This paper is the result of large-scale collaborative efforts undertaken in the context of the project "Strengthening innovation policies for SPECA countries in support of the 2030 Agenda for Sustainable Development" conducted by UNECE in partnership with ESCAP under the 12th tranche of the UN Development Account. In particular, section 3 of the paper "STI governance and policymaking in the SPECA countries" draws on the outcomes of country studies for the SPECA countries undertaken by local experts in each of these countries based on a uniform methodology.

Comparative assessment of SPECA countries' STI performance from an international perspective

International benchmarking is a widely practised method for assessing the relative standings of different countries in various aspects of socio-economic development. While benchmarking exercises produce limited useful information to directly support government decision making, such comparisons do provide a useful, albeit approximate, picture of the relative achievements, gaps, lags and problems of a country.

Benchmarking employs various indicators to compare the performance of a country with other countries that are connected in some way, such as by geography or developmental level, or those considered as world leaders in certain socio-economic areas. The point of such benchmarking is, on the one hand, to reveal existing gaps and, on the other hand, to identify internal opportunities for improvement. Such results can then be used to develop targeted policies, measures and actions on how to make improvements or adapt specific best policy practices to improve some aspect of performance.

A number of international organizations and institutions (both governmental and non-governmental) are active in benchmarking in areas covered by their mandates. For this study, a range of available assessments in areas relevant for STI development was selected with the rationale of such an empirical assessment being to get a better international perspective and

understanding of both the achievements and the existing problems of STI development in the SPECA countries. In this regard, three different perspectives were considered as follows:

- Comparing the SPECA countries with the best-performing countries in the world.
- Measuring the SPECA countries' performance vis-à-vis selected comparator countries.
- Comparing the SPECA countries' performance with each other.

One of the problems in international benchmarking is the quality and reliability of the data used and hence the validity of the results. Usually, the most reliable benchmarking exercises are those performed by official international organizations and institutions relying on official national statistics provided by the countries. However, even in such cases international organizations often face challenges as some countries (especially low-income countries) simply to not produce official statistics for the indicators needed for international benchmarking. As regards international benchmarking undertaken by some non-governmental organizations, these often rely on the goodwill of countries to provide the necessary date or on the efforts of independent experts to produce such data. In all these scenarios, one needs to exercise caution in interpreting the results of benchmarking, especially given that such exercises may contain informational voids because efforts to obtain the needed data have proven futile. Regrettably, the comparisons compiled in this section do contain such voids for some of the SPECA countries.

This study has thoroughly and comprehensively researched the publicly available benchmarking assessments relevant to STI performance that has been produced by different international organizations and institutions operating within the assessed countries. The study somewhat broadens the coverage of the comparative picture to include some features that are of a more general nature, such as economic growth, foreign direct investment (FDI) inflows and SDG achievement, however, these are required to produce a better understanding of the underlying factors impacting STI.

To the extent possible given the data availability limitations, the empirical results presented in this section cover all the SPECA countries but in some cases, the tables include only those countries for which data was available. To measure the SPECA countries' performance in an international context, China, the Republic of Korea and the Russian Federation were selected as comparator countries.

While the SPECA countries share several common characteristics, the region is quite heterogeneous in terms of per capita incomes. The main factor driving this heterogeneity is the availability of natural resources as the region comprises countries with different levels of such wealth and development. Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan are among the region's resource-rich countries given their reserves of hydrocarbon fossil fuels, this is not the case for the rest of the SPECA countries except for Kyrgyzstan which has significant gold reserves. According to the World Bank's classification of countries by their gross domestic product (GDP) per capita, Afghanistan and Tajikistan fall into the low-income group of economies, Kyrgyzstan and Uzbekistan are ranked among the lower-middle-income economies

while Azerbaijan, Kazakhstan and Turkmenistan are classified as upper-middle-income economies.[2]

The above disparity notwithstanding, their geographic proximity, similarities in cultural and historic traditions, as well as the existence of common economic and environmental problems, suggests that there are many collective policy challenges that all the SPECA countries face. Examples of this can be seen in the fact that they are all land-locked economies, dependent on each other for trade and transport, each has similar climatic conditions and territories affected by desertification. Additionally, despite their divergence in per capita incomes, all the SPECA countries are still mid-process in their efforts to develop mature economies and face some common development challenges in this regard, in particular, the need to diversify their economies.

STI development and economic growth are intrinsically linked together as, on the one hand, STI is a key driver of growth and prosperity in the contemporary world, while on the other hand, growth and prosperity allow countries to allocate more resources for STI development. To achieve robust and sustained economic growth, an economy needs to be broad-based and export-oriented which can only be achieved today based on a diversified, technology-driven economy. Dependence on the mining and export of primary resources produces a vulnerability to external shocks and boom-and-bust economic cycles, as has already been the experience of the SPECA countries.

In the first half of the decade of the 2000s, the resource-rich countries in the subregion benefitted from favourable world market prices for energy resources and recorded high rates of growth. However, this pattern of growth was not sustainable as it relied almost entirely on raw resource exports into booming markets. This period is now over and in more recent years one can observe the negative consequences of the excessive dependence on hydrocarbon exports. Moreover, the windfall profits collected by the resource-rich economies in the boom period translated into something similar to rent addiction which triggered excessive public spending and has now, with the passing of the hydrocarbon boom, resulted in painful reductions in public spending and real personal incomes. Nevertheless, even with these above-mentioned issues, the economic growth of SPECA countries during the decade of the 2010s was respectable, even when compared to more developed countries such as the Republic of Korea and the Russian Federation (see Table 1). This though does not diminish the need for both the resource-rich nations in the SPECA region and those that are not so well-positioned to establish multiple sources of economic growth by pursuing appropriate diversification strategies tailored to their local context.

Economic growth in all SPECA countries, however, suffered a major setback in 2020 due to the global economic shock caused by the novel Coronavirus (COVID-19) pandemic. No precise forecasts were available at the time of writing this paper, however, preliminary estimates were for a 5% to 10% drop in GDP for each of the SPECA countries in 2020.

[2] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

As already noted, the capacity of less advanced economies to innovate is critically dependent on their capability to adopt, absorb and adapt existing knowledge and technologies. Foreign direct investment to lower-income countries is one practice that typically embodies a process of technology transfer from more advanced economies. Therefore, the level and dynamics of FDI flows is often considered as one of the key indicators that characterize both the capacity of recipient countries to absorb new technologies and their attractiveness as destinations of such investments and for this reason Table 2 presents the annual FDI flows to the SPECA countries in the period 2010-2019 relative to their GDPs.

As can be seen, during the past decade many SPECA countries attracted relatively large amounts of FDI, even when taking into account the broader international perspective. However, a closer look at the data reveals that the main recipients of FDI in the region were the resource-rich countries of Azerbaijan, Kazakhstan and Turkmenistan (hydrocarbons) and Kyrgyzstan (gold). While these investments, primarily channelled into the energy sector, did provide a boost to economic growth, they had little transformative impact in terms of knowledge transfer and economic diversification.

Table 1. Annual GDP growth rates of the SPECA countries, %, 2011-2019

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2011-19 average
Afghanistan	0.4	12.8	5.6	2.7	1.5	2.3	2.7	2.9	3.0	3.7
Azerbaijan	-1.6	2.2	5.8	2.8	1.1	-3.1	-0.3	1.5	2.3	1.2
Kazakhstan	7.4	4.8	6.0	4.2	1.2	1.1	4.1	4.1	4.5	4.1
Kyrgyzstan	6.0	-0.2	10.9	4.0	3.9	4.3	4.7	3.5	4.3	4.6
Tajikistan	7.4	7.5	7.4	6.7	6.0	6.9	7.6	7.3	7.5	7.1
Turkmenistan	14.7	11.1	10.2	10.3	6.5	6.2	6.5	6.2	6.3	8.6
Uzbekistan	7.8	7.4	7.6	7.2	7.4	6.1	4.5	5.4	5.6	6.5
China	9.6	7.9	7.8	7.3	6.9	6.7	6.8	6.6	6.1	7.3
Republic of Korea	3.7	2.3	2.9	3.3	2.8	2.9	3.1	2.7	2.0	2.9
Russian Federation	4.3	3.7	1.8	0.7	-2.3	0.3	1.6	2.3	1.3	1.5

Source: The World Bank, World Development Indicators - World Bank Open Data.

Table 2. Annual FDI flows to the SPECA countries, as a % of GDP, 2010-2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2010-19 average
Afghanistan	1.3	0.5	0.5	0.2	0.2	0.8	0.5	0.3	0.7	0.2	0.5
Azerbaijan	1.1	2.2	2.9	3.5	5.9	7.6	11.9	7.0	3.0	3.2	4.8
Kazakhstan	7.8	7.3	6.4	4.4	3.8	2.2	6.2	2.8	2.1	1.7	4.5
Kyrgyzstan	9.1	11.2	4.4	8.5	3.3	17.1	9.0	-1.4	0.6	2.5	6.4
Tajikistan	0.3	1.1	3.1	2.5	4.7	7.1	4.9	3.8	4.2	2.7	3.4
Turkmenistan	16.1	11.6	8.9	7.3	8.8	8.5	6.2	5.5	4.9	5.2	8.3
Uzbekistan	3.5	2.9	0.9	0.9	1.0	0.1	0.2	0.2	0.8	4.2	1.5
China	1.9	1.6	1.4	1.3	1.2	1.2	1.2	1.1	1.0	1.0	1.3
Korea, Republic of	0.9	0.8	0.8	1.0	0.7	0.3	0.9	1.2	0.9	0.6	0.8
Russian Federation	2.8	2.7	2.3	2.3	1.4	0.9	2.9	1.6	0.8	1.9	2.0

Source: UNCTAD, *World Investment Report*, issues of different years; The World Bank, World Development Indicators – World Bank Open Data; author's calculations.

In summary, all the SPECA countries still need to put in place policies aimed at attracting FDI into a broader range of economic sectors to contribute to accelerated STI development in a more diversified economy. The business and investment climate in each country is the factor that most predominantly determines the willingness of investors, both domestic and foreign, to invest their local economies. Table 3 displays the countries' performances using so-called "Ease of doing business" scores as compiled by the World Bank. The table illustrates both the dynamics of global "Ease of doing business" scores in the period 2015-2020 and the global ranks of individual countries in the year 2020 (for those countries that participated in and contributed to the compilation of these indexes).

Table 3. Ease of doing business in the SPECA countries, global scores[1)] and rank, 2015-2020

	2015	2016	2017	2018	2019	2020	2015-20 average	Rank in 2020[2)]
Afghanistan	41.2	40.6	38.1	36.2	47.8	44.1	41.3	173
Azerbaijan	64.1	67.8	67.8	70.9	78.6	76.7	71.0	31
Kazakhstan	64.6	72.7	75.1	75.4	77.9	79.6	74.2	25
Kyrgyzstan	60.7	66.0	65.2	65.7	68.3	67.8	65.6	80
Tajikistan	48.6	54.2	55.3	56.9	57.1	61.3	55.6	106
Turkmenistan	..	..	..	..	..	..	..	
Uzbekistan	54.3	62.6	63.0	66.3	67.4	69.9	63.9	69
China	62.6	62.9	64.3	65.3	73.6	77.9	67.8	31
Republic of Korea	83.4	83.9	84.1	83.9	84.1	84.0	83.9	5
Russian Federation	66.7	71.0	73.2	75.5	77.4	78.2	73.7	28

[1)] An economy's ease of doing business score is reflected on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance.
[2)] Out of 190 countries.
Source: The World Bank, *Doing Business*, issues of different years.

The SPECA countries performance in terms of "Ease of doing business" is mixed. Countries such as Azerbaijan and Kazakhstan perform quite well from an international perspective and were assessed by the World Bank as among the better performing economies, comparable to China and the Russian Federation. Kyrgyzstan, Uzbekistan and Tajikistan are ranked among the average performers while Afghanistan is lagging considerably behind. Undoubtedly, their consistently high "Ease of doing business" score is another factor that contributed to the success of both Azerbaijan and Kazakhstan in attracting FDI.

Turning to the SPECA countries STI performance proper, Table 4 presents the so-called "Global innovation index" (GII) as computed under the methodological guidance of the World Intellectual Property Organization (WIPO) for the period 2011-2019. The GII is a complex indicator computed as an average score using two sub-indices, the Innovation Input Index and Innovation Output Index. In turn, each of these sub-indices is divided into subpillars and each

subpillar is composed of individual indicators (80 indicators in total were used in 2019). The table below reflects the results for those countries that participated in and contributed to the compilation of this index.

Table 4. Global innovation index (GII)[1)] in the SPECA countries, global index and rank, 2011-2019

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2011-20 average	Rank in 2020[2)]
Afghanistan	..	..	..	..	..	..	..	..	..	..	..	..
Azerbaijan	29.2	30.4	29.0	29.6	30.1	29.6	30.6	30.2	30.2	27.2	29.6	82
Kazakhstan	30.3	31.9	32.7	32.8	31.3	31.5	31.5	31.4	31.0	28.6	31.3	77
Kyrgyzstan	29.8	26.4	27.0	27.8	28.0	26.6	28.0	27.6	28.4	24.5	27.4	94
Tajikistan	24.5	26.4	30.0	23.7	27.5	29.6	28.2	26.5	26.4	22.2	26.5	109
Turkmenistan	..	..	..	..	..	..	..	..	..	..	..	..
Uzbekistan	..	23.9	23.9	25.2	..	..	..	..	..	24.5	24.4	93
China	46.4	45.4	44.7	46.6	47.5	50.6	52.5	53.1	54.8	53.3	49.5	14
Republic of Korea	53.7	53.9	53.3	55.3	56.3	57.2	57.7	56.6	56.6	56.1	55.7	10
Russian Federation	35.9	37.9	37.2	39.1	39.3	38.5	38.8	37.9	37.6	35.6	37.8	47

[1)] The Global Innovation Index (GII) is computed by taking as the average score in two sub-indices, the Innovation Input Index and Innovation Output Index.
[2)] Out of 129 countries.
Source: *The Global Innovation Index*, issues of different years.

What is of concern with regard to the GII assessment of the innovation performance of the SPECA countries for which such data is available is that they all managed only an average to mediocre performance. One can see that they are all in the bottom third of the countries participating in the index (129 countries in total in 2019), with Azerbaijan and Kazakhstan being the best performers in the SPECA region.

The next few tables (from Table 5 to Table 9) illustrate the relative standing of the SPECA countries, from an internationally comparative perspective, employing some widely used basic indicators of STI performance. The majority of these indicators are used as input data in the compilation of more composite indices such as GII, however, each also has relevance for STI development when viewed in isolation.

Table 5 presents the total research and development (R&D) expenditure in the SPECA countries in proportion to GDP in the period 2010-2018.

Table 5. Research and development expenditure in the SPECA countries, % of GDP, 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18 average
Afghanistan	..	..	..	..	..	..	..	..	..	..
Azerbaijan	0.22	0.21	0.21	0.21	0.21	0.22	0.21	0.18	0.18	0.21
Kazakhstan	0.15	0.15	0.17	0.17	0.17	0.17	0.14	0.13	0.12	0.15
Kyrgyzstan	0.16	0.16	0.17	0.15	0.13	0.12	0.11	0.11	..	0.14
Tajikistan	0.09	0.12	0.11	0.12	0.12	0.11	0.11	0.12	0.10	0.11
Turkmenistan	..	..	..	..	..	..	..	..	..	..
Uzbekistan	0.20	0.19	0.20	0.20	0.16	0.17	0.18	0.16	0.13	0.18
China	1.71	1.78	1.91	2.00	2.03	2.07	2.12	2.15	..	1.97
Republic of Korea	3.47	3.74	4.03	4.15	4.29	4.22	4.23	4.55	..	4.08
Russian Federation	1.13	1.01	1.03	1.03	1.07	1.10	1.10	1.11	..	1.07

Source: The World Bank, World Development Indicators - World Bank Open Data.

Two main conclusions can be drawn from this data. First, the average level of R&D expenditures in the SPECA countries is very low by any standards and considerably lags behind the comparator countries, furthermore, it is far below the levels that would be needed to support robust STI development. The second conclusion that can be drawn is that the general trend observable in most SPECA countries during the past decade is that of a further relative decline in R&D expenditures. Thus, contrary to stated policy objectives – which usually claim that STI is a policy priority in these countries – the hard data tend to suggest the opposite is true.

The available data on the number of researchers involved in R&D in the SPECA countries, as shown in Table 6, is rather patchy with such data only available for two countries, namely Kazakhstan and Uzbekistan. The one observation that can be made from this data is that, from an internationally comparative perspective, the number of active R&D researchers in the SPECA countries is very low, which is not surprising given the low levels of R&D expenditures. The numbers also serve to reinforce the argument that the limited capacity of the SPECA countries to implement and support an STI-driven type of diversified economy is likely unattainable in the near future.

Table 6. Researchers in R&D in the SPECA countries, per million people, 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18 average
Afghanistan	..	..	..	..	..	..	..	..	..	..
Azerbaijan	..	..	..	..	..	..	..	..	..	..
Kazakhstan	371	386	612	737	799	777	694	666	667	634
Kyrgyzstan	..	..	..	..	..	..	..	..	..	..
Tajikistan	..	..	..	..	..	..	..	..	..	..
Turkmenistan	..	..	..	..	..	..	..	..	..	..
Uzbekistan	545	575	513	507	501	497	506	496	476	513
China	885	958	1014	1066	1089	1151	1197	1225	..	1073
Republic of Korea	5331	5803	6304	6393	6826	7013	7086	7498	..	6532
Russian Federation	3081	3115	3078	3053	3075	3098	2952	2822	..	3034

Source: The World Bank, World Development Indicators - World Bank Open Data.

The data on patent applications displayed in table Table 7 below reveals a similar picture to that seen with the number of R&D researchers. The number of patent applications per million residents in the SPECA countries is by orders of magnitude lower than that in some of the world's leading economies such as China and the Republic of Korea. Adding to this issue, a second adverse aspect that can be observed in Table 7 is the negative dynamic of the number of patent applications ranging from stagnating in some SPECA countries to halving in others. By way of contrast, over the same period of 2010-2018, the number of patent applications per million residents in China increased fivefold and in the Republic of Korea they increased by 50%.

Table 7. Patent applications in the SPECA countries, per million residents, 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18 average
Afghanistan	..	..	..	..	..	..	..	..	..	..
Azerbaijan	28	21	15	17	18	19	15	21	16	19
Kazakhstan	104	85	101	107	101	72	56	58	43	81
Kyrgyzstan	25	22	20	19	23	20	14	22	..	21
Tajikistan	1	1	0	0	..	..	..	..	..	
Turkmenistan	..	..	..	..	..	..	..	..	..	..
Uzbekistan	13	10	9	10	11	9	11	11	14	11
China	219	309	396	519	587	706	874	899	1001	612
Republic of Korea	2660	2764	2951	3172	3233	3279	3191	3097	3150	3055
Russian Federation	201	185	200	200	167	203	186	158	173	186

Source: The World Bank, World Development Indicators - World Bank Open Data.

The next table in this series, Table 8, presents the number of science and technology journal articles published in the SPECA countries in the period 2010-2018. The situation with this aspect of STI development in the SPECA countries is slightly better, at least with regard to the general direction some countries are heading in. Thus, while in relative terms all SPECA countries considerably lag behind the more advanced comparator economies, Azerbaijan, Kazakhstan and Kyrgyzstan have each displayed a positive dynamic in connection with the publishing of scientific journal articles in more recent years.

Table 8. Science and technology journal articles in the SPECA countries, per milion people, 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18 average
Afghanistan	1	1	1	1	1	1	2	3	3	2
Azerbaijan	66	70	73	50	41	47	61	75	77	62
Kazakhstan	20	23	27	37	54	67	90	109	130	62
Kyrgyzstan	6	9	9	11	9	9	18	17	22	12
Tajikistan	5	5	6	8	5	7	6	7	7	6
Turkmenistan	1	2	3	1	3	1	1	1	1	2
Uzbekistan	14	13	11	11	11	9	12	10	11	11
China	234	243	244	265	286	298	318	341	379	290
Republic of Korea	1021	1076	1121	1147	1196	1228	1225	1246	1286	1172
Russian Federation	237	251	251	268	308	362	434	490	565	352

Source: The World Bank, World Development Indicators - World Bank Open Data.

The situation in the SPECA region is considerably more positive when it comes to another important indicator of STI development, namely the usage of the Internet by the local population. Table 9 displays the data concerning this indicator and shows that Azerbaijan and Kazakhstan are the leading countries in the region and have achieved higher growth rates for internet usage than in China and a similar rate to that in the Russian Federation. However, the situation is uneven across the SPECA region and with some SPECA countries still lagging considerably behind with respect to internet usage. Nevertheless, during the past decade internet usage has been robustly expanding in all SPECA countries and in some of them, the growth in recent years has been spectacular.

Table 9. Internet usage in the SPECA countries as a % of the population, 2010-2018

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2010-18 average
Afghanistan	4.0	5.0	5.5	5.9	7.0	8.3	11.2	13.5	..	7.5
Azerbaijan	46.0	50.0	54.2	73.0	75.0	77.0	78.2	79.0	79.8	68.0
Kazakhstan	31.6	50.6	61.9	63.3	66.0	70.8	74.6	76.4	78.9	63.8
Kyrgyzstan	16.3	17.5	19.8	23.0	28.3	30.2	37.0	38.0	..	26.3
Tajikistan	11.6	13.0	14.5	16.0	17.5	19.0	20.5	22.0	..	16.7
Turkmenistan	3.0	5.0	7.2	9.6	12.2	15.0	18.0	21.3	..	11.4
Uzbekistan	15.9	18.6	23.6	26.8	35.5	42.8	46.8	52.3	55.2	35.3
China	34.3	38.3	42.3	45.8	47.9	50.3	53.2	54.3	..	45.8
Republic of Korea	83.7	83.8	84.1	84.8	87.6	89.9	92.8	95.1	96.0	88.6
Russian Federation	43.0	49.0	63.8	68.0	70.5	70.1	73.1	76.0	80.9	66.0

Source: The World Bank, World Development Indicators - World Bank Open Data.

Finally, the performance of the SPECA countries vis-à-vis their SDGs is presented in Table 10. As previously noted, STI is an important vehicle not only for structural transformation and economic diversification but also for pursuing SDGs. Therefore, the degree to which SDGs are achieved by individual countries can also reveal gaps and policy areas where their Governments need to put in additional effort to promote STI development.

Table 10. Sustainable Development Goals Dashboards for the SPECA countries, 2019

	Sustainable development goals	Afghanistan	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	China	Rep. Korea	Russia
1	End poverty	grey	green	green	yellow	yellow	green	orange	yellow	yellow	green
2	Food security, sustainable agriculture	red	red	red	orange	red	orange	orange	orange	orange	orange
3	Healthy lives and wellbeing	red	orange	red	red	red	red	orange	orange	orange	red
4	Inclusive education, lifelong learning	red	yellow	yellow	yellow	yellow	grey	yellow	green	yellow	yellow
5	Gender equality, female empowerment	red	red	yellow	orange	red	yellow	orange	orange	red	orange
6	Sustainable water use and sanitation	red	orange	orange	orange	red	red	red	orange	orange	yellow
7	Sustainable and modern energy sources	orange	yellow	yellow	yellow	yellow	yellow	yellow	orange	orange	yellow
8	Inclusive and sustainable growth, full employment	red	red	yellow	orange	red	red	orange	green	yellow	orange
9	Sustainable infrastructure and industrialization, innovation	red	orange	orange	red	red	red	red	orange	yellow	orange
10	Reduce inequality within and among countries	grey	orange	red	yellow	orange	grey	orange	red	orange	red
11	Smart and sustainable cities	red	yellow	yellow	yellow	orange	orange	yellow	orange	yellow	yellow
12	Sustainable consumption and production	green	yellow	orange	yellow	green	yellow	yellow	orange	orange	orange
13	Combat climate change and its impacts	yellow	orange	red	yellow	yellow	red	yellow	red	red	red
14	Sustainable use of oceans, seas and marine resources	grey	grey	grey	grey	grey	grey	grey	red	orange	orange
15	Sustainable use of ecosystems and forests	red	yellow	orange	orange	orange	orange	orange	orange	orange	orange
16	Peaceful, inclusive societies for sustainable development	red	red	red	red	red	red	red	red	yellow	red
17	Global partnership for sustainable development	red	yellow	orange	yellow	yellow	yellow	yellow	orange	red	yellow

green	sufficient
yellow	compatible
orange	insufficient
red	highly insufficient
grey	not applicable or data not available

Source: Bertelsmann Stiftung and Sustainable Development Solutions Network, *Sustainable Development Report 2019. Transformations to Achieve the SDGs.*

Table 10 is based on the SDG Index and Dashboards Report which displays the assessment of the SDG performance and achievements of individual countries as prepared by non-governmental bodies.[3] While the SDG Index and Dashboards Report is not an official SDG monitoring tool (indeed, in some cases it utilizes proxies for missing data), the advantage of using it is that it presents estimates on SDG performance and progress for almost all countries vis-à-vis virtually all their SDGs.

Although this data is rather rudimentary, it does provide an overview of the progress of the SPECA subregion vis-à-vis the SDGs. In particular, it suggests that at present the SPECA countries face, to a greater or lesser degree, significant challenges to achieve their SDGs. In many cases, there are considerable shortfalls in the progress made thus far and hence they have a lot of ground to cover to reach the desired targets. The data also indicates that of the 17 listed SDGs, the SPECA countries as a whole have made sufficient progress only with respect to Goal 1 'End poverty in all its forms'.

STI governance and policymaking in the SPECA countries: insights gleaned from the national STI gap assessments

This section contains an analytical overview and synthesized summary of some selected results and conclusions drawn from the national STI gap assessments of the seven SPECA countries[4] which were undertaken by local experts for the project "Strengthening innovation policies for SPECA countries in support of the 2030 Agenda for Sustainable Development". This multi-part project was undertaken based on a uniform methodology applied to all the country reports, each of which contains two parts covering the following issues:

Part A. Overview of some main aspects of national STI governance such as:

- National STI priorities.
- Key STI policy documents.
- STI governance structures.
- STI policy formulation.
- STI policy instruments, policy implementation and coordination.
- COVID-19 and innovation activity.

[3] Bertelsmann Stiftung and Sustainable Development Solutions Network, SDG Index and Dashboards Report 2018. Global Responsibilities Implementing the Goals. In accordance with its self-proclaimed objectives, this report synthesizes metrics with available data (based whenever possible on the official SDG indicators) to enable countries to take stock of where they stand with regards to fulfilling their SDGs and help them set priorities to be actioned.

[4] The national STI gap assessments for the seven SPECA countries were carried out by the following experts: Afghanistan: Mr. Ahsanullah Mohsen; Azerbaijan: Ms. Yuliya Aliyeva; Kazakhstan: Ms. Yelena Shevchenko; Kyrgyzstan: Mr. Aziz Soltobaev; Tajukistan: Mr. Bahodur Mengliev; Turkmenistan: Mr. Yury Aronskiy and Uzbekistan: Ms. Nodira Kurnabaeva.

This part of each study contains an analytical text based on factual information relevant to each country and its critical assessment.

Part B. Key challenges and problems in fostering innovative development.

This part of each country report is based on the results of a stakeholder survey conducted with key national innovation stakeholders covering all the main stakeholder groups: government officials and experts, academic experts as well as representatives from both the business community and civil society. The survey covered the following main issues:

- Opinions about economic sectors with the highest innovation potential.
- The effectiveness of STI policy and policy instruments supporting STI development.
- An appraisal of the framework conditions and business environment in the country.
- Opinions about existing key problems hindering innovative development in the country.
- Opinions about the most important policy changes needed to invigorate innovative development.

The fact that the national STI gap assessments were conducted based on a uniform methodology ensures direct cross-country comparability of their results. This makes it possible to derive results and conclusions for the SPECA subregion as a whole that are unique in their nature as no such effort has been undertaken in the past.

STI policymaking and policy implementation practices

In general, science, technology and innovation are assigned high priority in the declared policy objectives in most SPECA countries. This is evidenced by the number of legislative and programmatic policy documents adopted by the authorities in these countries (see Annex Table A.1). Many SPECA countries have undertaken wide-ranging reforms that were needed to build-up their national innovation systems and establish an institutional and regulatory environment conducive to nurturing science and innovation.

It goes without saying that the declared STI policy priorities in the SPECA countries reflect, either explicitly or implicitly, the overall economic and policy objectives of these countries as well as the strategic sectoral orientation of their economies. One of the questions that local STI stakeholders in all the SPECA countries were asked in the context of the survey undertaken by the local experts was about the economic sectors/industries that they considered as having the highest potential to be technologically upgraded and targeted for innovative development. Table 11 contains a summary of the stakeholders'responses focusing on the identification of priority sectors and industries that are common for the region as a whole while Annex Table A2 contains a more extended excerpt of these responses for the individual SPECA countries. Table 11 illustrates to what extent the problems identified by the STI stakeholders in different countries are common across the region as a whole by indicating

the countries where the local stakeholder community has indicated the respective sector as a top priority for innovative development.

Table 11. Expert opinions about the economic sectors/industries with the highest potential to be technologically upgraded and targeted for innovative development across all the SPECA countries

No.	Economic sector/industry	Countries that indicated it as top-10 priority	
		No.	Countries
1	ICT, Telecommunications	6	Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan
2	Mining	6	Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan
3	Agriculture	6	Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan
4	Electricity, Energy	5	Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
5	Transportation	4	Afghanistan, Azerbaijan, Kazakhstan, Turkmenistan
6	Banking/Finance	3	Afghanistan, Azerbaijan, Tajikistan
7	Chemical industry	2	Turkmenistan, Uzbekistan
8	Light industry, textiles	2	Kyrgyzstan, Uzbekistan

Note: Contains sectors that were identified by more than one SPECA countries

Source: Author's compilation based on the national STI gap assessments of the SPECA countries

What clearly emerges from the results presented in Table 11 is that there are several sectors and industries, namely agriculture, information and communication technology (ICT) and telecommunications as well as the extracting industries (including oil and gas), that are seen as priority STI areas throughout the SPECA region. The presence of such a core of shared priority sectors and industries provides one of the underlying rationales of cross-border economic cooperation among the SPECA countries.

STI policy making and implementation in all SPECA countries has several levels and is distributed among various public bodies. The key strategic decisions concerning STI activity, including the directions of policy reforms, the setting of priorities as well as policy coordination, are usually taken by the respective national governments. At the working level, the initial policy formulation (in terms of preparing draft policy documents which are then subject to further approval) in most countries is usually mandated to pertinent ministries, such as the ministries responsible for the economy or education and science. Of course, there are specificities concerning the allocation of policy responsibilities among public bodies in the different countries as can be seen in the overview presented in Table 12.

Table 12. Public bodies with functional responsibilities in STI policy formulation and implementation in the SPECA countries

Country	Main public bodies tasked with preparing STI policy drafts and STI policy implementation
Afghanistan	Ministry of Communication and Information Technology, National Statistics and Information Authority, Afghanistan Telecom Regulatory Authority, Academy of Sciences, Ministry of Higher Education
Azerbaijan	Ministry of Transport, Communications and High Technologies (incl. Innovation Agency), Ministry of Education, Ministry of the Economy (incl. Small and Medium Business Development Agency), Science Development Foundation, Academy of Sciences, Intellectual Property Agency, State Agency for Public Service and Social Innovations.
Kazakhstan	Supreme Science and Technology Commission under the Prime Minister, Ministry of Digital Development, Innovation and Aerospace Industry, Ministry of Industry and Infrastructural Development, Ministry of Education and Science, Ministry of National Economy, National Academy of Sciences, National Welfare Fund "Samruk-Kazyna", QazTechVentures
Kyrgyzstan	State Agency on Intellectual Property and Innovation (Kyrgyzpatent), Ministry of Education and Sciences, Ministry of the Economy, State Committee on Information Technologies and Communications, National Academy of Sciences
Tajikistan	Ministry of Economic Development and Trade (incl. Innovation Fund and National Centre for Patents and Information), Ministry of Education and Science, Ministry of Industry and New Technologies, Academy of Sciences
Turkmenistan	Academy of Sciences, Ministry of Industry and Communications, Ministry of Finance and Economy
Uzbekistan	Ministry of Innovative Development, Ministry of Economic Development, Academy of Sciences, Fund to Support Innovative Development and Innovative Ideas

Source: Author's compilation based on the national STI gap assessments of the SPECA countries

Unsurprisingly, the level of development and sophistication of national innovation systems is usually accompanied with a diverse range of STI policy-making and implementation processes whereby more sophisticated processes involve a greater number of bodies being delegated responsibilities in the governance of innovation. This entails a growing complexity of an innovation governance process which, in turn, calls for closer inter-agency collaboration and coordination to effectively implement STI policy. As will be shown in the next sections, some SPECA countries are facing considerable challenges in ensuring this efficient coordination in their attempts to implement their STI policies.

When it comes to the funding of STI activities, practices also differ across SPECA countries. Historically, R&D funding was a prerogative of the public sector while innovation funding *per se* is a relatively new practice that has evolved in concert with the evolution of the innovation systems. This is reflected in the fact that those countries with relatively advanced innovation systems have developed quite diversified systems facilitating a mix of public and private funding for various STI activities, including both R&D and innovation. By contrast, in countries with less advanced national innovation systems, most of the STI funding still originates from the state budget and the largest share of this is directed towards R&D while

innovation funding, if present at all, accounts for only a fraction of the funds. Understandably, such a funding scheme does not require a complex system of funding institutions and at present, the STI funding systems in most SPECA countries, except for Azerbaijan and Kazakhstan, falls into this second category. However, it should also be noted that there are ongoing efforts in the region to establish more advanced innovation systems and for the diversification and enhancement of STI funding systems.

STI policies are operationalized through policy instruments and therefore any desired change in policy approach needs to be instrumentalized. Table 13 presents an overview of the STI policy instruments currently applied in the SPECA countries.

Table 13. STI policy instruments applied in the SPECA countries

Policy instruments	Afghanistan	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Grants for fundamental research	x	x[1)]	x	x	x		x
Grants for applied research	x	x[1)]	x	x	x		x
Grants for innovative startups		x[1)]	x	x	x[5)]	x	x
Innovation vouchers			x[3)]				
Coaching programmes for innovative startups		x	x	x			x
Competitions for innovative startups		x	x	x	x	x	x
Incubation and acceleration programmes for innovative startups	x	x	x	x	x	x	x
Entrepreneurship support programmes	x	x	x	x	x	x	x
Credit guarantees for innovative SMEs							x
Equity investment in innovative SMEs (venture financing)			x			x	x
Grants for the commercialization of R&D results	x		x[4)]		x[5)]		x
Tax incentives for R&D and/or technological	x	x[2)]	x	x	x		x

development in the business sector							
Budget subsidies for R&D and/or technological development in the business sector		x					x
Subsidized credit for R&D and/or technological development in the business sector		x	x				x
Grants for full-cycle STI projects (from R&D to market)					x		x
Grants for industry-science cooperation in STI projects	x		x				x
Support for industrial clusters	x	x			x		x
STI grants from international donors (World Bank, Asian Development Bank, etc.)	x		x	x	x	x	x

1) Exists as a policy option but is temporarily suspended.
2) Has been adopted in legislation but implementation is still pending.
3) Exists as a policy option but has not been applied yet.
4) Has not been applied since 2018.
5) Not regular and largely from private sources.

Source: Author's compilation based on the national STI gap assessments of the SPECA countries

As can be seen, the mix of STI policy instruments applied by policymakers in the SPECA region varies considerably across the countries. Public support for R&D activities in all the SPECA countries, as shown in the first two lines of the table, takes the form of grants which are primarily allocated based on competitive calls, although there is evidence of numerous distortions in the implementation of such calls. The remaining part of the table provides some detail regarding other tools employed for the funding of innovation activities *per se*, where practices can be seen to vary considerably from country to country. What is striking, however, is the fact that some important instruments that are commonplace in more advanced countries, such as innovation vouchers, grants for full-cycle innovation projects, credit guarantees for innovative small and medium-sized enterprises (SMEs) and so forth, are virtually non-existent in many SPECA countries.

The situation with innovation support institutions also varies considerably across the SPECA countries. Some countries, such as Afghanistan, are only now considering the establishment of institutions such as technology parks, business incubators and technology

transfer offices. In contrast, both Kazakhstan and Azerbaijan have established extensive networks of well-functioning innovation support institutions with the latter having an operational High Technologies Park along with 5 industrial zones/parks for large conglomerates and 4 industrial estates focused on SMEs. In addition to these, Azerbaijan has three technoparks specialized in providing support to innovative SMEs and its public sector operates two functioning business incubators and five more are expected to open in the near future. This is all in addition to the numerous university-based and private business incubation institutions currently operating in the country. Kazakhstan also has an extensive network of innovation support institutions and activities which focus their efforts on different phases of the innovation process. These include incubation and acceleration programmes that are administered by innovation support institutions such as the International Technology Park for IT startups "Astana Hub", QazTech Ventures, Astana Business Campus under the Nazarbayev University along with a number of others.

The rest of the SPECA countries follow on behind these two most advanced nations. Kyrgyzstan has a functioning High Tech Park and a regional technopark in the city of Osh and has started the process of establishing three more university-based technoparks. Most universities in Tajikistan have established technoparks which support their innovation activities and the commercialization of research results and there is also the national Business Incubator of Tajikistan which operates as a state enterprise. In Turkmenistan, there is a technopark operated under the auspices of the Academy of Sciences as well as several business incubators and technoparks operated by the private sector.

As regards policy evaluation, which is an essential component in the STI policy practice of more technologically advanced countries,[5] this is virtually absent in the STI policy environments of the SPECA countries, with the possible exception of Kazakhstan.

Key STI policy challenges identified in the national studies

This section contains a summary of some empirical results obtained through a stakeholder survey in the seven SPECA countries using a uniform questionnaire. While great efforts were made to apply the same methodology in all the countries to ensure cross-country consistency and comparability of the results, it is necessary to add some words of caution before turning to the actual outcomes of the survey. To begin with, there is some non-uniformity in the number and composition of stakeholders taking part in the survey in the different countries. In view of the specificity of each local environment, the number of participants who could be mobilized to take part in the survey in each country varied from single-digit numbers to several dozens. Furthermore, while efforts were made to include

[5] Policy evaluation refers to a process that seeks to determine the efficiency and effectiveness of a policy or policy mix, including their instruments, compared to their declared objectives. Policy evaluation is usually retrospective because it produces information garnered from assessments of the implementation of past policies or the monitoring of the results thus far of ongoing policy initiatives.

representatives from different types of stakeholders, namely government officials and experts, experts from academia as well as representatives from the business community and civil society, this was not achieved in all countries. As a result, the composition of the respondents is not always representative of the full stakeholder community in some countries. As a final point of note, the actual results of the survey may vary from country to country because of subjective bias caused national specificities creating diverse perceptions regarding the nature of the questions. Therefore, some caution may be needed when comparing directly the quantitative outcomes for different countries, although some of the tables presented below contain a "SPECA average score" which, to some degree, helps mitigate the possible country-specific subjective bias on the region's overall outcome.

Table 14 presents the summary of the expert opinions of SPECA stakeholders obtained from the common survey about the effectiveness of STI policy and its instruments in the SPECA countries. This table also contains the SPECA average effectiveness rank (on a scale from 1 to 5) computed as an arithmetic average for the region as a whole.

Table 14. Expert opinion about the effectiveness of science, technology and innovation (STI) policy and of the policy instruments supporting STI development in the SPECA countries

No.	Policy aspects	Average scores assigned by stakeholders in individual countries							SPECA average score
		Afghanistan	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	
1	The national authorities assign high importance to the development of science, technology and innovation (STI)	3.2	3.1	3.3	3.5	3.1	4.2	4.0	3.5
2	The national STI priorities and strategic directions of STI development are well formulated and widely publicized	3.7	3.2	3.3	3.4	3.1	4.0	3.2	3.4
3	The officially proclaimed national STI priorities correspond to sectors and businesses with high innovation potential	3.7	3.2	3.2	3.5	3.3	4.4	3.2	3.5
4	There is a clear division of responsibilities between the public bodies tasked with STI governance	3.6	4.0	3.7	3.3	3.5	3.9	3.0	3.5
5	There is good coordination in the functioning of the different public bodies tasked with STI governance	3.8	3.8	3.8	3.1	3.5	3.6	2.9	3.4

6	The functioning of the main R&D institutions in the country is well guided and managed	4.3	4.1	3.7	3.2	3.2	4.1	3.1	3.7
7	The authorities allocate sufficient public funds to the support of STI activities	3.9	3.5	3.8	3.2	3.4	3.8	3.1	3.5
8	The policy instruments used to support STI activity are efficient and well managed	3.8	3.2	3.8	3.4	3.4	3.5	3.0	3.4

Note: The numbers in each cell reflect the average scores assigned by the respondents where "1" is "fully agree/fully adequate" … and "5" is "completely disagree/ unsatisfactory"
Source: Author's compilation based on the national STI gap assessments of the SPECA countries

One general conclusion that can be drawn regarding the survey's outcomes is that stakeholders in the SPECA region do not rate highly the effectiveness of the STI policy instruments applied in their countries. According to these results, stakeholders had the lowest opinions of the following three policy aspects: "The national authorities and strategic directions of STI development are well formulated and widely publicized" and to the propositions that "There is good coordination in the functioning of the different public bodies tasked with STI governance" and "The policy instruments used to support STI activity are efficient and well managed". At the other end of the scale, the average opinion of SPECA stakeholders suggests that R&D activity is relatively well-guided and managed, at least when compared to other STI activities.

Table 15 presents the summary of the stakeholders' opinions concerning the relevance and supportiveness of the various STI framework conditions and business environments in the SPECA countries. It also contains the SPECA average relevance/supportiveness rank, again on a scale from 1 to 5, computed as an arithmetic average for the region as a whole.

Table 15. Expert opinions about the framework conditions and business environments in the SPECA countries: to what extent they are conducive to innovative development?

No.	Aspects of the framework conditions and business environment	Average scores assigned by stakeholders in individual countries							SPECA average score
		Afghanistan	Azerbaijan	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	
1	The authorities make efforts to reduce the administrative hurdles to doing business	3.2	2.1	3.1	2.9	2.9	4.8	3.4	3.2
2	The authorities assign high priority to SME development; access to public support	3.5	2.2	3.1	3.5	2.8	4.4	3.7	3.4
3	Entrepreneurship is encouraged and supported by the authorities	3.4	2.4	3.2	3.5	3.0	4.6	3.7	3.4
4	It is relatively easy for entrepreneurs to start and develop a new business	3.4	2.2	3.3	3.6	3.0	4.1	3.5	3.3
5	Businesses cooperate with R&D institutions for R&D commercialization	3.7	4.2	3.9	3.2	3.5	3.7	2.4	3.4
6	Universities encourage the establishment of academic startups and spin-offs	3.5	2.9	3.3	2.7	3.5	3.8	2.5	3.2
7	Intellectual property rights are well protected by law and regulations	3.4	2.8	3.3	2.9	2.9	4.0	2.9	3.2
8	Innovators and SMEs have access to public funds for early-stage development	4.0	3.5	2.5	3.3	3.3	3.5	3.1	3.3
9	There is private funding support for innovators / SMEs in the early stages	3.9	3.9	3.3	2.5	3.3	3.0	2.3	3.1
10	SMEs have easy access to bank credit for the development of their business	3.3	3.8	3.4	2.6	3.5	3.7	2.7	3.3

Note: The numbers in each cell reflect the average scores assigned by the surveyed community of local stakeholders where "1" is"fully agree/fully adequate" … and "5" is "completely disagree/ unsatisfactory"
Source: Author's compilation based on the national STI gap assessments of the SPECA countries

Similar to the situation shown in Table 14 above, stakeholders in the SPECA region do not rate highly the relevance and supportiveness of the STI framework conditions and business environments in their countries. The average scores for this group of questions are even lower than those regarding the effectiveness of the STI policy instruments. According to these results, stakeholders consider that the biggest gaps and problems in the framework conditions and their respective business environments are related to the existing administrative hurdles to

doing business, the early stage funding of innovative entrepreneurs and SMEs, and the poor protection of intellectual property rights.

Table 16 presents the summary of the various stakeholders' opinions when they were explicitly asked to list the main problems, obstacles and bottlenecks hindering innovative development in their countries.

Table 16. Expert opinions about the main problems, obstacles and bottlenecks that hinder innovative development that are common for the SPECA countries

No.	Main problems, obstacles and bottlenecks that hinder innovative development	Countries that indicated it as a top problem	
		No.	Countries
1	Low STI capability in the country	7	Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistzan
2	Corruption and administrative hurdles	4	Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan
3	Poor access to finance for startups	4	Afghanistan, Azerbaijan, Tajikistan, Turkmenistan
4	Low level of government support	4	Afghanistan, Azerbaijan, Tajikistan, Uzbekistzan
5	Generally low level of skills in the country	4	Afghanistan, Tajikistan, Turkmenistan, Uzbekistzan
6	Low competence of government officials	3	Kazakhstan, Kyrgyzstan, Tajikistan
7	Poor policy coordination	3	Azerbaijan, Kazakhstan, Uzbekistzan
8	Unsatisfactory framework conditions	3	Azerbaijan, Tajikistan, Uzbekistzan
9	Poor industry-science collaboration	2	Kazakhstan, Kyrgyzstan
10	Poor business competence	2	Azerbaijan, Turkmenistan
11	Weaknesses in the education system	2	Kyrgyzstan, Tajikistan
12	Small domestic market	2	Afghanistan, Kyrgyzstan

Note: Contains problems that were identified by more than one SPECA country.
Source: This is the author's compilation based on the national STI gap assessments of the SPECA countries.

Finally, Table 17 presents a summary of the respondents' opinions regarding the most important changes (in legislation, in policymaking and implementation, in framework conditions, and so forth.) that need to be introduced to invigorate innovative development. The individual results for each SPECA country are contained in Annex Table A4 whereas Table 17 illustrates to what extent the proposed policy changes are shared across countries. As many of the policy proposals put forward by individual stakeholders are quite country-specific and bound to the local context, some of the formulations used in Table 17 have been generalized in order to highlight those aspects that are common across the whole region.

Table 17. Expert opinions about important changes (in legislation, in policymaking and implementation, in framework conditions, and so forth.) that need to be introduced to invigorate innovative development that are common for the SPECA countries

No.	Policy changes that would support innovative development.
1	Introduce measures to reduce corruption and administrative hurdles.
2	Implement a result-oriented approach in STI policy implementation.
3	Put in place measures for coordination of STI policy implementation.
4	Ensure skills development for entrepreneurs to promote an innovation and entrepreneurship culture.
5	Provide for capacity building and skills development of innovation governance practitioners.
6	Adopt measures to improve inter-agency collaboration and coordination.
7	Improve the prioritization of STI activities.
8	Accelerate the digital transformation.
9	Strengthen technology transfer processes, enhance innovation support institutions.
10	Increase public funding of STI activities, stimulate private financing of innovation.
11	Introduce measures to improve the access to finance for innovative entrepreneurs and SMEs.
12	Upgrade and widen the policy instruments to support tech-savvy industries.

Source: Author's compilation based on the national STI gap assessments of the SPECA countries

COVID-19 and STI activity in the SPECA countries

The COVID-19 pandemic has provoked the worst global crisis in living memory. In most countries, various economic and social activities have ground to a standstill for a considerable period. Between a third and a half of the world's population was placed under partial or full lockdown and public services were either scaled-down or restructured. Businesses have inevitably suffered huge losses throughout the crisis leading many to bankruptcy and workers confined to their homes have either lost their jobs or been obliged to work remotely. Conventional social interaction and traditional social networks based on face-to-face contact have been disrupted. The negative economic implications are already momentous and the estimates of their magnitude increase day by day.

Inevitably, the COVID-19 pandemic has had a perceptible effect on STI activity worldwide. In general, this effect can be classified as double-edged. On the one hand, the pandemic has generated increased demand for STI responses that can have a direct beneficial impact with regard to COVID-19's threat to human health and wellbeing. Prime examples of this involve the elaboration of vaccines and new medications and currently, these STI spheres are attracting unprecedented amounts of new resources that are both financial and human in nature. In a similar vein, the pandemic has generated new demand for a range of other STI activities that address the indirect implications of the virus created by the drastic change in

human behaviour. In this respect, one can mention the growth of STI support for the rapid upscaling of virtual care capacity and the mainstreaming of telehealth remote patient monitoring, the surge in eCommerce and BOPIS (Buy Online, Pickup in Store) shopping, the rapid embrace of public sector innovation with eGovernment and eEducation, as well as the proliferation of various social innovations in a range of new areas.

On the other hand, considering the depth of the global recession and its negative effect on public finances in all countries, the pandemic has led to a general reduction of the public funding allocated to STI activities. Coupled with the internal shifts in STI funding as indicated above, this has led to widespread underfunding for most "traditional" STI activities, including the public funding of fundamental and applied research and the funding of innovation projects that do not address the direct and indirect challenges of the COVID-19 pandemic.

Undoubtedly, the SPECA countries are caught up in this global upheaval and the trends characteristic for the world as a whole are observable in the SPECA region as well. The pandemic affected various SPECA countries to different degrees and the available statistics of confirmed cases in each SPECA nation is not always reliable. However, from an international perspective, one can probably safely assume that the region is thus far not among the most profoundly affected parts of the world. Nevertheless, having given due attention to the healthcare perspective, all the SPECA countries introduced a temporary lockdown and/or other containment measures restricting physical contact.

The COVID-19 pandemic has dealt a heavy blow to economic activity in all parts of the world producing an idiosyncratic and simultaneous negative economic shock. GDP growth in the SPECA region will be severely affected, indeed, according to preliminary and approximate estimates, the year-on-year plunge of GDP in 2020 for the SPECA countries is expected to be in the range of 5% to 10%. This situation is exasperated by the almost unprecedented drop in global demand which will mean exports from the SPECA region are also expected to fall sharply for the short term at least.

Faced with the dramatic health and economic cost of the pandemic, the authorities in the SPECA countries have introduced a range of policy measures aimed at addressing some of the most acute negative implications and mitigating the impacts of the pandemic on the economy, the labour market and the public at large. Table 18 presents a summary of some of these main policy responses to the COVID-19 pandemic introduced in the SPECA region.

Table 18. Covid19-related policy measures in the SPECA countries (as of August 2020)

Country	Fiscal measures	Monetary measures	Measures targeting STI activity	International support
Afghanistan	A health package amounting to AFN6.2 billion, including for building hospitals; A social package (AFN2.8 billion), including a bread distribution programme and a World Bank-supported social distribution program (AFN20.8 billion); A wheat purchase programme (AFN1.7 billion); A package to support agriculture (AFN5.9 billion) and short-term jobs (AFN1.0 billion).	Easing of prudential regulations	..	World Bank grant
Azerbaijan	Increasing spending on public health (AZN 8.3 million); creation of a COVID Response Fund for public health needs (AZN 114 million). Construction of ten modular hospitals; AZN 3.3 billion worth of support for affected businesses and individuals; Tax benefits to affected businesses; Social assistance for unemployed and low-income people.	Easing of prudential regulations; Transfer from the Oil Fund	Support to affected entrepreneurs (Entrepreneurship Development Fund)	Swap agreement with the EBRD
Kazakhstan	An anti-crisis package including cash payments to the unemployed and self-employed, an increase in pension and social benefits, additional health spending and support for employment as well as business. KZT 1 trillion of additional subsidized lending. Tax incentives for agriculture and other hard-hit sectors.	Easing of prudential regulations	Actions to help SMEs including credit support and loan repayment deferrals	..
Kyrgyzstan	Health sector contingency plan to provide training for health-care workers, procure personal protective equipment and medical tests. Package of anti-crisis measures including the postponement of tax payments and exemptions of property and land taxes, temporary price controls on essential food items, food security programme for vulnerable groups and subsidized credit from banks.	Easing of prudential regulations	Temporary tax exemptions for SMEs	Emergency financial support from the IMF (US$121 million)
Tajikistan	VAT exemptions on essential imports; lump-sum assistance to vulnerable households and socially disadvantaged groups; supplemental pay to health workers; tax holidays and relief to targeted industries and small businesses	Easing of prudential regulations. Loan restructuring for affected businesses	Tax holidays and relief for SMEs	Emergency budget support from the IMF (US$190 million)
Turkmenistan	Increased health spending; support for businesses affected by the containment measures through tax relief and assistance in providing raw materials. Increased custom duties to protect domestic suppliers. A special regime for essential and high-priority imports and projects.	Subsidized loans to affected businesses	..	..
Uzbekistan	Increased funding for healthcare, including for medicines and salaries of medical employees; expanded access to social benefits; assist affected businesses via interest subsidies; additional public works in different regions to support employment. Tax relief for affected businesses; grace period on property taxes.	..	Tax relief for individual entrepreneurs	..

Source: Author's compilation based on International Monetary Fund (IMF) information and the national STI gap assessments of the SPECA countries

Most of the specific measures adopted by the governments in the SPECA countries are designed to support business activities. These include public sector support to expand the capacity of the liquidity and credit lines available to businesses as well as support the deferral of loan repayments to banks. Other fiscal measures include the deferral of tax payments and/or exemptions for firms from social contributions. As regards monetary policy responses, in most cases these included the easing of prudential regulations which has allowed commercial banks to release liquidity for additional lending to the business sector and households. In addition to these cited measures, some countries have made allowance for loan restructuring for affected businesses and for such businesses to gain access to subsidized loans.

Several SPECA countries have also requested emergency financial support from international financial institutions and their other development partners to help mitigate the economic impact of COVID-19. At the time of writing this paper, four SPECA countries (Afghanistan, Azerbaijan, Kyrgyzstan and Tajikistan) had already received such support from several international partners as detailed in Table 18 above.

Some SPECA countries have developed and adopted longer-term economic measures and programmes aimed at overcoming the negative effects of the pandemic and speeding up the post-pandemic recovery. In Azerbaijan, the Ministry of the Economy has set aside some 1 billion Manat in a program to support 11 economic sectors to minimize the economic consequences of the pandemic. The Government of the Republic of Kazakhstan adopted an integrated plan for revitalizing economic growth which covers 10 areas of policy intervention and 172 specific measures to stimulate business activity and support employment and household incomes. The proposed measures provide new options for financing and concessional lending, in particular for SMEs, as well as new mechanisms to support exports. In August 2020, Turkmenistan adopted a national anti-crisis development programme which, among other things, envisages significant increases in the support for business, particularly SMEs.

Most pandemic-related policy measures adopted in the SPECA countries are targeted to support business activity and employment, although currently there are no specific support measures direct targeting STI activities. Nevertheless, it should be noted that some of the policy measures designed to support general entrepreneurial activity and SMEs (as detailed in Table 18) do have a positive indirect effect on the innovation activities of such entities. Moreover, some SPECA countries reported that during their lockdown periods the demand for digital solutions increased and ICT companies generated extra sales and profit.

However, according to the available information, STI activity in the SPECA countries was on the whole negatively affected by the COVID-19 pandemic. In several countries, the forced restructuring of public finances resulted in a reduction of the funds allocated to STI activities. This has led, for example, to the underfunding of several development projects in Afghanistan entailing innovation and technology while the revision of Azerbaijan's 2020 state budget undertaken in August 2020 reduced the allocations to education, research and science to

approximately 10%. In Kyrgyzstan, the intensity of STI activity declined notably during the pandemic due to the reduction in working hours and, in some cases, dismissal of staff. The occupants of the Kyrgyz High Tech Park, the country's export-oriented innovation centre, reported a sharp decline in the demand for their services.

Overall, given the sudden and serious challenges created by the COVID-19 pandemic, the SPECA countries have made commendable efforts to mitigate its negative effects on STI activity. Following international good practice, the authorities in these countries introduced a range of policy support measures targeting affected businesses and households with some of these having either a direct or indirect positive effect on STI activity. At the same time, public funding earmarked to support "traditional" STI activities has been reduced as the market demand for such activity has declined. Undoubtedly, this has resulted in an overall downward shift in the level of STI activity across the region.

Obviously, in the future, there will be a need for a better balance between the emergency interventions to support business activity and the measures oriented towards STI. Providing liquidity support to businesses should not come at the expense of defunding the measures and programs that support STI, technological development and innovative entrepreneurship. Taking stock of the accumulated impacts felt during the pandemic and surveying the new global economic landscape could present an opportunity for governments in the SPECA countries to revisit and reshape existing policy models to better suit new future realities.

Main conclusions from the STI gap assessment of the SPECA countries

The results from the international benchmarking and the analytical summary of the state of STI governance and policymaking in the SPECA countries suggest that the subregion is quite heterogeneous as regards its progress and achievements in promoting STI. Notably, the resource-rich countries have been able to allocate more public sector resources to build up the institutional framework supporting their national innovation systems and provide more funds for STI activities. At the same time, this assessment indicates that most of the SPECA countries still face a range of common challenges and problems in forging their way forward. This commonality of issues opens up a window of opportunity for international cooperation within the region. As such, this section of the report seeks to identify areas of common interest for the SPECA countries where, through a united effort, the individual countries could generate synergies and significantly increase the effectiveness and efficiency of their policy efforts in promoting STI activities.

STI gaps from the international perspective

The international benchmarking exercise presented in Section 2 suggests the existence of some significant STI gaps in the SPECA countries when considered from an international perspective, particularly with regard to their weak manufacturing base. Technological innovation usually finds its way to the market in processing industries and all the leading innovator economies in the world have a well-developed manufacturing base. However, the economic structure of all SPECA countries is skewed towards agriculture and primary resource production while manufacturing only accounts for a limited share of their economies. Unsurprisingly and as evidenced by the national STI gap assessments, manufacturing does not feature among the priority economic sectors defined by the SPECA Governments (see Table A.2).

The available international comparisons on the overall economic and institutional environment in the SPECA countries provide a mixed picture with some countries, such as Azerbaijan and Kazakhstan, being assessed fairly favourably with respect to providing conditions conducive to doing business while in other countries in the region this environment seems to be problematic and unsupportive.

Judging by the "Global innovation index (GII)", those SPECA countries represented in this index lag well behind the countries that are considered as innovation leaders. What is more, the dynamics of the index over the past decade (2011-2019) indicate a stagnation of their position compared to the innovation activity in the rest of the world. This outcome is partly associated with the rather low R&D expenditures in the SPECA countries which hovers between 0.1% and 0.2% of GDP. This would be considered as unsatisfactory in many nations, as evidenced by the fact that the more advanced countries can spend more than 3% of their GDP on R&D. Even in countries such as the Russian Federation and China, spending in this area is from 1% to 2% of GDP, i.e. by a magnitude of one order higher than that in the SPECA countries. Moreover, even in the better performing SPECA countries such as Azerbaijan and Kazakhstan, R&D expenditure has been trending down in relative terms for the past decade.

This picture described above is mirrored in the numbers of patent applications per million residents in the SPECA countries which are again both very low from the international perspective and with a declining tendency.

The situation is slightly better concerning the percentage of the population using the Internet as this has experienced rapid growth throughout the whole region in recent years. Some SPECA countries, notably Azerbaijan and Kazakhstan, are already among the leading nations in the region when measured using this indicator.

This brief overview suggests a mixed picture of the STI achievements of the SPECA countries from an international perspective, albeit a picture with a prevalence of unsatisfactory outcomes. One general conclusion that can be drawn from this is the stark mismatch between declared priorities and policy objectives, which prioritize STI in all the SPECA countries, and the

actual STI achievements which are disappointing in many cases. Moreover, some indicators such as the trend in R&D spending (which to a large degree consists of public budgetary allocations and is a direct reflection of public policy priorities) reveals the exact opposite, namely that R&D has been demoted on the list of public policy priorities.

Gaps in the innovation ecosystems of the SPECA countries[6]

The available evidence suggests that innovation ecosystems in most SPECA countries are still underdeveloped and many of the building blocks of typical mature innovation systems are either still missing or in their embryonic form. In particular, this concerns such essential elements as:

- Connectivity and linkages. As innovation is the result of the interactions of numerous innovation stakeholders, good connectivity and efficient linkages are essential for the existence of a vibrant national innovation system. While many of the institutional elements of the innovation systems can be established with government support, their effectiveness will be limited in the absence of interactions in the system. From this perspective, the assessment of the national innovation systems of the SPECA countries suggests that all of them still suffer from poor connectivity and linkages between innovation stakeholders which is a major impediment for the invigoration of STI activities.
- Systemic failures. The innovation ecosystem is a complex network which is subject to various systemic failures (such as capability failures, institutional failures, network failures and framework failures) and these are even more frequent when the system is still underdeveloped as it is in the case of the SPECA countries. Thus, poor linkages and insufficient connectivity between innovation stakeholders result, at least partially, from network failures and this ultimately results in the absence of spontaneous, bottom-up collaboration among such stakeholders. The fragmentation of innovation governance (see below) is also too frequently experienced in SPECA countries and is an example of a coordination failure. These issues are among the serious systemic weaknesses hindering the functioning of the region's innovation ecosystems.
- One related gap in the innovation ecosystems of the SPECA countries is the inadequate coordination capacity of the innovation stakeholders which limits their ability to respond swiftly to both emerging challenges and opportunities. This deficit in coordination capacity is one of the root causes of some systemic failures in the innovation ecosystems.
- Innovative entrepreneurship. The innovative entrepreneur is the central figure in any innovation process and is its main driver. Therefore, the overall state of innovative

[6] The conclusions in this section draw also on the results of the Innovation for Sustainable Development Reviews undertaken by the UNECE in a number of SPECA countries.

entrepreneurship to a large degree determines the level and productiveness of STI activity in any country. The surveys of national experts in the SPECA countries, as discussed in section 3, generally indicate there is both low capacity and competence for innovative entrepreneurship as well as low STI capabilities and these impediments are among the most damaging for innovative development in the region.

- Innovation intermediaries and support institutions. Innovation intermediaries and support institutions facilitate the market's uptake of innovative ideas and entrepreneurial projects and are indispensable for the successful completion of innovative projects. However, as indicated by the national STI gap assessments, such institutions are virtually absent in some SPECA countries and only exist only in rudimentary form in others. The building of such infrastructure is in itself a long-term process and this will require continued policy support efforts from the various Governments.
- Financial systems. Deep and diversified financial intermediation is also essential to promote and sustain vibrant innovation activity. However, the available evidence suggests that the financial systems of all the SPECA countries are still underdeveloped and dominated by the commercial banking sector. This is a serious impediment not only for innovative development but also to economic growth in general and the ability of these countries to attract FDI, which is an important channel for technology transfer from abroad.
- Seed and early-stage financing. When it comes to financing mechanisms, access to seed and early-stage finance is probably the most important for the success of innovative startups. The key required feature of such a financing mechanism – and that which distinguishes it from support provided by banking institutions – is that it extends non-debt finance to entrepreneurs in different forms (grants, equity finance, future options, and so forth). Without the support of such a mechanism most, if not all, innovative entrepreneurial ventures are not likely to get off the ground and cross the "valley of death". This being the case, given the information gathered through the national STI gap assessments, poor access to early-stage finance in the SPECA countries is probably the most serious lacuna in their financial systems.
- Limited role of market demand. Innovation emerges as the result of the interplay between supply and demand factors. This is because even if an abundance of supply factors supports innovative activities, such activities will not materialize if the outputs have no markets. Notably in this regard, the domestic markets for R&D and innovative products in all SPECA countries are very limited, making it extremely difficult for entrepreneurs to realize worthwhile returns on their innovations if they can only sell into these local markets. Moreover, the growth of the vast majority of innovative businesses nowadays are critically dependent on international economic integration and, in particular, on being successfully incorporated into global value chains.

Therefore, it is important for STI policy, on the one hand, to support domestic demand but, on the other hand, to also support international linkages and cooperation at all stages of the innovation process, including the commercialization of the process' outputs.

- Fragmentation of innovation governance. Policy coordination and information exchange between institutions mandated with innovation management are essential for the efficiency of innovation governance. The national STI gap assessments provide evidence of frequent failures in this process due to a lack of information sharing and consultation among institutions. In practical terms, this results in the fragmentation of innovation governance at the operational level.
- The capacity of the public administration. The presence of knowledgeable, capable and efficient public administrations mandated with the design and implementation of STI policy is another key factor for innovation to succeed. However, the stakeholder surveys tended to suggest that this is not always the case in the SPECA countries as very often respondents had grievances regarding the efficiency of many of the involved public administrations.

Gaps in the policy environment and instruments

The SPECA countries have made significant progress with the adoption of a range of legislative and programmatic documents governing science and innovation. However, what remains of concern at the operational level of various innovation policy instruments is that these supporting frameworks still have room for further improvement. When comparing the declared policy priorities with the actual practice of innovation management it becomes obvious that there are serious gaps between intentions and reality.

As regards the funding of fundamental and applied research, one issue that clearly needs to be addressed to improve the policy environment in the SPECA countries is the role of competition in allocating public funds earmarked to support research. The established practice in countries with more advanced innovation systems is that most, if not all, public funds earmarked to support STI activities, that includes both R&D and innovation funding, are allocated based on competitive calls. Indeed, it should be noted that all SPECA countries have made important steps towards adopting such a system for their STI funding, however, there is again much room left for improvement in the implementation practices. Areas that need to see such improvement include the funding instruments at all phases of the implementation process and extends to the design of the competitive calls, the organization of bidding processes, the screening and evaluation of bids, the awarding of winners and the monitoring of the implementation of the funded STI projects.

Moreover, Table 13 presents clear evidence of some obvious gaps in the STI policy support instruments that are being employed in the SPECA countries. In short, this

demonstrates that instruments that are commonplace in more advanced economies, such as the offering of credit guarantees for innovative SMEs or grants for full-cycle STI projects from R&D to market, have not been taken on board by policymakers in most of the SPECA countries.

As already stressed, one of the most acute problems that innovators are facing in the SPECA countries is the availability of seed and early-stage financing. Here the problem is compounded by the very limited amounts of public resources dedicated to this purpose, as can be seen from the data presented in Table 5. As a consequence of this, even in cases where early-stage financing support instruments exist, the outreach of such instruments is very limited and their effect is marginal. Furthermore, as also indicated by the information presented in the same table, even in the SPECA countries that are at a relatively advanced stage in their STI development and where the arsenal of available policy instruments is relatively broad, some of these instruments are being applied sporadically, at times with breaks measured in years.

The reluctance of commercial banks to finance risky innovation undertakings in a business sector is a typical case of a market limitation which is by no means unique to the SPECA countries as it occurs in all economic environments. Effective international practice has found various ways to address this failure through public sector intervention that supports lending using preferential terms for such firms. This can be done by specialized finance institutions supported by the State or by providing state credit guarantees or credit subsidies to innovating firms. This type of financing is virtually non-existent in most SPECA countries but would be a highly desirable mechanism to introduce by developing policy instruments earmarked to promote such support.

Policies could also be targeted to support the development of private sector early-stage finance such as business angels and venture capital firms. While angel and venture financing is only in its embryonic form in most SPECA countries, best international practice suggests that public policy can serve as a catalyst to invigorate private early-stage financing through appropriate intervention. Thus, targeted public support, by providing such entities with adequate tax incentives, for example, could encourage both new entries to this market and the growth of existing angel and venture entities.

More generally, there is a need for greater public-sector involvement to support innovative entrepreneurship and innovative SMEs. This applies not only to the introduction of new funding instruments and the expansion of the coverage of existing one but also to non-financial support instruments such as providing coaching and business services, supporting both local and international networking, supporting the integration of innovative SMEs into global and regional supply and value-added chains, and so forth.

Another STI gap common to all SPECA countries that needs further policy attention is the disconnect between publicly funded research and the market. As previously noted, at present almost none of the SPECA countries apply instruments that cover both the research phase and the later phases of the innovation cycle, namely the transformation of research

results into new products and services that reach the market. As such, it would be beneficial to introduce such instruments rather than breaking the innovation process into separately funded phases as this would increase the likelihood that innovative outcomes will indeed reach the market. In addition, such project funding would further contribute to the building and strengthening of innovation systems by specifically supporting linkages and collaboration among stakeholders. This can be achieved by making funding conditional on the establishment of collaborative linkages, such as between both R&D and academic institutions on the one hand and industry on the other, prior to the project start. Similar schemes could also be used to encourage the establishment of cross-border industry-science linkages which thus strengthen the region as a whole.

This case for the promotion of connectivity, linkages and stakeholder collaboration not being limited to domestic stakeholders is a strong one. Given that each SPECA country has a limited domestic market, they individually lack the size and scale to successfully develop some innovative activities meaning it is important for policy to support both local and international linkages and cooperation in all stages of the innovation process, including commercialization.

In terms of the outreach of the policy instruments, the private sector at present essentially lies outside the scope of the existing instruments in most SPECA countries. There are very few instruments specifically aimed at incentivizing the private sector to pursue STI activities or technological modernization. This is also an area that merits greater policy attention and tailor-made instruments to address the issues here. Many countries in the region have long-standing traditions in effectively establishing and operating microfinance institutions, something that could be developed further with the specific objective of supporting innovation. Microfinance institutions operate by supplying credit and cannot substitute for proper early-stage innovation financing agencies which extend non-debt finance, however, microfinance can serve as a complementary funding source. Moreover, targeted public support in the form of loan guarantees or subsidized loans can make microfinance more attractive to innovative entrepreneurs and SMEs by offering preferential terms well-suited to support university start-ups and/or spin-offs as well as young entrepreneurs and those from disadvantaged groups.

The current policy mix in most SPECA countries includes very few instruments addressing systemic weaknesses and failures in their innovation systems. In particular, there is a need to introduce new mechanisms that would enable better coordination between the public institutions tasked with innovation governance and better synchronize their functioning. Enriching this part of the policy portfolio could be one specific objective for innovation policymaking in the region, however, there is also a need for targeted policy efforts aimed at strengthening formal and informal linkages among local innovation stakeholders as well as between local actors and foreign partners. On the one hand, this would open up new opportunities for local actors and, on the other hand, it would expose them to greater competitive pressure. Such changes in the business environment would facilitate the transfer

of new technologies to the country and would incentivize SPECA businesses to innovate and grow.

Another systemic problem in the present business environment in most SPECA countries is the weak institutional collaboration in the implementation of STI activities and projects. Some innovation projects, especially large-scale ones, cannot be effectively implemented without formal collaboration between the various institutional partners, such as academic and research institutes as well as firms, and this collaboration needs to be soundly grounded in legally binding contracts. However, the STI policy instruments currently applied in most SPECA countries are not designed to facilitate public support for innovation projects initiated and implemented by institutional partners as the existing instruments are only intended to deal with teams of individual researchers. This significantly reduces the possible scope and outreach of public support for innovation activity.

Recommendations for cooperative actions of the SPECA countries in the implementation of the SPECA Innovation Strategy for Sustainable Development

The empirical evidence and the analytical overview presented in the previous sections suggest that efforts to advance innovation as an intrinsic part of the sustainable development in the SPECA countries and would contribute to the technological transformation and diversification of their economies. However, the local context in most SPECA countries presents a considerable number of challenges to local policymakers because of existing developmental levels, historic legacies and the nations' geographic location. The generally narrow sectoral focus of the SPECA economies represents a developmental challenge but at the same time opens the door to pursuing a broad range of innovative opportunities that promote sustainable development in the region. Each nation's limited domestic market makes the case for pursuing export-led development strategies combined with incentives for inward FDI and advancing innovation can help these countries to diversify into higher-value-added activities and services exports in response. Given the local conditions, most innovative entrepreneurial ventures seeking to broaden the countries' specialization, be that export-oriented or of an import substitution type, will in all likelihood be ventures driving the innovation processes needed for sustainable development.

Developing and expanding the innovation potential of the SPECA countries requires further broad policy reforms. Furthermore, the presence of a range of common challenges and problems that these countries are facing opens many opportunities for fruitful international cooperation in addressing these challenges. As already noted, by making a combined intraregional effort, the SPECA countries can generate synergies and significantly increase the effectiveness and efficiency of their policy efforts in promoting STI activities.

Obviously, tackling the full range of needed policy reforms and joint cooperative actions aimed at the technological transformation and economic diversification of the SPECA countries goes well beyond the scope and objectives of this document. As such, the text that follows

shall focus on describing some of the possible joint collaborative activities that could be undertaken to close some of the existing STI gaps in the region and that could be pursued within the context of the UN SPECA programme. In turn, this could be considered as a starting point in the deliberations on the Action Plan for implementing the SPECA Innovation Strategy for Sustainable Development. Given the nature of the SPECA programme and the mandates of UNECE and ESCAP, the two UN agencies that support its implementation, the majority of the proposed implementation actions listed below are characteristically technical cooperation and technical assistance activities.

In accordance with the logical composition of the conclusions regarding the main existing STI gaps in the SPECA countries, the recommendations are structured in two groups as follows:

Part 1. Recommendations on possible actions of a general character, aimed at strengthening the national innovation systems in the SPECA countries

1.A Actions aimed at national capacity development in STI management.

1.B Actions aimed at strengthening innovation systems and improving STI governance.

1.C Actions aimed at improving national STI policymaking.

1.D Actions aimed at overcoming the implications of the COVID-19 pandemic.

Part 2. Recommendations on possible actions aimed at boosting innovation for sustainable development in the SPECA countries

2.A Actions facilitating the cross-border diffusion of innovations for sustainable development.

2.B Actions supporting the transfer of innovative technologies addressing sustainable development challenges.

2.C Actions aimed at strengthening subregional cooperation regarding STI for sustainable development.

As was highlighted in the STI gap assessments presented in the previous section, one serious challenge of a common nature for the whole subregion is the existing weaknesses in each countries' innovation systems. Therefore, one group (Part 1) of the proposed actions is more general and aimed at strengthening the national innovation systems in the SPECA countries. This is followed by a second group of proposed actions (Part 2) which are more specific in that they are designed to invigorate the innovation processes and boost innovation to meaningfully promote sustainable development in the SPECA countries. Furthermore, each of these two groups of proposed actions is broken down into sections which bring together actions under a common theme and targeting some common objectives which are spelled out in Table 19 below. The actual set of proposed cooperative actions forming this starting point is presented in this table which also lists the objectives that will be pursued within each section of actions.

In turning its attention to the concrete cooperative actions, the table specifies the expected scope of the action (national, regional or subregional), the possible mobilization of already existing UN support instruments from within the arsenal of the two UN agencies supporting the strategy's implementation (UNECE and ESCAP) and well as the envisaged timeline for implementing the various actions.

Finally, to expedite and facilitate the implementation of the actions advancing the SPECA Innovation Strategy for Sustainable Development, consideration of a new form of structuring, organizing and partnering in cooperative SPECA efforts is proposed. This is not a proposition for concrete or separate implementation action but rather an idea for a cross-cutting organizational framework that could be applied to implement some of the actions proposed above through what could be called "*Mission-oriented SPECA stakeholder partnerships*".

These stakeholder partnerships can be viewed as an organizational framework that would bring together relevant stakeholders, including policymakers, government officials and experts, leading academics as well as representatives of the business community and civil society, with these individuals being drawn from across the SPECA region to focus on selected "missions" defined within the implementation actions of the SPECA Innovation Strategy for Sustainable Development. These mission-oriented SPECA stakeholder partnerships will act as informal networks of like-minded individuals and organizations backed by their respective governments that would work together towards their common mission by coordinating research and development efforts as well as the practical implementation steps in the different countries. Such partnerships and their associated ecosystems would be conducive for raising the public and private sector financial support needed for the mission and to implement the action. In the course of pursuing its mission, each partnership can also initiate proposals for regulatory changes aimed at facilitating the STI activities that it seeks to promote. Furthermore, the SPECA stakeholder partnerships would serve to not only stimulate the initiation of supplementary STI activities but to also facilitate their implementation.

Table 19. Proposed cooperative actions to be considered for the action plan implementing the SPECA Innovation Strategy for Sustainable Developmen

Objectives	Description of actions	Scope (R = regional; N= national)	UN instru-ments	Timeline
	Part 1. Recommendations on possible actions of a general character aimed at strengthening national innovation systems in the SPECA countries.			
1.A Upgrading human capital for STI-driven development	***1.A Actions aimed at national capacity development in STI management.***			
	Capacity development seminars with leading international experts on innovation policies for sustainable development for SPECA countries' STI policy-makers and stakeholders.	N, R	UNECE, ESCAP	2021
	Hands-on skill-building workshops with leading international experts for SPECA region innovation practitioners and stakeholders on practical policy implementation issues.	N, R	UNECE, ESCAP	2022
	Develop and disseminate training materials on good practices on STI policies for sustainable development, including technology transfer and innovation support institutions.	R	UNECE, ESCAP	2020-2021
	"Train-the-trainers" capacity building courses for local coaches on STI management to ensure the sustainability of capacity development activities.	N	UNECE, ESCAP	2022
	Promotional campaigns for the broader public in the SPECA countries to enhance awareness of technology and innovation in society and develop a culture of innovation.	N		2021
	Promotional operations to raise awareness among the broader public on the objectives and activities of the SPECA Innovation Strategy for Sustainable Development.	N		2021
1.B Closing existing gaps in the innovation ecosystems	***1.B Actions aimed at strengthening innovation systems and improving STI governance.***			
	Roundtables with policymakers and STI stakeholders to reveal and discuss existing gaps and failures in national innovation systems.	N, R	UNECE, ESCAP	2021
	Roundtables with policymakers and STI stakeholders to discuss existing problems in STI governance.	R	UNECE	2021
	Roundtables with SPECA policy makers and STI stakeholders as well as international experts on policy measures addressing weaknesses in innovation systems and aiming to improve STI governance.	N, R	UNECE, ESCAP	2021
	Development of practical guidelines and hands-on skill-building workshops for SPECA region innovation practitioners and stakeholders on the management of innovation support institutions (business incubators, tech parks, tech transfer offices, and so forth).	N, R	UNECE, ESCAP	2022
	Development of practical guidelines and technical assistance missions by international experts to assist SPECA policymakers and stakeholders in implementing new policy measures addressing weaknesses in innovation systems and aiming to improve STI governance.	N, R		2023

Table 19 (contd.) 1 Proposed cooperative actions to be considered for the action plan for implementing the SPECA Innovation Strategy for Sustainable Development

Objectives	Description of actions	Scope (R = regional; N= national)	UN instru-ments	Timeline
1.C Designing and implementing efficient STI policy instruments	*1.C Actions aimed at improving national STI policymaking*			
	Capacity-building activities (training seminars and hands-on skill-building workshops) regarding best practice in policy design and coordination of STI policies for sustainable development.	R	UNECE, ESCAP	2021
	Training seminars with leading international experts on selected STI policy instruments addressing key gaps and failures in innovations systems (early-stage financing, systemic failures, and so forth).	R	UNECE, ESCAP	2021
	Hands-on skill-building workshops for SPECA country innovation practitioners and stakeholders on promoting leading-edge technologies for sustainable development (industry 4.0, a transition to a circular economy, and so forth).	N	UNECE, ESCAP	2022
	Development of practical guidelines and technical assistance missions by international experts to assist SPECA region policymakers in designing and implementing programmes for policy evaluation.	N		2023
1.D Speeding post-COVID-19 recovery	*1.D Actions aimed at overcoming the implications of the COVID-19 pandemic.*			
	Knowledge sharing roundtables for SPECA region policymakers and international experts on good practices for post-COVID-19 recovery and the role of STI.	R		2021
	Taking stock roundtables for SPECA region policymakers on actual experiences in overcoming the implications of the COVID-19 pandemic.	R		2023
	Part 2. Recommendations on possible actions aimed at boosting innovation for sustainable development in the SPECA countries.			
2.A Establishing a common environment conducive to STI and sustainable development	*2.A Actions facilitating the cross-border diffusion of innovations for sustainable development.*			
	Consultations on sustainable development challenges with high priority for the SPECA countries and that call for transborder/regional cooperation and approaches.	R	UNECE, ESCAP	2021
	Identification of obstacles to cross-border cooperation in implementing STI policies for sustainable development and consultations on measures for eliminating or reducing these obstacles.	R	UNECE, ESCAP	2021
	Cooperation with existing global initiatives such as the UN Technology Facilitation Mechanism, the UN Forum on STI for the SDGs and the Inter-Agency Task Team for STI for the SDGs.	R	UNECE, ESCAP	2021-2022
	Liaison with relevant international donors for mobilizing additional expertise and resources to support innovation for sustainable development undertakings.	R		2022-2023

Table 19 (contd.) 1 1

Table 19 (contd.) 2 Proposed cooperative actions to be considered for the action plan for implementing the SPECA Innovation Strategy for Sustainable Development

Objectives	Description of actions	Scope (R = regional; N= national)	UN instru-ments	Timeline
2.B Speeding up technology transfer for sustainable development	*2.B Actions supporting the transfer of innovative technologies addressing SD challenges*			
	Policy dialogue on coordinated policy measures supporting international linkages of SPECA countries with global technological value chains, including coordinated strategic approaches to FDI.	R	UNECE, ESCAP	2021
	Consultations on the establishment of a joint regional technology transfer office to support the synergetic transfer of innovative technologies in the region.	R	ESCAP	2022
	Consultations on possible joint STI projects for sustainable development where international cooperation can generate regional synergies and economies of scale.	R	UNECE, ESCAP	2022
	Identification of leading-edge technologies (industry 4.0, a transition to a circular economy, and so forth) of common interest for the SPECA countries and dialogue on measures supporting their transfer.	R	UNECE, ESCAP	2022
	Dialogue with the broader international community on best practice regarding technology transfer, including with the UN Technology Facilitation Mechanism.	R	UNECE, ESCAP	2021-2023
	Consultations on the establishment of a joint SD Innovation Fund for early-stage support for innovative entrepreneurs in sustainable development undertakings in the SPECA countries.	R	UNECE, ESCAP	2022-2023
2.C Innovating together towards the SDGs	*2.C Actions aimed at strengthening subregional cooperation in STI for sustainable development.*			
	Policy dialogue on innovation policy issues of common interest and of high priority to the SPECA countries.	R		2021
	Consultations on the establishment of a dedicated stakeholder network and mechanisms for regular consultations among SPECA countries on innovation policies of common interest.	R		2021
	Consultations on the establishment of a network of research institutions dealing with STI for sustainable development and a SPECA region network of innovation support institutions.	R		2022
	Consultations on the possibility to establish a joint SPECA region competition for innovation projects targeting sustainable development.	R		2021-2022
	Identification of possible joint measures to support regional supply chains based on innovative technologies and innovative organizational methods of production and trade.	R		2022
	Consultations on the possible launch of a joint regional online support service for innovative entrepreneurs, startups and SMEs (including consulting, mentoring, match-making, and so forth).	R		2022-2023

ANNEX

Table A1. Main legislative and programmatic documents targeting STI activities in the SPECA countries

Country	Legislative and programmatic documents
Afghani-stan	National IT Industry Development Policy
	Law of the Academy of Science
	Law of Higher Education
	Law of the Access to Information
Azerbaijan	National Strategy for the Development of an Information Society for 2014-2020
	State Programme on the Implementation of the "National Strategy for IS" for 2016-2020
	Law on Education
	Law on Science
	National Strategy for the Development of Education
	National Qualifications Framework for Lifelong Learning
	Charter of the National Academy of Sciences
	State Programme for the Development of Industry for 2015-2020
	Strategic Roadmap for the Development of Heavy Industry and Engineering
	Law on State Support for Small Business
	Decree of the president "On the establishment and functioning of industrial clusters"
Kazakhstan	Strategy Kazakhstan 2050
	Strategy Kazakhstan 2025
	State Programme for Industrial and Innovative Development for 2020-2025
	State Programme for Development of Education and Science for 2020-2025
	State Programme for Business Support and Development "Roadmap Business-2025"
	Intersectoral Plan for S&T Development until 2020
	Law on Science
	Law on the Commercialization of the Results of R&D and Technical Activities
	State Programme "Digital Kazakhstan"
	Entrepreneurial Code
Kyrgyzstan	Law on Innovative activity
	Law on Science
	Law on Education
	Law on the Academy of Sciences
	Law on the High-Tech Park of the Kyrgyz Republic
	Law on State Support to Small Entrepreneurship
	Law on the Protection of Entrepreneurs
	Concept of Scientific and Innovative Development of the Kyrgyz Republic until 2022
	State Programme on Intellectual Property in the Kyrgyz Republic for 2017-2021
Tajikistan	Law on Innovation Activity
	Law on Technological Park(s)
	Law on Scientific Activity and State Scientific and Technological Policy
	Law on Copyright and Related Rights
	Law on Academy of Sciences
	Law on Education
	National Strategy for The Development of Intellectual Property for 2014-2020
	Innovative Development Strategy until 2020
	Innovative Development Program for 2011-2020

Source: National STI gap assessments of the SPECA countries

Table A1 (continued). Main legislative and programmatic documents targeting STI activities in the SPECA countries

Country	Legislative and programmatic documents
Turkmenistan	Concept for the Development of the Digital Economy until 2025
	Concept for the Development of the Digital Education System
	Law on Innovation Activity
	Law on State Science and Technology Policy
	Law on Scientific Organizations
	Law on the Status of Scientific Workers
	Law on Scientific Intellectual Property
	List of Priority Directions for the Development of Science and Technology
	Law on Science and Technology Parks
	Law on Electronic Documents, Electronic Document Management and Digital Services
Uzbekistan	Strategy for Innovative Development of the Republic of Uzbekistan for 2019–2021
	Roadmap for the implementation of the Strategy for Innovative Development until 2030
	Programme of Comprehensive Measures for Strengthening the Infrastructure of Research Institutions and Development of Innovation Activities for 2017-2021
	Law on Science and Scientific Activity
	Law on Innovation Activity
	Resolution of the president on measures to improve the implementation of innovative ideas, technologies and projects
	Presidential decree on additional measures to improve the mechanisms for introducing innovations to industry and the economy
	Resolution of the president on additional measures to increase the efficiency of the commercialization of the results of STI activities
	Presidential decree on additional measures to improve financing mechanisms for projects in the field of entrepreneurship and innovation

Source: National STI gap assessments of the SPECA countries

Table A2. Expert opinions about the top 6 economic sectors/industries[1)] with the highest potential to be technologically upgraded and innovative in the SPECA countries

Country	Economic sector/industry	Priority ranks[2)]
Afghanistan	Agriculture	54%
	Banking/Finance	46%
	Telecommunication	23%
	Electricity, Energy	23%
	Transportation	23%
	Mining	15%
Azerbaijan	Agriculture	70%
	Telecommunications, ICT	54%
	Mining (oil and gas)	46%
	Banking/Finance	38%
	Tourism	31%
	Transportation	15%
Kazakhstan	Agriculture	83%
	Metal processing	56%
	Engineering	44%
	Mining (oil and gas)	38&
	ICT	33%
	Transportation	29%
Kyrgyzstan	Information technologies	60%
	Agriculture and food processing industry	40%
	Tourism	40%
	Light industries, textiles	40%
	Energy sector	10%
	Mining	10%
Tajikistan	Manufacturing	60%
	Energy/Electricity	33%
	ICT/Telecommunications	33%
	Agriculture/Food processing	31%
	Banking/Finance	20%
	Mining	20%
Turkmenistan	Digital technologies/ICT	90%
	Extraction industries (oil and gas)	81%
	Energy	72%
	Communication and telecommunications	72%
	Transportation	63%
	Chemical industry	45%
Uzbekistan	Biotechnology	30 %
	Agriculture	30 %
	Chemical industry	30 %
	Textile industry	20 %
	Pharmaceutical industry	20 %
	Energy	20 %

[1)] Excluding public services
[2)] Percentage of the surveyed local stakeholders who indicated the named sector as having high potential for innovative development
Source: National STI gap assessments of the SPECA countries

Table A3. Expert opinions about the top 6 main problems, obstacles and bottlenecks that hinder innovative development in the SPECA countries

Country	Main problems, obstacles and bottlenecks that hinder innovative development	Priority ranks
Afghanistan	Corruption	
	Uncertain environment	
	Lack of government support	
	Limited access to finance for startups	
	Poor ICT capability in the country	
	Unsophisticated domestic market	
Azerbaijan	Poor access to finance for startups	
	Low STI capability in the country	
	Low level of government support	
	Poor policy coordination	
	Poor business competence	
	Unsatisfactory framework conditions	
Kazakhstan	Corruption and administrative hurdles	
	Poor policy coordination	
	Low competence of government officials	
	Poor industry-science collaboration	
	Science and R&D are disconnected from the real economy	
	Poor coordination among support instruments	
Kyrgyzstan	Low competence level of state officials dealing with STI	
	Excessive direct government interference in the economy	
	Excessive legal regulation of the private sector and administrative hurdles	
	Small domestic market and low demand for innovative products	
	The education system does not promote human capital development	
	Generally poor national capacity and capabilities for innovation	
Tajikistan	Corruption and administrative barriers	
	Generally low level of skills in the country	
	Low level of public funding	
	Punitive system of taxation	
	Low STI competence and capability in the country	
	Low level of competence of government officials	
Turkmenistan	Poor conditions for the creation of start-ups (lack of funding and coaching)	
	Low capacity and competence for innovative entrepreneurship	
	Low STI capability, especially in SMEs	
	Absence of private funding of innovative SMEs	
	Underdeveloped private sector in the economy	
Uzbekistan	Shortage of skilled labour	
	Unsatisfactory quality of higher education	
	Obsolete technical equipment in R&D institutions	
	Low level of R&D funding	
	ICT is lagging behind	
	Unsupportive business environment	

Source: National STI gap assessments of the SPECA countries

Table A4. Expert opinions about the top 6 most important changes (in legislation, in policymaking and implementation, in framework conditions, and so forth) that need to be introduced to invigorate innovative development in the SPECA countries

Country	Policy changes that would support innovative development
Afghanistan	Upgrade legislative and regulatory support for innovative development
	Introduce more incentives for innovation development
	Accelerate the digital transformation
	Capacity building and technical support for innovative entrepreneurs
	Improve access to finance
	Mainstream sustainability and environmental protection
Azerbaijan	Improve and harmonize the legislative framework for innovative development
	Introduce measures to improve industry-science collaboration
	Improve the process of technology transfer
	Accelerate the digital transformation
	Strengthen tax incentives for innovative development
	Stimulate private finance of innovation (including venture financing and FDI)
Kazakhstan*	Introduce measures to reduce corruption and administrative hurdles
	Implement a result-oriented approach in STI policy implementation
	Capacity building to raise the innovation and entrepreneurship culture
	Adopt a national plan to improve inter-agency collaboration and coordination
	Improve the prioritization of STI activities
	Increase public funding of STI activities
Kyrgyzstan	Provide more financial incentives to knowledge-based industries
	Introduce new mechanisms and means to support tech-savvy industries
	Expand the High Tech Park tax regime to other innovative industries
	Reduce the amount of direct government involvement in the economy
	Review existing regulations to better coordinate and synchronize policy measures
	Reform the system of state governance to have a project-based approach
Tajikistan	Reform the tax system to have lower levels of taxation
	Increase the level of public funding to STI
	Raise public awareness of and build capacity for STI
	Strengthen the enforcement of laws and regulations
	Streamlining of business regulations
	Improve access to the Internet
Turkmenistan	Need for supplementary by-laws for the implementation of existing legislation
	Need for a new law on innovative entrepreneurship
	Need to develop a state programme to enhance innovative development
	Need to improve the system of funding for STI
Uzbekistan	Strengthen technological transfer processes and market uptake of R&D results
	Increase funding for innovators and startups, including a small grants programme
	Take measures to to strengthen tertiary education and university sciences
	Need to upgrade R&D equipment and enhance innovation support institutions
	Introduce measures to stimulate private sector involvement in R&D activities
	Introduce measures to motivate young people to engage in STI activities

Source: National STI gap assessments of the SPECA countries